making communications work
for everyone

Enabling wireless innovation through local licensing

Shared access to spectrum supporting mobile technology

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STATEMENT:

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Contents

Section

1. Overview

Radio frequencies are of significant importance to the UK economy and society because they allow all wireless communications devices, including mobile phones and wireless broadband, to operate. We want to support innovation and enable new uses of spectrum, and we recognise there is growing interest in the use of mobile technology, including 5G, to develop solutions to meet local wireless connectivity needs. To ensure that lack of access to the radio spectrum does not prevent innovation, we are introducing a new licensing approach to provide localised access to spectrum bands that can support mobile technology.

This statement explains how we will allow more people and businesses to use spectrum from a choice of frequency bands. Local access to these bands could support growth and innovation across a range of sectors, such as manufacturing, enterprise, logistics, agriculture, mining and health. It could enable organisations to set up their own local networks with greater control over security, resilience and reliability than they may have currently. For example, manufacturers connecting machinery wirelessly, farmers connecting agricultural devices such as irrigation systems and smart tractors wirelessly, enterprise users setting up secure private voice and data networks within a site, as well as rural wireless broadband connectivity using fixed wireless access (FWA).

What we have decided – in brief

We are making spectrum in the 3.8-4.2 GHz, 1800 MHz[1] and 2300 MHz[2] spectrum bands available through local licences. People can apply to Ofcom for coordinated access (this ensures they won't cause interference) to these bands on a first come, first served basis and will pay a licence fee that reflects Ofcom's cost of issuing the licence. To achieve a simple process across the shared access bands, we will also align the authorisation approach for existing licensees in the 1800 MHz shared spectrum with the authorisation approach for the shared access bands confirmed in this statement.

We are introducing a new way to access spectrum that is already licensed to mobile operators but which is not being used or planned for use in a particular area within the next three years. People can apply to Ofcom for a licence and, if the application is successful, will pay £950 per licence, which allows them to use the spectrum for three years unless they ask for a different period and this can be agreed with the existing licensees.

We have added the 24.25-26.5 GHz band to our spectrum sharing framework for indoor-only deployment. This is part of the 26 GHz band, identified as a European pioneer 5G band, and could provide additional spectrum options for new applications.

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

[1] 1781.7-1785 MHz paired with 1876.7-1880 MHz, referred to as "the 1800 MHz shared spectrum"
[2] 2390-2400 MHz, referred to as "the 2300 MHz shared spectrum"

Background

1.1 In December 2018, we set out proposals[3] to support innovation by enabling more people to access spectrum in a choice of bands that support mobile technology. Our proposed approach reflected the different ways these bands are managed.

a) For the shared access bands, we want as many users as possible to be able to access the airwaves they need. This would be achieved by allowing people to choose which of the bands best suits their needs and offering more certainty over access and quality of service compared to licence-exempt or lightly licensed spectrum. To help make this happen our proposed licensing approach is designed to allow the flexibility to rapidly respond to changing demand and spectrum would only be authorised when and where it is needed.

b) In licensed mobile spectrum bands,[4] our aim is to make it as easy as possible to access any unused spectrum where this would not cause interference to existing use and does not raise objections from the incumbent mobile operators.

1.2 Following our consultation, the UK Government's Department for Digital, Culture, Media and Sport (DCMS) consulted on and published its *Statement of Strategic Priorities for telecommunications, the management of radio spectrum and postal services* ("the SSP").[5] The decisions we have taken in this statement are aligned with, and in some places go beyond, a number of the objectives set out in the SSP. In particular, we have:

a) Established a sharing framework that will support the development of 5G services from existing and new players by allowing access to 5G spectrum;

b) Gone beyond the Government's objective to release 1 GHz of spectrum in the 26 GHz band, by making 2.25 GHz available for indoor, shared use;

c) Made 3.8-4.2 GHz available for shared use;

d) Identified that there is opportunity to share mobile spectrum and have opened these bands up for local access.

1.3 This statement confirms our decisions following the consultation.

[3] Ofcom, *Enabling opportunities for innovation: Shared access to spectrum supporting mobile technology*, 18 December 2018, https://www.ofcom.org.uk/consultations-and-statements/category-1/enabling-opportunities-for-innovation
[4] Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011, as amended, http://www.legislation.gov.uk/uksi/2011/1507/contents
[5] DCMS, *Statement of Strategic Priorities for telecommunications, the management of radio spectrum and postal services,* July 2019, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/817921/SSP_-_post_consultation_version_FINAL.pdf

Summary of our decisions

The shared access bands

1.4 We are making available the 3.8-4.2 GHz, 1800 MHz shared spectrum and 2300 MHz shared spectrum bands for new users under the spectrum sharing framework outlined in our December 2018 consultation. We will manage and coordinate access to these bands on a per location, first come, first served basis. We are also adding further spectrum in the 26 GHz band to this framework and discuss this separately below.

1.5 People can apply for two types of Shared Access licence (distinguished primarily by permitted power levels) to cater for different types of potential uses:

- **Low power licence (per area licence)**: This will allow users to deploy the required number of base stations in a circular area with a 50-metre radius without further authorisation from Ofcom. For large sites, people can apply for multiple licence areas to achieve the required coverage area.
- **Medium power licence (per base station licence)**: Given the higher transmit power and larger potential interference area, this licence will be issued on a per base station basis and, generally, for deployments in rural areas only,[6] where they are unlikely to constrain low power users.

1.6 Where mobile terminals are deployed in the 3.8-4.2 GHz band, licensees must keep an accurate record of them and of the address of the site or building they are limited to operate within. We are not permitting this band to be used to provide national mobile broadband services because this could deny opportunities for local users. We have published proposals to award national licences for spectrum in the 3.6-3.8 GHz band for that purpose.[7]

1.7 We will charge an annual licence fee for both the low power licence (charged on a per area basis) and medium power licence (charged on a per base station basis) as set out below:

- **£80 per 10 MHz** for 3.8-4.2 GHz (so 20 MHz = £160; 100 MHz = £800 etc.)
- **£80** for 2300 MHz shared spectrum (10 MHz) and 1800 MHz shared spectrum (2 x 3.3 MHz)

1.8 Demand for these new licences is currently uncertain and we will keep fees under review as we gather more evidence on actual use. We expect to consult on proposals to change the fee if we believe there is evidence to do so.

1.9 The licence will include conditions enabling Ofcom to require transmitting equipment to change frequency (within the 3.8-4.2 GHz band) from time to time if necessary e.g. for spectrum planning purposes. Equipment would also have to start transmitting within six

[6] In this document, we define "rural" as in paragraph 3.55, which is different from the definition used in other Ofcom documents.
[7] Ofcom, *Award of the 700 MHz and 3.6-3.8 GHz spectrum bands*, 18 December 2018, https://www.ofcom.org.uk/consultations-and-statements/category-1/award-700mhz-3.6-3.8ghz-spectrum

months of the licence being issued and continue to be operational afterwards. If spectrum is not used in this timeframe or is subsequently no longer used, Ofcom may revoke the licence with one month's notice.

1.10 We have published a guidance document[8] alongside this statement to support people wishing to apply for a licence. We will keep the guidance under review and may amend it from time to time as appropriate in light of further experience.

Access to licensed mobile spectrum

1.11 Where spectrum is licensed on a national basis to mobile network operators and is not being used in every location, we think it is appropriate to enable access to this spectrum for new users. If we agree, following discussion with the incumbent licensee, that the new user is unlikely to interfere with their network or constrain their future plans, we will issue a local access licence.

1.12 We anticipate that spectrum is only likely to be available to share in remote areas, but it could be used in these locations to support, for example, private networks or wireless broadband services. There may also be other locations that are not served by the existing mobile network, for example underground mining operations, where mobile technology could be used to support a private network without impacting the incumbent networks or their future plans.

1.13 We will consider applications for short-term access to licensed mobile bands (the default period will be three years but could be more or less as discussed below) in specified locations. Our first consideration will be to confirm that the spectrum is not being used in that location and that a new user in that area would not interfere with existing or planned use of the band. We will expect applicants to provide any relevant information on which they based their assumption and will verify this with the licensed operator in the band.

1.14 Unless the operator raises a reasonable objection, we will issue a three-year licence. In some cases, it may be desirable, and possible, to negotiate (through agreement with the operator) a longer-term licence and in those cases, we would issue the licence for the agreed period. We would also consider applications for shorter-term access.

1.15 We have published a guidance document alongside this statement to support people wishing to apply for a licence.[9] We will keep the guidance under review and may amend it from time to time as appropriate in light of further experience.

[8] Ofcom, *Shared Access licence: Guidance document*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0035/157886/shared-access-licence-guidance.pdf
[9] Ofcom, *Local Access licence: Guidance document*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0037/157888/local-access-licence-guidance.pdf

Adding the lower 26 GHz band to shared access bands

1.16 We are adding the 24.25-26.5 GHz band ("the lower 26 GHz band") to our spectrum sharing framework for indoor use. We will manage and facilitate access to this spectrum on a per location, first come, first served basis.

1.17 This band forms part of the wider 26 GHz band,[10] which has been harmonised[11] across Europe as the pioneer millimetre wave band for 5G.[12] There is also a requirement to make spectrum at 26 GHz available in the 2020 timeframe.[13] Our actions align with this requirement, and with Ofcom's wider objective of making the 26 GHz band available for 5G.

1.18 By enabling access to the lower 26 GHz band, we are adding to the spectrum options that would enable deployment of new 5G indoor applications, for example for industrial users, with little to no impact on existing services and without prejudicing any future use of the band outdoors.

1.19 Our approach will allow users to apply for a 26 GHz Shared Access licence for indoor use. Licensees can deploy the required number of indoor base stations in a circular area with a 50-metre radius without requiring further individual base station authorisations from Ofcom. Terminal stations will also be covered on the same licence.

1.20 A licence fee of £320 will be applicable per licence, payable annually for 50 MHz, 100 MHz or 200 MHz channels.

1.21 The licence will also contain terms, similar to the licence for the other shared access bands, which enable Ofcom to request equipment to change frequency from time to time, e.g. for spectrum planning purposes or to manage the interference environment. Equipment will also have to start transmitting within six months of the licence being issued and continue to be operational afterwards. If spectrum is not used in this timeframe or is subsequently no longer used, we may revoke the licence with one month's notice.

1.22 We have also set out the process and licence terms outlined in this statement in an accompanying guidance document published alongside this statement.[14]

Next steps

1.23 People and businesses can apply for Local Access licences for licensed mobile spectrum bands immediately following this publication, and Shared Access licences in the 1800 MHz

[10] The "full" 26 GHz Band is 24.25-27.5 GHz.
[11] European Commission, *Commission Implementing Decision (EU) 2019/784 of 14 May 2019 on harmonisation of the 24.25-27.5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D0784&from=EN
[12] RSPG, *Opinion on spectrum related aspects for next-generation wireless systems (5G)*, 9 November 2016, http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf (accessed 11 July 2019)
[13] *Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN
[14] Ofcom, *Shared Access licence: Guidance document*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0035/157886/shared-access-licence-guidance.pdf

shared spectrum, 2300 MHz shared spectrum, 3.8-4.2 GHz band and lower 26 GHz band by the end of this year.

1.24 We will issue a licence variation notice to the existing licensees in the 1800 MHz shared spectrum to align with the Shared Access licence as soon as possible.

1.25 We are commencing work to consider whether it would be appropriate in the future to transition towards a dynamic spectrum access (DSA) approach supported by a fully automated central database in the bands outlined under our spectrum sharing framework. We would like to work with industry in developing our approach and encourage interested parties to get in touch with us at SharedSpectrumAccess@ofcom.org.uk.

1.26 We will continue to work with the Ministry of Defence in the 26.5 GHz-27.5 GHz ("the upper 26 GHz band") so that this band can also be made available[15] in the future. We will also consider how best to authorise other 5G uses across the full 26 GHz band (such as for outdoor high power mobile) in a way that optimises the use of the spectrum. We will also continue to engage with stakeholders more generally and monitor demand for 5G mobile spectrum to help inform our work in this area.

[15] Alongside some defence uses

2. Introduction

Background

2.1 Radio frequencies are of significant importance to the UK economy and society because they are the means by which all wireless communications devices operate. They are also in scarce supply.

2.2 As set out in the December consultation, we recognise the growing interest in the use of mobile technology to meet the local wireless connectivity requirements in a range of sectors such as manufacturing, enterprise, logistics, mining and agriculture. Given the local nature of demand and that bands supporting mobile technology are generally in use but may not be used everywhere, we think spectrum sharing in these bands could provide additional spectrum options to support innovation and enable new uses.

2.3 Access to the radio spectrum in these bands could enable the deployment of private networks with greater control over security, resilience and reliability for various uses ranging from low latency wireless automation, robotics and industrial Internet of Things (IoT), enterprise users setting up secure private voice and data network within its premise and rural wireless broadband connectivity using fixed wireless access (FWA).

2.4 Our overarching principle is to ensure that lack of access to the radio spectrum is not an inhibitor of innovation and that new users who need to access to spectrum are able to do so under a simple and common approach.

2.5 We published a consultation in December 2018 proposing two ways for users to access spectrum supporting mobile technology on a shared basis:[16]

a) A spectrum sharing framework which would enable new users access to a number of spectrum bands adjacent to awarded (or planned for award) mobile spectrum. These are 3.8-4.2 GHz, 1781.7-1785 MHz paired with 1876.7-1880 MHz ("the 1800 MHz shared spectrum") and 2390-2400 MHz ("the 2300 MHz shared spectrum") collectively referred to in this document as the three "shared access bands".

b) We also proposed a simple, Ofcom facilitated, process for new users wishing to access licensed mobile spectrum covered by the Mobile Trading Regulations in locations where this would not adversely impact the incumbent licensee's planned use of the spectrum.[17] New users must respect the rights of the existing user and not interfere with or constrain their operations.

[16] Ofcom, *Enabling opportunities for innovation: Shared access to spectrum supporting mobile technology*, 18 December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0022/130747/Enabling-opportunities-for-innovation.pdf
[17] Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011, as amended, http://www.legislation.gov.uk/uksi/2011/1507/contents

2.6 Having considered the 69 responses received to our consultation, this statement sets out our general decisions on the spectrum sharing approach by which new users can access the shared access bands and licenced mobile spectrum.

2.7 We have also identified the 24.25-26.5 GHz band as suitable band to be included in the spectrum sharing framework.

2.8 Alongside this statement, have published guidance documents providing prospective licensees with information on each of the licence products we are making available for shared access.

The bands we are making available for shared access

2.9 The figures below show the four bands we are making available under our spectrum sharing framework for new users. For each band, we also include the existing users currently operating in the band.

Figure 2.1: 1800 MHz shared spectrum

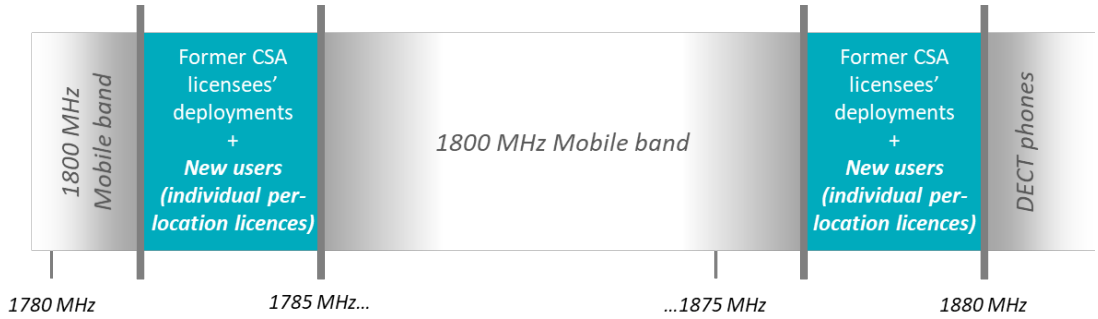


Figure 2.2: 2300 MHz shared spectrum

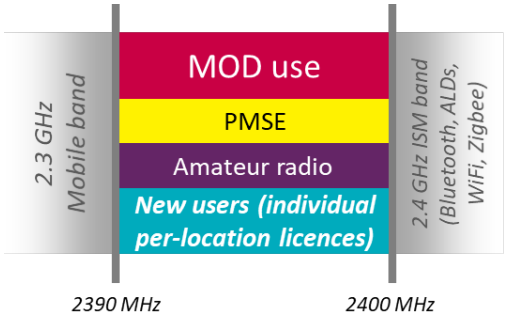


Figure 2.3: 3.8-4.2 GHz[18]

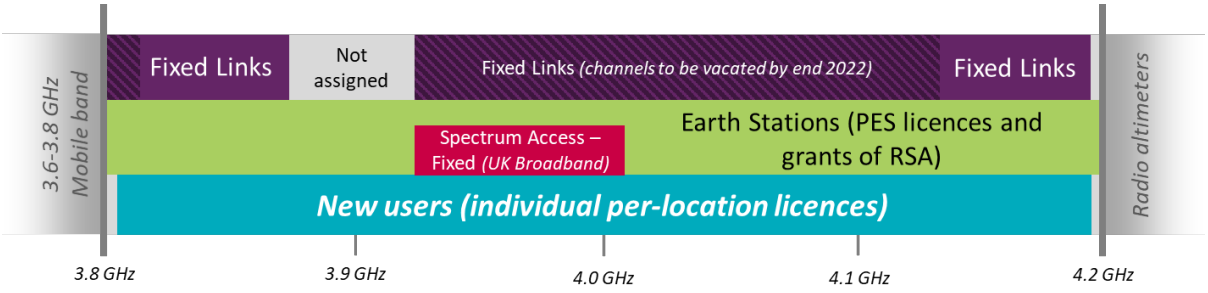
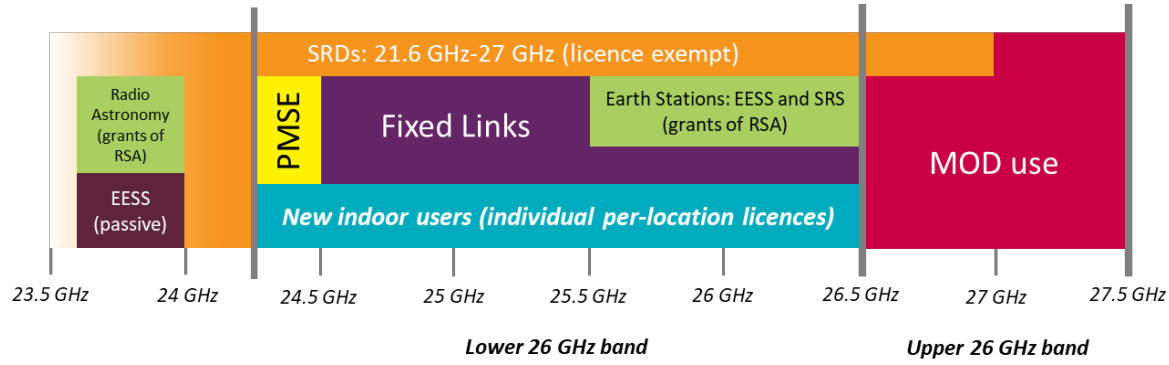


Figure 2.4: Lower 26 GHz band



Access to licensed mobile spectrum

2.10 New users can access the spectrum covered by the Mobile Trading Regulations.[19] These are the 800 MHz, 900 MHz, 1400 MHz, 1800 MHz, 1900 MHz, 2100 MHz, 2300 MHz, 2600 MHz and 3.4 GHz bands. As new bands are added to the Mobile Trading Regulations, we will also include these in the list of frequency bands which could be covered by the local access licensing approach.

2.11 The spectrum we are making available could support innovation and enable new uses, including potential uses as shown in the table below.

[18] Ofcom is currently undertaking work to clear the 3.6-3.8 GHz band to make this spectrum available for nationwide high power mobile use. One of the effects of this clearance work will be to clear some channels of fixed links in the 3.8-4.2 GHz band, due to the duplex nature of the fixed link channel plan between 3.6-4.2 GHz. Fixed link channels 8 & 9 on the 30 MHz channel plan remain available for assignment (3815-3875 MHz paired with 4135-4195 MHz)

[19] Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011, as amended, http://www.legislation.gov.uk/uksi/2011/1507/contents

Table 2.1: Potential uses of the band we are making available under spectrum sharing

Uses	1800 MHz shared spectrum	2300 MHz shared spectrum	3.8-4.2 GHz	Lower 26 GHz band	Licensed mobile spectrum
Private network	✓ (narrowband)	✓	✓	✓ (indoor)	✓
Mobile coverage (rural)	✓	certain locations[20]	✗	✗	✓
Mobile coverage (indoor)	✓	✓	✗	✓	✓
Fixed wireless access[21]	✗	✗	✓	✓[22]	✓

Our statutory duties

2.12 Ofcom's responsibilities for spectrum management are set out primarily in two Acts of Parliament which confer on Ofcom specific duties, powers and functions in respect of spectrum: the Communications Act 2003 and the Wireless Telegraphy Act 2006 (the "WT Act").

2.13 Amongst our functions and powers in relation to spectrum are the making available of frequencies for use for particular purposes and the granting of rights of use through wireless telegraphy licences and licence exemptions.

2.14 Our principal duties under Section 3 of the Communications Act 2003 are to further the interests of citizens in relation to communications matters, and to further the interests of consumers in relevant markets, where appropriate, by promoting competition. In doing so, we also required to secure the optimal use of spectrum and the availability throughout the United Kingdom of a wide range of electronic communications services. We must also have regard to: (i) the desirability of encouraging investment and innovation in relevant markets, (ii) the desirability of encouraging the availability and use of high speed data transfer services throughout the United Kingdom and (iii) the different needs and interests, so far as the use of the electro-magnetic spectrum for wireless telegraphy is concerned, of all persons who wish to make use of it.

[20] Due to coexistence with other users, the availability of medium power will be limited initially.
[21] Fixed Wireless Access (FWA) networks provide an alternative solution to traditional fixed broadband services. These networks use a wireless link for the final connection to a home or business, avoiding the installation of a line into the building.
[22] FWA is available through existing fixed links authorisation. However, we are not encouraging people to apply for new licences in the band. See paragraph 5.28.

2.15 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 the use of that spectrum for wireless telegraphy.

2.16 We also have a duty to have regard, in particular, 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 (WT Act, s. 3(2)).

2.17 The UK legislative framework (including Ofcom's powers and duties) sits within the framework of EU law set out in the various Directives,[23] and which are now consolidated into the European Electronic Communications Code.[24] In addition, there is specific EU legislation which harmonises use of radio frequency bands across the EU. The two most relevant Decisions in this context are those relating to the 3.4-3.8 GHz (adjacent to the 3.8-4.2 GHz shared access band) and 26 GHz bands.[25]

2.18 We have reached the decisions in this statement by reference to these statutory duties. We consider that our decisions strongly align with our statutory duties. Our aim is to encourage the development of new uses which will benefit both businesses and consumers in a range of sectors, and to facilitate access to spectrum to enable that innovation to take place.

Securing optimal use of spectrum

2.19 Spectrum is a scarce resource. There is increasing demand for new wireless applications in frequency bands already allocated to other users.

2.20 In particular, there is growing interest in the use of mobile technology (LTE, 5G New Radio[26] or proprietary adaptations) as the technology of choice for wireless applications beyond consumer mobile broadband. However, spectrum where mobile technology can be used has generally been licensed on a national basis to enable operators to offer mobile services to meet national demand for mobile broadband. We consider that this is the most efficient way to meet this demand.

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[23] The Common Regulatory Framework comprises the Framework Directive (Directive 2002/21/EC), the Authorisation Directive (Directive 2002/20/EC), the Access Directive (Directive 2002/19/EC), the Universal Service Directive (Directive 2002/22/EC) and the Directive on privacy and electronic communications (Directive 2002/58/EC), as amended by the Better Regulation Directive (Directive 2009/140/EC).

[24] Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN

[25] *Commission Implementing Decision (EU) 2019/235 of 24 January 2019 on amending Decision 2008/411/EC as regards an update of relevant technical conditions applicable to the 3400 – 3800 MHz frequency bands; Commission Implementing Decision (EU) 2019/784 of 14 May 2019 on harmonisation of the 24.25-27.5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D0784&from=EN

[26] Next generation mobile technology

2.21 Alongside this, our aim is to ensure that alternative spectrum is available which could support the rollout of new wireless applications addressing local connectivity needs through localised access.

2.22 We consider that access to spectrum in bands where mobile technology is supported could offer important benefits to citizens and consumers, complementing the benefits from the award of national licences. Specifically, we consider that this could unlock opportunities for innovation and facilitate new investment models.

Encouraging innovation

2.23 Making additional spectrum available to meet this demand is in line with our duties to have regards to promote innovation.

2.24 One way in which innovation would be supported is by unlocking the benefits provided by 5G and other technologies for applications beyond consumer mobile broadband, which may not require a national licence, by providing an alternative mechanism to access suitable spectrum.

2.25 Additional spectrum for localised use could provide connectivity solutions for the deployment of private networks across a number of sectors including industrial Internet of Things (IoT) devices.

