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Annual Licence Fees for UK Broadband's 3.4 GHz and 3.6 GHz spectrum

STATEMENT:

Publication date: 7 June 2019

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Section

Annex

1. Overview

This document contains Ofcom's decision on the level of annual licence fees ("**ALF**") for the 40 MHz of 3.4 GHz spectrum and 80 MHz of 3.6 GHz spectrum that is licensed to UK Broadband ("**UKB**"), which is a wholly owned subsidiary of Hutchinson 3G UK Limited ("**Three**").

What we have decided – in brief

We have decided that ALFs for this spectrum should be set by reference to market value based on the market clearing price of 3.4 GHz spectrum in the auction of the 2.3 GHz and 3.4 GHz bands completed in April 2018 (the "2018 auction"). The fees will therefore be set on the basis of a lump-sum value of £37.8m per 5 MHz (in April 2018 prices).

We are today making the regulations which give effect to this decision. The new fees will become effective on 31 July 2019.

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

1.1 UKB's 3.4 and 3.6 GHz spectrum sits within the 3.4-3.8 GHz band, which has been identified as the primary 5G band in Europe, and the long-term use case will be the same across the entire band. In April 2018 we completed an auction of spectrum at 2.3 GHz and 3.4 GHz. That auction provided us with direct evidence of the market value of spectrum at 3.4 GHz. On the basis that we consider the long-term use of 3.4 GHz and 3.6 GHz will be the same, the auction information on 3.4 GHz also provides a good indication of the value of the 3.6 GHz spectrum, and we are therefore setting fees for both bands at the same level.

1.2 Consistent with our long-term policy of setting fees for spectrum that – as here – is expected to be in excess demand, we have decided to set the annual licence fees for all 120 MHz of this spectrum by reference to market value.

1.3 We have considered how most appropriately to determine the market value of the relevant spectrum in this case. We explained in our December 2018 consultation[1] that, taking the recent auction outcomes for the 3.4 GHz spectrum in the 2018 auction, we are able to identify both the market clearing price of 3.4 GHz spectrum (for which a conservative estimate is £37.8 million per 5 MHz) and the marginal opportunity cost to other users (for which a conservative estimate is £31.1 million per 5 MHz). In our December 2018 consultation, we proposed to use the marginal opportunity cost to other users as the measure of market value for setting annual fees.

1.4 We have reconsidered this proposal in light of various factors, including the responses that we received to our consultation, our statutory duties taken together, and our general

[1] *Annual Licence Fees for UK Broadband's 3.4 GHz and 3.6 GHz spectrum*, Consultation, 17 December 2018, Ofcom, https://www.ofcom.org.uk/__data/assets/pdf_file/0013/130540/Annual-Licence-Fees-for-UK-Broadbands-3.4-GHz-and-3.6-GHz-spectrum.pdf.

policy preference in light of our duties in situations where there is a divergence between the market clearing price and marginal opportunity cost to other users.

1.5 We have consequently decided to set fees based on the market clearing price of 3.4 GHz spectrum in the 2018 auction. This puts all operators on a fair, level playing field, and reduces the risk of unintended consequences in particular as regards the future trading of spectrum.

1.6 We are today making the necessary regulations to give effect to this decision. The new fees for UKB's 3.4 GHz spectrum will apply from 31 July 2019. In line with our original proposal, we have decided that the licence fees for 3.6 GHz should be phased in such that Three will be required to pay 50% of the difference between the current level of fees (under the 2011 Regulations) and the new ALFs from 31 July 2019 until the end of June 2020.

1.7 Once the 3.6 GHz ALFs have been phased in, the ALF for both 3.4 GHz and 3.6 GHz spectrum will be £0.435 million per MHz, expressed in April 2018 prices (i.e. before adjustment for CPI inflation). Because UKB has 120 MHz of 3.4 GHz and 3.6 GHz spectrum, this would amount to ALF payments of around £52 million a year (in April 2018 prices) after the phasing-in period.

2. Introduction and legal framework

Introduction

2.1 In this section we explain which spectrum licences are relevant to this decision, and the legal framework within which we review and set spectrum licence fees.

2.2 UKB, which was acquired by Three in 2017, holds a licence which authorises it to use 40 MHz of spectrum in the 3.4 GHz band in two separate 20 MHz blocks at 3480-3500 MHz and at 3580-3600 MHz. In this document we refer to this as UKB's **3.4 GHz spectrum**.

2.3 This spectrum was acquired by auction in 2003, when 15 regional licences for wireless broadband were sold. The licences were consolidated under common ownership through company acquisitions, with the separate licences ultimately combined into a single 3.4 GHz licence by Ofcom in March 2007.[2]

2.4 UKB also holds a licence which authorises it to use 164 MHz of spectrum in two separate blocks at 3600-3680 MHz and at 3925-4009 MHz. In this document we refer to the 80 MHz of spectrum at 3600-3680 MHz as UKB's **3.6 GHz spectrum**.

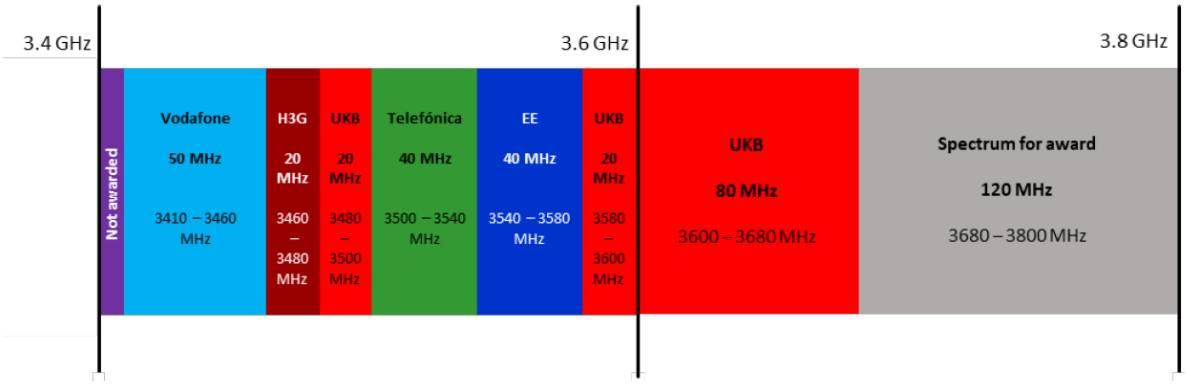
2.5 The licence for this spectrum was initially administratively granted in 1992 by the Radiocommunications Agency (one of Ofcom's predecessor regulators) to Millicom, and was traded several times before being sold to UKB in 2010. In December 2018, we granted a licence variation request by UKB concerning the lower frequency block of this licence, which included: amending the frequencies in this block (from 3605-3689 MHz to 3600-3680 MHz, as above); and aligning the technical requirements for these frequencies with the technical requirements that apply to UKB's 3.4 GHz spectrum.[3]

2.6 Within the 3.4 GHz to 3.8 GHz band, the current spectrum authorisations are as follows. UKB's holdings of 40 MHz at 3.4 GHz and 80 MHz at 3.6 GHz are shaded red.

[2] See paragraphs 3.3-3.4, Ofcom, *Variation of UK Broadband's 3.4 GHz Licence*, Statement, October 2014, https://www.ofcom.org.uk/__data/assets/pdf_file/0018/74610/uk_broadband_statement.pdf.

[3] See Section 2, Ofcom, *Variation of UK Broadband's spectrum access licence for 3.6 GHz spectrum*, Statement, December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0014/130253/Statement-UK-Broadbands-spectrum-access-licence-3.6-GHz.pdf. The licence variation request did not include a request to align the technical requirements for the upper frequency block of this licence (i.e. 3925-4009 MHz).

Figure 2.1: The 3.4 GHz to 3.8 GHz spectrum band



2.7 In December 2018, we consulted on proposals to set annual licence fees (ALFs) in respect of UKB's 3.4 GHz and 3.6 GHz spectrum, including on draft regulations giving effect to our proposals (the "**December 2018 Consultation**").[4] This statement sets out our decision on the level of ALFs that should apply to UKB's 3.4 GHz and 3.6 GHz spectrum, taking account of responses to the December 2018 Consultation.[5] A copy of the regulations that Ofcom is today making in order to give effect to our decision is published on our website alongside this statement. The fees prescribed by these new regulations will become payable on 31 July 2019.[6]

3.4 GHz licence fees

2.8 UKB does not currently pay annual licence fees in relation to its 3.4 GHz spectrum. In our October 2014 statement on UKB's 3.4 GHz licence variation, we said that this licence would be subject to an annual fee following the expiry of the initial term of the licence in July 2018.[7] We inserted a clause in UKB's licence to reflect this intention. We also said that bids and prices from the 2018 auction would be relevant evidence in considering the level of this fee.[8]

3.6 GHz licence fees

2.9 Annual licence fees are already payable in respect of UKB's 3.6 GHz spectrum. The current fees for this spectrum are set out in the Wireless Telegraphy (Licence Charges) Regulations 2011 (the "2011 Regulations").[9]

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[4] https://www.ofcom.org.uk/__data/assets/pdf_file/0013/130540/Annual-Licence-Fees-for-UK-Broadbands-3.4-GHz-and-3.6-GHz-spectrum.pdf

[5] In this document, we are not setting new licence fees for the upper frequency block at 3925-4009 MHz.

[6] In line with the proposal in our December 2018 consultation, we will shortly be varying the licence payment date in UKB's 3.4 GHz licence from 17 July (annual) to 31 July (annual).

[7] Paragraph 15.9, Ofcom, *Variation of UK Broadband's 3.4 GHz Licence*, Statement, October 2014: https://www.ofcom.org.uk/__data/assets/pdf_file/0018/74610/uk_broadband_statement.pdf,.

[8] Paragraph 15.10

[9] A copy of the 2011 Regulations can be found at: https://www.legislation.gov.uk/uksi/2011/1128/made. To date, UKB has been paying Annual Licence Fees of £821,088 per annum for its licence covering spectrum at 3605-3689 MHz and 3925-

2.10 We have previously said that we would consider reflecting the opportunity cost of mobile use in the licence fee that UKB pays for its 3.6 GHz spectrum and that, in reviewing this fee, we would expect to take into account the bids and prices in the 2018 auction, along with any other relevant evidence.[10]

2.11 In our 2010 Strategic Review of Spectrum Pricing ("SRSP")[11], we set out four pricing review principles to guide us in addressing how and when we will review administered incentive pricing (AIP) reflective of the opportunity cost of the spectrum, and cost-based fees. The first principle set out that we would "conduct a fee review only where the evidence suggests that a review would be justified, including evidence of a likely and sufficiently material misalignment between the current rates and the opportunity cost of the spectrum for fees based on AIP"[12].