Encouraging investment

2.26 We consider that early signalling of spectrum availability and the terms of access removes spectrum uncertainty for innovation and provides clarity in support of equipment development for new wireless applications in bands where there is currently no equipment ecosystem.

2.27 Clarity on the mechanism to access spectrum will also support infrastructure investment by new users looking to deploy private wireless communications within their premises.

2.28 Providing additional spectrum options for new users may also support new investment models, for example, provision of spectrum could support rural wholesale access provided by third parties cooperating with mobile network operators (MNOs) through roaming agreements to provide coverage in key not-spots.

Structure of this document

2.29 In the remainder of the main body of this statement, we summarise the specific proposals we set out in the December 2018 consultation, the responses we have received to our proposals, and our assessment of those responses.

2.30 The rest of this document is set out as follows:

- **Section 3** sets out our decision on our spectrum sharing approach to access the shared access bands;
- **Section 4** sets out our decision on the approach to access awarded mobile spectrum;

- **Section 5** outlines our decision to add the 24.25-26.5 GHz band to our spectrum sharing framework; and
- **Section 6** outlines our next steps.

2.31 Our annexes are split into two documents. The first contains five annexes of supporting information:

- **Annex 1** outlines the responses we received to our December consultation;
- **Annex 2** sets out our assessment of adjacent band coexistence in 2300 MHz shared access band;
- **Annex 3** covers our assessment of coexistence in the 26 GHz band;
- **Annex 4** covers our coordination methodology and parameters that Ofcom will use to perform coordination in the shared access bands; and
- **Annex 5** contains a glossary of terms used in this document and annexes.

2.32 The second contains licences and Interface Requirements:

- **Annex 6** contains an example of a Shared Access Low power licence;
- **Annex 7** contains an example of a Shared Access Medium power licence;
- **Annex 8** contains an example of a Shared Access Indoor 26 GHz licence;
- **Annex 9** contains an example of a Local Access licence; and
- **Annex 10** contains links to our draft Interface Requirements.

3. The shared access bands

3.1 We have identified three bands supported by mobile technology for further shared access (3.8-4.2 GHz, the 1800 MHz shared spectrum and the 2300 MHz shared spectrum). We are making these bands available under the spectrum sharing framework we consulted on in December. Ofcom will authorise, manage and coordinate access to the bands on a per location, first come, first served basis.

3.2 We want to make it easy for users to access spectrum in locations where spectrum is available, through a simple process offering a choice of bands to suit users' needs. Our approach gives more certainty over spectrum access and quality of service than under a licence exempt or light licence basis. We also want to ensure that our licensing approach is sufficiently flexible to rapidly respond to changing demand.

3.3 Particularly, we consider that the 3.8-4.2 GHz band could enable use of 5G technology for private industrial networks. We are not permitting this band to be used to provide national mobile broadband, where we are proposing to make available national licences in the 3.6-3.8 GHz band for that purpose.

3.4 In this section, we confirm the framework for the shared access bands. In doing so, we discuss responses received in relation to the proposals published in our December 2018 consultation and our analysis of these. Finally, we summarise our overall decisions in relation to the new Shared Access licence that we are making available in these bands.

Spectrum sharing framework for the shared access bands

What we proposed

3.5 We proposed to extend shared access in the 3.8-4.2 GHz band, 1800 MHz shared spectrum and 2300 MHz shared spectrum under the following spectrum sharing framework:

- Users apply to Ofcom for licence(s) for the location(s), band(s) and bandwidth(s) that they need to provide a service;
- Ofcom assesses requests with regards to interference to and from other licensees in the band;
- Ofcom grants individual licences for the requested location(s), band(s) and bandwidth(s) on a first come, first served basis, where there is no undue interference to other users; and
- Users pay cost-based licence fees to recover the cost of Ofcom managing the licence, where spectrum demand does not outstrip supply (consistent with our established pricing principles). This will help to keep the licence product affordable for smaller users.

3.6 We said we would add spectrum to this framework where we believe it appropriate to do so.

3.7 The 3.8-4.2 GHz band is currently used by three main types of users: satellite earth stations, point-to-point fixed links and fixed wireless access (FWA) provided by UK Broadband.[27] Deployments in the band are technically coordinated by Ofcom on a first come, first served basis in order not to cause undue interference between users. We said that new users would access spectrum under a similar coordination approach as for existing users in the 3.8-4.2 GHz band. We noted that expanding access to new users may reduce the amount of spectrum available for incumbent users to expand their services in some locations. However, we did not consider that the impact on incumbent users was likely to be significant.

3.8 The 1800 MHz shared spectrum is currently licensed to 12 Concurrent Spectrum Access (CSA) licensees, who were awarded their licences in an auction in 2006. They all have equal access to the band and are bound by a shared Code of Engineering Practice agreed by all parties. Under this system, users record deployments on a register held by a third party (the Federation of Communications Services, or FCS). We proposed that Ofcom would manage access to this shared spectrum and perform coordination between incumbent and future users in the band. To achieve this, we proposed changes to the authorisation approach for existing licensees in the 1800 MHz shared spectrum, to align with the single authorisation approach across the shared access bands. Given the current limited use in the band, we did not consider that expanding access for new users would impact on the future ability of existing licensees to continue to deploy.

3.9 The 2300 MHz shared spectrum is used by MOD for air-to-air and air-to-ground telemetry systems, and a small number of land-based systems. There is also some use by radio amateurs and Programme Making and Special Events (PMSE) users. A number of Short Range Devices (SRDs) such as Wi-Fi, Zigbee, Assistive Listening Devices (ALDs) and Bluetooth operate on a licence exempt basis in the adjacent Industrial, Scientific and Medical (ISM) band between 2400-2483.5 MHz. As with the 3.8-4.2 GHz band and 1800 MHz shared spectrum, we proposed that access in the 2300 MHz shared spectrum be coordinated by Ofcom and authorised on a per location, first come, first served basis.

3.10 We proposed a single authorisation approach where users would apply for licences in each of the three bands in the same way, operating on a first come, first served basis.

Summary of responses and our position

General comments on the authorisation approach

3.11 Most respondents agreed with our overall approach of adopting an Ofcom-managed, single authorisation process on a first come, first served basis across the three bands. Some respondents said they appreciated that the approach we outlined was simple, fair and easy to understand, and suggested our proposal would provide smaller businesses affordable access to spectrum for a range of different applications. Others commented that an Ofcom-managed approach would mean records of users in the bands would be

[27] Acquired by Hutchison 3G UK Limited in 2017.

kept up to date, which would ensure the spectrum is used and managed efficiently and be helpful in assessing the impact of any future changes to the authorisation of the bands.

3.12 A number of respondents agreed with the potential new uses we had identified for the shared access bands, whilst others had additional suggestions we had not included. Several respondents considered that the 3.8-4.2 GHz band could at some stage become suitable for mobile coverage extensions, and one respondent emphasised that the shared access bands could be used for increasing mobile capacity as well as just coverage. Other suggestions included PMSE equipment and e-health applications, as well as neutral host solutions (though some stakeholders added that more work was needed from a regulatory perspective before this could be achieved effectively).

3.13 In the sub-sections below, we outline comments made by respondents relating to each of the shared access bands, along with our analysis of the issues raised.

3.8-4.2 GHz band

3.14 Satellite users, including Avanti, the BBC, BT, ESOA, Intelsat and two confidential respondents ([✂]), were worried that the introduction of new users would mean interference to existing earth stations.

3.15 We would like to reassure satellite users that new users will only be licensed by Ofcom if their licence application is successfully coordinated. The protection criteria used to coordinate with existing services will remain the same as they are currently.

3.16 Some respondents were concerned that allowing new sharers in the 3.8-4.2 GHz band would constrain future growth and flexibility for earth stations. We appreciate that regulatory certainty is important to enable earth station users to make investment decisions. However, we also note that there are growing and competing demands on the spectrum used by earth stations from other services which can also deliver a range of benefits. We consider that spectrum sharing could allow a broader range of services to operate to support growth in both areas. Earth stations currently access the band on a first come, first served basis and this will continue to be the case when new users gain access to the band.

3.17 Some respondents brought up the fact that due to the clearance of the 3.6-3.8 GHz band as part of Ofcom's preparations for the auction of that spectrum, satellite earth stations may be looking to move traffic into the 3.8-4.2 GHz band and we should consider reserving spectrum to safeguard the future growth of the satellite sector. We confirmed our plans to clear existing earth station use from the 3.6-3.8 GHz band in October 2017, and users have until June 2020 to make alternative plans for themselves.[28] We consider that most earth station operators will now be advanced in these plans, and will be in a good position to seek a variation of their existing licences or acquire new Permanent Earth Station (PES)

[28] For more information, see https://www.ofcom.org.uk/consultations-and-statements/category-1/future-use-at-3.6-3.8-ghz; one earth station operator has until 1 September 2020 to vacate the band.

licences or grants of Recognised Spectrum Access for Receive-Only Earth Stations (RSA for ROES) in order to protect any new use at their sites.

3.18 Three, which owns UK Broadband, argued that the introduction of new users in the band was a dilution of their existing rights to access this spectrum under the UK Broadband licence. We note that the existing terms of the UK Broadband licence require it to share with other users, which it can be notified of by Ofcom from time to time.

3.19 Some respondents doubted that there would be sufficient demand for spectrum in 3.8-4.2 GHz from new sharers and suggested alternative approaches. [✂]. Ericsson suggested making 100 MHz of the total 400 MHz in the band available for sharing, and the remaining spectrum available nationally for mobile, until demand from sharers for more spectrum than this has been sufficiently proven. We do not agree that this would be a more effective way of making the band available, as existing users in the band will continue to require access to spectrum for their services. We outlined both in 2015[29] and 2017[30] that making the 3.6-4.2 GHz band available for national mobile services without withdrawing incumbent users' rights to access spectrum would not be possible without leaving large areas of the UK unserved; this is one of the key reasons why we have adopted different approaches in 3.6-3.8 GHz and 3.8-4.2 GHz.

3.20 Huawei also argued that we should only authorise a portion of the band through the Shared Access licence, and the remainder should be authorised through nationwide licences with per-location coordination to support proven demand for FWA, as this would provide greater certainty for FWA providers that spectrum would be available in the areas they need it. We do not agree with this argument, as access to the band would be based on per-location coordination regardless of whether the user held a national licence (unless only one user had exclusive rights to a given portion of the band, which we do not think would be an efficient use of spectrum). A key benefit to the approach we have outlined is that users only pay for the locations in which they deploy, rather than having to be able to afford a national licence. This approach will appeal to a wider range of users (both large and small).

3.21 A handful of respondents also raised doubts about the availability of suitable equipment in the 3.8-4.2 GHz band, as the band is not harmonised globally for mobile broadband in the same way that 3.4-3.8 GHz is. Other respondents, however, agreed with our position that equipment is either available now or will be soon, especially radio chipsets for devices which some respondents highlighted are already available. Our position remains that providing regulatory certainty on access to spectrum in this band will provide a considerable incentive for manufacturers to produce the equipment users need. As noted by some respondents, we would also highlight the existence of compatible chipsets across

[29] Transfinite Systems, *Geographic Sharing in C-band: Final Report*, 31 May 2015, https://www.ofcom.org.uk/research-and-data/technology/radio-spectrum/c-band-sharing

[30] Ofcom, *Improving consumer access to mobile services at 3.6 to 3.8 GHz: Consultation*, 6 October 2016, https://www.ofcom.org.uk/__data/assets/pdf_file/0035/91997/3-6-3-8ghz-consultation.pdf

the whole 3.3-4.2 GHz range, catering for the different availability of spectrum in different countries.

1800 MHz shared spectrum

3.22 We received responses representing 8 of the 12 CSA licensees. Shyam Telecom, TalkTalk, Vodafone and Telefónica agreed with our proposed changes to the band. BT and FMS Solutions suggested that the new licensing and fees structure would have an adverse effect on their business models, as it would involve higher costs than under the current structure. Ofcom's position is that the concept of the band has always been for shared use and licensees were always aware that following the initial ten-year period after the award of the band in 2006, the licences would become eligible for the imposition of annual licence fees. Over the course of the development of our new policy in this area, licences have remained free of fees for an additional period of over three years and we believe the proposals and fees we have outlined are appropriate. We will continue to work with affected stakeholders to understand and address any transitional issues to integrate their current deployments into the new licensing structure.

3.23 FMS Solutions additionally argued that the proposal was effectively a revocation of their licence to access spectrum, which would require five years' notice. We are not removing the existing and future ability of existing CSA licensees to access the band. We are instead changing the authorisation approach so that this can be coordinated against future deployments. This also means that existing CSA licensees will no longer be required to fund a third party to maintain a record of deployments.

3.24 Two confidential respondents ([✂]) highlighted that there is some earth station use of spectrum in the wider 1800 MHz band, including the lower uplink half of the 1800 MHz shared spectrum. This use is outlined in footnote UK90A to the UK Frequency Allocation Table.[31] Prospective licensees should, therefore, be aware that deployments using the 1800 MHz shared spectrum operating near the sites outlined in this footnote could be subject to interference from defence use of the band. However, we consider that the risk of interference from these deployments to new users is very low.

3.25 Some respondents questioned how useful the 1800 MHz shared spectrum would be to new users given the small bandwidth available (2 x 3.3 MHz). This spectrum could be coupled with licence exempt LTE in the 5150-5925 MHz band (3GPP Band 46) to provide additional channels to support higher capacity applications.

3.26 It could also support narrowband IoT (NB-IoT) devices and other users looking to deploy GSM or LTE for voice or text, as well as low data rate applications. A number of stakeholders responded supporting our view.

[31] This can be found on the Ofcom website (http://static.ofcom.org.uk/static/spectrum/fat.html) and reads as follows: "*The Space Operations service is limited to MoD use of 1750.0 -1850.0 MHz at Oakhanger (SU 776 357), Colerne (ST 808 717) and Menwith Hill (SE 210 560).This assignment is recorded for information. The parties concerned will take all practical steps to minimise the impact of the use of the assignment on services operating in accordance with the UK Frequency Allocation Table*."

2300 MHz shared spectrum

3.27 The Radio Society of Great Britain (RSGB), which represents amateur radio users, requested clarification on the ability for amateur users to continue to use the band. We will allow continued use of the 2300 MHz shared spectrum by the Radio Amateur Service. We believe that, due to the low numbers of amateur users in the band, the intermittent nature of their transmissions and careful operation by users, the band can be shared with limited risk. We note that current amateur use of the band is on the basis of not causing harmful interference to other users of the radio spectrum[32] and should this arise, the licence provides that we may vary the Amateur Radio licence to remove the 2390-2400 MHz band for reasons related to interference management (after first giving reasonable notice of three months).[33] We consider that the potential for interference from radio amateur use of the 2300 MHz shared spectrum is small, and that we have the necessary mechanisms in place to deal with interference should it arise.

3.28 BT, Cisco and the IEEE LAN/MAN Standards Committee thought the introduction of new users into the band would risk interference to Wi-Fi and Zigbee,[34] which operate above 2400 MHz. They suggested we hold off on releasing this band for new sharing users until further study had been carried out. As outlined in more detail from paragraph 3.135 below and in Annex 2, we continue to be of the view that the possibility of interference from indoor low power use to adjacent users such as Wi-Fi will be very small.

3.29 The 2390-2400 MHz band is allocated for use by PMSE (wireless cameras and video links). In our statement published on the 28 October 2014[35], we set out our spectrum strategy for video PMSE. This specifies that the preferred bands for video PMSE are the 7 GHz bands (7.110-7.250 GHz and 7.300-7.425 GHz), and the 2 GHz bands (2010-2110 MHz and 2200-2300 MHz). The 2390-2400 MHz channel was excluded from our video PMSE strategy on the basis that it would have limited utility due to interference from new mobile services in the adjacent release band at 2.350-2.390 GHz.

3.30 While the channel remains available for PMSE use, we do not consider that our decision to allow new shared access users materially reduces the utility of the spectrum for PMSE beyond our assessment in 2014. However, to manage access to the band, we will coordinate PMSE assignments with new shared access licensees.

3.31 As with the 1800 MHz shared spectrum, some respondents questioned the usefulness of the 2300 MHz shared spectrum to new users given the small bandwidth available (10 MHz). We consider that the 2300 MHz shared spectrum would be useful for GSM and LTE voice or text services.

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[32] Information on licences that we issue will be available in the Spectrum Information Portal. https://www.ofcom.org.uk/spectrum/information/spectrum-information-system-sis/spectrum-information-portal

[33] Clause 4(6) of the Amateur Radio Licence

[34] Zigbee is a type of wireless technology used to create personal area networks based on low power, low data rate devices. It is employed in a number of applications such as smart meters, building automation systems and smart home technology (heating systems, lighting etc.)

[35] Ofcom, *Programme Making and Special Events: Strategy for video PMSE applications*, 28 October 2014, https://www.ofcom.org.uk/__data/assets/pdf_file/0031/68953/statement_on_camera_strategy.pdf

Our decision

3.32 We have decided to make the new licence available in the 1800 MHz shared spectrum, 2300 MHz shared spectrum and 3.8-4.2GHz band on an Ofcom-managed, first come, first served basis, with no restrictions on eligibility for licences and a single authorisation approach across all three bands, as outlined in the consultation.

3.33 In addition, we confirm that we intend to change the licensing approach in the 1800 MHz shared spectrum, moving existing deployments under the CSA licences into the new Shared Access licence product and processing any new deployments by the CSA licensees through the same Shared Access licence process. This means that existing CSA licensees will no longer be required to fund maintenance of the existing third-party database.

Low power area licence

What we proposed

3.34 In December 2018, we outlined our proposal for two variants of the Shared Access licence: one low power and one medium power.

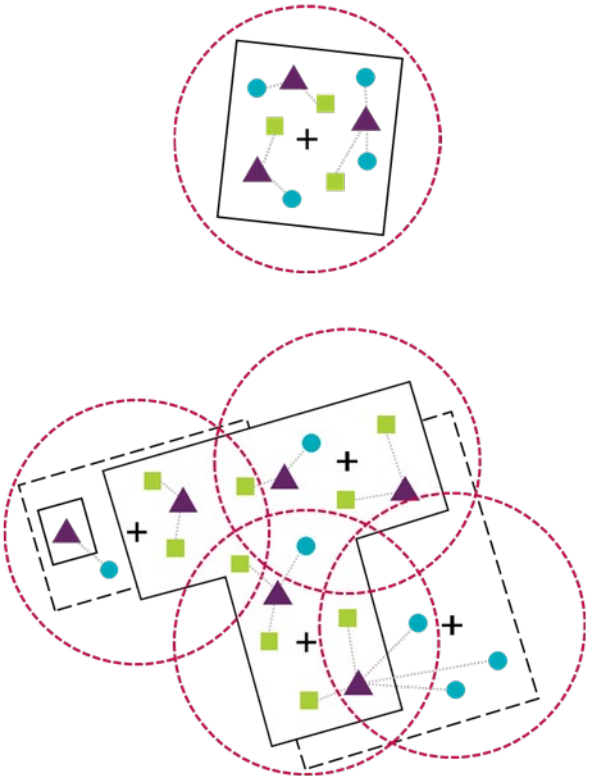
3.35 The low power licence would authorise any number of base stations located in a circular area with a radius of 50 metres, centred on the coordinate provided by the user, rather than one specific base station. The associated fixed/installed terminals connected to base stations operating within the licensed area would also be authorised as part of the licence. We proposed that mobile/nomadic terminals connected to licensed base stations would be licence exempt, except in the 3.8-4.2 GHz band where these would also be included in the licence.

3.36 Users would have the freedom to deploy the required number of base stations in the licensed area and move the base stations within this area as they wished without informing Ofcom of any such changes.

3.37 Users who want to deploy base stations in a larger area could apply for multiple areas as part of the same licence application; these could be contiguous and overlapping, as shown in Figure 3.1 below, or spaced out around a larger site.

3.38 Users would be able to apply for an indoor-only licence or one which permitted both indoor and outdoor use.

Figure 3.1: Examples of low power area licence use



3.39 We anticipate the low power licence product could be suitable for industrial and enterprise users looking to deploy their own private networks, whether to support voice and text applications or other wireless data applications around their site. It could also potentially be used for indoor mobile coverage extension schemes.

Summary of responses

3.40 Most respondents agreed with our proposal for the low and medium power licence products, though some others suggested that implementing a Dynamic Spectrum Access (DSA) database approach would be more efficient as it would remove the need for such a distinction. We discuss our position on an automated DSA approach further down in this section.

3.41 Some stakeholders did have specific comments on the low power licence proposal and suggestions for things that could be changed. AWTG argued that the 50-metre radius of the circle was too small and this would constrain the possible deployment scenarios, while Nokia suggested increasing the size of the area for outdoor deployments due to the fact that signals will propagate further outdoors. Motorola suggested we should give options for larger areas if users wanted these, and Ericsson proposed we allow users to define the

shape of the area they want to cover, with defined radio conditions on the border of this area to prevent interference. Google argued that instead of a circle we should use a shape that tessellates without overlapping, such as a 100 x 100 metre square.

3.42 Heathrow Airport commented that while it will be possible to license very large sites such as their own using a large number of low power licence areas next to each other, this would not be very efficient and could be prohibitively expensive.

3.43 Ericsson and Disruptive Analysis queried whether the 50 metre-radius circle authorised by the low power licence would have an associated height, or if the area licensed would in effect be a 2D circle.

Our decision

3.44 A number of respondents made comments about larger areas or adapting the area according to prospective licensees' different uses. Our policy objective is to make spectrum available that could facilitate deployment of local networks in different sectors, such as for industrial and enterprise users. We are not permitting this band to be used to provide national mobile broadband, where we are proposing to make available national licences in the 3.6-3.8 GHz band for that purpose. Using the 3.8-4.2 GHz spectrum this way could deny other users the opportunity to access spectrum, and to develop and use innovative wireless technologies on a localised basis throughout the UK.

3.45 In addition, our aim is to provide users with a simple process to access spectrum that is easy to understand. We recognise that the size of the local area where connectivity is required could range from a single office building to a large industrial park. Our approach is modular so that users can apply for the number of low power licences they need to deploy multiple small cells based on the size of the premises where connectivity is required. We consider the proposal we have laid out strikes the right balance between something which is easy for applicants and which will suit the needs of a wide range of users. We do not think that adding different options for different-sized areas will make a big difference to users, but this could make the licensing process more complex and therefore could increase Ofcom's costs, and as a result increase the cost of the new licence. This same problem, of increased complexity and therefore increased associated costs, also exists for the bespoke area licensing approach suggested by Ericsson.

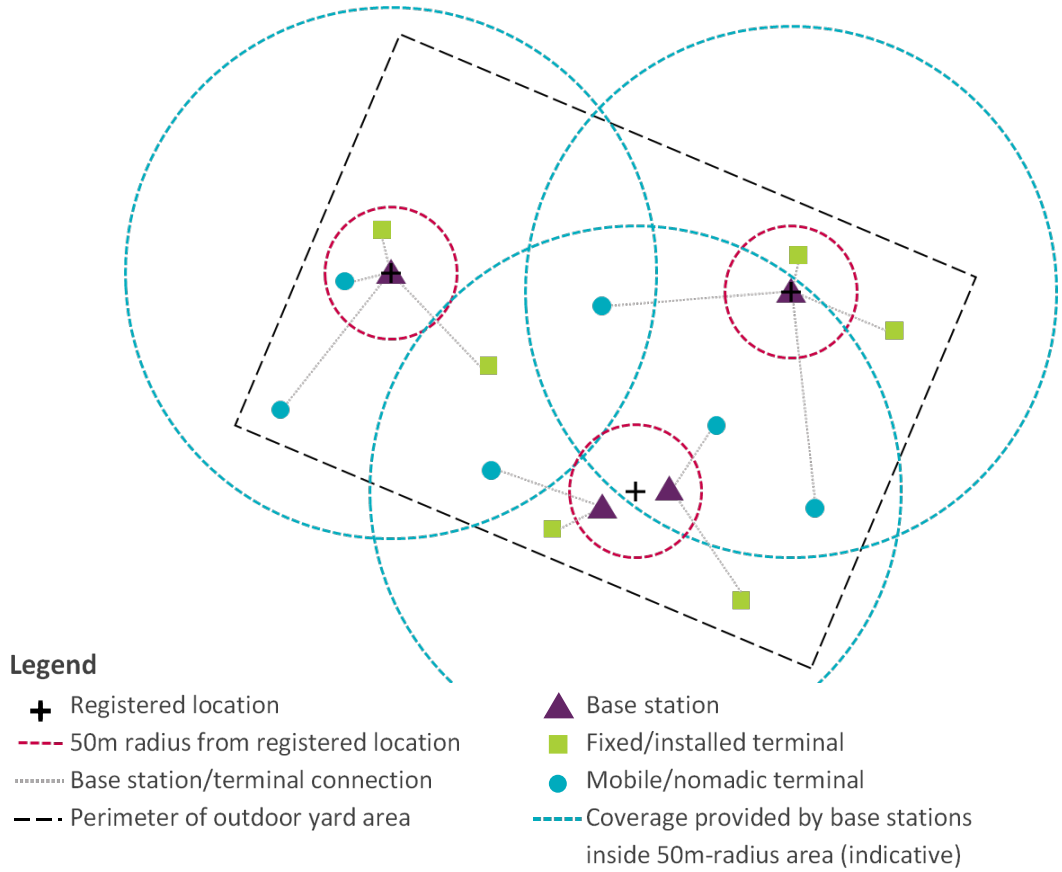
3.46 In response to Google's comments on changing to square areas for the low power licence, we would need to define the orientation of the square and decide how to coordinate for base stations that could be as little as 50 metres away from the centre point of the area (in the middle of the square's sides), or as much as ~70 metres (at the corners). This would change the coordination method and make our licensing and coordination process more complex, which could in turn drive up the cost of the licence product.

3.47 In response to Heathrow Airport's comments, the low power licence does not limit the user to only covering a 50 metre-radius circular area; while base stations must be located within this area, the same restriction does not apply to terminal stations as long as they are connected to a base station within the licensed area. In practice, the coverage provided

from an outdoor base station operating at 24 dBm could extend from a few hundred metres to 1km (which we consider as part of our coordination process). Therefore, the number of low power licences required to cover an outdoor site is likely to correspond to the number of base stations needed to provide the required outdoor coverage. This is illustrated in Figure 3.2 below. However, we would reiterate that our policy objective is not for users to acquire as many low power area licences as possible in the 3.8-4.2 GHz band to provide national mobile broadband, as we are proposing to make available national licences in the 3.6-3.8 GHz band for this purpose.

3.48 For this reason, we are also adding to the licence conditions for the 3.8-4.2 GHz band a requirement that licensees should keep an accurate record of all mobile terminals, and specifically the address of the site or building they are limited to operate within.

Figure 3.2: Example of terminal stations outside the area licensed by the Shared Access low power licence, but connected to licensed base stations within this area



3.49 For indoor-only licences, users can deploy across the entire height of the building in which the area is located. For outdoor use, a maximum height of 10 metres above ground level applies to base stations, except in the 3.8-4.2 GHz band.

3.50 Users wishing to provide both indoor and outdoor coverage should apply for an indoor/outdoor licence. The price of the licence would remain the same regardless of whether it was indoor-only or not; however, we would encourage users who do not expect to deploy base stations and fixed/installed terminals outdoors to apply for an indoor-only

licence, as this is more likely to pass coordination than an application for both outdoor and indoor use. Users applying for indoor licence will need to ensure that all base stations and fixed/installed terminals are deployed indoor. Conversely, if you do expect to deploy any equipment outdoors, you should not apply for an indoor-only licence, in order to pass coordination, as you will be restricted to indoor use only and will be breaking your licence conditions if you also use for outdoor use.

3.51 We are therefore proceeding with our proposal to make available a low power Shared Access licence, which will authorise all base stations operating in a circular area with a radius of 50 metres, centred on a coordinate provided by the user. All terminals connected to a base station in this licensed area will be covered by the licence. Additionally, mobile/nomadic terminals in the 1800 MHz and 2300 MHz shared spectrum will be licence exempt. Where mobile terminals are deployed in the 3.8-4.2 GHz band, licensees will be required to keep an accurate record of all mobile terminals and the address of the site or building they are limited to operate within. An example licence is included as Annex 6.

Medium power per base station licence

What we proposed

3.52 In addition to the low power Shared Access licence, we also proposed a medium power version which would authorise a single base station and any connected terminal stations. Mobile terminal stations in the 1800 MHz and 2300 MHz shared spectrum would additionally be licence exempt.

3.53 Compared to the low power licence, we envisaged that this licence would be more suitable for users who needed a longer transmission range from their base station, but did not expect to need to change the locations of base stations once deployed. We thought that rural FWA providers could be one such user, along with third parties looking to provide rural mobile coverage.

3.54 We explained that we expected users of the low power Shared Access licence were most likely to want to deploy in urban areas, and to allow medium power users to deploy in urban areas, with their higher power and increased range, would risk low power users suffering from limited or no availability of spectrum.

3.55 For this reason, we proposed in our consultation that we would restrict medium power use to rural areas only. Using publicly available data from the UK's statistical bodies, we proposed to define "rural areas" as:

a) Any location in England or Wales in an ONS 2011 Census Output Area which falls into categories E1, E2, F1 or F2 (i.e. "villages" and "hamlets and isolated dwellings");[36]

[36] Office of National Statistics, "2011 Rural/Urban Classification", https://www.ons.gov.uk/methodology/geography/geographicalproducts/ruralurbanclassifications/2011ruralurbanclassification

b) Any location in Scotland which falls into categories 6-8 based on the Scottish Government's 8 fold Urban Rural Classification (i.e. any area outside a settlement of over 3,000 people);[37] and

c) Any location in Northern Ireland which falls into bands G or H of the Northern Ireland Statistics and Research Agency's settlement classification bands (i.e. any area outside a settlement of over 2,500 people).[38]

3.56 We also outlined that for medium power users in the 3.8-4.2 GHz band, we would only permit fixed terminal stations, due to the existing equipment ecosystem in the band and the uses we predicted. We would authorise both the base station and the associated fixed/installed terminal stations in the same licence (as would be the case for fixed/installed terminals in the 1800 MHz and 2300 MHz shared spectrum).

Summary of responses

3.57 Several stakeholders commented on our proposed rural restriction for the medium power Shared Access licence. Some respondents agreed with what we had proposed and thought this was a good way to ensure suitable spectrum would be available for as many users as possible. Others, however, had some concerns, suggesting that users could be prevented from deploying due to the restriction, citing in particular industrial users with larger or more distributed sites, including ports, railyards and large factories. Some respondents suggested that the definition we had proposed for what constitutes a "rural" area was too strict and would prevent providers from deploying services such as FWA in areas that could reasonably be described as rural.

3.58 Similarly, some respondents to the consultation were also concerned that our proposed restriction of mobile terminals in 3.8-4.2 GHz would constrain some users' legitimate deployments, such as industrial users with larger sites who wanted to use mobile terminals. On the other hand, some satellite earth station users agreed with our restriction and were wary of the prospect of mobile terminals being used in the band.

Our decision

3.59 Higher power deployment has an increased transmission range and could limit availability of spectrum for low power users. Therefore, generally, we will only consider applications for medium power in rural areas.

3.60 We noted responses to our consultation indicating that the definition we had proposed for what constitutes a "rural" area was too strict and could exclude industrial users with larger or more distributed sites. Therefore, we have decided to revise our definition of a rural area, which means that fewer areas will now be excluded from deploying medium power compared to the definition we consulted on. We have brought our definition of a rural

[37] Scottish Government, "Scottish Government Urban Rural Classification", https://www.gov.scot/Topics/Statistics/About/Methodology/UrbanRuralClassification
[38] Northern Ireland Statistics and Research Agency, "Urban-Rural Classification", https://www.nisra.gov.uk/support/geography/urban-rural-classification

area into line with that used by the ONS, Scottish Government and NISRA, classing any settlement of over 10,000 people as an urban area and any other location as rural. Based on the rural/urban classification systems used by these bodies, we will now consider a rural area to be:

a) Any location in England or Wales in an ONS 2011 Census Output Area which falls into **categories D1, D2, E1, E2, F1 or F2** (i.e. "town and fringe", "villages" and "hamlets and isolated dwellings");[36]

b) Any location in Scotland which falls into **categories 3-8** based on the Scottish Government's 8 fold Urban Rural Classification;[37] and

c) Any location in Northern Ireland which falls into **bands E-H** of the Northern Ireland Statistics and Research Agency's settlement classification bands.[38]

3.61 In addition, any area which falls outside one of these areas, but which is within the limit of the UK's territorial seas, will be considered to be rural.[39]

3.62 However, we also want to strike the right balance between securing optimal use of spectrum and encouraging new uses. If applicants wish to deploy in areas outside the above, but believe their use is still consistent with our policy objectives, they can approach Ofcom for us to consider their individual case. It could take longer for the user to obtain a licence under these circumstances. Amongst the non-exhaustive criteria that we may require users to demonstrate are:

a) That their intended use would not be technically possible using the low power licence product;

b) That emissions from the user's site, insofar as these are likely to reduce access to spectrum for other users, would not be higher using a medium power base station than using low power base stations (e.g. because in practice no other user would be able to deploy within the coverage area served by the medium power deployment, as the land is owned or operated by only the one user, or because the site is underground or otherwise shielded from the outside); or

c) That the irregular boundaries of one of the rural/urban classification systems places a location in an "urban" area even though surrounding locations with similar characteristics on the ground have been classed as "rural".

3.63 To aid users in applying for the medium power Shared Access licence, we plan to make available on our website an interactive map to help prospective licensees to check whether their deployment location falls within the rural or urban category.

3.64 We noted comments that our restriction on mobile terminals in the 3.8-4.2 GHz band may prevent deployment by users who wanted to use mobile terminals in larger sites such as university campuses, ports, railyards and larger factories, which don't meet the rural definition. We want to facilitate such deployments and consider that multiple low power

[39] For more information, see the UK Government website: https://www.gov.uk/guidance/uk-maritime-limits-and-law-of-the-sea.

licences would be suitable in most instances. For example, the outdoor transmission range of a base station operating under the low power licence could extend up to 1km in rural areas using the 3.8-4.2 GHz band.

3.65 However, we also recognise that there could be circumstances where higher power is required for longer range connectivity in a private network, for terminals which could be mobile in nature but would still be contained within the sites operated by the users. Whilst we want to enable this, we are not permitting mobile use in the 3.8-4.2 GHz band to be used to provide national mobile broadband services. Therefore, we are also adding to the licence conditions the requirement that licensees using the 3.8-4.2 GHz band must keep an accurate record of all mobile terminals, including the address of the site or building they are limited to operate within.

3.66 In conclusion, we will proceed with our plan to make available a medium power Shared Access licence product, authorised on a per base station basis. Terminals are also authorised as part of the licence. Additionally, mobile terminals in the 1800 MHz and 2300 MHz shared spectrum are licence exempt. The licence is intended to be generally available for deployment in rural areas only. Where mobile terminals are deployed in the 3.8-4.2 GHz band, licensees will be required to keep an accurate record of all mobile terminals and the address of the site or building they are limited to operate within.

Technical licence conditions for low and medium power licences

What we proposed

3.67 In our December 2018 consultation, we proposed that the technical conditions for the new Shared Access licence be based on existing technology neutral technical conditions. These are stipulated in the relevant European Commission (EC) and Electronic Communications Committee (ECC) Decisions for these bands or, in the case of the 3.8-4.2 GHz band, we have referred to the EC Decision for use of the adjacent 3.4-3.8 GHz band.

3.68 For each of the three bands we proposed the following parameters for both low power and medium power base stations:

a) **Authorised bandwidth:** a single paired 2 x 3.3 MHz channel in the 1800 MHz shared spectrum, a single 10 MHz channel in the 2300 MHz shared spectrum and multiple channel bandwidths in the 3.8-4.2 GHz spectrum (10, 20, 30, 40, 50, 60, 80 and 100 MHz).

b) **Outdoor antenna height:** outdoor base station antenna systems to be no more than 10m above ground, except for the medium power licence in the 3.8-4.2 GHz band where there was to be no such restriction.

c) **Maximum base station power:** 24 dBm EIRP per carrier per sector for the low power licence for carriers ≤ 20 MHz (or 18 dBm / 5 MHz per sector for carriers > 20 MHz) and 42 dBm EIRP per carrier per sector for the medium power licence for carriers ≤ 20 MHz (or 36 dBm / 5 MHz per sector for carriers > 20 MHz).

d) **Maximum terminal station power:** 23 dBm TRP for mobile or nomadic terminals and 23 dBm EIRP for fixed/installed terminals.[40]

e) **Frame structure requirements:** for the 2300 MHz shared spectrum and 3.8-4.2 GHz band, outdoor base stations to deploy a 3:1 frame structure with a common reference start time and a 1ms timeslot. In addition, if any other licensees in these shared bands demonstrated that they were suffering harmful interference in a shared indoor environment, then the user would also be required to comply with these frame alignment and frame structure requirements. Users in 3.8-4.2 GHz could deviate from the required frame structure (but would still have to align the start of the frame at a common reference time) provided that they also applied a more restricted emission mask outside of the authorised bandwidth.

3.69 We also asked for views on the use of Adaptive Antenna Systems (AAS) in the 3.8-4.2 GHz spectrum, including whether there were any additional considerations we would need to take account of in the technical conditions and coordination methodology to support this technology, and to ensure that incumbent users remained protected.

3.70 Full details of the proposed set of technical licence conditions were presented in Section 5 of our consultation document. In the following section we consider each of the main elements of the proposed technical licence conditions, respondents' views on our proposals and our assessment in light of these responses. We then present the final set of technical licence conditions for low and medium power licences in the shared access bands.

Authorised bandwidths

Summary of responses

3.71 Only a small number of respondents commented on the proposed channel bandwidths. For the 1800 MHz shared spectrum, Telet Research believed that better use could be gained from granting multiple narrow channel licences and suggested a standard channel bandwidth of 200 kHz. Shyam Telecom on the other hand suggested that the longer-term goal should be to increase the bandwidth in the 1800 MHz shared spectrum to 2 x 5 MHz to accommodate 5G services.

3.72 For the 2300 MHz shared spectrum, Simon Pike suggested that this band should be configured as 2 x 5 MHz channels rather than a single 10 MHz channel, to allow more than one user in any given location. Telet Research suggested that both 5 and 10 MHz bandwidths could be used.

3.73 For the 3.8-4.2 GHz spectrum, AWTG thought that it was unnecessary to limit channel bandwidths to 100 MHz, noting that 5G services could use channel bandwidths of 200 MHz or more.

[40] The European harmonisation and our authorisation include an additional 2 dB tolerance, taking the limit to 25 dBm in the 2300 MHz shared spectrum and 3.8-4.2 GHz band.

Our decision

3.74 For the 1800 MHz shared spectrum, we continue to consider that authorising a channel with a bandwidth of 3.3 MHz is more consistent with a technology neutral approach than an approach based on 200 kHz channel bandwidths. Our proposed approach will still allow applicants to utilise 200 kHz channels if they wish to do so, whereas authorising 200 kHz channels only would make it difficult for users to obtain access to wider bandwidths. Furthermore, we note that if we were to authorise both 200 kHz and 3.3 MHz channel bandwidths, this would not necessarily increase spectrum reuse in the band. We also note the call from Shyam Telecom to make 2 x 5 MHz paired spectrum available in the 1800 MHz band, but this is outside the scope of our consultation.

3.75 For the 2300 MHz shared spectrum, we accept that the use of 5 MHz channels instead of a 10 MHz channel would allow more than one user in any given location. However, as with the 1800 MHz spectrum, we need to make a trade-off. Smaller channel bandwidths potentially allow a greater number of users in an area but can make it more difficult to obtain access to wider bandwidths (e.g. because a licensee using a narrower bandwidth is already operating in the area). On the other hand, larger channel bandwidths still allow users of smaller bandwidths to gain access to spectrum, and concurrent trading allows this spectrum to be shared with other users. We also note that, in general, we are seeing a move towards greater demand for larger bandwidths as licensees look to increase speed and data throughput and use spectrum for a wider variety of applications. Finally, we note that only two respondents suggested that 5 MHz channel bandwidths were preferable. We therefore judge that, in this case, we should proceed with our original proposal to authorise channels with a bandwidth of 10 MHz.

3.76 For the 3.8-4.2 GHz band, our proposal to offer different size channel bandwidths up to 100 MHz is in line with the 3GPP standard for base station transmission and reception (for New Radio operating band n77).[41] Applicants requiring larger bandwidths may wish to consider the 26 GHz band (see Section 5) which we are also making available for indoor shared access.

Outdoor antenna height

Summary of responses

3.77 Two respondents requested that we consider deployment of base stations with higher antenna heights on a case-by-case basis. Motorola said it would prefer to see the outdoor low power base station antenna height limit raised to 15m above ground level, noting that signals at these high frequencies (in the 3.8-4.2 GHz band) are greatly attenuated by terrain and clutter features.

[41] 3GPP, *TS 38.104 V15.5.0: Technical Specification Group Radio Access Network; NR; Base Station (BS) radio transmission and reception*, https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3202

Our decision

3.78 Our proposal was designed to ensure that we can accommodate as many uses as possible. Increasing outdoor antenna height has the effect of increasing the interference range which may limit others' ability to deploy. We consider that the outdoor antenna height for the low power licence is appropriate and is consistent with typical small cell deployments. However, we agree that certain deployments in rural areas may be constrained by the 10m antenna height restriction for medium power outdoor base stations in the 1800 and 2300 MHz shared bands. We may therefore consider exceptions to the maximum antenna height on a case-by-case basis, taking into account the potential for other users to be denied access to spectrum by the increased potential for interference. There is no antenna height restriction for medium power outdoor base stations in the 3.8-4.2 GHz shared band, and no restrictions on indoor antenna height for any of the shared access bands.

Maximum base station power

Summary of responses

3.79 Three respondents said it was unclear how the transmit power and EIRP limits had been derived for the two types of new licence and asked us to clarify the rationale behind the proposed limits.

3.80 For the low power licence, several respondents suggested that the proposed base station power limit of 24 dBm EIRP was too low. BT said that, for the 1800 MHz shared spectrum, the permitted power for wide carriers such as LTE would be substantially lower compared to the 35 dBm permitted under the existing licence. Dense Air said that enterprise grade indoor base stations are capable of higher powers and suggested setting a limit of 4W EIRP (i.e. 36 dBm). Huawei said the 24 dBm EIRP limit would restrict coverage of its low power pico-cell base stations for channel bandwidths of 40 MHz or lower. Motorola said it would prefer to see the EIRP limit increased to 30 dBm/10 MHz.

3.81 For the medium power licence, Huawei said the 42 dBm EIRP limit would restrict coverage of their medium power micro-cell base stations for channel bandwidths of 40 MHz or lower and said this was not suitable for efficient deployment of FWA at 3.8-4.2 GHz. Google and UKWISPA & INCA said there were circumstances where base station power would need to be higher than 42 dBm (e.g. in certain remote rural locations). Motorola said it would prefer to see the EIRP limit increased to 43 dBm/10 MHz.

Our decision

3.82 Our proposed power limit for low power base stations was based on the rated output power limit at the antenna connector for a Local Area Base Station, as defined in Table 6.2.1-1 of 3GPP TS 38.104.[42] This, combined with an assumption that base stations use an

[42] 3GPP, *TS 38.104 V15.5.0: Technical specification Group Radio Access Network; NR; Base Station radio transmission and reception*, https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3202

omnidirectional antenna with 0 dBi gain, provides an EIRP of 24 dBm per carrier for carriers ≤ 20 MHz.[43] In addition, we note that the proposal for a 50 metre-radius authorisation area means that new users will be able to deploy as many base stations as they feel are necessary to provide coverage for their services within the authorised area, subject to managing interference in their networks. Users may also apply for multiple low power licences to cover a larger site.

3.83 For the medium power licence, the EIRP value of 42 dBm aligns with the existing DECT guard band licences (30 dBm/200 kHz or 42 dBm/3.3 MHz). We consider that the proposed power level is appropriate for the provision of rural broadband in 3.8-4.2 GHz, noting that in the 5.8 GHz band the regulatory limit for FWA services is 36 dBm,[44] which is lower than our medium power proposal.

Maximum terminal station power

Summary of responses

3.84 Several respondents disagreed with our proposals to limit fixed terminal station power for medium power licences to 23 dBm in the 3.8-4.2 GHz band, pointing out that this would not be sufficient to enable reliable rural broadband coverage.

Our decision

3.85 For fixed terminal station power for medium power licences in the 3.8-4.2 GHz band, we agree that it would be beneficial to allow use of higher gain directional antennas pointing towards medium power base stations, particularly for rural broadband scenarios. We will therefore set both an EIRP and a TRP limit for fixed/installed terminals: a maximum EIRP of 35 dBm/5 MHz and a maximum TRP of 28 dBm. This should enable use of higher gain directional antennas for the medium power licence, while aligning with the limits set in the EC Decision.

3.86 We have set the maximum TRP of 28 dBm[45] (from 25 dBm consulted) to align with the revised EC Decision[46] on the maximum terminal power in the 3.4-3.8 GHz band. We have therefore decided to increase the maximum power for mobile terminals associated with both the low and medium power licences in the 3.8-4.2 GHz band from 25 dBm to 28 dBm

[43] Or 18 dBm / 5 MHz for carrier bandwidths greater than 20 MHz.
[44] Ofcom, *Improving access to 5.8 GHz spectrum for broadband fixed wireless access*, 29 November 2017, https://www.ofcom.org.uk/consultations-and-statements/category-2/improving-access-5.8-ghz-broadband-fixed-wireless-access
[45] The EC decision and our authorisation include an additional 2 dB tolerance
[46] European Commission, *Commission Implementing Decision (EU) 2019/235*, 24 January 2019, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1549615962331&uri=CELEX:32019D0235

TRP. This also aligns with the limit for Class 2 equipment for band n77 in 3GPP standard TS 38.101.[47]

3.87 In permitting higher power mobile terminals we have taken into account that these terminals are temporal in their use (i.e. they send bursts of data, rather than continuous uplink traffic); they are likely to be operating below the maximum permitted power in most scenarios; and any potential interference would be short-lived as the terminals are likely to be mobile.

3.88 For terminal stations in the 1800 MHz and 2300 MHz shared spectrum, we confirm that the maximum permitted powers will be 23 dBm and 25 dBm respectively.[48] This is a TRP limit for mobile or nomadic terminals and an EIRP limit for fixed or installed terminals.

Synchronisation requirements in the 2300 MHz spectrum and 3.8-4.2 GHz band

Summary of responses

3.89 We received mixed responses on our proposed approach to synchronisation. A number of mobile equipment manufacturers supported our proposals, although some suggested that additional flexibility could be allowed. A number of other respondents disagreed with the proposal, saying that it would preclude the use of certain technologies and would not be technology neutral.

3.90 Huawei said that it was essential for outdoor deployments in 3.8-4.2 GHz to be synchronised with each other, and with services below 3.8 GHz, in order to avoid base-to-base and terminal-to-terminal interference. It suggested that unsynchronised use could be allowed for indoor deployments if these applied radio engineering measures to mitigate interference to outdoor deployments.

3.91 Nokia, the University of Strathclyde and one confidential respondent ([✂]) generally agreed with the synchronisation proposals but suggested that some additional flexibility could be allowed. Nokia and a confidential respondent ([✂]) suggested that this flexibility could be introduced in line with the suggestions in ECC Report 296. Nokia additionally noted that the business models of verticals could be different from those of commercial mobile networks and might result in different uplink/downlink ratios. The University of Strathclyde highlighted that there are some specific use-cases, particularly in rural communities, where higher uplink speeds are required and noted that this is often achieved by using more uplink sub-frames. It suggested that consideration be given as to how to permit such usage where it is not detrimental to other users.

[47] 3GPP, *TS 38.101-1 V16.0.0, Technical specification Group Radio Access Network; NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone*, https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3283

[48] The European harmonisation and our authorisation include an additional 2 dB tolerance

3.92 Motorola supported frame alignment of TDD technologies but said frame structure restrictions were unnecessary, noting that other means (such as sub-frame conflict aware scheduling) were available to alleviate interference issues.

3.93 Two respondents thought that the proposed approach was inconsistent with technology neutrality. Cisco said that the proposed technical rules, including the proposed frame structure, were quite 3GPP centric and that this could exclude certain technologies or future evolutions of technology. Kazalia said that a range of different technology platforms may be suited to offer cost-effective FWA in rural areas, not just LTE-based solutions, and said there was non-LTE equipment from at least two wireless vendors already on the market that covered this frequency band and that could be used for such deployments.

3.94 A number of respondents thought that the frame structure proposals would preclude, or be incompatible with, certain technologies:

- AWTG said that very narrow bandwidth applications such as sensor networks, and perhaps "smart-X" and some forms of IoT, would be less compatible with the proposed technical conditions, including the frame structure requirement.
- Motorola said that TDD frame configuration flexibility was especially important for certain use cases that may need higher uplink capability, such as in systems deploying remote video links (e.g. as used in remote robotics and security applications).
- Dense Air said that using a legacy 4G frame structure would preclude 5G New Radio technologies.
- Simon Pike said that many potential applications of 5G require low latency but that the frame structure proposal was incompatible with this. He suggested there should be no restriction on frame structure in part of the 3.8-4.2 GHz band, e.g. the upper 100 MHz.
- UKWISPA & INCA thought that the 3:1 frame structure would be unduly limiting and unnecessary in the case of long-range FWA. They thought that FWA would normally be well separated from mobile users, and that it was unclear that it was necessary to specify the TDD cycle to be used.

3.95 Dense Air also suggested that spectrum holders should work together to agree the best frame structure for 4G and 5G and said this should not be a matter for Ofcom to mandate. Heathrow Airport hoped that it would be possible for the licensee to select the appropriate frame structure in order to optimise the uplink/downlink data rate split according to business requirements.