2.12 As explained in the December 2018 Consultation, we consider that such material misalignment arises in the case of the UKB 3.6 GHz spectrum. In summary, this is because:

a) having started the process to clear the 3.6-3.8 GHz spectrum,[13] we consider that the long-term value of the 3.6-3.8 GHz band will be the same as the 3.4 GHz band;

b) the bids and prices in the 2018 auction provide evidence with regard to the long-term value of the 3.4 GHz and 3.6 GHz spectrum; and

c) this value is materially higher than the annual fees that currently apply to UKB's 3.6 GHz spectrum (i.e. £2,226 per MHz to £8,436 per MHz[14], compared with a fee of £435,000 per MHz (in April 2018 prices) if set by reference to the market clearing price in the 2018 auction).

The legal framework

Ofcom's power to set fees

2.13 Under section 12 of the Wireless Telegraphy Act 2006 (the "**Wireless Telegraphy Act**"), Ofcom has power to require licensees to pay fees to Ofcom on the grant of a licence and subsequently. The requirement to pay fees at times after the grant of a licence must be imposed by way of regulations made by Ofcom. The timing of the fee payment must be set out in the regulations, and the amount of the fee can be prescribed in the regulations, or

4009 MHz. As explained in paragraph 2.3, we have very recently varied that licence so that it now covers spectrum at 3600-3680 MHz and 3925-4009 MHz. The changes we are proposing in this consultation affect only the lower block of those frequencies, namely 3600-3680 MHz.

[10] Paragraph 5.4, *Variation of UK Broadband's Spectrum Access Licence for 3.6 GHz spectrum*, Ofcom, 27 June 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0017/115343/Variation-UK-Broadband-Licence-3.6-GHz-spectrum.pdf

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

[12] Paragraph 6.30 of the SRSP. We explain in more detail in Section 3 why we consider (consistent with the SRSP) that fees should be set to reflect the opportunity cost of spectrum, and also how this relates to the market value for spectrum.

[13] *Improving consumer access to mobile services at 3.6GHz to 3.8GHz*, Ofcom, 26 October 2017, https://www.ofcom.org.uk/__data/assets/pdf_file/0019/107371/Consumer-access-3.6-3.8-GHz.pdf

[14] There are currently two fee rates in this band, depending on the interference environment and the coordination required. See Schedule 2 of the 2011 Regulations.

alternatively the regulations may provide for the amount to be determined by Ofcom in accordance with the regulations.

2.14 Section 13 of the Wireless Telegraphy Act provides for Ofcom to set fees at an amount that is higher than the cost to us of carrying out our radio spectrum functions. This power may be exercised if we think fit in the light (in particular) of the matters to which we must have regard under section 3 of the Wireless Telegraphy Act.

2.15 Section 122 of the Wireless Telegraphy Act is a general provision about matters relating to Ofcom's powers to make statutory instruments (including fees regulations under section 12 of that Act). It includes a requirement that where we are proposing to make regulations we must publish a notice setting out the general effect of the regulations and give a period of at least one month within which representations on the proposed regulations may be made to us.

2.16 The legal framework for the setting of fees derives from our duties under both European and domestic legislation, specifically from:

- the Common Regulatory Framework[15] for electronic communications networks and services, in particular the Framework Directive and the Authorisation Directive; and
- the Wireless Telegraphy Act and the Communications Act 2003 (the "Communications Act") which transpose the provisions of those directives into national law.

2.17 We set out below our statutory duties under the Common Regulatory Framework, the Wireless Telegraphy Act and the Communications Act.

Common regulatory framework

2.18 Article 8 of the Framework Directive sets out the objectives which national regulatory authorities must take all reasonable steps to achieve. These include:

- the promotion of competition in the provision of electronic communications networks and services by, amongst other things, ensuring there is no distortion or restriction of competition in the electronic communications sector and encouraging efficient use and the effective management of radio frequencies; and
- contributing to the development of the internal market by, amongst other things, removing obstacles to the provision of electronic communications networks and services at a European level, and encouraging the interoperability of pan-European services.

2.19 In pursuit of these policy objectives, Article 8 requires national regulatory authorities to apply objective, transparent, non-discriminatory and proportionate regulatory principles by (amongst other things):

[15] 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).

- promoting regulatory predictability by ensuring a consistent regulatory approach over appropriate review periods;
- ensuring that, in similar circumstances, there is no discrimination in the treatment of undertakings providing electronic communications networks and services; and
- promoting efficient investment and innovation in new and enhanced infrastructures.

2.20 Article 8 also requires Member States to ensure that in carrying out their regulatory tasks, national regulatory authorities take the utmost account of the desirability of making regulations technologically neutral.

2.21 Article 9 requires Member States to ensure the effective management of radio frequencies for electronic communications services in accordance with Article 8, and to ensure that spectrum allocation used for electronic communication services and issuing general authorisations or individual rights of use of such radio frequencies are based on objective, transparent, non-discriminatory and proportionate criteria. Article 9 also requires Member States to promote the harmonisation of use of radio frequencies across the Community, consistent with the need to ensure effective and efficient use of frequencies. It requires Member States to ensure technology and service neutrality.

2.22 Article 13 of the Authorisation Directive states that Member States may impose fees for the rights of use of radio frequencies which reflect the need to ensure the optimal use of that resource. Fees must be objectively justified, transparent, non-discriminatory and proportionate in relation to their intended purpose and must take into account the objectives in Article 8 of the Framework Directive.

2.23 Recital 32 to the Authorisation Directive states that in addition to administrative charges, usage fees may be levied for the use of radio frequencies as an instrument to ensure the optimal use of such resources and provides that such fees should not hinder the development of innovative services and competition in the market.

2.24 Recital 33 to the Authorisation Directive states that Member States may need to amend charges and fees relating to rights of use of radio frequencies where this is objectively justified and provides that such changes should be duly notified to all interested parties in good time, giving them adequate opportunity to express their views on any such amendments.

The duties imposed by the Wireless Telegraphy Act

2.25 Section 3 of the Wireless Telegraphy Act imposes a number of duties on Ofcom relating to spectrum management.

2.26 Amongst other things, in carrying out its spectrum functions Ofcom is required to have regard to the extent to which spectrum is available for use, and the demand (both current and future) for the use of spectrum.

2.27 Section 3 of the Wireless Telegraphy Act also requires Ofcom to have regard to the desirability of promoting:

a) the efficient management and use of spectrum available for wireless telegraphy;

b) the economic and other benefits that may arise from the use of wireless telegraphy;

c) the development of innovative services; and

d) competition in the provision of electronic communications services.

2.28 However, section 3(5) of the Wireless Telegraphy Act also provides that where it appears to Ofcom that a duty under that section conflicts with one or more of its duties under sections 3 to 6 of the Communications Act, priority must be given to its duties under the Communications Act.

The duties imposed by the Communications Act

2.29 Section 3 of the Communications Act sets out Ofcom's general duties including its principal duty:

- 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.

2.30 In carrying out its functions, section 3(2) provides that Ofcom is required, amongst other things, to secure the optimal use for wireless telegraphy of the electro-magnetic spectrum, the availability throughout the UK of a wide range of electronic communication services and the availability throughout the UK of a wide range of television and radio services.

2.31 Section 3(3) of the Communications Act provides that in performing its duties, Ofcom must in all cases have regard to the principles of transparency, accountability, proportionality and consistency, as well as ensuring that its actions are targeted only at cases in which action is needed. It also provides that Ofcom must have regard in all cases to any other principles appearing to it to represent the best regulatory practice.

2.32 Section 3(4) of the Communications Act requires Ofcom, in performing its duties, to have regard to a number of factors as appropriate, including the desirability of promoting competition, encouraging investment and innovation in relevant markets, encouraging the availability and use of high speed data transfer services throughout the UK, the different interests of persons living in rural and in urban areas and the different needs and interests of everyone who may wish to use the spectrum for wireless telegraphy.

2.33 In performing our duty under section 3 of furthering the interests of consumers, we must have regard, in particular, to the interests of those consumers in respect of choice, price, quality of service and value for money.

2.34 Section 4 of the Communications Act requires Ofcom to act in accordance with the six Community requirements, which give effect to the requirements of Article 8 of the Framework Directive, when carrying out certain specified functions, including our functions under the Wireless Telegraphy Act 2006.

3. Approach to determining annual licence fees

3.1 In this section, we begin by explaining the rationale for setting ALFs at market value. In doing so, we explain what we mean by market value, market clearing price and opportunity cost. We then explain our view that the long-term value of the 3.6-3.8 GHz band will be the same as the 3.4-3.6 GHz band, and therefore that the ALF for these spectrum bands should be equivalent. Finally, we set out the structure of our approach to determining the level of ALFs for UKB's 3.4 GHz and 3.6 GHz spectrum, before summarising our approach to deriving annual fees based on our estimates of the market value for this spectrum.

Rationale for setting ALFs at market value

December 2018 Consultation

3.2 In the December 2018 consultation, we summarised our general approach to setting spectrum fees (which was originally outlined in detail in our SRSP in 2010). Our policy is to set licence fees by reference to the value of the spectrum (known as administered incentive pricing (AIP) fees), for spectrum that is expected to be in excess demand, while charging cost-based fees where AIP is not appropriate. Following the convention of more recent documents, we typically refer to ALFs hereafter and any references to AIP should be read as equivalent to ALF.

3.3 In the SRSP we explained that, when setting AIP fees to reflect the value of spectrum, we have usually meant that fees would be set at the price that would emerge in a well-functioning market. In a well-functioning market, the price for a marginal block of spectrum would be expected to reflect the valuation of the best alternative use of the spectrum i.e. the opportunity cost of the use of the spectrum. Through this mechanism, prices in well-functioning markets can be expected to reflect the opportunity cost or the value of the best alternative use or user that is denied access to the spectrum.[16]

3.4 Setting fees on this basis promotes the efficient use of spectrum since there is an incentive for users to sell spectrum to alternative users where the next best alternative is more valuable than the current use.