Our decision

3.96 For the 2390-2400 MHz band, we have decided to proceed with the proposed approach we consulted on.

3.97 Outdoor deployments in the 2390-2400 MHz spectrum will need to be synchronised with the licensed user[49] in the adjacent 2350-2390 MHz band to facilitate sharing between both users and to ensure that networks in both bands can operate on an uncoordinated basis.

[49] Telefónica holds a national licence in the 2350-2390 MHz band.

3.98 We will impose frame alignment and frame structure requirements for outdoor base stations which are the same as those currently in the 2350-2390 MHz licence. This requirement does not apply for indoor low power base stations. However, if interference is being caused to other licensees in the 2300 MHz shared spectrum, or to the licensee in the 2350-2390 MHz band, we reserve the right to require the indoor low power base stations to adopt the same frame alignment and frame structure requirements as those licensees.

3.99 If the licensee in the 2350-2390 MHz band requests a licence variation to use an alternative frame structure, we would consult on this request and at the same time consult on changing the frame structure requirement in the 2390-2400 MHz band to align with the request. This is in line with our policy that users in the 2300 MHz shared spectrum should be synchronised with users below 2390 MHz to ensure efficient use of spectrum.

3.100 In relation to the common reference time that will be used to enable new users to synchronise with the licensee in the 2350-2390 MHz band, UTC should be used. A new frame should start at the start of the UTC 1 second boundary.

3.101 For the 3.8-4.2 GHz band, we recognise that our proposed frame structure may not be optimal for some future uses, including those that require low latency. Several respondents said that the proposed frame structure A and alternative frame structure B might not be optimal for all services. No alternative frame structures were put to us as part of the consultation process, although we recognise that there may not be a single preferred solution.

3.102 After careful consideration and taking into account our policy objective to enable opportunities for innovation, including use of the spectrum for 5G technologies, we have decided not to mandate synchronisation in the 3.8-4.2 GHz band.

3.103 In view of this, we will now adopt an I/N threshold of -6dB in our coordination tool to manage the co-channel protection requirement between new users.

3.104 In relation to the emission requirement outside the permitted channel, we will keep the limits that we specified for transmissions following the preferred 3:1 frame structure (see Table 3.5).

3.105 We will maintain our proposed approach to not undertake adjacent channel co-ordination between new users in the 3.8-4.2 GHz band. We recognise that there could be a risk of interference when users in adjacent channels are operating in close proximity to each other, particularly when operating at medium power and with antenna heights significantly above the surrounding clutter. We would encourage users in these circumstances to cooperate and reach mutual agreement on mitigation measures including, for example, appropriate synchronisation arrangements. Information on licences that we issue will be available in the Spectrum Information Portal.[50] This includes the location, technical details and licensee name.

[50] Ofcom, "Spectrum information portal", https://www.ofcom.org.uk/spectrum/information/spectrum-information-system-sis/spectrum-information-portal

3.106 In cases where undue interference occurs and where the licensees have been unable to agree suitable mitigation measures after a reasonable time (likely to be a few months), we reserve the right to enforce a synchronisation regime that we consider appropriate in the circumstances. We are including licence conditions that require licensees to comply with such requirements if notified by Ofcom. The factors that we may take into account when deciding an appropriate synchronisation regime will likely include, but are not limited to, which user deployed first in an area and the size/extent of networks that have been deployed. This means that users, when procuring radio equipment, should take into account the fact that they may need to adjust to different synchronisation regimes or risk having to replace their radio equipment in order to comply with any future synchronisation requirements.

3.107 In relation to coexistence with future licensees below 3.8 GHz, we proposed to award the 3.6-3.8 GHz band under national licences where licensees would be able to deploy anywhere within the UK to provide a national mobile network.[51] In that consultation, we proposed that the licensees' networks in the 3.6-3.8 GHz band should be synchronised to manage adjacent channel interference.

3.108 Given the higher transmit power allowed below 3.8 GHz, the risk that new users above 3.8 GHz will suffer interference from networks below 3.8 GHz is greater than the risk in the other direction (when users above 3.8 GHz are not synchronised with the networks below). To mitigate the potential risk of interference across the 3.8 GHz boundary, new users operating close to the 3.8 GHz boundary may wish to adopt the same synchronisation requirements as those proposed for spectrum below 3.8 GHz. Other mitigation options could also be considered such as site screening and other site engineering solutions.

3.109 We expect that existing and future licensees in the 3.4-3.8 GHz band may in the future make a licence variation request to use a different frame structure, for example, a frame structure that is more suitable for enhanced mobile broadband services allowing for lower latencies. Consistent with the approach highlighted above for Telefónica's 2350-2390 MHz spectrum, we would expect to consult on such a request.

3.110 In reaching this policy decision, we have considered that there could be greater opportunities for innovation in the 3.8-4.2 GHz band compared to the 2300 MHz shared spectrum, given that there is more spectrum available and that some new uses could be facilitated by 5G technology that covers this band. We have therefore taken a slightly different approach in the two bands, which we consider achieves the right balance of ensuring efficient use of spectrum while enabling opportunities for innovation.

3.111 We reserve the right to introduce a synchronisation regime for all users in the 3.8-4.2 GHz band in the future should we consider this necessary to ensure efficient use of shared spectrum. We are including licence conditions that would require licensees to comply with such requirements if notified by Ofcom. Where possible, licensees should ensure that

[51] Ofcom, *Award of the 700 MHz and 3.6-3.8 GHz spectrum bands*, 18 December 2018, https://www.ofcom.org.uk/consultations-and-statements/category-1/award-700mhz-3.6-3.8ghz-spectrum

equipment has the capability to operate under a different synchronisation regime, e.g. different frame structures, to ensure continuity of service.

Active antenna systems

Summary of responses

3.112 Approximately thirty respondents provided comments on the use of active antenna systems (AAS) and additional considerations we may need to take into account to ensure incumbent users remain protected. Respondents' views on this issue were mixed, with some supporting the inclusion of technical conditions to facilitate this technology and others suggesting that it should not be considered at this time, e.g. because it would make coordination more difficult and/or would increase the risk of interference.

Our decision

3.113 Users could deploy AAS in the 3.8-4.2 GHz band provided they comply with the technical licence conditions set out in this statement. However, we consider that further engagement with stakeholders is necessary before we consider any amendments to the technical conditions to further facilitate AAS in the 3.8-4.2 GHz band. We need to better understand the availability of commercial equipment, the implications for co-existence and how best to define the technical licence conditions to support AAS technology while ensuring incumbent users remain protected. We will continue to monitor developments in AAS technology with a view to consulting on any changes to the technical licence conditions and coordination methodology for AAS, if appropriate, at a later date.

Summary of our decisions

3.114 We summarise our decisions on the low and medium power technical licence conditions for the shared access bands in Tables 3.1 and 3.2 below. The base station emission limits outside the permitted channel for each of the shared access bands as well as the base station emission limits within the 1800 MHz shared spectrum are presented in Tables 3.3 to 3.7.

Table 3.1: Technical licence conditions for low power Shared Access licence

Parameters	Bands		
	3.8-4.2 GHz	*1800 MHz shared spectrum*	*2300 MHz shared spectrum*
Permitted deployment	Indoor and outdoor *Outdoor antenna system limited to 10 metres height above ground*		*Initially likely to be widely available for indoor only*
Authorised bandwidth	10, 20, 30, 40, 50, 60, 80 and 100 MHz (actual frequency range provided by Ofcom)	A paired 2 x 3.3 MHz	10 MHz
Maximum base station power (EIRP)	24 dBm / carrier for carriers ≤ 20 MHz; or 18 dBm / 5 MHz for carriers > 20 MHz	24 dBm / carrier (up to 3 MHz)[52]	24 dBm / carrier (up to 10 MHz)
Maximum terminal station power:			
For mobile/ nomadic	28 dBm[53] TRP	23 dBm TRP	25 dBm[53] TRP
For fixed/ installed	28 dBm[53] EIRP	23 dBm EIRP	25 dBm[53] EIRP
Frame structure requirements	Not applicable	Not applicable	3:1 structure for all outdoor deployments

[52] This power will only be available over 3 MHz of the 3.3 MHz bandwidth as existing power density requirements restrict the power in the first 200 kHz and last 100 kHz of the bandwidth.
[53] The European harmonisation and our authorisation include an additional 2 dB tolerance.

Table 3.2: Technical licence conditions for medium power Shared Access licence

Parameters	Bands		
	3.8-4.2 GHz	*1800 MHz shared spectrum*	*2300 MHz shared spectrum*
Permitted deployment	Rural areas	Rural areas *Outdoor antenna systems limited to 10 metres height above ground* *Initially limited availability in the 2300 MHz shared spectrum*	
Authorised bandwidth	10, 20, 30, 40, 50, 60, 80 and 100 MHz (actual frequency range provided by Ofcom)	A paired 2 x 3.3 MHz	10 MHz
Maximum base station power (EIRP) per sector	42 dBm / carrier for carriers ≤20 MHz; *or* 36 dBm/5 MHz for carriers > 20 MHz	42 dBm / carrier (up to 3 MHz)[54]	42 dBm / carrier (up to 10 MHz)
Maximum terminal station power			
For mobile/ nomadic	28 dBm[55] TRP	23 dBm TRP	25 dBm[55] TRP
For fixed/ installed	28 dBm[55] TRP and 35 dBm/5 MHz EIRP	23 dBm EIRP	25 dBm[55] EIRP
Frame structure requirements	Not applicable	Not applicable	3:1 structure for all deployments

[54] This power will only be available over 3 MHz of the 3.3 MHz bandwidth as existing power density requirements restrict the power in the first 200 kHz and last 100 kHz of the bandwidth.
[55] The European harmonisation and our authorisation include an additional 2 dB tolerance.

In band emission limits in the 1800 MHz shared spectrum

Table 3.3: 1800 MHz shared spectrum base station in band emission limits[56]

Frequency offset from the lower frequency of the band edge	Maximum mean EIRP density	
	Low Power	*Medium Power*
0 to 0.05 MHz	-33.6 + 153.3 x Δ_{FL}* dBm / kHz	-33.6 + 153.3 x Δ_{FL}* dBm / kHz
0.05 to 0.1 MHz	-26 + 60 x (Δ_{FL}*- 0.05) dBm / kHz	-26 + 60 x (Δ_{FL}*- 0.05) dBm / kHz
0.1 to 0.2 MHz	-23 + 230 x (Δ_{FL}*- 0.1) dBm / kHz	-23 + 300 x (Δ_{FL}*- 0.1) dBm / kHz
0.2 to 3.2 MHz	24 dBm / carrier	42 dBm / carrier
3.2 to 3.3 MHz	-23 + 230 x (3.3 - Δ_{FL}*) dBm / kHz	-23 + 300 x (3.3 - Δ_{FL}*) dBm / kHz

* Note: Δ_{FL} in MHz is the offset from the lower edge of the permitted frequency band at 1876.7 MHz (it has values in the range 0 to +0.2 MHz and +3.2 to +3.3MHz)

Out of band emission limits in the 1800 MHz shared spectrum

Table 3.4: 1800 MHz shared spectrum base station out of band emission limits[56]

Frequency offset from the lower frequency of the band edge	Maximum mean EIRP density
-6.2 to -3.2 MHz	-55 dBm / kHz
-3.2 to 0 MHz	-45 + 10 x (Δ_{FL}*+ 0.2)/3 dBm / kHz[57]
Frequency offset from the upper frequency of the band edge	**Maximum mean EIRP density**
0 to 0.05 MHz	-23 - 60 x Δ_{FH}* dBm / kHz
0.05 to 0.1 MHz	-26 - 153.3 x (Δ_{FH}* - 0.05) dBm / kHz
0.1 to 2.8 MHz	-45 - 10 x (Δ_{FH}* + 0.2)/3 dBm / kHz[57]
2.8 to 5.8 MHz	-55 dBm dBm / kHz

* Note: Δ_{FL} in MHz is the offset from the lower edge of the permitted frequency band at 1876.7 MHz (it has values in the range -3.2 to 0 MHz)
Δ_{FH} in MHz is the offset from the upper edge of the permitted frequency band at 1880 MHz (it has values in the range 0 to 2.8 MHz)

[56] These limits are the same as those permitted in the 1800 MHz shared spectrum following the TalkTalk licence variation in 2016: Ofcom, *Variation of Concurrent Spectrum Access 1781 MHz Licence*, 29 September 2016, https://www.ofcom.org.uk/__data/assets/pdf_file/0024/90447/160929-1781-MHz-Variation-Statement_final.pdf . Note however that we have made a minor change in the maximum mean EIRP density in the -3.2 to 0 MHz frequency offset from the lower band edge and 0.1 to 2.8 MHz frequency offset from the upper band edge

[57] As noted in the consultation, we correct the (-) sign to (+) in (Δ_{FL}*+ 0.2) and (Δ_{FH}* + 0.2) to ensure there is no negative step at 3.2 and 2.8 MHz from the lower and upper edge respectively as shown in Figure 9 of our December consultation.

Out of band emission limits in the 2300 MHz shared spectrum and synchronisation requirement

Table 3.5: 2300 MHz shared spectrum base station out of band emission limits

Frequency	Maximum mean EIRP density
2385 to 2390 MHz 2400 to 2403 MHz	(Pmax - 40) dBm / 5 MHz EIRP per antenna
2300 to 2385 MHz	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Above 2403 MHz	
24 dBm < Pmax ≤ 42 dBm	(Pmax - 41) dBm / 5 MHz EIRP*
Pmax ≤ 24 dBm	-17 dBm / 5 MHz EIRP*

* The maximum mean power relates to the EIRP of a specific piece of Radio Equipment irrespective of the number of transmit antenna.
Pmax is the maximum mean carrier power for the base station in question

3.115 The licensee's base stations must transmit within the limits of transmission Frame Structure A, except for indoor low power base stations. If indoor low power base stations cause undue interference to other licensees in the 2300 MHz shared spectrum, or to the licensee in the 2350-2390 MHz band, we reserve the right to require the indoor low power base stations to transmit within the limits of transmission Frame Structure A. This is shown in Figure 3.3.

3.116 Frame Structure A means:

- timeslots (or subframes) 0, 2 to 5 and 7 to 9 must be allocated to Downlink (D) or Uplink (U) transmissions as indicated or may be left with no transmissions;
- the Licensee must ensure that the special subframe (S) in timeslots 1 and 6 has a structure that is compatible with TD-LTE special subframe configuration 6, also known as 9:3:2;
- all timeslots must be 1 millisecond in duration and the frame must start at a common reference time so that frames are aligned with Telefónica and transmissions synchronised; and
- TD-LTE frame configuration 2 (3:1) is compatible with this frame structure. Other technologies are permitted provided that the requirements are met.

Figure 3.3: Frame Structure A

DL/UL ratio	Subframe number									
	0	1	2	3	4	5	6	7	8	9
3:1	D	S	U	D	D	D	S	U	D	D

Maximum power of base stations outside the permitted frequency channel in the 3.8-4.2 GHz band

Table 3.6: 3.8-4.2 GHz maximum power of base stations outside the permitted frequency channel

Frequency offset	Maximum mean EIRP density
-5 to 0 MHz offset from lower channel edge 0 to 5 MHz offset from upper channel edge	(Pmax - 40) dBm / 5 MHz EIRP per antenna
-10 to -5 MHz offset from lower channel edge 5 to 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna
< -10 MHz offset from lower channel edge > 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna

3.117 In addition, the EIRP emanating from the radio equipment transmissions at any frequency outside the 3.8-4.2 GHz band shall not exceed the following additional band edge requirements:

Table 3.7: 3.8-4.2 GHz base station out of band emission limits

Frequency	Maximum mean EIRP density
3795 MHz-3800 MHz 4200 MHz-4205 MHz	(Pmax - 40) dBm / 5 MHz EIRP per antenna
3760 MHz-3795 MHz 4205 MHz-4240 MHz	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Below 3760 MHz Above 4240 MHz	-2 dBm / 5 MHz EIRP per antenna

Coordination approach for potential assignment and methodology to be undertaken by Ofcom

What we proposed

3.118 We said that we would coordinate potential assignments on the basis that the proposed deployment may both cause interference to other users within the shared spectrum, as well as suffer interference from them. This would provide users with an understanding of the likely quality of service that they will experience.

3.119 We explained that, in order to do this, we would need relevant parameters of both new users and other services operating within the shared spectrum environment. In some cases these parameters would be provided as part of the licence application and enforced via the resulting licence, e.g. the site location and EIRP. For some of the parameters we proposed

to make assumptions about equipment performance or deployment approaches, e.g. assumptions about the transmit and receive antenna patterns.

Summary of responses

3.120 Most respondents that commented on this subject broadly supported our proposed coordination approach and methodology. A number of respondents asked for additional information on certain aspects of the methodology, and some gave specific feedback on the proposed parameters. We discuss some of these points below, and respond to detailed points in Annex 1.

3.121 Two respondents provided suggestions on how Ofcom could help applicants when an application fails the coordination process. Huawei suggested that it would be helpful if Ofcom could provide more granular feedback about the outcome of the coordination process, rather than just a yes/no answer, while a confidential respondent suggested that the licensed power could be varied on a case-by-case basis in order to maximise the potential for new entrants (e.g. reducing the maximum power by 2 dB if this would enable the application to be agreed).

3.122 A number of respondents commented on our proposal to include an additional 2 dB EIRP in our coordination calculations for "proxy" base stations. Huawei asked for more details on how the 2 dB proxy EIRP was arrived at. Avanti, ESOA and Intelsat said that our proposal for an additional 2 dB to compensate for multiple base stations may be adequate when considering traditional mobile applications, but that 5G consists of a variety of use cases where a high density of base stations may be required. Avanti, ESOA and SES additionally urged Ofcom to include the additional 2 dB in an enforceable total EIRP envelope or cap for all emissions under that licence.

Our decision

3.123 We agree that it would be useful to provide additional feedback as part of the coordination process. For example, in cases where the application fails the interference tests, we can provide applicants with information where relevant, on the margins by which they failed the coordination thresholds. Applicants for medium power licences will be able to use this information to inform any adjustments to their requested power and deployment location. Applicants for low power licences will be able to use this information to inform any adjustments to their *requested location only* but not the licensed power.

3.124 The additional 2dB was included with the aim of taking into account the possibility that interfering and victim low power base stations may be located anywhere within their respective 50 metre-radius areas and that the separation distance between them may therefore be less than if they were assumed to be located at the centre of the 50-metre area. This assumption is based on a scenario where the 50-metre areas are very close together; the additional 2 dB will be more than is required for scenarios where the 50-metre areas are further apart and is therefore a conservative assumption for the majority of cases.

3.125 We also consider that the probability of multiple low power base stations within a 50-metre area producing an aggregate interference impact towards nearby satellite earth stations that exceeds the levels assumed in our coordination approach (24 dBm EIRP + additional 2 dB) will be very low in practice. We therefore consider that the assumption of an additional 2 dB for the purposes of coordination between low power base stations and other users is a proportionate response to the interference risk. We also note that we have powers to require licensed users to modify their radio equipment in the event that harmful interference occurs.

3.126 Having reviewed responses on this subject, we continue to consider that the coordination methodology and parameters presented in our consultation are fit for purpose. As we have decided not to mandate synchronisation in the 3.8-4.2 GHz band, we have also decided to adopt an interference to noise ratio (I/N) of -6 dB as the co-channel protection requirement between unsynchronised users.

3.127 We may review these parameters at a future date if practical experience indicates that this would be beneficial.

Protecting users adjacent to the 3.8-4.2 GHz band

What we proposed

3.128 In our consultation, we proposed not to authorise new use in the top and bottom 5 MHz of the 3.8-4.2 GHz band (i.e. 3800-3805 MHz and 4195-4200 MHz), to reduce or remove the risk of undue interference to and from mobile base stations below 3.8 GHz and to radio altimeters above 4.2 GHz.

Summary of responses

3.129 Some respondents expressed concern about the potential for interference to radio altimeters above 4.2 GHz. ASRI pointed out that the ICAO paper cited in Annex 5 of our December consultation was just a working paper from one author that provided a preliminary assessment and said that further studies would be needed. It noted that the study did not include possible multipath effects, aggregate power from multiple base stations, or terminals situated at different points around the approach path or airport. It also said that there was ongoing testing of the performance of radio altimeters to better understand performance in the presence of adjacent band orthogonal frequency-division multiplexing (OFDM) signals, which it expected to be published in approximately Q2 2019, and recommended that this should be considered by Ofcom before implementing changes below 4.2 GHz. The CAA asked for regulatory assurance that there would be no interference to radio altimeters or WAIC systems operating in the frequency band 4200-4400 MHz. [✂].

3.130 Telet Research, on the other hand, said that it did not see any obvious issues with the use of either of these guard bands. Simon Pike also thought that Ofcom could allow assignments in 3800-3805 MHz for low power indoor base stations.

Our decision

3.131 We presented our analysis of potential interference from new shared use of 3.8-4.2 GHz spectrum to radio altimeters above 4.2 GHz in Annex 5 of the December consultation. Respondents did not indicate that they disagreed with our analysis and did not provide any technical evidence that indicated that our analysis was wrong. However, we note the points made about ongoing testing of the performance of radio altimeters. If additional evidence presented to us indicates that there are new unforeseen risks of interference, we have the flexibility to build additional safeguards into our coordination and assignment process as required.

3.132 In relation to Telet Research's comments, we consider that the remaining degree of uncertainty around radio altimeters as highlighted above supports our view that we should take a cautious approach and, in the immediate term, not permit use in the 4195-4200 MHz spectrum.

3.133 We do not intend to authorise new use in the 5 MHz block between 3800-3805 MHz. We note that, as mentioned in our consultation, the inclusion of this guard band does not materially reduce spectrum availability given that we are assigning spectrum with minimum bandwidths of 10 MHz.

3.134 We therefore continue to consider that it is appropriate to not authorise new shared use in the two 5 MHz blocks at the top and bottom of the 3.8-4.2 GHz band.

Protecting users in and adjacent to the 2300 MHz shared access band

What we proposed

3.135 For low power use, we considered that the interference risk from low power deployments to co-channel MOD users and ALDs/Wi-Fi in the adjacent 2400 MHz band to be low. However, as an additional measure, we proposed to make applicants aware that careful base station deployment should be considered in locations close to Wi-Fi access points and in environments where long-range ALD systems are more likely. We proposed to consider on a case-by-case basis whether outdoor base stations can be authorised when taking the various other uses and risks into account at those locations.

3.136 For medium power use, we proposed to take a precautionary approach and expected that medium power would be available in selected rural locations only, if we considered that interference to other users was minimal.

Summary of responses

3.137 We received responses from BT, the IEEE LAN/MAN Standards Committee and Cisco on coexistence with Wi-Fi, and from the IEEE on coexistence with other licence exempt services operating in 2400-2483.5 MHz.

3.138 BT, the IEEE LAN/MAN Standards Committee and Cisco were concerned that making 2390-2400 MHz available for mobile could reduce the performance of Wi-Fi in the adjacent 2400 MHz band, and said that further study was required before the band could be authorised for mobile. BT was particularly concerned that Wi-Fi coverage could be reduced and recommended that we consider the risk of harmful interference again.

3.139 Cisco and the IEEE LAN/MAN Standards Committee challenged our coexistence analysis, saying that:

- Previous studies considered a previous generation of Wi-Fi technology, not the most recent generation going on the market this year;[58] and that
- There are realistic scenarios where a 2300 MHz shared spectrum base station could be installed within 3m of Wi-Fi users, including residential and commercial scenarios, and the evidence shows an increased risk of Wi-Fi degradation at this range.

3.140 Cisco also made two further challenges, arguing that:

- Ofcom could not rely on improved Wi-Fi receiver standards, because these have not been agreed in Europe yet, and these would only improve coexistence for new devices, not the very large number of Wi-Fi devices in use today; and
- The "additional measures" proposed by Ofcom in the consultation were insufficient to overcome the risks described in the previous bullet points.

3.141 The IEEE LAN/MAN Standards Committee said that we should have also taken into account IEEE 802.15.4 technologies, including Zigbee and Wi-Sun.

Our decision

3.142 We understand that there could be several scenarios where a Wi-Fi device could be used when close to a 2390-2400 MHz base station, for example within an enterprise location or factory where both systems are installed. However, our review of the previous studies found that several factors must occur simultaneously for there to be a material risk of harmful interference[59] and that proximity between a Wi-Fi device and a 2300 MHz shared spectrum base station or terminal is, on its own, no guarantee that harmful interference will occur. We discuss the factors which affect the risk of interference and some coexistence scenarios in more detail in Annex 2.

3.143 We accept that previous studies only considered Wi-Fi devices designed to previous generations of the Wi-Fi standards, however, we consider that the recent changes to those standards are likely to make Wi-Fi more robust to interference and not less robust. We also accept that we will not be able to rely on new receiver standards when assessing coexistence with existing Wi-Fi devices in use and on the market today, however the new standards are expected to improve coexistence for future devices.[60] Taken together, we

[58] Previous studies had considered IEEE 802.11n whereas the most recent Wi-Fi technology is IEEE 802.11ax, also known as "Wi-Fi 6".
[59] Including harmful interference which manifests as a reduction in the range of the wanted Wi-Fi signal.
[60] New receiver standards for RLANs, including Wi-Fi, were agreed in ETSI on 1 July 2019.

consider that improvements in the standards will mean that future Wi-Fi devices will be more robust to interference from new users in 2390-2400 MHz. We discuss the technical reasoning behind our judgement in more detail in Annex 2.