3.5 Our SRSP also considered the interplay between setting spectrum fees and spectrum trading in delivering optimal use of the spectrum. We concluded that many secondary markets are unlikely to be sufficiently effective to promote the optimal use of the spectrum without the additional signal from AIP fees, and that such fees are likely to

[16] See in particular paragraph 4.32 of the SRSP.

continue to be needed to play a role complementary to spectrum trading for most licence sectors.[17]

Responses to consultation

3.6 Telefónica agreed that ALFs for UKB's 3.4 GHz and 3.6 GHz spectrum should be set based on market value.[18] Similarly, Vodafone said it accepts that setting ALFs at market value is likely to deliver the best outcome (though both respondents said we have not properly identified the most appropriate market value to best meet our statutory duties).[19]

3.7 BT said that setting ALFs at market value is not necessary to ensure that operators make efficient use of their spectrum holdings, as operators face the implicit price – or 'opportunity cost' – of spectrum irrespective of any administratively imposed fee. BT made the following specific points:[20]

a) Operators have incentives to use their spectrum holdings efficiently, to meet growing demand for coverage and data capacity (this point was also made by Three).

b) It is accepted by Ofcom and Government that mobile use is the highest value use of this spectrum.

c) Ofcom has not provided sufficient evidence that operators do not sufficiently account for opportunity costs when considering whether to trade spectrum. BT said:

   i) A perceived lack of trading does not in itself imply a risk of inefficient spectrum allocation, particularly as operators make equipment investments with existing spectrum holdings and so are likely to be the highest value users of that spectrum;

   ii) Several spectrum trades have occurred since 2010 (in addition to frequent spectrum auctions), with more trades proposed; and

   iii) Ofcom had provided no empirical evidence to substantiate a view that managers take less account of opportunity costs than accounting costs in their decision-making. BT said the majority of operators disagreed with this claim in their responses to our 2010 SRSP and the recent 900/1800 MHz ALF decision, while BT's previous support for it was conditional on the specific circumstances at the time.

3.8 BT said we must make a stronger case for intervention than simply asserting a possibility that a licensee may not be the highest value user, despite what it considered to be strong evidence to the contrary (although, notwithstanding its concerns with our approach, BT said that we should set ALFs for UKB spectrum immediately on the basis we had proposed, to ensure there is no discrimination between operators in this regard).

3.9 Three said that ALFs have no role to play in ensuring UKB spectrum is used efficiently:[21]

[17] This is AIP Principle 4 in our SRSP.
[18] Telefónica response to December 2018 consultation, page 25.
[19] Vodafone response to December 2018 consultation, page 14.
[20] BT response to December 2018 consultation, Section 2.1.
[21] Three response to December 2018 consultation, Section 1.

a) The 2018 auction results show that it is the highest-value user for UKB's spectrum;

b) Even if other operators had a higher incremental value than Three for some of UKB's spectrum, their ability to bid for 3.6 GHz spectrum in the upcoming auction would mitigate any inefficient allocation of UKB's spectrum;

c) The only other justification for imposing ALFs is to ensure long-term efficiency i.e. if Three's value for UKB spectrum fall below rivals' valuations over time. Three said that we indicated in our December 2018 Consultation that this was unlikely. In any event, Three said it could trade UKB spectrum to users who value it more in future.

3.10 Three argued that we are being inconsistent in our approach by setting ALFs for UKB spectrum but not for the initial 20-year licence term of the 3.6 GHz spectrum to be awarded next year, as there is no more reason to be concerned about fluctuations in value leading to suboptimal use in one case than another.

3.11 BT made a separate point that ALFs could restrict efficient investment due to the presence of a possible information failure on the part of capital markets, which may cause external providers of finance to turn down efficient investment requests by capacity-constrained operators.[22]

Our assessment

3.12 We agree with BT that mobile use is likely to be the highest value use of 3.4 GHz and 3.6 GHz spectrum. We also recognise that Three may be incentivised to make the most efficient use of spectrum that it currently holds. However, neither of these points preclude the possibility that at least a portion of Three's UKB spectrum holdings could be valued more highly by another operator, particularly in the medium to long-term. In other words, even if Three is incentivised to maximise the value of its use of that spectrum, it may not necessarily be the most efficient user.

3.13 As set out in our December 2018 Consultation, we recognise that mobile operators can trade or acquire spectrum licences, and that in principle this creates incentives for operators to only hold licences for which they are the highest-value users. However, we consider there is a risk that operators may be less responsive to the opportunity cost of holding spectrum (through forgoing the revenue from trading it) than to ALFs set at market value, which implies that trading may not in itself be sufficient to ensure that spectrum is allocated most efficiently.

3.14 We disagree with BT that we have not sufficiently justified this view. Our 2018 Statement on 900 MHz and 1800 MHz ALFs, and our December 2018 consultation, set out in detail why we consider that operators may be less responsive to the opportunity cost of holding

[22] BT response to December 2018 Consultation, Section 2.2 and Executive Summary.

tradeable spectrum than to ALFs set at market value.[23] This view is consistent with our position set out in the 2010 SRSP.[24]

3.15 In relation to BT's specific points:

a) While the tailoring of networks to spectrum holdings means existing licensees may be particularly high-value users of their spectrum, this does not rule out the possibility that alternative users may have higher values for marginal increments of spectrum, particularly over longer time horizons;[25]

b) There have been relatively limited examples of spectrum trades to date, which does not suggest the presence of a liquid spectrum market (see paragraphs 4.27-4.28 of the December 2018 consultation). BT further noted that Vodafone and Telefónica requested a partial trade of 900 MHz frequencies, following our December 2018 consultation publication. However, as this application is essentially a swap of 900 MHz frequencies (which does not involve any changes in the quantity of 900 MHz spectrum used by either operator), we do not consider that it necessarily constitutes evidence of operators responding to the opportunity cost of their spectrum.[26]

c) In coming to our view, we have not just relied on stakeholder comments to our 2010 SRSP. In the context of our decision on 900 MHz and 1800 MHz ALFs, we received submissions from mobile operators that we consider are consistent with our view that opportunity costs are not reflected in full by decision-makers. Despite extensive consultation, we did not receive any separate documentary evidence from the operators to suggest that our view is incorrect.[27]

3.16 Regarding Three's comments on the specific situation in relation to UKB spectrum, we agree that the 2018 auction outcomes indicate that Three is currently likely to have the highest valuation (at the margin) for 3.4 GHz spectrum. We also recognise that there is scope for new spectrum auctions to provide some correction to inefficiencies in spectrum holdings over time. However, as recognised by Three itself (and as stated in paragraph 4.21 of our December 2018 Consultation), setting ALFs at market value is intended to provide operators with long-term price signals. Three may not necessarily remain the highest-value user of the entirety of its 3.4 GHz and 3.6 GHz holdings in the medium to long-term.

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[23] See paragraphs 5.41-5.59, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands*, Ofcom, 17 December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0020/130547/Statement-Annual-licence-fees-900-MHz-and-1800-MHz.pdf. See also paragraphs 4.22 to 4.28 of the December 2018 3.4 GHz consultation.

[24] See paragraph 4.203 of the SRSP.

[25] See paragraphs 5.53 to 5.57 of the 2018 Statement on 900 MHz and 1800 MHz ALFs.

[26] For details, see https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/mobile-wireless-broadband. We further note that operators would likely have expected their 900 MHz licences to be liable for ALFs set by reference to the market value of this spectrum band, at the point that this swap was considered. This is because the application was received shortly *after* we published our decision in which we set ALFs for the 900 MHz and 1800 MHz bands by reference to market value, and six months after we published a consultation proposing to set ALFs for that spectrum by reference to market value.

[27] See paragraphs 5.45-5.46 of the 2018 Statement on 900 MHz and 1800 MHz ALFs.

3.17 Three said we had indicated in our December 2018 Consultation that the current situation is unlikely to change in future. We consider that Three has misinterpreted our December 2018 Consultation on this point (specifically, paragraph 3.34). We meant here that setting ALFs using a conservative interpretation of the market clearing price, which is somewhere between £37.8 million and £39.7 million (per 5 MHz in April 2018 prices), will guard against the risk of *inadvertently* setting ALFs at such a level that it would lead to inefficiencies (such as from spectrum lying fallow). We were not commenting on the likelihood that Three's value for 3.4 GHz spectrum would fall below rivals' valuations in future. For the avoidance of doubt, we consider that relative valuations at the margin could change, either because Three's private values fall or because other operators' marginal values increase.[28]

3.18 Three also said that we are treating UKB's 3.4 GHz and 3.6 GHz spectrum inconsistently with the 3.6 GHz spectrum due to be auctioned next year. In the present decision, we are setting ALFs for UKB spectrum. This reflects the terms of the licences for this spectrum, which (in the case of 3.6 GHz spectrum) already require the payment of annual fees and, in the case of 3.4 GHz spectrum, stipulate that annual fees are payable as soon as the initial licence term is over. For spectrum outside the initial term of the original award (as here) or which has not previously been auctioned, our approach is to set ALFs if the spectrum is expected to be in excess demand. For the reasons set out here, we consider that setting ALFs at market value will best meet our statutory duties. We have separately consulted on our proposal of having a 20-year initial term (without ALFs) in the context of the 700 MHz and 3.6-3.8 GHz auction. We consider that the approach to licence terms proposed is in line with previous auctions, and so is likely to be well understood by potential bidders. We will make final decisions on the auction, including licence terms, later this year.

3.19 Overall, for the reasons explained above, we maintain that there is a risk that Three may be less responsive to the opportunity cost of its UKB 3.4 GHz and 3.6 GHz spectrum than to ALFs set at market value, which gives rise to a consequent risk for efficient spectrum use. We recognise this risk may be smaller in this case than in situations where there has not been a recent auction of spectrum in the same band. Nevertheless, setting ALFs for this spectrum at market value is likely to secure optimal spectrum use by strengthening Three's incentives to retain spectrum only if it is the highest-value user of the underlying spectrum, particularly over the medium to long-term.

3.20 In respect of BT's comments on investment impacts, our view remains that it would not be appropriate to set ALFs below market value.

a) First, investment decisions should reflect the true costs of inputs, which is achieved by setting ALFs at market value. We consider that ALFs at market value impose an important discipline on investment decisions and protect against inefficient investments.

b) Second, while we recognise that imperfect capital markets could in theory result in some efficient investment opportunities being foregone, we disagree that we should

[28] We discuss the risk to optimal spectrum use from Three's values falling below the market clearing price in Section 4.

necessarily intervene by subsidising an input price as this would not be targeted at the potential market failure in question.

c) Third, BT has provided no new evidence (that we have not already considered in our Statement on 900 MHz and 1800 MHz ALFs[29]) that lower ALFs would lead to increased levels of efficient investment.

3.21 In conclusion, our view remains as set out in the December 2018 Consultation and the preceding SRSP. In most markets, firms pay the market value for inputs to the goods and services they produce. This is also the case for mobile operators in relation to other inputs such as sites, network equipment and labour. With the increasing importance of radio spectrum in the provision of modern communication services, it is important to ensure that each mobile operator has appropriate incentives to retain spectrum rights only if it is the highest-value user of the underlying spectrum. As such, ALFs continue to be required to play a role complementary to spectrum trading.

Equivalence of 3.4 and 3.6 GHz spectrum in future

3.22 UKB's 3.4 and 3.6 GHz spectrum falls within the 3.4-3.8 GHz band, which is the primary band for 5G services in Europe.

3.23 We auctioned 150 MHz of spectrum in the 3.4-3.6 GHz band in the 2018 auction. Prior to that, in October 2017, we published our decision to remove fixed links and satellite earth station authorisations in the 3.6-3.8 GHz band.[30]

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3.24 Our provisional view was that, whilst there are some short-term constraints on UKB's use of 3.6 GHz spectrum which mean that there will be some difference in value between 3.4 and 3.6 GHz spectrum in the short term, the long-term value of the 3.6-3.8 GHz band will be the same as the 3.4-3.6 GHz band. We therefore proposed that the bids and prices for 3.4 GHz spectrum in the 2018 auction also provide a good indication of the value of UKB's 3.6 GHz spectrum in the long-term.

3.25 In our statement on the UKB licence variation, we noted that UKB currently shares the band with other users. The main constraint on the use of UKB's 3.6 GHz spectrum is related to satellite earth stations as these are co-channel with the UKB spectrum, whereas there are no co-channel fixed links. Authorisations of satellite earth stations in the band will end by June 2020 (and in one case September 2020). As such, we expect the majority of the constraints on the use of UKB's 3.6 GHz spectrum to have been removed by June 2020.[31]

[29] See for instance paragraphs 5.98 to 5.101 of the December 2018 Statement on 900 MHz and 1800 MHz ALFs.
[30] *Improving consumer access to mobile services at 3.6GHz to 3.8GHz*, 26 October 2017, https://www.ofcom.org.uk/consultations-and-statements/category-1/future-use-at-3.6-3.8-ghz
[31] See the update we published in February 2018 on the timing of availability of the 3.6-3.8 GHz band, https://www.ofcom.org.uk/__data/assets/pdf_file/0018/110718/3.6GHz-3.8GHz-update-timing-spectrum-availability.pdf.

3.26 We also explained that, following our December 2018 decision to grant UKB's 3.6 GHz licence variation request, the technical licence conditions for both UKB's 3.4 GHz and 3.6 GHz licence have been aligned. In practice, there is therefore no difference between the technology that Three is able to deploy in its 3.4 GHz and 3.6 GHz spectrum.

Responses to consultation

3.27 Both Three and Telefónica agreed with our provisional view. Vodafone said that there is, in its view, no evidence that suggests user device availability, technical standards or propagation characteristics will differ between the bands. Both Vodafone and Telefónica also emphasised that many European countries have awarded the bands in a single exercise and that any approach that does not treat the two bands equally would be contrary to best practice across Europe.[32]

3.28 BT stated that UKB should immediately pay for the spectrum it has been assigned, in light of the principle of non-discrimination. It did not disagree with our provisional view that the long-term value of 3.4 GHz and 3.6 GHz spectrum will be the same. It did, however, suggest that the prices in the forthcoming auction of 3.6 GHz spectrum may be lower than those for 3.4 GHz spectrum from the 2018 auction.[33]

Our assessment

3.29 For the reasons set out in the December 2018 Consultation, and taking account of stakeholder responses, our view remains that the long-term value of the 3.6-3.8 GHz band will be the same as the 3.4-3.6 GHz band and therefore that the annual fees for these spectrum bands should be equivalent in the long-term. No respondent disagreed with this.

3.30 We also remain of the view that, given the short-term constraints on use of the 3.6 GHz spectrum, there will be some difference in value between 3.4 and 3.6 GHz spectrum in the short-term. We discuss how we take account of this difference, along with other considerations, when we consider the phasing in of the new licence fees in section 5.

Structure of our approach to determining the level of fees

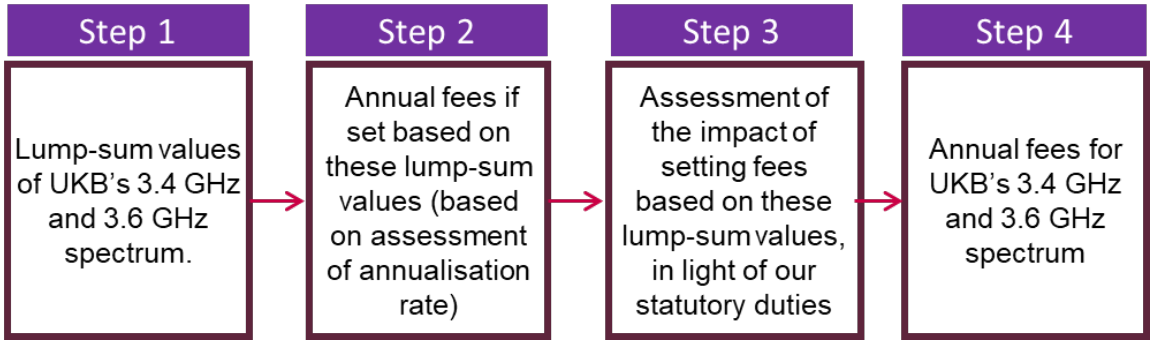
3.31 Having concluded that it is appropriate to set ALFs to reflect the market value of this spectrum, and that the annual fees for UKB's 3.6 GHz spectrum should be the same as for UKB's 3.4 GHz spectrum in the long-term, we now explain how we derive the specific level of fees for UKB's 3.4 GHz and 3.6 GHz spectrum.

3.32 The framework we have used is summarised in Figure 3.1 below. Steps 1 and 2 are outlined in the rest of this section (section 3), with more detailed points from stakeholders addressed in Annex 1 and Annex 2. The next section (section 4) sets out our assessment

[32] Page 10, Vodafone response to December 2018 consultation. Paragraph 9, Telefónica response to December 2018 consultation.
[33] Paragraph 4 and Section 3.1, BT response to December 2018 consultation.

under Steps 3 and 4. Section 5 sets out how we will implement the fees for UKB's 3.4 and 3.6 GHz licences, including the phasing in of these fees.

Figure 3.1: Framework of steps



3.33 In its consultation response, Vodafone argued that our framework focused too narrowly on the question of whether to depart from setting ALFs at market value, rather than whether a specific view of market value best meets our statutory duties.[34] In light of Vodafone's comments, we now do this more explicitly in Section 4 of this document.

Identification of lump-sum market values for the relevant spectrum

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3.34 Step 1 of our framework involves identifying the lump-sum market values. We proposed to base our estimate of lump-sum market value for this spectrum on the results of the 2018 auction of 3.4 GHz spectrum. We considered this particularly relevant evidence as it is a recent UK auction of spectrum in one of the bands for which we are seeking to set ALFs, and in which all four UK mobile operators competed for, and won, spectrum.[35]

3.35 We explained that, when setting spectrum fees, we have focussed on the forward-looking marginal opportunity cost of the spectrum. We also explained that we have tended to use marginal opportunity cost, market value and market clearing price interchangeably, as we consider that the forward-looking marginal opportunity cost and market clearing price in a well-functioning market would be the same, and would both capture market value. This is consistent with our general position in the SRSP.[36]

3.36 Based on the results of the principal stage of the 2018 auction, we identified:

a) a **market clearing price** between £37.8 million and £39.7 million per 5 MHz. The former is the last price in the auction for which there was excess demand. The next price in the auction was £39.7 million per 5 MHz. Three declined to pay this price for 30 MHz of

[34] Vodafone response to December 2018 consultation, pages 7-9 and 14.
[35] We noted that there have been recent auctions of 3.4-3.8 GHz spectrum in other EU and non-EU countries, but we considered these auctions to be less informative of UK market value.
[36] See for instance the summary in paragraph 3.3 above.

3.4 GHz spectrum, so it was awarded 20 MHz for £37.8 million per 5 MHz (bringing overall demand equal to supply). We took a conservative approach to identifying the market clearing price and proposed a value of £37.8 million per 5 MHz. We considered that the market clearing price is also the marginal opportunity cost of the spectrum in the auction;[37] and

b) a **marginal opportunity cost to other users** of between £31.1 million and £32.7 million per 5 MHz. The former is the last price in the auction for which a bidder *other than Three* bid for more 3.4 GHz spectrum than it ultimately won (i.e. Telefónica's bid of £31.1m per 5 MHz lot for 55 MHz). When the price rose to £32.7 million, Telefónica dropped its demand to 40 MHz and, thereafter, maintained this demand until the auction ended. A conservative estimate of the marginal opportunity cost to other users of Three holding 3.4 GHz spectrum would therefore be £31.1 million per 5 MHz.

3.37 This distinction between market clearing price and marginal opportunity cost to other users reflected the specific results of the 2018 auction, namely, the fact that Three continued to bid in the auction (as it was entitled to do) and so set the market clearing price. However, as Three was the marginal bidder and is the ultimate owner of the UKB spectrum, the marginal opportunity cost of UKB's spectrum to other users is lower.

Responses to consultation

3.38 BT said that, if any ALFs are applied, the marginal opportunity cost of spectrum to other users (i.e. £31.1 million per 5 MHz) should be used to set ALFs for this spectrum. In contrast, Vodafone and Telefónica said that the market clearing price (£37.8 million per 5 MHz) is the best estimate of the market value of this spectrum.

3.39 Three disagreed with our proposed lump-sum market values. It said we had overstated the marginal opportunity cost of its UKB spectrum to other users, and that the correct measure of this value is £29.6 million per 5 MHz. It also said that the best available estimate of market value is the average opportunity cost of its total 120 MHz UKB holding, which it estimated to be £19.1 million per 5 MHz.[38]

3.40 Respondents also suggested reasons why bids in the 2018 auction may have understated or overstated intrinsic values for 3.4 GHz spectrum, which could affect our lump-sum market value estimates as derived from the results of the 2018 auction.

3.41 We set out stakeholders' responses in more detail in Annex 1.

[37] See paragraph 3.20 of the December 2018 consultation.

[38] Three further proposed that if we applied its discount factor to account for what it considered to be the first-mover advantage in respect of 5G services, the adjusted lump-sum value for the purposes of setting its UKB ALFs would become £17.2 - £17.8 million per 5 MHz.

Our assessment

3.42 We have considered Three's alternative estimates of market value in detail in Annex 1. We have also assessed whether there are grounds to adjust our market value estimates in light of any risk of 2018 auction bids understating or overstating intrinsic values, as well as whether there are other meaningful evidence sources that we could rely on.

3.43 Based on this assessment, we remain of the view that the market clearing price and the marginal opportunity cost to other users, as identified in the 2018 auction, are the most relevant measures of lump-sum market value for the purposes of setting ALFs in this case. We have also maintained our estimates of these measures, as follows (April 2018 prices):

a) £31.1 million per 5 MHz, which is a conservative estimate of the marginal opportunity cost to other users; and

b) £37.8 million per 5 MHz, which is a conservative estimate of the market clearing price.