3.144 We consider that the additional measures we consulted on remain appropriate for mitigating harmful interference from 2300 MHz shared spectrum devices to 2400 MHz licence exempt devices. We observe that these additional measures are not, on their own, necessary to prevent harmful interference because there is a combination of factors which need to happen simultaneously for harmful interference to occur. However, we consider that these additional measures effectively contribute to our ability to further reduce the risk of harmful interference.

3.145 Specifically, we will make applicants aware that careful base station deployment should be considered in locations close to Wi-Fi access points and in environments where long-range ALD systems are more likely. This will be set out in the guidance document we are publishing alongside this statement.

3.146 Secondly, we will initially limit the availability of licences in the 2300 MHz shared spectrum to indoor low power only. We will need to gather more evidence before making outdoor low power and medium power uses more generally available. This includes taking into account, amongst other uses, the risk of interference with Defence systems through further discussion with MOD.

3.147 We consider that our previous analysis took all licence exempt services into account and that the coexistence analysis discussed above for Wi-Fi also applies to other licence exempt services including those based on IEEE 802.14.5 (e.g. Zigbee and Wi-Sun).

Licence fee for the shared access bands

Type of fee

What we proposed

3.148 We considered it appropriate to set cost-based fees given our expectation of limited excess demand and the desire to encourage new and innovative use of underutilised spectrum. We also needed to balance the risk of over-recovery and under-recovery of spectrum management costs given the uncertain demand for these new licences. We said it was important to provide certainty to licensees, particularly in bands such as these where there is opportunity for innovation in the uses of the spectrum. We noted that we will keep the fees under review as we obtain evidence of actual demand and we would expect to review only if:

a) There was a significant misalignment with costs in the future; or

b) There was evidence of excess demand such that it was appropriate to move to AIP-based fees.

3.149 We found that existing users in the 3.8-4.2 GHz band are likely to create excess demand given the larger sterilisation areas from the deployment of these users. We proposed to

continue charging AIP-based fees for these users, consistent with Ofcom's Strategic Review of Spectrum Pricing ("the SRSP").[61]

3.150 However, we found that new users of the medium and low power licences for the shared access bands would not result in excess demand, thus we proposed to set cost-based fees.

3.151 We anticipated that the medium power licence was likely to be used for FWA and mobile coverage improvements in rural areas. Given the nature of these services, we found it likely that only a few users would be interested in using the spectrum in a given geographic area. Therefore, we concluded that there will be enough spectrum available for all users who wish to deploy these services in a given area.

3.152 For low power licences, we recognised the possibility for more users to be in very close proximity which could lead to a situation of very localised excess demand, particularly in urban areas. However, we found there to be insufficient evidence to suggest that these situations would often occur so concluded that in most instances there will not be any excess demand.

3.153 We noted that we might reassess our position once the new licences were rolled out and evidence of their actual demand and use was available. However, we would be mindful of the potential impact of large fee increases on licensees if we found that a fee review was required.

Summary of responses

3.154 Avanti, ESOA, Intelsat, SES, Vodafone and a confidential respondent ([✂]) argued that it was inconsistent and unfair to charge cost-based licence fees for new sharers when incumbent users pay higher, AIP-based fees. Federated Wireless argued that the price of spectrum should reflect the underlying market conditions.

Our decision

3.155 We believe the difference in fees is justified given that an earth station sterilises a much larger geographic area than a new user would. For example, a Permanent Earth Station is more sensitive to interference and thus requires a high level of protection, coupled with the assessment of short-term propagation conditions.

3.156 We will continue with our proposal to set cost-based fees for the new Shared Access licences as we consider it unlikely that demand from new users will lead to excess demand. We may reassess this position once new services have been rolled out and evidence of their actual demand and use is available, but there is currently insufficient evidence to suggest that a market-based price is required.

[61] Ofcom, *SRSP: The revised Framework for Spectrum Pricing*, 17 December 2010, https://www.ofcom.org.uk/__data/assets/pdf_file/0024/42909/srsp-statement.pdf

Level of fee

What we proposed

3.157 Having determined that cost-based fees were appropriate for new users, we proposed using the costs associated with the Business Radio Tech Assigned licence product as a proxy. We considered the use of a proxy to determine cost-based fees to be appropriate given the uncertain demand and costs associated with the new Shared Access licences. We noted that the process of issuing the licence for this proxy product is very similar to the proposed new product, thus we said that the ongoing costs were likely to be similar.

3.158 We proposed to set the average licence fee at £320 per year based on recent actual cost data for the Business Radio Tech Assigned licence product. We did not identify any reason for providing a concession to licensees and accordingly we proposed to introduce fees that fully reflect our spectrum management costs. Furthermore, we did not identify any need to phase in the introduction of fees given this is a new licence product.

3.159 However, we set out our concerns about potential unintended consequences with our proposed pricing approach, specifically the incentive to request an inefficiently large volume of spectrum which would end up being underutilised. We provided three drivers for inefficient use of spectrum:

a) Users fail to surrender licences that are no longer being used;

b) Users request more bandwidth than necessary to mitigate their own risks; and

c) Anti-competitive behavior such as hoarding.[62]

3.160 To resolve these issues, we proposed varying licence fees based on the amount of spectrum requested whilst having a consideration for the following principles:

a) In aggregate, what we collect in fees from the proposed new licence should fully recover our spectrum management costs. That is, the average cost-based fee charged should be £320;

b) All fees should cover at least the notional variable costs of issuing the licence, which we estimate based on the Business Radio Tech Assigned cost data to be roughly 10% of the average cost per licence. That is, the fee for the smallest bandwidth should be no lower than £32; and

c) All fees should contribute towards common and specific fixed costs, but we consider it reasonable and appropriate for higher bandwidth licences to make a greater contribution towards these costs.

[62] This is where a licensee requests more spectrum than it requires in a given location with the intention of not deploying that spectrum. The intention could be to prevent others from using the spectrum in that location, perhaps to reduce competition.

3.161 We assumed that the average licence would be for 40 MHz and proposed that fees for higher and lower bandwidths should be proportional to the fee set for a 40 MHz licence. This resulted in the proposed fees shown in Table 3.8 below.

Table 3.8: Proposed cost-based fees per annum by bandwidth

Channel size	Price per channel
2x3.3 MHz	£80
10 MHz	£80
20 MHz	£160
30 MHz	£240
40 MHz	£320
50 MHz	£400
60 MHz	£480
80 MHz	£640
100 MHz	£800

Summary of responses

3.162 Some stakeholders suggested alternative structuring of the cost-based fees. Two confidential respondents ([✂]) found the fee structure to be affordable but suggested scaling the licence fees to be consistent with the cost culture of customer premises equipment (CPE). Fairspectrum suggested pricing based on population density as it considered this to be correlated with demand. BT and Neutral Wireless argued for lower fees if a licence uses narrower channels.

3.163 Other stakeholders considered the fees to be too expensive. Two confidential respondents ([✂]) suggested that the fees should be lower, whilst Telet Research and Telint argued that the fees should be zero. Several stakeholders (FMS Solutions, Google, Heathrow Airport, Nokia, Simon Pike, and Urban Connected Communities) suggested that the pricing structure did not work for some use cases, e.g. femtocell or large-scale deployment.

3.164 FMS Solutions, Nominet and two confidential respondents ([✂]) suggested that Ofcom should provide the option for shorter duration licences to support temporary events where the spectrum may be needed for a short period of time. [✂].

3.165 Some stakeholders (Avanti, ESOA, Intelsat, [✂]) raised concerns about the impact on PES licence fees, specifically that new users should pay for any additional costs incurred by Ofcom.

Our decision

3.166 We consider it appropriate to have a simple pricing structure that helps to keep licences affordable, incentivises innovation and provides the opportunity for efficient use of spectrum. We do not consider structuring the fees to scale with CPE costs or population density or size of channel is consistent with our cost-based approach, nor is it clear that doing so would result in a more efficient use of spectrum. We set out our arguments for not allowing licences with narrower channels in paragraphs 3.74 to 3.75.

3.167 We consider cost-based fees to be at an affordable level whilst ensuring the recovery of costs incurred from the introduction of these licences. Although total fees vary depending on the number of licences required for larger scale deployments, we would also expect the gains from such a deployment to be relatively large. We note that most stakeholders either did not comment on or agreed with our fee proposals. Stakeholders who disagreed with the fee suggested both higher and lower fees.

3.168 We will charge the proposed annual fees by bandwidth. We continue to consider it appropriate to monitor demand but will only review fees when sufficient evidence is provided to suggest this is necessary, as set out in the consultation.

3.169 We consider it appropriate to allow short-term licences, i.e. those with a duration of less than 12 months. We have decided to set fees for these licences on a pro rata basis, subject to a minimum fee of £32 per licence.[63] The position in the December consultation for the annual fee to apply for short-term use would involve a risk of cost over-recovery.[64] On the other hand, with fees for short-term licences on a pro rata basis there is a risk of cost under-recovery.[65] On balance, we favour setting pro rata fees for short-term licences as it may encourage greater use of the spectrum.[66]

3.170 We currently do not expect to make any changes to PES licence fees as a result of the additional costs incurred by introducing the new Shared Access licences. New users will pay fees that not only recover the costs directly incurred by the Shared Access licences, but also some of the fixed and shared costs associated with coordinating, enforcing, and distributing licences more generally.

[63] As set out in paragraph 3.160 above, all fees should cover at least the notional variable costs of issuing the licence which we estimate to be £32 per licence.
[64] With short-term licences at the annual fee, multiple licences could be issued and charged when otherwise only one licence might be expected to be charged. Thus, total cost recovery could be greater and result in over-recovery.
[65] The average licence fee will reduce below £320 with short-term licences issued and fees set on a pro rata basis. If the introduction of short-term licences does not result in more licences, then total cost recovery will have reduced with a risk of under-recovery.
[66] This greater use can be because users are encouraged to not hoard spectrum throughout the year thus potentially providing more opportunities for users to benefit from the spectrum. Furthermore, it may reduce barriers to entry for use cases that support transient events or services.

Hoarding

What we proposed

3.171 We said that we did not expect hoarding to be a significant problem but clarified that the first come, first served basis of these proposed licence products must not be exploited to limit local competition. We saw no reason why users could not reach an agreement to transfer unused licences. We argued that in the extreme case that no agreement could be met, Ofcom could authorise one user over an existing user if the existing user could not legitimately deploy.

3.172 We said that if individual licensees appeared to be acquiring large volumes of licences to achieve a wide coverage area, then we may review access to the band for these users, particularly if there is a risk that their behaviour is sterilising spectrum access for a large number of other users. We also proposed the possible use of measures such as introducing a cap on the number of assignments each licensee can hold or limiting the number of applications that can be made over a given period.

Summary of responses

3.173 Sixteen stakeholders raised concerns about the prospect of new users hoarding spectrum, especially considering the first come, first served licensing process we have outlined. Federated Wireless, FMS Solutions, Motorola, Vodafone and two confidential respondents ([✂]) suggested implementing a use-it-or-lose-it clause in the licence or a cap on the amount of spectrum any single user can hold in a given location, or a reduction in the maximum licence period.

3.174 We note that AWTG thought that 5G services would use channel bandwidths larger than 40 MHz.

Our decision

3.175 We note that no stakeholders suggested a change to our proposed fees to address the risk of hoarding. We consider it likely that a cap would restrict some use cases, particularly at the suggested 40 MHz, which might significantly reduce the benefits of shared access.

3.176 We consider our pricing approach strikes the correct balance of reducing incentives to hoard without creating significant barriers to entry. Our aim is for spectrum to be used by those who need it and for the duration for which spectrum is required.

3.177 As outlined below, we are including in the licence terms and conditions a requirement for equipment to start transmitting within six months of the licence being issued and continue to be operational afterwards. If spectrum is not used in this timeframe, Ofcom may revoke the licence with one month's notice. We expect this will further reduce the risk of hoarding, particularly with a one-month notice period to revoke.

3.178 We consider that this new licence terms and conditions and the pricing approach proposed in the consultation, i.e. pricing per MHz, will allow us to deal with any hoarding issues that might arise. We will also monitor applications for any potential hoarding behaviour.

Dynamic spectrum access and the evolution towards a database approach

What we proposed

3.179 We want to ensure that the shared spectrum is used effectively and efficiently so that we can accommodate as many users as possible. We indicated in the December consultation our intention to consider a move towards an automated Dynamic Spectrum Access (DSA) approach which would ensure that access to spectrum is only authorised when equipment is transmitting. We want to achieve greater spectrum management flexibility and encourage the development of frequency agile equipment.

3.180 We indicated our aim to work towards a fully automated dynamic spectrum assignment approach whereby equipment communicates directly with a spectrum assignment database to be granted access to spectrum at the location and time required on frequencies unused by others (i.e. automatic spectrum assignment). This could facilitate more efficient sharing because frequencies would be available for new users when no longer required by previous users.

Summary of responses

Timing to introduce automated DSA

3.181 Most respondents agreed with our aim to work towards an automated DSA approach although there were varying views on the timing for this.

a) Respondents who supported moving to automatic spectrum assignment from the outset suggested that technology supporting this was already available and doing so now would remove disincentives to move to an automated DSA approach at a later date.

b) Respondents expressing caution indicated that the transition to a fully automated approach should take account of the availability of spectrum, the costs and complexity of equipment, the ability to perform bilateral discussions with neighbouring users and applications requiring guaranteed spectrum availability.

Other bands for DSA

3.182 Dense Air, the Dynamic Spectrum Alliance, Federated Wireless, Google, Nominet, Telet Research and Telint suggested that DSA should be introduced in the 3.6-3.8 GHz band (the University of Strathclyde and IET suggested 3.4-3.8 GHz), leveraging the availability of CBRS equipment. Nominet and University of Strathclyde additionally suggested the 700 MHz band.

Equipment supporting automated DSA capability

3.183 AWTG, Dynamic Spectrum Alliance, Fairspectrum, Neutral Wireless, Shyam Telecom and the University of Strathclyde noted that equipment already supports this method. AWTG, Motorola and UCC indicated that communication between equipment and the database is essentially a software issue, which can be performed at higher network control layers. Fairspectrum, Simon Pike and University of Strathclyde cautioned against specifying DSA functionality as part of device regulation, as this could limit future adaptability, and AWTG indicated that additional technical requirements such as sensing would be burdensome on equipment manufacturers. Motorola expected the 5G ecosystem in 3.3-4.2 GHz (NR Band 77) would rapidly develop and become commercially available whilst the IET & 5GFF and Ruckus Wireless expected it would take five years for a suitable equipment ecosystem to develop in the 3.8-4.2 GHz band.

Our position

3.184 We consider DSA as a concept whereby access to spectrum is only authorised when equipment is transmitting, and spectrum becomes available to others when it is no longer required by the previous users. This will facilitate flexible and efficient spectrum management.

3.185 Further time is needed to implement a DSA approach supported by a fully automated authorisation database where radio equipment used is capable of communicating with the database. We remain of the view that making spectrum available for new users in the meantime, as proposed, is important to facilitate innovation and assess the nature and volume of demand.

3.186 We also agree that it is important to be clear that the current approach is an interim measure, and to signal that we may move towards a fully automated database approach if appropriate in due course in line with our objective to ensure that the shared spectrum is used effectively and efficiently. This underlines the need for the development of frequency agile equipment with the capability of communicating with a central database.

Licensing provisions

3.187 In order to support a future transition, we consider it is necessary to adopt an innovative licensing approach which embeds the DSA concept in our Shared Access licences from the outset and to emphasise this approach in this statement, we will:

a) Add to the Shared Access licence terms and conditions, the requirement that Ofcom can notify licensees to change frequency from time to time in the 3.8-4.2 GHz band.

i) We note that chipsets are already available to support the entire 3.3-4.2 GHz band, catering to the different spectrum availability in different countries. We would encourage users to deploy equipment that has the capability to deploy across the entire band (particularly 3.8-4.2 GHz) to ensure continued ability to deploy when we transition to a fully automated database. This requirement would enable us to

be flexible and efficient in managing access to the band including moving users to different frequencies in the event of interference.

b) Require equipment to transmit within six months of the licence being issued and continue to be operational afterwards. Failure to do so could result in Ofcom revoking the licence with one month's notice. We want to ensure that spectrum is only used by those who continue to need it and is available to others if no longer required by existing users.

3.188 We note that once we have implemented a spectrum assignment database, if appropriate, that can interface directly with the equipment, we will be able to take a much more efficient and proactive approach to enforcing equipment being brought into actual use. For example, this could be triggered when a new user is prevented from deploying because an assignment has already been made to another user, suspected of being inactive, in the same location.

3.189 Access to our shared access bands will be on a first come, first served basis and we would expect that established installations would generally be able to continue their deployment in the band as long as their equipment remains operational and provided that any relevant technical parameters are complied with, for example in relation to transmission.

3.190 We are commencing work following publication of this statement to assess whether it would be appropriate to transition towards dynamic spectrum access supported by a fully automated authorisation database. We consider that the specification of the communication between the radio equipment and database is best done in collaboration with industry, particularly equipment vendors. This would allow appropriate consideration of the costs and complexity of implementation, both in relation to the radio equipment and the spectrum assignment database.

3.191 We note comments from stakeholders recommending we introduce DSA in the 700 MHz and 3.6-3.8 GHz bands. We have proposed a separate approach to enable access to licenced mobile spectrum and this would apply to the 700MHz and 3.6-3.8 GHz bands if we decide to award them. Our proposal to award these bands is currently the subject of a separate consultation.

Other licence conditions

3.192 We proposed non-technical licence conditions for the Shared Access licence which were broadly in line with the standard licence terms and conditions Ofcom includes in all its licences.[67]

3.193 Licences issued by Ofcom do not grant exclusive rights over the frequencies covered by the licenses, and we have the discretion to authorise use of these or any other frequencies, for other purposes, in line with our statutory duties.

[67] December consultation, paragraphs 4.22-4.30

Trading

What we proposed

3.194 We proposed that the licensee would be able to transfer their spectrum rights and obligations in the following ways:

a) Outright total transfer of rights to another party;

b) Concurrent total transfer of rights, so two or more parties jointly hold the licence; or

c) Partial outright and partial concurrent transfers of frequency rights in one or more blocks of 10 MHz in the 3.8-4.2 GHz band.

Summary of responses

3.195 Several respondents (AWTG, Fairspectrum and Motorola) supported our position that the Shared Access Licence should be tradeable. Motorola also supported the idea of being able to trade licences in the 3.8-4.2 GHz band in blocks of 10 MHz. On the other hand, a confidential respondent ([✂]) suggested that trading should not be permitted, and that spectrum should go only to those who can deploy in order to prevent speculating.

Our decision

3.196 Given that we are adopting a flexible approach in the Shared Access licence to clarify that access to spectrum is only authorised when equipment is transmitting, we consider that trading has limited value as users should only apply for the spectrum that they need.

3.197 However, we note that there could be circumstances where the ability to allow a transfer of spectrum may be useful, such as when transferring assets between companies as part of a takeover, or to ensure a continuation of service where multiple users agree to jointly hold a licence, for example in a multi-storey building.

3.198 We therefore will allow licensees to transfer all their spectrum rights through an outright or concurrent trade but will not allow any form of partial transfer.

3.199 We intend to consult shortly on a draft Statutory Instrument to achieve this.

Licence duration and revocation

What we proposed

3.200 In common with many of our existing licence terms and conditions, we proposed that the licence would be for an indefinite duration, subject to the payment of an annual licence fee. The licence would also permit Ofcom to give five years' notice to revoke the licence for spectrum management purposes.

Summary of responses

3.201 Some respondents, including several from the satellite sector, suggested that the licences should not be for an indefinite duration, and should be time-limited. Suggestions for the appropriate licence duration included three, five and ten years.

3.202 We also received some comments that it would be useful to have the option for a shorter-term licence than one year, and that this could be beneficial to transient or temporary users, such as those looking to provide a service for an event.

3.203 Several respondents commented on the Shared Access licence's proposed five-year revocation period for spectrum management purposes. Although some respondents agreed with the five-year period we proposed, others suggested that this was too short, as the long-term investment needed for industrial and business users to deploy wireless installations on their premises required a greater security of tenure than this. Conversely, several respondents suggested that five years was too long, as this would make it difficult for Ofcom to revoke the licences of users who obtained licences but then failed to use these, in order to allow new users to make better use of the spectrum.

Our decision

3.204 In relation to shorter-term licences of less than one year, we agree and will allow licences for shorter durations. These licences will follow our standard short-term licensing process. Licences will be charged on a pro-rata fee subject to a minimum fee of £32 per licence.

3.205 In response to the request for a time limited licence, we consider that an indefinite licence period enables users to continue to deploy as long as they remain operational upon payment of an annual licence fee. This gives users a degree of certainty and control over their spectrum access. We also want to ensure that spectrum is available to others when no longer required which is reflected in our proposed licence terms.

3.206 In relation to the licence revocation period, we are adopting a different approach to the standard five years' notice, given the uncertainty about how use of these frequencies may develop. We therefore think it is appropriate to maintain discretion and flexibility for Ofcom to deal with unforeseen circumstances that might arise and enable it to make and give effect to any future spectrum management decisions in an efficient manner.

a) We consider a one-month notice period is appropriate to allow us to revoke licences more quickly to enable more efficient use of spectrum, for example where the user fails to transmit as required under the licence.

b) Nevertheless, we understand the need for certainty on access to spectrum to support investment; in particular we recognise that wireless connectivity solutions in some sectors require long-term investment. Should we consider repurposing the band for alternative uses, we will take account of the impact of this decision in determining a reasonable notice period. This will be longer than one month and will not occur without us first conducting a formal consultation.

Information gathering

What we proposed

3.207 We explained that in line with our duty to manage the spectrum efficiently, the licence would include standard conditions to require licensees to provide us – on request – with general information regarding their equipment and use of frequencies, or the rollout of their network.

3.208 Provision of this information could help identify actual spectrum usage and facilitate authorisation of frequencies for other purposes where we consider this appropriate in line with our statutory duties.

Summary of responses

3.209 [✂]. Dense Air was concerned that the inclusion of such a provision would require it to register thousands of small cells.

Our decision

3.210 The information gathering provisions in the licence are intended to allow Ofcom to request information regarding the use of the spectrum by the licensee. The provisions allow Ofcom to request information regarding the use of the spectrum by the licensee. We would expect that licensees would be keeping records of their deployed equipment. Information collected under Ofcom's powers is subject to a number of legal provisions relating to its handling and disclosure.[68] Any commercially sensitive information will be handled in accordance with these provisions.

3.211 For low power licences, we are to require the licensee to maintain a record of the address, antenna height above ground and antenna type of all base station deployments. In cases of interference being reported, this should enable Ofcom to narrow down the source of any potential problem. The recording of such information would also be needed when the authorisation process moves to a DSA approach supported by fully automated database.

3.212 For fixed terminals for both the low and medium power licences, licensees will be required to keep an accurate record of the location (NGR to 1 metre resolution) and antenna information (antenna type and height above ground). This will facilitate Ofcom in carrying out its enforcement duties in the case of interference being reported.

3.213 For mobile terminals deployed in the 3.8-4.2 GHz band for both the low and medium power licences, licensees will be required to keep an accurate record of the mobile terminals and the address of the site or building they are limited to operate within. This is in line with our policy that use of the 3.8-4.2 GHz band is not intended to supplement national mobile networks.

[68] For example, under the WT Act, Communications Act 2003, Data Protection Act 2018, Freedom of Information Act 2000 and Environmental Information Regulations 2004

Geographical boundaries

What we proposed

3.214 We outlined that the licence would allow the deployment of transmitters at the locations defined in the licence. Licences would be available for locations within the United Kingdom and territorial seas. We said that authorisation in the Channel Islands and Isle of Man may be possible, but this would be subject to further discussions with the island authorities.

Our decision

3.215 Licences will be available for locations within the United Kingdom and the UK territorial seas.

3.216 The 1800 MHz shared spectrum will not be available in the Channel Islands or Isle of Man. Additionally, the 2300 MHz shared spectrum will not be available in the Isle of Man or Northern Ireland. However, if in the future these bands do become available in these locations then we would consider incorporating them into the licence products.

Other issues

Process of issuing licence

3.217 Several stakeholders insisted that it would be crucial for Ofcom to be able to issue the new licences within a reasonable timeframe, in order to provide certainty to users and their clients. Although the WT Act sets out that Ofcom will process licence applications within six weeks for all licences set out in the UK Plan for Frequency Allocation[69] (unless international coordination is required),[70] in practice the majority of licence applications are dealt with much more quickly than this, where we have the necessary information to assess the application. Applicants can help us to ensure that their applications are dealt with promptly by ensuring they submit accurate, fully completed applications and that payment is made quickly on receipt of the invoice. In the future, when we transition to a fully automated spectrum assignment database, this should make the licensing process quicker.