3.44 In Section 4, we assess which of these market value measures for determining the ALFs for UKB's 3.4 GHz and 3.6 GHz spectrum would best meet our statutory duties. We next explain how these lump-sum market values are converted into annual payments for the purposes of setting ALFs.

Annualisation

December 2018 consultation

3.45 Step 2 of our framework involves deriving annual fees based on the lump-sum market values set out above. This requires an annualisation rate. We proposed to use an annualisation rate of 5.75%, which was the same rate that we used to derive ALFs in the 2018 900 MHz and 1800 MHz ALF statement.[39]

Responses to consultation

3.46 Only two respondents commented on our proposed annualisation rate. Vodafone agreed with our proposal. Telefónica agreed that we should adopt the same annualisation methodology as for 900 and 1800 MHz ALFs, but it said that we had overstated the annualisation rate as a result of two specific parameter values which feed into the rate. Telefónica's reasoning is set out in more detail in Annex 2.

Our assessment

3.47 Following our approach in the 2018 900 MHz and 1800 MHz ALF statement, and after consideration of Telefónica's more recent submission (which we explain in Annex 2), we

[39] Table 4.1, Ofcom, of *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018, https://www.ofcom.org.uk/consultations-and-statements/category-2/annual-licence-fees-900-1800-mhz.

remain of the view that the most appropriate annualisation rate for the purposes of setting UKB's 3.4 GHz and 3.6 GHz ALFs is **5.75%**.

3.48 Based on this annualisation rate and the lump-sum market values identified earlier in this section (i.e. the marginal opportunity cost to other others and the market clearing price), we obtain the annual fees shown in the middle column of Table 3.1 below:

Table 3.1: ALFs based on the candidate lump-sum market values (April 2018 prices)

	Lump-sum value (£ million per 5 MHz)	Implied annual fee (£ million per MHz)	Total implied annual fee for UKB spectrum[40] (£ million)
Marginal opportunity cost to other users	31.1	0.358	43.0
Market clearing price	37.8	0.435	52.2

[40] UKB has 120 MHz of 3.4 GHz and 3.6 GHz spectrum. This is the implied fee once the new 3.6 GHz ALFs have been phased in (i.e. after June 2020, as explained in section 5).

4. Decision on market value for annual licence fees in light of our statutory duties

Introduction

4.1 In Section 3, we conclude that the most relevant measures of market value to consider for the purposes of setting ALFs for Three's UKB 3.4 GHz and 3.6 GHz spectrum are (in April 2018 prices):

i) £31.1 million per 5 MHz (which is a conservative estimate of the marginal opportunity cost to other users); and

ii) £37.8 million per 5 MHz (which is a conservative estimate of the market clearing price).

4.2 Both measures would be consistent with the general principles set out in the SRSP (which was in itself taking into account our statutory duties). In this section, we consider which of these two measures of market value to adopt, in light of our statutory duties.

4.3 As explained in Section 3, we have typically considered that the forward-looking marginal opportunity cost and market clearing price in a well-functioning market would be the same. However, in this case, the marginal opportunity cost *to other users* of UKB's 3.4 GHz spectrum is different from the market clearing price. This means that, if we were to set fees for UKB's 3.4 GHz spectrum with respect to the marginal opportunity cost to other users, UKB would pay a lower amount than other operators (including its parent company Three) paid in the 2018 auction for equivalent spectrum. It would also mean that, if we were setting fees for any other operator in the same band, the marginal opportunity cost to another user would have been the same as the market clearing price in the 2018 auction i.e. £37.8 million per 5 MHz.

4.4 Two respondents to our consultation argued strongly against setting licence fees which could be different, depending on the identity of the licensee. They argued that this would be inconsistent with the approach taken in our recent decision on annual licence fees for the 900 and 1800 MHz bands,[41] where operators pay equal amounts for equivalent spectrum. One respondent also suggested that, in the context of administrative fee setting, a regulator must have strong arguments for deviating from the standard approach of charging the same price for the same thing to all operators. In its view, we had failed to identify such arguments in our consultation.

4.5 The specific circumstances in which we set ALFs for 900 MHz and 1800 MHz were such that we did not have clear evidence that the issue of divergence between market clearing price

[41] Ofcom, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands*: Statement, December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0020/130547/Statement-Annual-licence-fees-900-MHz-and-1800-MHz.pdf.

and marginal opportunity cost to another user arose.[42] However, it is possible that the issue of different market values could arise again in relation to future fee setting exercises, potentially again raising questions around discrimination and fairness. In view of this, we have given careful thought to our policy approach in such situations.

4.6 When thinking about well-functioning markets (as described in the SRSP), we typically envisage a market for a product with many buyers and sellers, with none able to influence the market price. In such a market, a single market clearing price would emerge and would be the same for any buyer. We recognise that different prices may emerge for the same product in some markets – for example, if there is some degree of market power and price discrimination is possible. Alternatively, even with competitive market mechanisms, different prices for the same product can emerge – for example if the costs of supply differ. Such a situation can arise in a combinatorial clock auction (CCA), because the use of a second price rule, coupled with multiple lots and bidders with different demands, means that the price per MHz can vary for different "winning" bidders.

4.7 Nevertheless, in regulated markets in which the regulator is setting the price, it is more common to do so by means of a uniform price, rather than a price that varies depending on the identity of the purchaser. This is often the case when setting price caps and, as we explain below, we consider is more appropriate when setting spectrum licence fees.

4.8 In our judgment, it is preferable to set fees which are agnostic to the identity of the licensee and that do not result in different fees for equivalent spectrum.

4.9 In the rest of this section, we present an updated assessment of the impact of setting ALFs by reference to the market clearing price and the marginal opportunity cost to other users, in relation to a number of factors which derive from our statutory duties:

a) securing the optimal use of spectrum;

b) competition;

c) consumers;

d) investment;

e) the risk of discrimination and/or an unfair outcome;

f) efficient and effective spectrum management; and

g) regulatory predictability and consistency with previous decisions.

Securing the optimal use of spectrum

4.10 As set out in section 2 above, section 3(2) of the Communications Act requires us to secure the optimal use of spectrum, and Article 13 of the Authorisation Directive permits the imposition of spectrum fees which reflect the need to ensure the optimal use of such resources.

[42] See in particular footnote 23 of our December 2018 Statement on 900 MHz and 1800 MHz ALFs.

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4.11 We said that setting 3.4 GHz and 3.6 GHz ALFs using the market clearing price or marginal opportunity cost to other users would be consistent with and therefore capable of securing the optimal use of spectrum.

4.12 We considered whether there were reasons why one measure of market value might fulfil this duty more effectively than the other. We said:

a) It might be argued that ALFs set using the market clearing price are higher than necessary to secure optimal use (noting that in this particular case, we have bid data which allows us to identify the marginal opportunity cost to other users). However, given the available bid data, we also considered that using the market clearing price would pose little risk of inadvertently setting ALFs at such a level that it would lead to inefficiencies (i.e. to some spectrum being returned and left unused).

b) On the other hand, using the marginal opportunity cost to other users could conceivably have adverse consequences for future trading in that spectrum (e.g. by creating uncertainty for potential trading partners about the level of ALFs post-trade, with the consequent risk that trading may be less likely to occur).

4.13 Our provisional view was that, on balance, the marginal opportunity cost to other users was no higher than necessary to promote the optimal use of the spectrum and so we were minded to use this measure of market value for setting ALFs.

Responses to consultation

4.14 Three disagreed that the market clearing price and marginal opportunity cost to other users are both capable of securing optimal use. It said that an ALF at market clearing price could lead to large inefficiency if Three's valuation for some of UKB's spectrum fell below £37.8 million but remained above the marginal opportunity cost to other users. Three said this inefficiency would not arise if the ALF is based instead on the marginal opportunity cost to others (although, as discussed in Annex 1, it considered that either a non-linear ALF or an ALF set using average opportunity cost would be more efficient than using a uniform marginal opportunity cost).[43]

4.15 In contrast, Telefónica said that setting ALFs using the market clearing price has a much better chance of achieving an efficient allocation of spectrum in the 3.4 – 3.8 GHz band. It said that an ALF set above Three's own marginal value would presumably spur it to try and trade surplus spectrum, and that, even if Three returned UKB spectrum to Ofcom, it could be promptly re-auctioned either within the forthcoming 3.6 GHz award or on terms reflecting the outcome of that award. This could facilitate efficient reallocation and more timely deployment than the current allocation. It may also facilitate band defragmentation.[44]

[43] Paragraph 1.118, Three response to December 2018 consultation.
[44] Paragraphs 33 and 36, Telefónica response to December 2018 consultation.

4.16 ✂ said the risk of Three returning spectrum is low because the other three operators would all like to acquire up to 100 MHz of contiguous spectrum in the 3.4-3.8 GHz band, so "*there is a good chance that Three could find willing buyers even if ALFs are set at the market clearing price*". It said it would itself willingly acquire UKB's spectrum at a price equivalent to £37.8 million per 5 MHz block.[45]

4.17 Vodafone said that in our impact assessment we occupied ourselves with the question of whether to adopt market value and not to any extent with what that market value ought to be, in order to secure optimal spectrum use. It said that an appropriately set ALF would encourage a user to divest spectrum where the value it achieves is less than the ALF, but that Three's UKB spectrum confers on it a strategic advantage from denying competitors the spectrum required ✂ (which increases its value for the spectrum). It also questioned whether our analysis was rich enough to factor in the value of contiguity.[46]

4.18 Vodafone also said that tailoring ALFs to the incumbent licensee is deeply flawed because it implies that anyone who subsequently acquires UKB spectrum would either pay a higher ALF or continue to pay an ALF based upon someone else excluding access to the spectrum. In the case in which ALFs are left unchanged following a spectrum trade, Vodafone said this would be to accept that ALFs are not charged according to the marginal opportunity cost of excluded users, but instead with reference to whichever user was excluded at the time that Ofcom last examined the ALF. Vodafone said, "*our point is not about encouraging or discouraging spectrum trades, rather that if Ofcom's approach results in a different ALF being set between equivalent spectrum bands and/or between competing licensees, then spectrum trades that occur will expose the illogicality of the approach adopted by Ofcom*".[47]

4.19 Finally, stakeholders also commented on the implications of our choice of market value measure for the forthcoming award of 700 MHz and 3.6 GHz spectrum. Vodafone and Telefónica said that setting ALFs using the marginal opportunity cost to other users will increase the risk of price-driving by Three.[48] Three said that both measures of market value would risk distorting bidding incentives in auctions, as they were affected by a winning bidders' bids in the 2018 auction.[49]

Our assessment

4.20 We disagree with Vodafone that we did not consider what market value would best secure the optimal use of spectrum. We specifically addressed this question in paragraphs 3.31 to 3.43 of Section 3 of the December 2018 Consultation.[50] We also do not consider Vodafone's argument that Three's value for the spectrum may be higher (for example for reasons of contiguity) to be relevant as an indicator of market value. Our framework for

[45] ✂
[46] Pages 16 and 11, Vodafone response to December 2018 consultation.
[47] Page 13, Vodafone response to December 2018 consultation.
[48] Vodafone response to December 2018 consultation. Pages 16-17, Telefónica response to December 2018 consultation.
[49] Section 4, Three response to December 2018 consultation.
[50] However, as explained in paragraph 3.33, we consider more explicitly in this section which measure of market value best meets our statutory duties, including optimal spectrum use.

setting ALFs focuses on the forward-looking marginal opportunity cost of the spectrum, rather than Three's value for its UKB spectrum holdings.