Numbering

3.218 In our December consultation we commented that the introduction of new licensees in mobile bands could potentially have an impact on demand for numbering resources. If a communications provider sets up a mobile network, or infrastructure which offers services using a publicly-available mobile network, a Mobile Network Code (MNC) is required to ensure calls can be routed through to users on the network. If new entrants want to offer

[69] Ofcom, "Spectrum information portal", https://www.ofcom.org.uk/spectrum/information/spectrum-information-system-sis/spectrum-information-portal
[70] WT Act, Schedule 1, para. 2(1)(a): https://www.legislation.gov.uk/ukpga/2006/36/schedule/1

commercial mobile services directly to consumers they will also need to have mobile numbers assigned to them, either directly by Ofcom or by another provider with an allocation of mobile numbers.

3.219 Our initial assessment suggested that the potential increase in demand for mobile numbers and MNCs would not put undue pressure on our current supply. However, we sought stakeholder comment on this issue as we were concerned that future demand might be difficult to predict.

3.220 Responses to the consultation confirmed that forecasting demand remained difficult, with some respondents agreeing it should be manageable, while others identified potential use cases that could result in a significant increase.

3.221 We welcome the comments received on potential demand for mobile numbers and MNCs. We also welcome the suggestions for how Ofcom might manage significant increased demand for numbering resources, should that situation arise. These include options for extending the digit length of MNCs and for sharing MNCs between providers. These are useful in our ongoing work to ensure we can support opportunities for innovation with appropriate access to numbering resources. We will continue to monitor demand closely and plan to look in more depth at the examples provided by respondents to understand scenarios where demand is likely to arise and how we might manage that demand.

Roaming

3.222 FMS Solutions commented that attempts to establish localised roaming arrangements with UK MNOs was very challenging as they do not support national roaming. They further outlined the ways in which it felt provision of additional localised coverage by third parties was a benefit to the MNOs and their customers, rather than a threat to the MNOs. FMS Solutions also described two additional barriers even if MNOs were minded to support third-party roaming, namely call charges for consumers (i.e. if urban and rural customers are to be charged the same, the third-party provider makes money from transiting traffic onto the local network so the MNO has to pay) and interconnect testing. FMS solutions suggested the latter costs several hundred thousand pounds per MNO.

3.223 We note these comments and hope that our plans for both the Shared Access and Local Access licences open up new opportunities for this sort of collaboration between MNOs and local providers.

Action in cases of interference

3.224 Arqiva asked what approach we would take if interference was found to occur between a new and incumbent user even if both were operating within the terms of their respective licences. Arqiva suggested that enforcement action should be taken against the new user, rather than the incumbent. Generally speaking, in such situations we would look to amend the licence of the new user to prevent any further interference. However, we would assess any case based on the specific circumstances involved. The terms and conditions of the Shared Access licence, outlined above (and included in Annexes 6 and 7), include

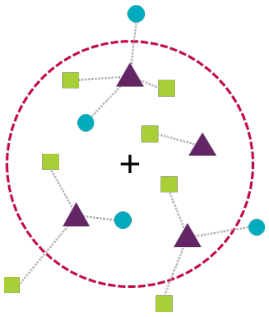
provisions that enable Ofcom to inspect licensees' equipment and force closedown of users' equipment if this is causing interference.

Summary of our decisions

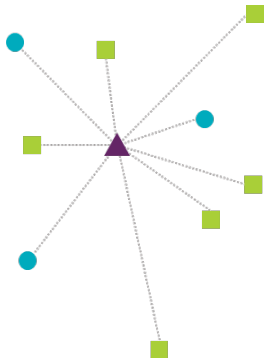
3.225 We confirm our decision to make available spectrum in the 1800 MHz and 2300 MHz shared spectrum, and the 3.8-4.2 GHz band, for shared access on a first come, first served, Ofcom-coordinated basis. We also confirm our decision to align the authorisation approach for existing licensees in the 1800 MHz shared spectrum with the authorisation approach for the shared access bands covered in this statement.

3.226 We are creating a new type of licence product, the Shared Access licence. There will be two types of Shared Access licence available as shown below:

Figure 3.4: Low power (left) and medium power (right) Shared Access licences



Licence authorises all base stations within 50 metres of a given location (max EIRP 24 dBm), and any connected terminals.



Licence authorises a base station at a given location (max EIRP 42 dBm) and any connected terminals.

Legend

- Base station
- Fixed/installed terminal
- Mobile/nomadic terminal

3.227 In the 2300 MHz shared spectrum, this licence will initially be available for indoor low power only.

3.228 The medium power licence is intended to be generally available for deployment in rural areas only.

Technical licence conditions

3.229 The full technical licence conditions for the low power and medium power licences can be found in Tables 3.1 to 3.7 above. The key changes we are making are in relation to the 3.8-4.2 GHz band. These are:

a) We are removing the synchronisation requirements in the 3.8-4.2 GHz band. We will require licensees to cooperate and agree on an appropriate frame structure requirement if harmful interference is caused; failure to do so may result in Ofcom notifying licensees of additional technical conditions in relation to the synchronisation requirement.

b) We are increasing the power level for fixed/installed terminals operating under the medium power licence in the 3.8-4.2 GHz band. Terminals must comply with both a maximum TRP of 28 dBm and maximum EIRP of 35 dBm / 5 MHz.

c) We are increasing the maximum power level for mobile/nomadic terminals operating under both the low and medium power licence for the 3.8-4.2 GHz band. We will allow a maximum TRP of 28 dBm, which aligns with the EC Decision covering the 3.4-3.8 GHz band.

Technical coordination

3.230 We set out the coordination parameters and methodology that we intend to use to coordinate access to the shared access bands in Annex 4. This remains the same as proposed except we will be using I/N of -6 dB for co-channel interference between new users in the 3.8-4.2 GHz band instead of I/N of 0 dB, given we are no longer mandating synchronisation in this band.

Non-technical licence conditions

Duration of the licence

3.231 The licence will be for an indefinite duration, subject to the payment of an annual licence fee. We will also allow short term licences for less than one year, which will be charged on a pro-rata basis subject to a minimum fee of £32 per licence.

3.232 The licence will be subject to a one-month revocation notice. We can revoke the licence for spectrum management purposes, or if licensees are in breach of their licence conditions.

Licence transfer through spectrum trading

3.233 Licensees will be able to transfer their spectrum rights and obligations in the following ways:

- Outright total transfer of rights to another party; or
- Concurrent transfer of rights, enabling two or more parties to jointly hold the licence.

Access and Inspection

3.234 In accordance with our standard spectrum licence conditions, the licence includes a condition that reserves to Ofcom the right 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, should we decide that is appropriate.

Modification, Restriction and Closedown

3.235 In accordance with our standard spectrum licence conditions, the licence includes a condition that gives Ofcom the right 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.

Geographical boundaries

3.236 The licence allows the deployment of transmitters at the locations defined in the licence. Licences will be available for locations within the United Kingdom and the UK territorial seas. The 1800 MHz shared spectrum will not be available in the Channel Islands or Isle of Man. Additionally, the 2300 MHz shared spectrum will not be available in the Isle of Man or Northern Ireland. However, if in the future these bands do become available in these locations then we would consider incorporating them into the licence products.

Provision of information to facilitate optimal spectrum use

3.237 In line with our duty to manage the spectrum efficiently, the licence includes 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.

3.238 For low power licences, licensees will be required to maintain a record of the address, antenna height above ground and antenna type of all base station deployments.

3.239 For fixed terminals for both the low and medium power licences, licensees will be required to keep an accurate record of the location (NGR to 1 metre resolution) and antenna information (antenna type and height above ground).

3.240 For mobile terminals deployed in the 3.8-4.2 GHz band for both the low and medium power licences, licensees will be required to keep an accurate record of the mobile terminals and the address of the site or building they are limited to operate within.

Requirement to commence and maintain transmission within six months

3.241 Licensees will be required to start transmission within six months of the issue of their licence and remain operational thereafter.

Special conditions relating to the radio equipment

3.242 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 across the entire band when requesting channels in the relevant band.

Licence fee

3.243 We will implement the licence fees as proposed. Licence fees will be applicable for both the low power licence (charged on a per area basis) and medium power licence (charged on a per base station basis), and payable annually:

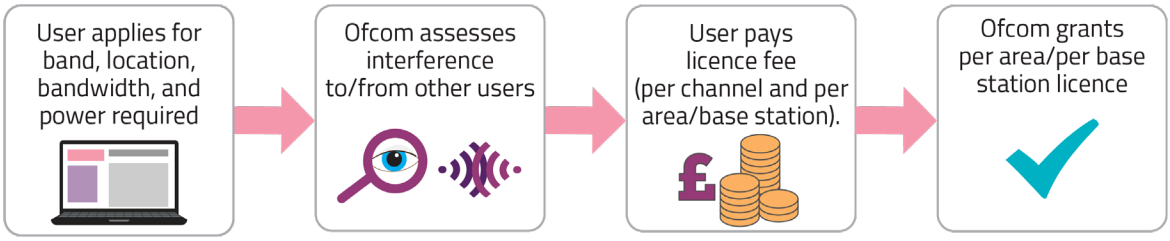
- **£80 per 10 MHz** (for 3.8-4.2 GHz and the 2300 MHz shared spectrum, so 20 MHz = £160; 100 MHz = £800 etc.)
- **£80 for 2x3.3 MHz** (for the 1800 MHz shared spectrum).

3.244 Short-term licences (i.e. less than one year) will be charged on a pro rata basis, with a minimum price per licence of £32.

Process for considering applications

3.245 The chart below summarises the high-level process for users to access spectrum.

Figure 3.5: Shared Access licence application process



3.246 The guidance we have published alongside this statement sets out the approach Ofcom generally expects to take when assessing and issuing shared access licences.[71] However, we may consider exceptional applications on a case-by-case basis and we retain the discretion to amend our approach, and to make exceptions or disapply the guidance if it is appropriate to do so in the particular circumstances. We will also keep this general guidance under review and may amend it from time to time as appropriate.

[71] Ofcom, *Shared Access licence: Guidance document*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0035/157886/shared-access-licence-guidance.pdf

4. Access to licensed mobile spectrum

Introduction

4.1 There is spectrum that is currently licensed on a national basis to MNOs, but is not being used in every location. We think it is appropriate to enable this unused spectrum to be made available to new users in line with our duties, including to promote spectrum efficiency and support innovation. Allowing access to these bands potentially provides additional spectrum options for people wishing to use spectrum that supports mobile technology, whilst recognising the fact that there are licensees with existing rights of access to mobile spectrum on a UK-wide basis. We would therefore expect only to allow new users in the licensed mobile bands where this would be unlikely to interfere with the existing licensees' network and would not unreasonably constrain their future plans.

4.2 Given the nature and extent of existing use of licensed mobile spectrum we anticipate that spectrum is only likely to be available to share in remote areas to support, for example, private networks or wireless broadband services. There may also be other specific locations that are not served by the existing mobile network, for example underground mining operations, where mobile technology to support a private network could be utilised without impacting the incumbent network or future plans. We think that in these cases the current market mechanism for obtaining access to the bands, through a spectrum trading agreement, might not be attractive, as discussed below.

4.3 In our December 2018 consultation we proposed an alternative, simple way for people to request access to licensed mobile spectrum where possible by applying to Ofcom. Although people could apply for access to spectrum in any of the mobile bands defined in the Mobile Trading Regulations,[72] clearly any discussion on current and planned use with the relevant MNO would vary from band to band. In particular, we recognised that it would take time for newly awarded spectrum to be rolled out to an extent that we would expect a new user to confidently assert there was a location where the spectrum was not being used or planned to be used.

4.4 This section explains our decision to proceed with the proposal to make a new Local Access licence available. It outlines what we proposed in more detail and how we made our decision having taken account of the responses received during the consultation.

Approach to enabling access to licensed mobile spectrum

What we proposed

4.5 We outlined an approach for new users to access licensed mobile spectrum in locations where we agree this would not adversely impact the incumbent licensee's current or

[72] Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011, as amended, http://www.legislation.gov.uk/uksi/2011/1507/contents

planned use of the spectrum. We proposed that this approach would not replace but rather sit alongside our existing spectrum trading framework. Our view was that this could be a less burdensome and more proportionate approach in some cases than spectrum trading. We also recognised that leasing spectrum rights in mobile bands is not currently permitted but felt that our approach could achieve a similar outcome.

4.6 Our aim was to provide a simple process for MNOs to share access to their licensed but unused spectrum with other users and we expected that this could generally work in one of two ways:

a) In cases where the new user was unlikely to impact the current or planned use of the spectrum by the MNO, and where this was relatively easily determined, Ofcom would expect to issue a three-year licence on receipt of a cost-based fee; or

b) In cases where the new user required access to the spectrum for a period longer than three years, this could require a commercial agreement between the new user and the MNO in order to secure access for that period. Following confirmation of an agreement between both parties Ofcom would then issue a licence for the duration agreed, on receipt of a cost-based fee.

4.7 Under our proposal, a potential new user would apply to us for a time-limited local access licence to use specific frequencies at a particular location. We would engage with the relevant MNO(s), to confirm the terms of the new licence or to discuss any specific concerns or objections they might have. We considered that a minimum three-year period was a reasonable time frame over which an MNO would have sufficient certainty about their deployment plans to respond quickly to the request. It would also provide new users with certainty of access over a reasonable time period to support a business case for investment.

4.8 In the following section, we consider respondents' views on our proposals and set out our decisions in light of these responses.

Spectrum trading

Summary of responses

4.9 BT, Vodafone, Three and Telefónica, although in favour of the general aims of ensuring spectrum is used efficiently, were not supportive of the proposals as set out in the December consultation. BT and Three stated that the proposed approach represented a move away from spectrum being deployed based on market-based mechanisms (including trading that supports both transfer and lease), to a more prescriptive approach reminiscent of the earlier "command and control" approach to spectrum management. Both believed that as there is no obvious market failure there was no need for Ofcom to intervene.

4.10 BT considered that Ofcom's proposals could reduce the incentive to transfer spectrum under the spectrum trading regime. Under Ofcom's proposals, new users would only have

to pay an administration cost-based licence fee for any unused spectrum rather than what BT pays in regards to Administrative Incentive Pricing (AIP).

4.11 BT, Ericsson, techUK, Telefónica and Vodafone suggested that Ofcom should allow licensees to lease access to their spectrum. Three and BT considered that spectrum leasing can promote sharing without the need for further intervention. Vodafone welcomed Ofcom's proposals as it provided a mechanism to effectively sub-let spectrum but wanted access only for those third parties that it had reached an agreement with. Others outlined that spectrum leasing should be allowed in order for MNOs to recover some of their costs when dealing with such requests. BT and Three highlighted that the proposals were inconsistent with requests by Government for Ofcom to clarify that spectrum leasing is not prohibited.

Our position

4.12 We recognise that it is already possible for people to gain access to currently licensed mobile spectrum through the spectrum trading process which is based on a commercial agreement between the parties with very little Ofcom involvement. However, our experience shows that this process is used mainly to enable the transfer of rights to spectrum from one user to another rather than to share access rights. Furthermore, although spectrum trading can be effective in facilitating such outright transfers of spectrum rights, we note that even here it is only likely to happen where there is sufficient return to make the effort worthwhile. Where the transaction costs are too high, because it takes too much effort to organise a transaction or where there is too much perceived risk, it is not likely to happen. Sharing spectrum in a particular location is both complex in terms of the transaction and less likely to realise a significant return.

4.13 Spectrum leasing is a simplified form of spectrum trading that we permit in a small proportion of our licences (not currently mobile licences). As well as incurring transaction costs, the leasing process makes the incumbent licensee responsible for ensuring that the new user it leases spectrum to adheres to the terms of the licence. This introduces additional effort and an element of risk to the process which could act as a disincentive to share spectrum by this method. We are therefore introducing a simple process to ensure access to spectrum can be shared in instances where spectrum trading is not likely to be attractive. We consider that the process we proposed will complement trading. Our approach does not rule out agreements being reached between the parties, which may involve some commercial element (including payments between them).

4.14 Our guidance on spectrum trading is clear that leasing in mobile bands is not currently permitted although we will keep this position under review. We believe we can realise the same benefits that leasing might achieve more quickly and easily through our proposed local access approach.

4.15 We do not think that the Local Access licence will reduce incentives to transfer spectrum under the spectrum trading regime nor do we anticipate that they will impact any annual licence fees that current licensees pay or the basis of those fees. Users of a Local Access licence will pay a fee below those levels, but the licence they receive will be in respect of

only very localised geographic locations, and they will face less certainty regarding the long-term availability of the licence. Therefore, some users may prefer a traded licence, e.g. those facing a long payback period for their investments, whilst others may prefer a Shared Access licence.

4.16 We also do not expect shared access to undermine the private value of spectrum or the incentive to invest since access will only be granted where the incumbent licensee has no foreseeable plans to deploy.

Alternative approaches

Summary of responses

4.17 BT, Vodafone and Telefónica all proposed broadly similar alternative solutions. BT recommended a process whereby the MNO would issue a certificate to the third party once an agreement had been reached between the two parties. Telefónica and Vodafone said they would expect that any agreement by Ofcom to over-license MNOs' spectrum would be accompanied by a commercial agreement between the licensee and the prospective sharer. Once these agreements were in place Ofcom could then proceed to issue the licence.

4.18 Vodafone argued such an agreement was required to protect both parties as they could factor the application into their network planning tools and give certainty of access to the prospective sharer.

4.19 BT and Telefónica stated their alternative approach was a more appropriate and fair way to incentivise existing licence holders to facilitate spectrum sharing. It would compensate them for the costs of examining the sharing proposal and the potential opportunity costs that such sharing may give rise to in relation to the existing rights of the affected MNO. BT stated that its proposed approach would provide greater benefit for consumers because MNOs would have strong incentives to support a certification regime, given the prospect of commercial revenues from new users that enable the MNO to recover costs and pass the licence conditions to the new user.

4.20 BT stated that MNOs may have the greatest interest in accessing one another's spectrum where it is not yet deployed. They noted that existing licensees are not prevented from applying for each other's spectrum under the proposals therefore, they could apply for licences simply to prevent their competitors from deploying spectrum in future for uses they cannot envisage today. They suggested that Ofcom might wish to consider how it is able to address any competition issues that arise prior to granting licences for shared use. They advised that it will be important that Ofcom has the necessary statutory powers to perform ex-ante competition checks and where necessary decline to issue licences for shared spectrum. They advised that their proposal would stop MNOs gaming the system to expand their holdings.

4.21 Three suggested that an alternative approach could be that the Local Access licences are issued on a concurrent basis whereby the names of the third party and the incumbent

licensee were both on the licence. Ruckus proposed that Ofcom should encourage the formation of one or more licence marketplaces or brokerages where existing licensees could register used and unused areas along with operational characteristics. They suggested that new users could then register their need for spectrum in a certain location or/ area along with the relevant technical characteristics. They argued that this could ease the administrative burden on Ofcom, the existing licence holders, and the new users.

4.22 A number of respondents raised concerns over the manual nature of the proposals and that they believed that this should be automated. iWireless Solutions stated that the process, although acceptable, would be slow and unlikely to facilitate widespread usage by third parties. techUK raised concerns about Ofcom's ability to scale the proposed labour-intensive approach if responding to large volumes of applications for local access licences. techUK's response was to suggest that Ofcom should proceed with authorising the sharing of spectrum in these bands using DSA rather than the proposed manual approach. The IET & 5GFF suggested that Ofcom should set the parameters that would protect incumbent users' deployments and that everything outside of that could then be made available for sharing.

Our position

4.23 Our proposals would not prevent incumbent users from reaching a commercial agreement with new sharers if this was needed to underpin significant effort required to secure longer term access to mobile spectrum. Our local access licensing approach provides for a range of circumstances where a commercial agreement may or may not be needed. All applications for access to mobile spectrum will be discussed and agreed with the incumbent licensee – some may be simple and require little effort; others may be more complicated and a commercial agreement between the parties may be appropriate. In all cases Ofcom will seek to facilitate agreement with the relevant MNO and be responsible for authorising access to spectrum by the new user.

4.24 An MNO could apply for a Local Access licence but, as with all other applications, a licence will only be granted in areas where the spectrum is not being used or is not planned for use in the foreseeable future as agreed with the incumbent licensee.

4.25 If, in order to gain agreement from an MNO, new users wished to enter into a concurrent licensing arrangement,[73] this is possible under the current spectrum trading framework. As for third-party marketplaces or brokerages being established, there are no regulatory barriers to this for access to MNO or other spectrum. We note, however, that none have arisen since spectrum trading was introduced in 2004 and extended to mobile licences in 2011.

4.26 Regarding an automated DSA solution, we consider our proposed approach will enable us to respond appropriately to initial requests for access to mobile spectrum and to assess the level and nature of demand. Our licensing model is based on the existing licensing process

[73] A concurrent licence is a single licence jointly held by two or more entities and can be achieved via a spectrum trade.

that Ofcom operates for those companies wishing to have an Innovation and Trial licence. This has been running successfully for a number of years.

Incentives for MNOs to engage in the process

Summary of responses

4.27 Arqiva and Dense Air questioned why an incumbent licensee would agree to Local Access licence applications. They encouraged Ofcom to consider an incentive for existing licence holders to cooperate in this process. Ruckus Wireless and IET & 5GFF also highlighted this need. IET and 5GFF suggested an approach whereby the lending MNO would have the right of free access to some of the cell capacity for their own customers to use. Ruckus Wireless suggested that the new user's operations should be counted towards the overall coverage figures for the original licence holder. AWTG suggested that a mutually agreeable plan and revenue-sharing model between the incumbent and new entrant may provide incentives to encourage further sharing. BT stated that MNOs should be given the ability to fully recover their costs. If they were, they would be more willing to engage in negotiations with new users.

4.28 Facebook and DTG considered that without provisions to compel incumbent licensees to share they will refuse all applications. Facebook suggested that incumbent licences should be varied to include a "use or share" provision. This, they argued, would put more of the onus on them to share rather than letting them refuse applications. However, BT and AWTG warned that such a policy could undermine incentives to invest, because spectrum could be valued differently by new operators compared to existing licensees.

4.29 Some respondents also noted that the proposed approach placed most of the burden onto the incumbent licensees to carry out the analysis. Others argued that it would require incumbent licensees to provide commercially sensitive information on rollout plans that could be made public either through information provided to a third party, or via Ofcom, given the requirements of access to information legislation. This would act as a disincentive for the operators to engage.

4.30 Some respondents had concerns that the proposed process had no agreed timescales for processing licence requests. They strongly encouraged that we should set defined time limits for each step of the process, including for the incumbent licensees to consider any objection. The Energy Networks Association specifically asked how Ofcom would ensure timely engagement by the incumbent licensees.

Our position

4.31 We note that our December 2018 consultation on coverage obligations for the 700 MHz and 3.6-3.8 GHz spectrum award[74] provides some incentive to engage with third parties

[74] Ofcom, *Consultation: Coverage obligations in the 700 MHz and 3.6-3.8 GHz spectrum award - Ofcom's approach to verifying compliance*, 31 January 2019, paras. 1.7, 4.43 and 4.166, https://www.ofcom.org.uk/consultations-and-statements/category-2/coverage-obligations-in-the-700-mhz-and-3.6-3.8-ghz-spectrum-award

wishing to provide coverage extension schemes. We said that good quality coverage delivered through roaming could count towards delivering any such coverage obligation and set out what we would consider in deciding if a proposal could count towards it.

4.32 On mandating "use it or share it" conditions in the MNO licences, our view is that it is difficult to make workable in practice for this type of licences as we set out fully in our response to DCMS on the issue.[75] In this, we explained that it is difficult to define what constitutes "use" in order to trigger an enforced trade or revocation. There could be legitimate reasons why the spectrum may not be in use as the licensee is holding it back until they see a suitable commercial opportunity or until the technology they wish to use is ready to use. Finally, we consider that imposing such an obligation here could potentially distort competition and/or chill the incentives to invest in the spectrum.

4.33 We hope to minimise the burden of the new process on the incumbent operators by requesting a degree of due diligence in advance, and by Ofcom conducting an initial check of applications in order to avoid purely speculative requests being sent to the MNOs. We would expect that as part of any application, the applicant will provide evidence as to why they considered that the requested spectrum is unused in an area.

4.34 Ofcom regularly deals with commercially sensitive information as part of regulating the communications industry and is subject to various statutory restrictions on its disclosure. We note the concerns raised regarding the sensitivity of rollout plans and will liaise with the incumbent licensees regarding the level of information that will be shared with us and made available to third parties. However, we are aware that for a number of years operators have been providing local councils with potential rollout locations of their networks for the upcoming 12 months.

4.35 Finally, given the ad-hoc nature of these requests, the uncertainty over the level of demand and the discussions that may need to take place to achieve agreement, we do not believe a one-size-fits-all mandatory time limit would be appropriate in terms of a timescale for responses from MNOs. However, we would like to work with both incumbent licensees and potential applicants to come to a working agreement on timescales that would balance the needs of the applicant for a response whilst acknowledging the impact on incumbent licensees' resources.