4.21 We now address stakeholders' comments on the implications for optimal spectrum use from setting ALFs using the market clearing price, or marginal opportunity cost to other users.

Risk to efficiency from spectrum lying unused

4.22 Our provisional view in the December 2018 consultation was that using the market clearing price rather than the marginal opportunity cost to other users would pose little risk of *inadvertently* setting ALFs at such a level that it would lead to inefficiencies. In the context of setting ALFs for UKB spectrum, we have bid data from a recent UK auction of the same (or similar) spectrum which shows that Three was willing to pay *at least* £37.8 million per 5 MHz for additional spectrum.

4.23 However, we recognise that Three's values for spectrum could change over time, and that (with ALFs set at the market clearing price) this could create a risk of spectrum lying unused. For instance, if Three's value for 3.4 GHz spectrum fell below £37.8 million but remained above £31.1 million per 5 MHz (i.e. the marginal opportunity cost to another user), while other operators' values remained unchanged from the 2018 auction, Three may then return that spectrum to Ofcom despite still being the highest value user.

4.24 In considering the likelihood and impact of this risk, we note the following:

a) First, a fall in Three's marginal value for 3.4 GHz spectrum is only one possible future scenario. We have no reason to believe this is any more likely than Three's values increasing over time.[51] Furthermore, even if Three's values fell, the value of additional 3.4 GHz spectrum to one or more of the other mobile operators could increase over time (e.g. due to changes in market shares or better than expected take-up of their 5G services) such that efficient trades are possible. We note, in this regard, that one respondent to our December 2018 Consultation explained that it would willingly acquire UKB spectrum at a price equivalent to £37.8 million per 5 MHz block.

b) Second, as explained in Annex 1 (paragraph A1.29), Three's values for its infra-marginal spectrum (i.e. the bulk of its existing 3.4 and 3.6 GHz holdings) will likely exceed the conservative estimate of the market clearing price (i.e. £37.8 million per 5 MHz). As such, while Three's value for *marginal* spectrum could fall below this market clearing price over time, the risk that Three relinquishes a *large amount* of its spectrum holdings (despite being the highest value user) is mitigated by the fact that its infra-marginal values would have to change significantly for this to occur.

[51] Frontier Economics (on behalf of Three) suggested that Three's value for UKB spectrum may fall if its fixed wireless access business case is affected by competition from FTTP services. While we recognise that spectrum values will be affected by the competitive interaction between different services, we do not consider that this demonstrates that a fall in overall values is more likely than an increase in values (nor did Frontier Economics discuss the likelihood of this scenario). For example, fixed wireless access services could prove more successful in competing with fixed line broadband than originally anticipated.

c) Thirdly, even if Three did relinquish some 3.4 GHz spectrum in the near term, and it was returned to us because there was no willing buyer at the market clearing price in the 2018 auction, we might be able to reauction this spectrum relatively quickly as part of the forthcoming 700 MHz and 3.6 GHz award (as noted by Telefónica). This could help to mitigate the inefficiency created by spectrum lying fallow for a period of time.

4.25 In summary, we recognise that the risk of inefficiency arising from spectrum lying unused is somewhat greater if ALFs are set using the market clearing price than using the marginal opportunity cost to other users, but that there are also factors which may reduce this risk.

Risk to efficiency from impact on incentives to trade

4.26 We have also considered the implications of our choice of lump-sum market value for incentives to trade spectrum.

4.27 Vodafone suggested that setting ALFs using the marginal opportunity cost to other users implies that anyone who subsequently acquires UKB spectrum would either pay a higher ALF or continue to pay an ALF based upon someone else excluding access to the spectrum. We recognised this in our December 2018 Consultation, saying that setting ALFs using the marginal opportunity cost to other users could imply that the level of the ALF should be changed following the trade (i.e. the ALF should be licensee-specific). We said it is possible that this could lead to uncertainty for potential trading partners, with the consequent risk that trading may be less likely to occur. However, we also said in the December 2018 Consultation that there might be no clear reason to change the ALF following a trade. This is because the transaction leading to the change in licensee would have been a spectrum trade from Three to another operator, which might question the assumption that Three had a higher value for that spectrum than the other operator. [52]

4.28 Since the December 2018 Consultation, the prospect of trades appears to have increased. In particular, Three has recently engaged a specialist consultancy to design a trading process to defragment this spectrum band. This may require various trades or 'swaps' within the 3.4 – 3.6 GHz band. Three has expressed a desire to complete this process as soon as practicable.[53] We also understand that other operators may be interested in such trades, to facilitate defragmentation (noting that there is a general consensus among UK mobile operators that a minimum of 80 MHz of contiguous spectrum is desirable for delivering 5G services).

4.29 Unlike with a trade of just one tranche of spectrum, a pure swap of 3.4 GHz spectrum does not necessarily indicate that each operator's marginal valuation expressed in the 2018 auction has changed. This is because a swap does not involve changes in the quantity of spectrum held by the operators. The bid data that we have used is from the principal stage of the 2018 auction and therefore reflects demand for a given quantity of 3.4 GHz

[52] Paragraphs 3.37-3.38 of the December 2018 consultation.
[53] See paragraph 1.151, Three response to December 2018 consultation.

spectrum, rather than demand for 3.4 GHz frequencies in a particular location in the band plan (which is determined at the assignment stage of the auction).

4.30 If ALFs were set on the basis of the marginal opportunity cost to other users, then the ALF for a block of spectrum which is swapped would reflect *Three's* marginal opportunity cost to other users, despite it now being held by a different operator, for whom a higher marginal opportunity cost to other users would be appropriate.[54] This would seem illogical if the basis for the ALF was the marginal opportunity cost to other users. However, the possibility of Ofcom increasing the ALF to reflect the new holder's higher marginal opportunity cost to other users could undermine the incentive to swap in the first place (thus deterring a potentially efficiency-enhancing reallocation).

4.31 Setting ALFs at the market clearing price avoids this problem. Because it does not vary with the holder of the spectrum, there would be no clear reason to revise ALFs following a swap. Using the market clearing price to set ALFs would therefore be more compatible with facilitating spectrum swaps than the marginal opportunity cost to other users.

4.32 In light of the above, we now consider that there is a greater benefit to optimal spectrum use from setting ALFs at the market clearing price than at the time of our December 2018 Consultation, on the grounds that we would be less likely to revise ALFs following a series of swaps of the type described above. In other words, the market clearing price is a more robust price signal for optimal spectrum use given the prospect of efficiency enhancing spectrum trades or swaps.

Risk to efficiency from the impact on auction bidding incentives

4.33 We have also considered the implications of our choice of lump-sum market value for bidding incentives in future auctions – in particular the forthcoming award for 700 MHz and 3.6-3.8 GHz spectrum.

4.34 Regarding stakeholder comments on price-driving incentives, we note that the choice of market value measure used to set UKB ALFs could only reduce Three's price-driving incentives in the forthcoming award to the extent that it expected the outcome of that auction to affect the ALFs paid for UKB spectrum. As explained in Section 5, we always retain the ability to revise fees in the future in appropriate circumstances, including after the forthcoming auction of 700 MHz and 3.6-3.8 GHz spectrum, if we consider there is evidence to suggest a revision to fees is warranted. However, we also consider that there is benefit for licensees in a period of certainty on fees. This remains our general position, and we intend to retain the fees as set unless there is strong evidence that a material misalignment has arisen between the level of the fees and the value of the spectrum.

4.35 In the event that Three anticipated a fee review prompted by strong evidence of a material misalignment in the forthcoming auction, we recognise that setting ALFs at the market clearing price might limit Three's incentives to price-drive (if it expected that its bids could

[54] Following such a swap, some of the spectrum would be held by an operator other than Three and the best available evidence of marginal opportunity cost to other users for that operator would be represented by Three's value of additional 3.4 GHz spectrum (which, from the conservative estimate of market clearing price, would be £37.8 million per 5 MHz).

more clearly affect the market clearing price – and hence the level of its ALFs – than the marginal opportunity cost to other users). However, this would only affect incentives if Three considered that there would be a divergence between these measures of market value in the auction. The strength of any impact of our approach to setting ALFs for UKB spectrum on bidding incentives would also likely depend on the auction design itself (e.g. whether the auction is a CCA or an SMRA), on which we have taken no decision to date.

4.36 As such, we do not consider that the risk of strategic bidding in the forthcoming auction would clearly be greater if we set ALFs for the UKB spectrum using the marginal opportunity cost to other users rather than the market clearing price, although we recognise that this could be a risk in some circumstances.

4.37 Regarding Three's argument that both measures of market value would risk distorting auction bidding incentives, we have addressed this point in Annex 1. In this section we are concerned about the choice between the two most relevant measures of market value identified in Section 3 for the purposes of setting ALFs (i.e. market clearing price and marginal opportunity cost to other users), not between these and the alternatives proposed by Three.

Summary

4.38 We remain of the view that both the market clearing price and the marginal opportunity cost to other users are consistent with and therefore capable of securing the optimal use of spectrum. Both would provide Three with a long-term signal of the value of its 3.4 GHz and 3.6 GHz spectrum and would be consistent with the general principles set out in the SRSP.

4.39 On the basis of optimal use, we consider that the choice between market clearing price and marginal opportunity cost to other users is finely balanced:

a) we recognise that the risk of inefficiency arising from spectrum lying unused is somewhat greater if ALFs are set using the market clearing price than using the marginal opportunity cost to other users, but that there are also factors which may reduce this risk;

b) however, the marginal opportunity cost to other users implies setting licensee-specific ALFs. This could have adverse consequences for future trading, particularly in the case of spectrum 'swaps' within the 3.4-3.8 GHz band where the quantities of 3.4-3.8 GHz spectrum held are unchanged. This problem is avoided with the market clearing price (which is not licensee-specific). In light of this, and the increased possibility of spectrum swaps, there would be an efficiency advantage from setting ALFs at the market clearing price;

c) we do not consider that the risk of strategic bidding in the forthcoming auction would clearly be greater if we set ALFs for the UKB spectrum using the marginal opportunity cost to other users rather than the market clearing price, although we recognise that this could be a risk in some circumstances.