MNOs' rights to continue to deploy

Summary of responses

4.36 The ability for the incumbent licensees to continue to deploy services was raised by a group of respondents. AWTG, Motorola and a confidential respondent ([✂]) all had the same concern that Ofcom should ensure that in the case of emergencies and natural disasters, operators should be able to deploy their services quickly even if a Local Access licence has been issued in that area.

[75] Letter from Ofcom to DCMS on spectrum sharing models, 13 December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0021/130728/Letter-from-Ofcom-to-DCMS.pdf

4.37 UKWISPA & INCA advised that the MNO should be able to ask for the spectrum back, ideally with a notice period of two years, but on the premise that the licence would be issued on an indefinite basis.

4.38 Telefónica asked that Ofcom provide more detail and clarity about rights to deploy and, where a local access licence has been issued, about the incumbent licence holder's rights to deploy in the future, in the area where the local access licence holder has deployed. It stated that it would not provide any commitment not to deploy outside of the locations identified in its submissions to Ofcom at a given time. It argued that this would undermine the rights it currently enjoys and that should incoming licensees require greater certainty than this, they would need to reach a commercial agreement with Telefónica.

Our position

4.39 The proposed licence already contains a provision that allows Ofcom to shut down or modify the licence in emergency situations. If either a local or national emergency is declared Ofcom has the necessary powers to enable operators to deploy their services as needed. We do not therefore consider that any further provisions to this effect are necessary.

4.40 We do not believe that allowing MNOs to effectively trigger a notice of revocation would provide sufficient security of tenure for new third-party users. The defined licence period is intended to provide clarity to users on which they can build their business case. We note in this context that any licence period will have been agreed with the incumbent MNO at the outset; where an MNO has a reasonable objection in this regard, no Local Access licence will have been issued.

4.41 Incumbent users' rights to deploy services will not be diluted by our proposals. Ofcom's approach is to allow access to spectrum that is not going to be used in the foreseeable future. Where operators are currently using the spectrum in that area or have plans to do so within three years, they are able to raise an objection to the application. If we consider those objections are reasonable we would not grant a Local Access licence. Where Ofcom has granted a licence, all parties will be required to cooperate and not cause interference to each other's networks as this is a condition included in both parties' licences.

Ability to raise a reasonable objection

Summary of responses

4.42 Most comments received regarding the process related to our proposal to allow the incumbent licensee an opportunity to object to the application if they had reasonable cause to do so. A number of respondents commented that the proposals needed further clarification. Google stated that giving incumbent licensees a veto threatened to nullify the concept and UKWISPA & INCA were concerned about the potential lack of teeth in the process. Telint urged Ofcom to use far stronger language or be accused of being "soft" at the expense of citizens and consumers.

4.43 Another concern raised was that the incumbent licensees could object if they stated that they had future plans to roll out in that area. Facebook suggested that unless the incumbent licensee can demonstrate that it is committed to serve that area within a short period of time, such as six months, then the licence should be granted. However, BT [✂] advised that the process assumed that MNOs would know with sufficient certainty where they plan to deploy in 3 years' time. This, they stated, is not always the case.

4.44 Three and Angetech Consultants raised the fact that the process as set out in the December consultation did not include a mechanism that would allow an appeal of any objections raised or decisions made by Ofcom. Three advised that as part of any process it would be unacceptable for them to be compelled to share any commercially sensitive detailed rollout plans with Ofcom or third parties.

Our position

4.45 In our consultation we purposely did not seek to define what we consider constitutes a reasonable objection, as each case will be evaluated on the specific circumstances of the application. We believe that this approach will provide more opportunities for sharing, compared to setting out a list of defined criteria. However, for an incumbent licensee to raise an objection, this should be based on a technical assessment that shows that the spectrum is already in use in that area; there is planned future use within the next three years; or the proposed third-party transmission site would cause interference to their existing deployments in the local area. As described in the process, the final decision on licensing rests with Ofcom and incumbent licensees have no right of veto. However, our aim for this process is to facilitate discussions between the applicant and incumbent licensee to be able to reach an agreement, rather than to impose a decision.

4.46 We recognise that our process and decisions will need to take into account incumbent licensees' reasonable expectations to deploy future services in line with their UK-wide spectrum rights. We note that for newly awarded frequency bands it may take some time for the MNOs to develop detailed deployment plans. In these cases, we would take this into account when considering applications for access to any newly released/acquired frequency bands and would expect any grant of Local Access licences in such circumstances to be rare.

4.47 We also acknowledge concerns that future deployment plans could potentially be used as a way to refuse sharing requests without due consideration. If we see a pattern that significant numbers of applications are being rejected by incumbent licensees on the grounds of future deployments, we will be monitoring rollout to compare stated plans with actual deployment. Although we accept that the complexity surrounding mast deployments and contractual negotiations may impact on timescales, we would hope that these, on the whole, are in line with the information provided. If we find this is not the case, then we will need to reconsider this part of the process.

4.48 We note BT's concern over the sharing of sensitive information. We recognise that operators' network deployment plans can be commercially sensitive, and it is not our intention that this process should result in the disclosure of information which is

commercially confidential. At the same time, we would be concerned if claims of commercial confidentiality were to be used in a way that unreasonably frustrated our aim to make Local Access licences available. Ofcom is very experienced in handling commercially sensitive information in the course of exercising its regulatory functions and we do not consider that this process should pose any particular concerns in this regard. We propose to work with parties to provide sufficient information for them to have confidence in the process, whilst ensuring that information which is commercially confidential is appropriately protected.

4.49 The process we set out did not include an appeals step. As discussed above, our aim is to try to facilitate parties reaching an agreement. However, this may not always be possible such that Ofcom may ultimately need to make a decision in relation to the application. In such cases we would make our provisional decision known to the parties involved and allow them to make representations before we come to a final decision.

Licence terms and conditions

What we proposed

4.50 We published a draft copy of the proposed Local Access licence and advised that the licence terms and conditions would mostly follow the standard conditions set out in most Ofcom licences. This included a standard five-year revocation clause to revoke the licence on spectrum management grounds.

4.51 We proposed that the licence would apply to all bands covered by the Mobile Trading Regulations and to the deployment of transmitters only at a location or an area defined in the licence. Licences would be for locations within the United Kingdom including the UK's territorial waters.[76] We also proposed that the licences should be tradable but limited to outright and concurrent trades only, with no partial trading of frequencies or geographic areas.

4.52 Unlike many of our licence products, we proposed that the Local Access licence would be authorised for a time-limited period. We proposed that this would be for a minimum period of three years, with the option of longer periods if agreement is reached with the incumbent licensee(s). We believed that the minimum three-year period would be a reasonable time frame over which an MNO would have sufficient certainty about their deployment plans to respond quickly to the request. It would also provide new users with a substantial time period over which they can expect to use the spectrum.

4.53 In line with our framework for setting cost-based fees we intended to set these fees to fully reflect our spectrum management costs applicable to these licence products. We therefore followed the same approach as for the Shared Access licence, i.e. using the actual per-

[76] Authorisation in the Channel Islands and Isle of Man may be possible, but this would be subject to the new user discussing any request with the relevant competition authorities that are responsible for the issuing of telecommunications licences (respectively the Channel Islands Competition and Regulatory Authorities, and the Isle of Man Communications Commission).

licence costs associated with a similar licence product. For this we used our Innovation and Trial licensing product. The Innovation and Trial licences are also manually built, bespoke licences and follow a similar process of consulting with incumbent licensees or spectrum users prior to a licence being granted. Given the similarity between these two products we believe that this is the most appropriate product to base our fees on. Based on our analysis,[77] our assessment was that a flat one-off fee of £950 was a reasonable indicator of the likely future average costs.

Licence duration

Summary of responses

4.54 Views on the proposed licence duration were mixed. Arqiva, Fairspectrum, Motorola, Neutral Wireless, Nominet, UCC and a confidential respondent ([✂]) all agreed that the three-year period was reasonable. Telefónica in their response advised that their plans are subject to continuous change and need to take into account factors such as demand and changes in consumer behaviour. Three and Vodafone stated that the licence term should be based on a commercial agreement with the provider and 17 respondents requested access for periods longer than three years.

4.55 Several respondents stated that the proposed minimum term was inadequate to stimulate the market, provide sufficient security of access for new operating models to become established and be enough time to secure a return on investment. Telet Research and Nokia said they expected over five years was needed in order to encourage investment in local infrastructure by private network providers. ip.access explained that in the US, the CBRS PAL licence period was debated heavily, and was extended from three years with no right of renewal to ten years.

4.56 IET & 5GFF, Telint and Ruckus Wireless all stated a preference for an indefinite licence duration with a licence clause to give 12 months' notice for the return of the spectrum if required by the MNO.

4.57 BT in their response wanted the revocation period to be less than five years. The revocation period, they argued, should be sufficiently short to allow Ofcom to revoke the new licence should the plans of the incumbent licensee change, and they wished to deploy in the area after the licence was granted.

4.58 We also received a number of requests from stakeholders asking that the licence be available for a shorter period than three years. They argued that this was to enable the deployment of temporary networks to support pop-up events and other use cases that do not require longer-term access to spectrum.

[77] See paragraphs 8.33 to 8.44 of the December Consultation

Our position

4.59 Having considered the comments received we have decided to maintain the default three-year duration of a licence, where there is no expectation that this would require a commercial agreement with the incumbent MNO. In determining the licence period, our aim was to strike a balance between the needs of the new user alongside consideration of what would be a reasonable timeframe to expect MNOs to take a confident view of their future plans. We understand that there could be instances where the MNO is not comfortable agreeing access for three years and in these cases, we will discuss this with them. We also recognise that some users may wish to negotiate access for longer periods and in those locations the MNO may be comfortable to agree a longer period. In the December consultation that we said that licences for periods of longer than three years would be granted if this can be agreed with the incumbent operator and this remains our position.

4.60 We do not consider that an indefinite licence with a 12-month notice period or less would be a workable solution in practice. A licensing approach where the licensee has little or no control over when and under what circumstances its rights could be withdrawn would undermine their business case. We think that it is preferable to have certainty over spectrum access up front when making an investment decision.

4.61 Based on the feedback received for the demand for short term access, we will consider applications specifying a shorter, fixed duration.

Licence fee

Summary of responses

4.62 Regarding the proposed fee, 19 respondents agreed with the £950 fee and most of these agreed it was proportionate. ip.access and Angetech Consultants stated that they were in favour of a flat one-off fee. Digital Colony Partners, Google and Western Power Distribution all urged Ofcom to keep the fees as low as possible to encourage productive uses of otherwise vacant frequencies. Nominet, Neutral Wireless, Telint and University of Strathclyde stressed that costs may be reduced by automating the process.

4.63 Telint disagreed with the proposed fee, suggesting that in deep rural areas even a fee of £1 could be deemed too much. A confidential respondent ([✂]) stated that the fees were too high and should be similar to the fees in the 5.8 GHz band.[78]

4.64 techUK and a confidential respondent both advised that the fees should be set at a level where MNOs are able to recover their costs through commercial arrangements. However, Three warned that the relatively low fee will encourage many applications and potentially lead to great administrative burden for MNOs. Vodafone suggested that the fee should be on a per operator basis so that if an applicant applies for spectrum that covers multiple incumbent MNOs then the cost should be based on the number of operators contacted.

[78] These are a £50 annual licence with a registration cost of an additional £1 per transmitter after the first 50 transmitters.

Our position

4.65 When proposing the fee, we considered the costs associated with issuing a similar type of licence. We do not believe that the 5.8 GHz licence is an appropriate proxy given that it requires no technical assessment and only requires the registration of terminals. Given our analysis, we believe we came to a suitable fee that would ensure Ofcom recovered its costs but kept the fee as low as possible.

4.66 Although we acknowledge that the individual transactional costs of an automated process compared to a manual approach may be lower, this does not account for the costs associated with setting up such a process. Where transactional volumes are high this would reduce the per licence cost for an automated process but demand for these licences is uncertain. If demand is low then this would significantly increase the cost of the licence given the costs of building and maintaining an automated authorisation platform.

4.67 When setting spectrum management costs Ofcom must act in accordance with the provisions set out in the WT Act. The Act gives Ofcom powers to set licence fees at a level necessary to recover our costs or where appropriate at above this level where we consider it is appropriate to do so in light, in particular, of our statutory duties. We do not consider it appropriate to charge fees at beyond administrative cost in this case. The licences are for very localised, time limited and opportunistic uses of already licensed but unused spectrum, given this we do not believe there is a need to use fees to incentivise optimal use. Our proposed fees are set to reflect Ofcom's costs and not those of the MNOs. As part of this process no licence fees received will be passed onto MNOs. Our process does not rule out commercial agreements between the parties being entered into but does not preclude access if one is not in place.

4.68 Our decision is to proceed on the basis we set out in the December consultation. We will therefore be charging a flat one-off fee of £950 per licence.

Other licence conditions

Summary of responses

4.69 Vodafone and a confidential respondent ([✂]) did not support our proposals to make these licences transferable. Vodafone said that if trading were to go ahead, then the consent of the MNO should be sought.

4.70 IET & 5GFF, Telint and UKWISPA & INCA suggested that a revocation clause could be added to the licence if the spectrum was not used.

Our position

4.71 Although we note the concerns raised over making these licences transferable, Ofcom is required to do so under the new European Electronics Communications Code (EECC),

which came into force in December 2018.[79] This is currently in the process of being transposed into UK law. Article 51 of the EECC requires Member States to allow all licensees to trade rights of use.[80] Given this, we will permit concurrent and outright total transfer of these licences.

4.72 The rights of use which could be transferred would be the existing licence terms and conditions (including duration, transmitter locations and other technical parameters) as initially agreed when the licence was first issued. Therefore, we do not expect that allowing transfers of the same terms would have any impact on the incumbent licensee.

4.73 Local Access licences are non-exclusive. If a licensee has not deployed in an area and has no timetable in which this was to happen then we would consider issuing a further licence to another party. However, given that we do not expect to have excess demand for spectrum from new users we believe the likelihood of this arising to be low.

4.74 We did not receive any comments on the other licence conditions and therefore these will remain the same as we proposed in the December consultation.

Spectrum information

What we proposed

4.75 We noted that information indicating where an operator may not be using spectrum plays an important part in our proposed licensing process. We also acknowledged that access to this information is not currently publicly available. We asked for stakeholder views on what information Ofcom should consider providing for potential applicants.

Summary of responses

4.76 Most respondents identified the locations of masts, their technical characteristics and operator coverage as the main information requirement that should be made available. Google explained that the maximum EIRP, antenna characteristics, centre frequency, and channel bandwidth were all information that were required. AWTG added that received power level estimations, propagation/loss maps and/or models, information on expected future deployments and monitoring information would also be of help.

4.77 In their responses the MNOs suggested that only basic information relating to the licence should be provided and that all applicants should be referred to them. They stated that much of this information is commercially sensitive and that they did not consider it should be made available to applicants.

[79] European Commission, *Directive (EU) 2018/1972*, 11 December 2018, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN (accessed 11 July 2019)
[80] Subject to a minor exception for those licences for broadcasting or those issued free of charge.

Our position

4.78 We acknowledge that finding detailed information in the public domain on spectrum use may be difficult. Current information on coverage provided by Ofcom and MNOs focuses on overall coverage, but this is not broken down into specific bands.[81] We would suggest that potential applicants wanting to know further information about spectrum availability discuss their requirements with Ofcom and the incumbent licensees where possible. We will work with the MNOs and ask that they provide contact information so that these requests can be directed to the relevant area in their organisation if appropriate.

4.79 We are aware that some of the requested information is sensitive both for commercial and, potentially, national security reasons and it may be difficult to make this available directly and in full to applicants. However, information is already in the public domain. Information on current and future mast deployments can be found through contacting local council planning departments. We are aware of websites that gather information using crowd sourced information and mobile applications that provide information on the signal strength and other technical information of a mast. Finally, for those applicants with access to monitoring equipment, they should be able to carry out their own site surveys to monitor if the spectrum is in use in that area.

Summary of our decisions on a Local Access licence

4.80 Having considered the representations received, we have decided to proceed with our approach broadly in line with our proposals as set out in the December consultation and make available access to already licensed mobile spectrum by issuing a Local Access licence. Confirmation the provisions of the licence and the process we will follow to consider applications are set out below.

The licence

4.81 The terms and conditions of the Local Access licence are set out in this section. All licences will be subject to a number of standard terms and conditions. As each request will be dealt with on a case by case basis, the technical transmission parameters will be unique to each licence as these will reflect the agreed transmission parameters (including location/service area, frequency, power, etc…) and any other requirements that may be needed to prevent the incumbent operator from suffering from interference. Below is a summary of the main provisions for the Local Access licence, it:

- Is available for any frequency band covered by the Mobile Trading Regulations;
- Will be time limited, the default period is three years but we will consider shorter or longer durations where specified;
- Is for a single location or area;

[81] Ofcom's mobile coverage maps can be found at https://www.ofcom.org.uk/phones-telecoms-and-internet/advice-for-consumers/advice/ofcom-checker

- Is not restricted to the same technology as the incumbent licensee;
- Can be transferred on a total outright or total concurrent basis to another party;
- Requires licensees to notify any customers of the time limits on the authorisation;
- Will include Ofcom's standard terms in other areas such as on access and inspection; and
- Will be charged a cost-based one-off fee of £950 per licence.

Licence frequency

4.82 The licence will permit use within any frequency band covered by the Mobile Trading Regulations. Currently, these are: 791-821 MHz paired with 832-862 MHz ("800 MHz band"); 880-915 MHz and 925-960 MHz ("900 MHz band"); 1452-1492 MHz ("1400 MHz band"); 1710-1781.7 MHz and 1805-1876.7 MHz ("1800 MHz band"); 1900-1920 MHz ("1900 MHz band"); 1920-1980 MHz and 2110-2170 MHz ("2100 MHz band"); 2350-2390 MHz ("2300 MHz band"); 2500-2690 MHz ("2600 MHz band"); and 3410-3600 MHz ("3.4 GHz band"). As new bands are introduced into the Mobile Trading Regulations, we will also include these in the list of frequency bands which could be covered by the licence. However, 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.

Licence duration

4.83 The default licence period will be three years. Requests for shorter or longer periods will also be considered.

Licence location/area

4.84 The licence will cover the deployment of transmitters only at the defined location or in an area defined in the licence. Depending on the request received we may authorise a single or multiple base station locations or a local area. Each request will be dealt with on a case by case basis with the licence reflecting the agreed transmission location or service area details.

4.85 Licences will be granted for locations within the United Kingdom including the territorial waters. Authorisation in the Channel Islands and Isle of Man may be possible, but this would be subject to the new user discussing any request with the relevant competition authorities that are responsible for the issuing of telecommunications licences on the islands.

Technical conditions

4.86 The technical conditions will be considered on a case by case basis and be dependent on the requests received. We expect that in most use cases the parties will wish to take advantage of being able to use existing mobile technologies and deploy equipment that is of a similar nature to the incumbent licensee. However, there may be cases where a user may wish to deploy an alternative technology and our licence will permit this.

4.87 As the initial coordination request with the incumbent licensee would have been based on a specific technology and technical parameters, the Local Access licence would reflect this. Licensees wishing to change these will need to request a variation to their licence. This will require us to liaise with the incumbent licensee to ensure that any change does not impact on their spectrum use.

Coordination and interference management

4.88 To minimise the risks of interference the licence will include the following provisions:

- Our standard requirements for the licensee to abide by any coordination procedures, both national and international, as notified by Ofcom;
- That the licensee must liaise and co-operate with other holders of licences in the same frequency band(s). This may require, if necessary, adjusting transmission power and other technical parameters of transmission in such a way that harmful interference is not caused by one network deployment to that of another licensee within the band. This condition is also included in the low and medium power Shared Access licences; and
- Where a licensee is deploying a mobile service, we will expect them to follow the appropriate in block and out of block power limits. The licence could also include, when deploying TDD systems outdoors or in a shared indoor location, the requirement to synchronise with other users in the band or use a restrictive transmission mask. In such cases these provisions will likely mirror those in the incumbent licensee's authorisation.

4.89 The incumbent operator's rights to deploy, even after a new user is issued with a licence, will not be affected. In practice we expect parties to agree coordination terms between themselves in line with their licence obligations to avoid interference. We believe that the measures outlined above should be sufficient to avoid any harmful interference from occurring. However, where there are disputes between parties, and no contractual agreement exists, we will deal with these on a case by case basis.

Licence transfer

4.90 The spectrum rights and obligations granted in the licence are transferable under the spectrum trading framework. The following types of transfer will be available: total outright and total concurrent transfers of all rights and obligations under the licence. No partial transfers of frequencies or locations are permitted.

Access and Inspection

4.91 In accordance with our standard conditions, the licence includes a condition that reserves to Ofcom the right 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, should we decide that is appropriate.

Modification, Restriction and Closedown

4.92 The licence includes a condition that reserves to Ofcom the right 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, that its operation is/may be causing or contributing to undue interference, or we consider this necessary in the event of a national or local state of emergency being declared. This is a standard clause in most WT Act licences issued by Ofcom.

Provision of information to facilitate optimal spectrum use

4.93 In line with our duty to manage the spectrum efficiently, the licence includes standard conditions to require licensees to provide us, on request, with general information regarding their equipment and use of frequencies, the rollout of their network or any such information we require.

Provision of information to customers

4.94 The licence will require the licensee to inform any customers of the service, provided over the frequencies authorised by the Local Access licence, of the time limited nature of the access to the spectrum. Customers should be made aware of this before signing up to any service and it should be included in any contract terms and conditions.

Licence fee

4.95 The licence will be subject to a single one-off fee of £950.

Process for considering applications

4.96 The process for considering applications for Local Access licence is set out in this section.

4.97 Under this new licensing approach, prospective new users wishing to access specific mobile frequencies that are not being used in a given location (this can be an individual location with a single base station or across a local area) can apply to Ofcom for a licence. Ofcom will assess the likely impact of introducing a new user in that location and will discuss with the relevant MNO(s) before deciding whether to issue a new licence.

4.98 As part of the licence application process, applicants will need to complete a form that will request details of the proposed deployment. These will include the technical details and the reasons why the applicant believes that the spectrum is not being used in that area. Applicants will also be able to provide any additional information that they believe could help when considering such a request.

4.99 Before we discuss the application with the incumbent licensee, we will carry out a number of checks to see whether the request could be successful. This may include an assessment of the amount of spectrum requested, the proposed location and requested technical parameters. As part of this process we may require the applicant to provide additional information. At this stage some applications may be declined.

4.100 If the application passes these initial checks, we will engage with the relevant MNO. We would hope that, where possible, applicants would have discussed their proposed request with the incumbent licensee(s) prior to submitting the application. We note that this may not always be possible so is not a prerequisite of this process unless the requested licence is for a period longer than three years. Requests for longer duration licences will likely require a prior agreement with the incumbent operator to be in place in order for us to proceed with the application. We will work with the MNOs to seek to make available information on who potential applicants should contact within their organisations to discuss any potential sharing agreements.

4.101 The incumbent licensee will then consider the application. 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. If they agree this does not adversely impact their planned use of the spectrum, then a Local Access licence would be issued. It should be noted that access to newly acquired spectrum bands may not be possible straight away as it may take time for the MNO to develop their rollout plans and this is something that Ofcom will take into consideration when dealing with requests.

4.102 If an objection is received, we will try to work with parties to see if a compromise solution can be found. As part of this process, the incumbent licensee and third party may be able to reach commercial terms to enable access. Such an arrangement might involve an MNO deciding to forgo deployment in that area or make changes to its network to accommodate the third-party user. Alternatively, the third party may offer to extend the MNO's coverage at that location or agree to a shorter licence period. These negotiations will be between the applicant and incumbent MNO and Ofcom will not impose such terms.

4.103 Before Ofcom makes a final decision on whether to issue a licence we will make known our provisional decision to the parties. We will allow a period of time for representations to be made before making our final decision. Throughout this process we will look at the evidence provided and our analysis of it to inform our decision.

4.104 We acknowledge that as this is a new approach to authorisation it may need to be slightly adapted in light of experience gained of processing these licence requests. We also intend to monitor the reasoning behind and volumes of any objections raised by the MNOs to ensure that the process is being followed in good faith. If we see evidence of widespread rejections of what in our view appear to be reasonable applications, then we may decide to make further changes to this process.

5. Adding the lower 26 GHz band to our sharing framework

Introduction

5.1 In our December consultation, we said we intended to add other bands to our sharing framework as appropriate. We consider the 24.25-26.5 GHz band ("the lower 26 GHz band") is a suitable addition to our spectrum sharing framework. We think that this additional band will complement the lower frequency bands and offer a significant opportunity for a range of new, wide bandwidth, high capacity 5G applications.

5.2 The 26 GHz band[82] is the new European pioneer millimetre wave (mmWave) band and has recently been harmonised[83] across Europe with a requirement to make spectrum in this frequency range available by the end of 2020.[84] Our shared access approach for the lower 26 GHz band will provide access to 2.25 GHz of spectrum for new indoor 5G applications without prejudicing future 5G outdoor use of the band.

5.3 We consider that given the low risk of interference to existing services with an indoor-only approach, the lower 26 GHz band can be made available in a rapid way in order to facilitate and expedite the possibility for innovation, application development and commercial 5G use in this part of the band. This approach is in line with both the requirements of the European Commission Implementing Decision (EU) 2019/784, and Ofcom's wider objective of making the 26 GHz band available for 5G. The EC Decision also requires the protection of certain applications, particularly the Earth Exploration Satellite (passive) services used to measure sea surface temperature and the water vapour content of the atmosphere, through specification of power density limits within the 23.6-24 GHz band. Our decision to enable access to the lower 26 GHz band provides such protection.

5.4 The rest of this section outlines the background and our rationale for adding this band to our sharing framework, the authorisation approach we are adopting, analysis of coexistence with existing users, the technical and non-technical licence conditions for the indoor licence we are making available and finally the licence fee.

Background

5.5 In November 2016 the European Radio Spectrum Policy Group (RSPG) published an opinion (RSPG Opinion 16-032)[85] on spectrum-related aspects for next generation wireless systems

[82] The "full" 26 GHz Band is 24.25-27.5 GHz.
[83] European Commission, *Decision (EU)2019/784*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D0784&from=EN (accessed 11 July 2019)
[84] European Commission, *Directive (EU) 2018/1972*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN (accessed 11 July 2019)
[85] Radio Spectrum Policy Group, *Opinion RSPG16-032*: http://rspg-spectrum.eu/wp-content/uploads/2013/05/RPSG16-032-Opinion_5G.pdf (accessed 11 July 2019)

(5G) as part of the European Commission's Strategic Roadmap towards 5G for Europe. The spectrum portfolio for 5G included the 26 GHz band which was recommended by the RSPG as the "pioneer" mmWave band for Europe, with an indication that the spectrum should be harmonised at the European level and made available by the end of 2020.

5.6 Following the adoption of the RSPG opinion and taking into account the ongoing interest in 26 GHz, Ofcom published a comprehensive Call For Input (CFI) and an overview of future possible mmWave bands (above 30 GHz) for 5G in the Summer of 2017.[86] In this document, we asked a wide range of questions and sought input from stakeholders on the band; we also highlighted the potential for the 26 GHz band to meet different types of demand.

5.7 While responses to the Ofcom CFI indicated that the band was likely to be become important for 5G, many suggested that it was too early in 2017 to say how the band would be used, and for what purposes. We therefore gave an indication that we would continue to collate evidence from stakeholders across the different sectors and continue with our engagement internationally in order to inform our understanding within the wider context of international interest in using this high frequency mmWave spectrum for 5G.

5.8 In our March 2018 5G strategy, *Enabling 5G in the UK*, we reaffirmed our objective of making 26 GHz available for 5G and have continued to be supportive of promoting and enabling the full 26 GHz band for 5G services.[87] In this document we also highlighted that we were particularly keen to encourage trials at 26 GHz and made some changes to our innovation and trial licence product to encourage and promote 5G trials in the band.

5.9 Since our CFI we have also held a number of stakeholder discussions and workshops and published several 5G-related documents[88] confirming our ongoing support for the future potential use of the 26 GHz band.

5.10 One of the key themes emerging from these ongoing discussions has been the need for spectrum access for the vertical markets,[89] such as businesses and organisations including for indoor applications.[90]

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[86] Ofcom, *Call for inputs on 5G spectrum access at 26 GHz and update on bands above 30 GHz*, 28 July 2017, https://www.ofcom.org.uk/__data/assets/pdf_file/0014/104702/5G-spectrum-access-at-26-GHz.pdf

[87] Ofcom, *Enabling 5G in the UK*, 9 March 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0022/111883/enabling-5g-uk.pdf

[88] i) *Enabling 5G in the UK*, 9 March 2018, ii) *UK preparations for the World Radiocommunication Conference 2019 (WRC-19)*, 7 June 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0017/114524/consultation-wrc-19.pdf and iii) *Award of the 700 MHz and 3.6-3.8 GHz spectrum bands,* 18 December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0019/130726/Award-of-the-700-MHz-and-3.6-3.8-GHz-spectrum-bands.pdf

[89] By "verticals market" we mean the businesses and organisations deploying wireless connectivity solutions. This group is often referred to as (industry) verticals.

[90] Ofcom, *Supporting the expanding role of wireless innovation in UK industry: a discussion paper*, 1 February 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0020/135362/supporting-role-wireless-innovation-uk-industry.pdf

The European legislative context

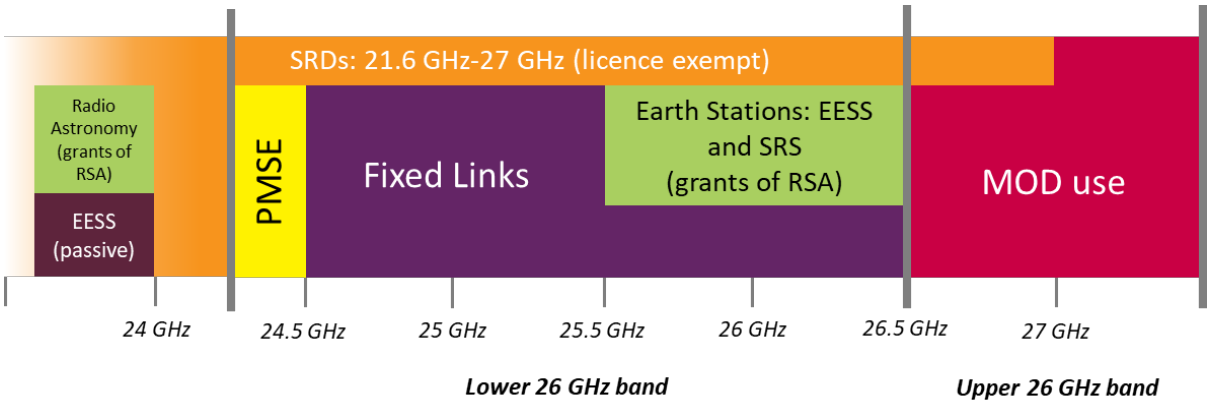
5.11 The European Commission has recently developed and adopted an EC Decision (EU 2019/784) which requires Member States to designate and make available the 26 GHz band by 31 March 2020. This decision was adopted on 14 May 2019.

5.12 Alongside this EC Decision, a new European Electronic Communications Code (EECC)[91] has also been adopted which 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. In this regard, we are of the view that since existing fixed links and earth stations can continue to operate under our approach of making the lower 26 GHz band available for indoor 5G use, there are no significant constraints for migration of existing users.

The lower 26 GHz band

5.13 Figure 5.1 below shows the existing UK use and authorisations currently available in the 26 GHz band.

Figure 5.1: UK Authorisations / Grants of RSA for ROES / Permissions for Use[92]



5.14 As can be seen the 26 GHz band can be broadly divided into two main parts:

a) the "upper 26 GHz band" (26.5-27.5 GHz), currently used by MOD; and

b) the "lower 26 GHz band" (24.25-26.5 GHz), managed by Ofcom. The band is used for fixed links, satellite receiving earth stations for the Earth Exploration Satellite Service

[91] *Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN

[92] This diagram shows the currently available authorisations / grants of RSA in the UK. In addition to these services there are also international allocations to the Mobile service, Inter-satellite Service and Fixed Satellite Service (E-s) within parts of the band. The EESS (passive) in the adjacent 23.6-24 GHz band is also an internationally allocated service, and while not requiring a specific authorisation in the UK, is shown for completeness given the specific technical requirements in EC Decision (EU)2019/784 for the protection of this service.

(EESS) and Space Research (SRS), Programme Making and Special Events equipment (PMSE) and Short Range Devices (SRDs).

5.15 In addition to the above, there are also primary allocations for the Earth Exploration Satellite Service (EESS) passive and the radio astronomy service in the adjacent 23.6-24 GHz band which need to be taken into account.

5.16 Unlike the upper 26 GHz band where we are currently working with MOD to understand defence spectrum use, we have considered current use of the lower 26 GHz band and have concluded this part of the band can be made available for indoor shared use now, by leveraging our sharing framework, with little to no impact on existing services. We consider that adding it to our sharing framework now will provide immediate and further opportunities for innovation, application development and commercial 5G use in this part of the band. Our action is in line with the requirements of the EC Decision. The EC Decision also requires the protection of certain applications, particularly the Earth Exploration Satellite Service (passive) used to measure sea surface temperature and the water vapour content of the atmosphere. Our decision to enable access to the lower 26 GHz band provides such protection.

5.17 This band also provides additional spectrum options for very high bandwidth 5G applications, complementing the 3.8-4.2 GHz band, which also supports 5G technology.

Authorisation approach for new indoor 5G users

5.18 In making this spectrum available we would like to ensure that different types of uses can be facilitated, so that rapid access to this new spectrum is possible now, but without limiting our options to authorise higher power 5G applications in the future, for example, outdoor 5G mobile services, as demand emerges.

5.19 Regarding the authorisation approach, although we consider the risk of interference to be low (see coexistence section below and Annex 3), and given that there is still uncertainty around how 5G will ultimately be deployed in the band, we consider that a licence exemption approach is not appropriate at this stage.

5.20 We therefore consider that making this band available as part of the spectrum sharing framework (as set out in this statement) provides us with a method to facilitate rapid access to the band and enable opportunities for new 5G innovation and investment, whilst also enabling us to take action in the event of interference or changing future spectrum management requirements.

5.21 In summary, by applying our spectrum sharing framework (which aims to make it easy for users to access spectrum supporting more predictable quality of service in a number of bands under a common framework), our approach for access to spectrum in the 24.25-26.5 GHz band will allow:

a) Users to apply for the indoor location(s) and the bandwidth (in 50, 100, 200 MHz channels) that they need to provide a service;

b) Ofcom to assign / allocate a free channel including taking into account a simplified co-ordination check against existing earth station and radio astronomy sites (see below) in the band and in the adjacent band;

c) Ofcom to grant individual licence(s) for the requested location(s) and bandwidth on a first come, first served basis (subject to the licence / co-ordination conditions);

d) Users to pay cost-based licence fees on an annual basis to recover the cost of Ofcom managing the licence.

Coexistence with existing services and future potential outdoor 5G systems

5.22 We have carried out and reviewed a number of existing co-existence studies with respect to the interference potential of indoor 5G base stations to existing services and future potential outdoor 5G systems. The details of these studies are given in Annex 3 of this document.

5.23 In summary, under the assumptions made, the studies generally show that there is a low probability of interference from indoor 5G deployments to existing services and future outdoor 5G systems. This is primarily made possible by the significant propagation losses at 26 GHz as signals are attenuated by buildings.

5.24 Below we highlight the current uses of the lower 26 GHz band and our approach to managing the interference environment with respect to these services.

Fixed links

5.25 There are currently approximately 1,800 fixed link licences in this band which authorise point-to-point fixed links on a first come, first served basis, in line with Ofcom coordination and technical frequency assignment criteria.[93] The links are used for a variety of applications such as; backhaul for mobile network operators, fixed networks, utilities, emergency service traffic, TV broadcast distribution, and by several other private and public entities.

5.26 As indicated by the coexistence studies in Annex 3, we consider that there is a low risk of interference between indoor 5G deployments and outdoor fixed links. We therefore do not consider it proportionate to perform individual technical coordination between indoor 5G base stations and outdoor fixed links in the 26 GHz band.

5.27 In the unlikely event that interference to an existing licensed service were to occur, then this could be managed at the local level as the general licence terms and conditions include provisions regarding undue interference. In addition, and as indicated in 3.187, we are also adding a requirement to the 26 GHz Shared Access licence which is similar to that in the licence for the lower three shared access bands: that Ofcom can notify licensees to change

[93] Ofcom, *OfW446: Technical Frequency Assignment Criteria for Fixed Point-to-Point Radio Services with Digital Modulation*, July 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0017/92204/ofw446.pdf

frequency from time to time. This will enable us to take appropriate action (e.g. by requiring a change of channel) to mitigate potential interference to fixed links in the unlikely event that interference occurs.

5.28 In relation to any new fixed links in the band, we indicated in our FWS Spectrum Strategy[94] that we support making this band available for 5G and advised applicants for fixed wireless links licences to take this into account in any future applications for this band. New licensees should consider alternative fixed wireless link bands to meet their requirements.

Earth stations, radio astronomy and EESS (passive)

5.29 There is currently one receiving earth station in the 25.5-26.5 GHz band that is authorised under a grant of RSA for ROES. This earth station is used as part of the Earth Exploration Satellite Service (EESS) to collect data downlinked from an Earth observation satellite in geostationary orbit. This data contains information about the Earth and its environment, including Earth imagery and weather data. Grants of RSA are also available in this band for receiving earth stations in the Space Research Service (SRS). This would involve downlinking data from spacecraft, for example the International Space Station or deep space missions to Mars and other planets.

5.30 The adjacent 23.6-24 GHz band is used by passive services such as radio astronomy and sensors used as part of EESS, which rely on access to specific frequencies to make measurements of naturally occurring radio emissions. There are several radio astronomy stations in the UK which are spread across six different radio astronomy sites that are authorised under grants of RSA. These radio astronomy stations are used to detect radio emissions from outer space. EESS use in the band involves passive sensors (radiometers) installed on Earth observation satellites, which are used to measure naturally occurring radio emissions from the Earth and its atmosphere.

5.31 While we consider that the risk of interference to all existing services is low (based on the coexistence studies we have conducted, shown in Annex 3) and in practice is unlikely to occur, we want to ensure that, in line with the new European Commission Implementing Decision (EU) 2019/784, earth stations in the 25.5-26.5 GHz band and radio astronomy stations in the adjacent 23.6-24 GHz band are appropriately protected.[95] We therefore plan, as an additional safeguard measure (and where the technical studies in Annex 3 show a slightly higher risk of potential interference), to initially not grant any indoor 5G licence requests within a 1km radius around the EESS earth station at Harwell in the 25.5-26.5 GHz band, and within 1km of two radio astronomy sites (Jodrell Bank & Cambridge) across the full 24.25-26.5 GHz band. We will keep this under review as appropriate.

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[94] Ofcom, *Review of spectrum used by fixed wireless services: Our decisions to enable future uses of fixed wireless links*, 5 July 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0017/115631/statement-fixed-wireless-spectrum-strategy.pdf

[95] In general radio astronomy site locations are in more remote areas, therefore the probability of an indoor 5G device being located in the immediate area and interfering with the radio astronomy stations is considered low.

5.32 The 25.5-26.5 GHz band remains open to applications for grants of RSA for ROES. However, as indicated in our Space Spectrum Strategy,[96] we strongly encourage stakeholders to discuss with us any plans they may be considering using the 26 GHz band for EESS or SRS data downlinks, and to very carefully consider the siting of any future earth stations.

5.33 For example, earth stations in or near urban areas could end up receiving interference from future roll-out of 5G services, particularly from future potential outdoor 5G services when these become available. In cases where the impact on future outdoor 5G services could be relevant, Ofcom will consider whether it would be appropriate to grant an RSA at these locations in this band. In contrast, earth stations using 26 GHz sited sufficiently far away from urban areas and/or screened from 5G deployments are more likely to be able to coexist with future 5G services.

Programme Making and Special Events (PMSE)

5.34 PMSE is allocated to the 24.25-24.5 GHz band, where typical applications are temporary outdoor point-to-point/video links. However, the band is lightly used, and there have only been two assignments since 2012 in this spectrum. As with our coexistence assessment for fixed links, we consider that the interference risk to and from PMSE is very low and that no coordination is required.

Short Range Devices (SRDs)

5.35 Short Range Device (SRD) is a general term applied to various radio devices designed to operate usually on a licence exempt basis, over short range and at low power levels. SRDs in the 21.65-27 GHz band operate on a non-interference, non-protection basis. We don't consider there is any interference risk from SRDs to indoor 5G that requires further regulatory action.

Future outdoor 5G Systems

5.36 The 26 GHz band is also intended for outdoor 5G systems and the system characteristics together with the deployment setup are different to indoor 5G systems. Building penetration loss is substantial in this band and this offers good isolation between indoor and outdoor 5G systems. Therefore, with current understanding of 5G systems and drawing on existing studies,[97] the risk of interference from an indoor 5G system to future outdoor 5G system is low. Therefore, we consider our action to enable indoor 5G use would not preclude future 5G outdoor use of the band.

[96] Ofcom, *Space spectrum strategy*, 19 January 2017, https://www.ofcom.org.uk/__data/assets/pdf_file/0030/96735/Statement-Space-Spectrum.pdf

[97] Draft ECC Report 307 Toolbox for the most appropriate synchronisation regulatory framework including coexistence of MFCN in 24.25-27.5 GHz in unsynchronised and semi-synchronised mode https://cept.org/files/9522/Draft%20ECC%20Report%20307.docx

Indoor area licence for new 5G users

5.37 We will extend the availability of the low power area licence as described in Section 3 to also include access to the 24.25-26 GHz band for indoor shared access.

5.38 Similar to the lower shared access bands, users can apply for a licence in the indoor area where they are looking to deploy, providing Ofcom with a specific defined location. The licence will then authorise all the indoor base stations operating on the same frequency within a 50-metre radius of the specified location, and all indoor terminal stations (fixed/installed and mobile/nomadic) associated with these base stations. Users can apply for multiple area licences to meet their indoor coverage requirements.

5.39 We will assign an available channel ensuring that there is no frequency/area overlap with other indoor 5G users, except in the cases where there is an overlap and it belongs to the same licensee. In this case a frequency/area overlap will be permitted, on the basis the licensee will manage their own deployments/interference management control.

Technical licence conditions

5.40 The technical conditions for the 26 GHz indoor licence are shown in Table 5.1 below. These are a combination of the "essential conditions" set out by the European Commission's Implementing Decision (EU) 2019/784[98] and additional transmitter power conditions as documented in 3GPP technical report 38.802, in order to set a maximum transmission power and to manage the co-existence with the existing services.

[98] European Commission, *Commission Implementing Decision (EU) 2019/784*, 14 May 2019, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D0784&from=EN

Table 5.1: Technical licence conditions for indoor Shared Access licence in lower 26 GHz band

Technical condition	Parameters / Technical Limits	Note
Permitted deployment	Indoor only	
Authorised bandwidths	50 MHz, 100 MHz and 200 MHz	
Maximum base station power (TRP)	23 dBm/200 MHz	Based on Technical Report 3GPP TR 38.802[99]
Maximum base station power outside permitted channel (TRP)		
• **Up to 50MHz below or above channel edge**	12 dBm / 50 MHz	As per EC Decision (EU)2019/784 for synchronised operation
• **Beyond 50MHz below or above channel edge**	4 dBm / 50 MHz	
Maximum base station power in the frequency range 23.6-24.0 GHz (TRP)	-42 dBW/200 MHz	As per EC Decision (EU)2019/784 to protect EESS passive services in the adjacent band
Maximum terminal station power (TRP)	23 dBm	Based on 3GPP TS 38.101-2[100]
Maximum terminal station power in the frequency range 23.6-24.0 GHz (TRP)	-38 dBW/200 MHz	As per EC Decision (EU)2019/784 to protect EESS passive services in the adjacent band

Non-technical licence conditions

5.41 The non-technical licence conditions will be similar to those of the low power Shared Access licence in the lower three shared access bands, as outlined in 3.231 to 3.242.

5.42 In terms of geographical availability, the licences will be available for locations within the United Kingdom and the UK territorial sea, also within the Channel Islands and Isle of Man.

5.43 The licence is not available initially within 1 km of the following locations:

i) Harwell EESS Earth Station Site (25.5-26.5 GHz)

[99] 3GPP TR 38.802 "Study on new radio access technology Physical layer aspects (Release 14)," V0.8.0, 2017-03
[100] 3GPP, *TS 38.101-2: NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone (Release 15)*, V15.5.0, March 2019, https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3284

ii) Jodrell Bank – Cheshire Radio Astronomy Site

iii) Cambridge Radio Astronomy Site

5.44 The additional licence conditions that we are adding to the Shared Access licence enabling Ofcom to notify licensees of a change in permitted frequency from time to time and requirement for equipment to transmit within six months of the licence being issued and continue to be operational afterwards, will similarly apply here.

5.45 In addition to ensuring spectrum efficiency, this will enable us to manage interference at the local level in the unlikely event that interference to an existing licensed service were to occur. We therefore expect that equipment deployed in the band will have the ability to tune across the whole 26 GHz band.

Licence fee

5.46 Given that we are extending access to the lower 26 GHz band under our spectrum sharing framework, we consider it appropriate to set the same cost-based fee for the lower 26 GHz band as for the Shared Access licence.

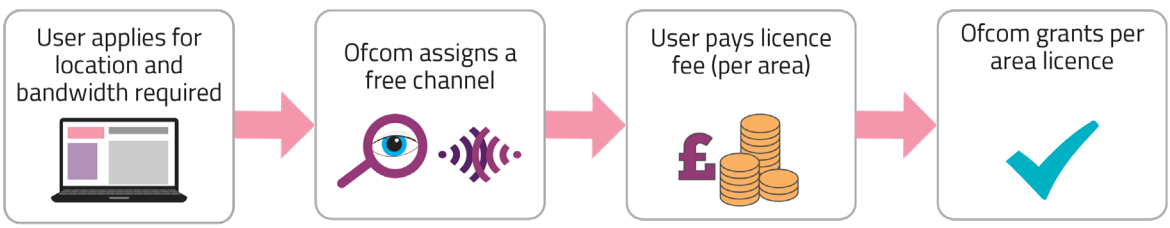
5.47 We do not consider it necessary to set different fees based on bandwidth, given the amount of spectrum available in the 26 GHz band and the low risk of interference. We consider it sufficient to rely upon the DSA conditions to mitigate any risk of hoarding for the 26 GHz band. We note that this will result in a lower cost per MHz for licences in the 26 GHz band but do not expect this to significantly distort users' choice of licence. In fact, deployment in the 26 GHz band may be more expensive than in the 3.8-4.2 GHz band. Access to a large amount of spectrum will be cheaper with a 26 GHz licence but users will also require more base stations to cover the same indoor area as a 3.8-4.2 licence. Therefore, we expect the choice of band to depend on the use case rather than users simply trying to minimise the cost per MHz of their licences.

5.48 Therefore, we consider it appropriate to charge £320 per annum per licence (the average cost-based fee for the other shared access bands), regardless of bandwidth, with pro rata fees for licences less than 12 months subject to a minimum licence fee of £32.

Process for considering applications

5.49 The chart below summarises the high-level process for users to access spectrum.

Figure 5.2: Shared Access 26 GHz licence application process



5.50 The guidance we have published alongside this Statement sets out the approach Ofcom generally expects to take when assessing and issuing shared access licences. However, we may consider exceptional applications on a case-by-case basis and we retain the discretion to amend our approach, and to make exceptions or disapply the guidance if it is appropriate to do so in the particular circumstances. We will also keep this general guidance for access to the shared access bands under review and may amend it from time to time as appropriate.

6. Next steps

Licence availability

6.1 Users can apply for Local Access licences for licensed mobile spectrum bands immediately following this publication, and Shared Access licences in the 1800 MHz shared spectrum, 2300 MHz shared spectrum, 3.8-4.2 GHz band and lower 26 GHz band by end 2019.

6.2 Stakeholders can sign up to Ofcom updates to receive further information relating to the opening up of the four bands for new applications.[101]

6.3 We have produced guidance documents published alongside this statement to support people wishing to apply for the local access licences and shared access licences. We will keep the guidance under review and may amend it from time to time as appropriate in light of further experience.

Variation of existing Concurrent Spectrum Access licensees

6.4 We will issue a licence variation notice to the existing CSA licensees in the 1800 MHz shared spectrum to vary their licence to align with the Shared Access licence as soon as practicable.

Implementing DSA

6.5 We are commencing work following the publication of this statement to assess whether it would be appropriate in the future to transition towards dynamic spectrum access supported by a fully automated authorisation database approach in the bands outlined under our spectrum sharing framework, where radio equipment would communicate directly with the spectrum assignment database.

6.6 We consider that the specification of the communication between the radio equipment and database is best done in collaboration with industry, particularly equipment vendors. This would allow appropriate consideration of the costs and complexity of implementation, both in relation to the radio equipment and the spectrum assignment database.

6.7 We encourage interested parties to get in touch with us at SharedSpectrumAccess@ofcom.org.uk.

Facilitating other 5G uses in the 26 GHz band

6.8 Regarding the upper 26.5-27.5 GHz part of the band, we will continue to work with MOD with the intention that this band can also be made available[102] in the future.

[101] https://www.ofcom.org.uk/about-ofcom/latest/email-updates
[102] alongside some defence uses

6.9 We will also consider how best to authorise other 5G uses across the full 26 GHz band (such as outdoor high power mobile) in a way that optimises the use of the spectrum.

6.10 We will continue to engage with stakeholders more generally and monitor demand for 5G mobile spectrum to help inform our work and participate in the international work to ensure that the UK is at the forefront of 5G discussions and developments across the full band.