Impact on competition

4.40 Our principal duty under the Communications Act requires us to further the interests of consumers in relevant markets, where appropriate by promoting competition. This is also reflected in section 3 of the Wireless Telegraphy Act, and implements Article 8 of the Framework Directive.

December 2018 Consultation

4.41 We said that setting ALFs below the market clearing price (i.e. using marginal opportunity cost to other users) would have differential financial effects on operators. There may therefore be some risk that there is an adverse impact on competition, as Three could be considered to be effectively receiving a discount or "subsidy" relative to the other MNOs who acquire their 3.4 GHz or 3.6 GHz spectrum at auction. However, we said the scale of the difference in fees (i.e. around £9 million per year in April 2018 prices) compared to the market clearing price suggests that any risk to competition is likely to be fairly limited. [55]

Responses to consultation

4.42 BT said that consideration of Ofcom's duties in relation to the promotion of competition, investment and the interests of consumers should lead to lower fees than those based on full market value (although it did not comment specifically on the competition impacts of setting ALFs using the market clearing price, relative to the marginal opportunity cost to other users).[56]

4.43 Three said that there is little reason to be concerned about potential risks to competition from different operators paying different amounts for the same spectrum, as this outcome arises in auctions. Three noted in particular that Telefónica paid more for its 3.4 GHz spectrum in the 2018 auction. It said there is no suggestion that this was unfair, created a competitive distortion or an administrative burden for Ofcom.[57]

4.44 Telefónica said that setting ALFs using the marginal opportunity cost to other users fails to ensure there is no distortion of competition. Telefónica argued that the scale of any competition impact is immaterial as Article 8 requires Ofcom to set fees such that there is absolutely no distortion to competition (i.e. not even a limited risk of distorting competition).[58]

4.45 Vodafone said that setting ALFs using the marginal opportunity cost to other users would harm competition and is inconsistent with Ofcom's duties (particularly our principal duty to promote competition). Vodafone argued that the market value of UKB's spectrum should reflect the value associated with the advantage that it confers on Three in its current form

[55] As shown in Table 3.1, setting ALF based on a lump-sum market value of £31.1m per 5 MHz (in April 2018 prices) would result in total annual payments by Three of around £43 million (for both the 40 MHz of 3.4 GHz and 80 MHz of 3.6 GHz spectrum), compared to around £52 million if a lump-sum market value of £37.8 million per 5 MHz were used.
[56] Paragraph 2, BT response to December 2018 consultation.
[57] Paragraphs 1.128-1.131, Three response to December 2018 consultation.
[58] Pages 14-15, Telefónica response to December 2018 consultation.

(i.e. 100 MHz of contiguous spectrum), and that we had failed to consider the competitive impact of Three having contiguous spectrum. It said that our impact assessment should at least take account of the competitive benefit that Three would obtain from paying ALFs some 20% lower than the equivalent of that which Three's competitors had to pay in the 2018 auction. Vodafone said that, as Three already has a significant advantage, this is a basis for choosing a higher rather than a lower market value.[59]

Our assessment

4.46 There is some risk that setting ALFs using the marginal opportunity cost to other users could have an adverse impact on competition, as Three could be considered to be effectively receiving a discount or "subsidy" relative to the other operators who acquired 3.4 GHz or 3.6 GHz spectrum at auction (an outcome which would not arise if the licence-holder was not Three). From the perspective of promoting competition, and when the regulator (rather than a market mechanism) is setting the price of an important input such as spectrum, the determination of a price at the same level as that paid by rival operators through a market mechanism (in this case the 2018 auction) is more consistent with the promotion of competition.

4.47 In respect of stakeholders' other points:

a) We disagree with Telefónica that Article 8 requires Ofcom to set fees such that there is absolutely no distortion to competition. We consider that this is too narrow a reading of Article 8 and note that we are required to consider our statutory duties in the round, balancing them appropriately.

b) We disagree with Vodafone that the market value of UKB spectrum should reflect the value to Three from any perceived advantage that it confers on it in terms of holding 100 MHz of contiguous spectrum for 5G. We focus on the forward-looking marginal opportunity cost of the spectrum rather than Three's value for its UKB spectrum holdings. Therefore, we have not adjusted the ALFs (based on the results of the 2018 auction) to reflect the purported competitive impact of Three having contiguous spectrum.[60]

4.48 Overall, we consider that the market clearing price would be more consistent with promoting competition, although the scale of the difference in fees compared to the marginal opportunity cost to other users suggests that this effect is likely to be limited.

[59] Pages 2, 10-11 and 18, Vodafone response to December 2018 consultation.

[60] In any case, we considered this issue in our decision on UKB's licence variation for 3.6 GHz spectrum. In summary, we did not consider it likely that the benefit to Three from holding 100 MHz of contiguous spectrum – in terms of higher average and peak speeds, and better 5G coverage – would be so significant as to provide Three with an unmatchable competitive advantage over its competitors. Moreover, we said there are a number of dimensions to competition, and capacity and 5G speeds are only one aspect of the competitive offering. See our Statement on Variation of UK Broadband's spectrum access licence for 3.6 GHz spectrum, Ofcom, December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0014/130253/Statement-UK-Broadbands-spectrum-access-licence-3.6-GHz.pdf.

Impact on consumers

4.49 As above, our principal duty under section 3 of the Communications Act requires us to further the interests of consumers, again reflecting the policy objectives in Article 8 of the Framework Directive.

December 2018 Consultation

4.50 We said one effect of setting ALFs using the market clearing price is that Three might seek to recover these higher fees from consumers through higher retail prices. However, we noted that ALFs at the market clearing price would only represent an input cost for the UKB 3.4 GHz spectrum at the same level as the input cost for the 3.4 GHz spectrum that both Three and other MNOs won in the 2018 auction.

Responses to consultation

4.51 As noted previously, BT said that consideration of Ofcom's duties in relation to the promotion of competition, investment and the interests of consumers should lead to lower fees than those based on market value (although it did not comment specifically on the consumer impacts of setting ALFs using market clearing price, relative to the marginal opportunity cost to other users).[61]

4.52 Vodafone said that our assessment of consumers' interests does not address the risk to consumers associated with a tilted playing-field in favour of Three if UKB ALFs are set too low. It argued that the harm to consumers arising from the risk of undermining competition is much greater than any harm to consumers from the incremental differences between a higher and lower ALF.[62]

Our assessment

4.53 We consider that setting ALFs using market value will benefit consumers in the long run by ensuring that spectrum is used in the most efficient way for the provision of downstream services for which there is greatest value. Furthermore, as market clearing price and marginal opportunity cost to other users both provide a measure of the market value of Three's UKB spectrum, both values are consistent with efficient price signals for the use of scarce spectrum.

4.54 We recognise that setting higher ALFs (i.e. using the market clearing price of £37.8 million per 5 MHz) could lead to higher consumer prices than would prevail if ALFs were set using the marginal opportunity cost to other users (£31.1 million per 5 MHz). However:

a) First, we consider this impact is far from certain, particularly as Three would be the only operator affected by this decision and the higher ALF would only represent an

[61] Paragraph 2, BT response to December 2018 consultation.
[62] Pages 2 and 17, Vodafone response to December 2018 consultation.

input cost for its UKB 3.4 GHz spectrum at the same level as the input cost for 3.4 GHz spectrum that both Three and other MNOs won in the 2018 auction.

b) Second, even if setting ALFs at the market clearing price were to affect retail prices, any impact is likely to be limited. Setting ALFs using the higher lump-sum market value given by the market clearing price would require a maximum increase in average prices for Three subscribers of around 9p per month (i.e. less than 0.5% of average spend).[63]

4.55 We do not consider this would likely create or worsen affordability issues for vulnerable consumers of existing mobile services. The scale of any impact on retail prices, as set out above, is likely to be limited. Furthermore, we note that the main tariffs affected would be for 5G services, which Three has yet to launch, and which we expect vulnerable consumers are generally less likely to consume.[64] In any case, even if we consider that otherwise efficient markets are not serving vulnerable consumers effectively, we prefer to intervene with targeted measures to address such concerns.

4.56 We disagree with Vodafone that we have ignored competition impacts and the implications for consumers. These points are addressed under the sub-heading above.

4.57 Overall, we therefore see little difference in the impact on consumers from setting ALFs using market clearing price or marginal opportunity cost to other users.

Impact on investment

4.58 Section 3(4) of the Communications Act requires us to have regard to the desirability of encouraging investment, reflecting Article 8 of the Framework Directive which requires us to promote efficient investment in new and enhanced infrastructures.

December 2018 consultation

4.59 In the December 2018 consultation, our consideration of investment effects focussed primarily on the proposal to set ALFs for this spectrum at market value in general, rather than on the specific choice between market clearing price and marginal opportunity cost to other users. In choosing between these two measures of market value, we recognised the differential financial effects on operators, although this consideration of financial effects

[63] In the December 2018 consultation (paragraph 4.41), we compared the possible impact on consumer bills of setting ALFs by reference to market value (compared with existing fees). Here, we are concerned with the specific measure of market value for the purposes of setting ALFs. The difference in ALFs from setting ALFs using market clearing price, relative to marginal opportunity cost to other users, is around £9 million per year. That is the equivalent to around £1.08 per active customer per year, inclusive of VAT (i.e. around 9p per active customer per month including VAT). An increase in retail revenue of this amount would be equivalent to less than 0.5% increase in Three's gross ARPU (which in 2018 was £18.23 per month). This assumes that ALFs would be passed through in full, which would likely overstate the true impact. Gross ARPU and active customer figures from 3UK's FY18 results. See http://www.threemediacentre.co.uk/~/media/Files/T/Three-Media-Centre/documents/three-uks-fy-18-results-one-pager-21-03-19.pdf.

[64] For example, Ofcom research suggests that smartphone ownership is lowest among consumers with two or more vulnerability factors e.g. older, lower socio-economics group, disabled. See Figure 3, Ofcom, Access and Inclusion report (January 2019), https://www.ofcom.org.uk/__data/assets/pdf_file/0018/132912/Access-and-Inclusion-report-2018.pdf.

was evaluated in the risk of distortion to competition from ALFs at marginal opportunity cost to other users rather than at market clearing price.

Responses to consultation

4.60 As noted previously, BT said that consideration of Ofcom's duties in relation to the promotion of competition, investment and the interests of consumers should lead to lower fees than those based on market value (although it did not comment specifically on the consumer impacts of setting ALFs using market clearing price, relative to the marginal opportunity cost to other users).[65]

4.61 Vodafone said that we had not considered whether Three's investment in 5G spectrum has been undertaken in a way that factors in a competitive advantage in 5G, and whether this implies that ALFs for UKB spectrum are set too low.[66]

Our assessment

4.62 We remain of the view that investment decisions should reflect the true costs of inputs, and that this is achieved by setting ALFs on the basis of market value. Furthermore, as market clearing price and marginal opportunity cost to other users both provide a measure of the market value of Three's UKB spectrum, both values should provide efficient investment signals to operators.

4.63 As such, when UKB ALFs are set at market value, we would expect Three to pursue efficient investment opportunities. However, we recognise the possibility that, if Three faced financial constraints, setting ALFs at the higher of our measures of market value (i.e. market clearing price) could in theory reduce the funds available to Three to the extent that an efficient and potentially profitable investment would not be made (but would have been made if ALFs were set using the lower of our market value measures).

4.64 In considering the likelihood of such an outcome, we note that setting ALFs using the market clearing price of £37.8 million per 5 MHz would lead to a higher ALF bill for Three of around £9 million per year, compared with ALFs set using the marginal opportunity cost to other users. This is a small fraction of Three's current investment and cashflow – equivalent to less than 2% of Three's annual capex bill, and around 3% of annual EBITDA less capex if there is no pass-through to retail prices.[67] We do not have evidence from Three or other stakeholders of any specific investments that depend on whether ALFs are set using the marginal opportunity cost to other users, or the market clearing price.

[65] Paragraph 2, BT response to December 2018 consultation.
[66] Page 17, Vodafone response to December 2018 consultation.
[67] Capex and EBITDA figures from Three's FY18 results. See: http://www.threemediacentre.co.uk/news/2019/three-uk-reports-fy18-results.aspx. We recognise that the overall financial effect on Three from setting ALFs at market value (specifically market clearing price) would be around 11% of capex and around 18% of EBITDA less capex. However, the relevant effect for the decision between market clearing price and marginal opportunity to other users is a difference in annual fees of £9 million.

4.65 Likewise, in response to Vodafone, we do not have any evidence that Three has over-invested in spectrum in order to secure a competitive advantage in 5G. Even if we did consider this to be the case, we do not consider that adjusting spectrum fees would necessarily be the most appropriate way to address a purported competition problem.

4.66 We recognise that the lower ALFs which would arise from using the marginal opportunity cost to other users (rather than market clearing price) could confer a competitive advantage on Three, and that this could manifest itself in a variety of ways including investing in a way that it would not have done, had it faced the same market clearing price for spectrum as its rivals paid at auction. However, as we have already considered effects on competition above, we have not further relied on this point in the consideration of investment effects.

4.67 Overall, we consider that the marginal opportunity cost to other users could be more consistent with promoting investment, although the scale of the difference in fees compared to the market clearing price suggests that this effect is likely to be limited.

Risk of discrimination and/or an unfair outcome

4.68 We have duties to avoid discriminatory and/or unfair outcomes that flow from Article 13 of the Authorisation Directive and Article 8 of the Framework Directive, and a duty under section 3(3) of the Communications Act to have regard in all cases to any principles which appear to us to represent the best regulatory practice.

4.69 In the December 2018 Consultation, we explained that ALFs set by reference to the marginal opportunity cost to other users could, in this case, be said to be unfair: it would result in different operators paying different amounts for equivalent spectrum.

4.70 In its response to our consultation, Telefónica said that setting ALFs using the marginal opportunity cost to other users fails to ensure that in similar circumstances there is no discrimination in the treatment of operators. It said that this approach gives Three a discount of between 18% and 22% compared to the prices other operators paid for equivalent spectrum in the 2018 auction. Telefónica's view was that "*any methodology consistent with Ofcom's statutory duty not to discriminate between operators must be based on establishing a common estimate of market value regardless of the identity of the licence holder*".[68]

4.71 Taking account of responses to the December 2018 Consultation, we remain of the view that ALFs set by reference to the marginal opportunity cost to other users could, in this case, be said to be unfair. This is because the market clearing price is the price which all holders of other spectrum in the 3.4 GHz band (including Three, UKB's parent company) paid for that spectrum in the auction. To set ALFs for UKB's spectrum in this band at a lower level would introduce a differential between UKB and the other operators, in respect of spectrum which is otherwise equivalent. This would result in different operators paying

[68] Pages 15-16, Telefónica response to December 2018 consultation.

different amounts for equivalent spectrum (and indeed, would result in UKB paying less than that paid by Three, its parent company, in respect of spectrum in the same band).

4.72 We also note that the reason that the market clearing price in the 2018 auction ended up being higher than the marginal opportunity cost to other users, is because Three continued to bid (as it was entitled to do) and so set the market clearing price which ultimately applied to all operators through its bidding.

4.73 In its response to our consultation, Telefónica explained its view that ALFs set by reference to the marginal opportunity cost to other users would be discriminatory. Whilst we do not agree with Telefónica that any differential between licence-holders in respect of spectrum which is otherwise equivalent is automatically discriminatory, we recognise this concern.

Efficient and effective spectrum management

4.74 Section 3 of the Wireless Telegraphy Act, to which we have to have regard when setting spectrum fees under section 13, requires us to have regard to the desirability of promoting the efficient management of spectrum.

4.75 In our judgment, it is more consistent with the efficient and effective management of spectrum to set fees which are agnostic to the identity of the licensee and that do not result in different fees for equivalent spectrum. This would support the use of the market clearing price rather than the marginal opportunity cost to other users.

4.76 Fees which are agnostic to the identity of the licensee would have the benefit of being simpler and, as discussed above, would arguably be fairer than setting different fees for spectrum which is otherwise equivalent. In regulated markets in which the regulator is setting the price, it is more common to do so by means of a uniform price, rather than a price that varies depending on the identity of the purchaser. This is often the case when setting price caps, for example.

4.77 We also consider that fees which are agnostic to the identity of the licensee are more consistent with our general position that there is benefit for licensees in a period of stability and certainty on fees (discussed at paragraph A1.23b). We explained in the SRSP that ALFs are intended to act as a valuable complement to other regulatory instruments, including trading, and we would be concerned if uncertainty and/or instability in the level of ALFs adversely affected incentives to trade. This is particularly the case given that, since the December 2018 Consultation, the prospect of trading or swaps between operators has increased (discussed at paragraph 4.28 above), and given the potential benefits to the optimal use of spectrum that could be achieved through trading.

4.78 In this regard, we consider there is a risk that licensee-specific fees, which would be implied by use of the marginal opportunity cost to other users, may have adverse practical consequences for future trading. One example, discussed at paragraph 4.29 above, is the potentially adverse impact of licensee-specific ALFs on swaps. We are also concerned about a more general risk that Ofcom may be perceived to be more likely to review ALFs following a trade (either a swap or a more general trade) in the event that those ALFs are

licensee-specific, and the risk that this could have the practical effect of adding unhelpful friction and uncertainty to the trading process. The fact that Vodafone suggested, in its response to our December 2018 Consultation, that it would appear "illogical" for Ofcom to leave ALFs unchanged after a trade if the ALF were licensee-specific suggests that there is a perception of such risk.

4.79 Taking account of the above, our view is that it is more consistent with the effective and efficient management of spectrum for ALFs to be agnostic to the identity of the licensee and therefore to not result in different fees for equivalent spectrum. This would support the use of the market clearing price rather than the marginal opportunity cost to other users, as the basis for setting ALFs.

Regulatory predictability and consistency with previous decisions

4.80 Section 3(3) of the Communications Act requires us to have regard to the principles of transparency, accountability, proportionality and consistency in performing our principal duties, as well as having regard to any other principles which we consider represent best regulatory practice. We consider that in general, it is appropriate for us to provide regulatory predictability and consistency.

4.81 Telefónica and Vodafone said that setting ALFs using marginal opportunity cost to other users would be a significant deviation from the method that Ofcom used to derive the market value of 800 MHz and 2.6 GHz spectrum, for the purposes of determining ALFs for 900 and 1800 MHz (which produced a consistent price for all operators with holdings in the same band, based on market clearing prices, rather than a bidder-specific price).[69] However, as explained in paragraph 4.5, in the case of 900 MHz and 1800 MHz ALFs, we did not have clear evidence of a difference between the market clearing price and the marginal opportunity cost to another user for the relevant spectrum bands being considered. As such, this specific issue did not arise in that context.

4.82 Telefónica also noted that operators pay the same ALF (on a per MHz basis) for other spectrum bands regardless of the size of their holdings, and whether or not they are in the preferred configuration.[70] We agree that it is in general preferable that operators pay the same ALF for equivalent spectrum (on a per MHz basis) and we have taken this into account in our overall decision on the appropriate level of ALFs.

Overall conclusion

4.83 There are arguments both for and against setting ALFs by reference to either the marginal opportunity cost to other users (for which our conservative estimate is £31.1 million per 5 MHz) or the market clearing price (for which our conservative estimate is £37.8 million per 5 MHz). Specifically:

[69] Page 14, Telefónica response to December 2018 consultation. Page 12, Vodafone response to December 2018 consultation.
[70] Pages 15-16, Telefónica response to December 2018 consultation.

a) both measures of market value are consistent with and capable of securing the optimal use of spectrum which we consider to be in the interests of UK citizens and consumers, and the choice between them on the grounds of optimal use is finely balanced;

b) the market clearing price would be more consistent with promoting competition, although the scale of the difference in fees compared to the marginal opportunity cost to other users suggests that this effect is likely to be limited;

c) ALFs at market value benefit consumers by ensuring spectrum is used in the most efficient way for the provision of downstream services for which there is greatest value. We recognise that setting ALFs using market clearing price could lead to higher consumer prices than if ALFs were set using marginal opportunity cost to other users. However, this is far from certain. Even if it occurred, any impact is likely to be limited;

d) the marginal opportunity cost to other users could be more consistent with promoting investment, although the scale of the difference in fees compared to the market clearing price suggests that this effect is likely to be limited.

4.84 We consider that there are advantages to setting fees which are agnostic to the identity of the licensee and that do not result in different fees for equivalent spectrum. In particular, setting fees in this way would be fairer in the sense that all operators would be paying the same regulatory fee for equivalent spectrum. It would also be simpler to implement, not just in this context but also in respect of other spectrum bands which become liable for ALFs in future. These advantages would be achieved by setting fees by reference to the market clearing price.

4.85 Even if fees set using the marginal opportunity cost to other users are not subsequently revised when the identity of the licence-holder changes, this would risk creating an illogical outcome whereby the fee is not set according to the marginal opportunity cost to another user.

4.86 These considerations underpin our general policy preference to set fees which are agnostic to the identity of the licensee and that do not result in different fees for equivalent spectrum.

4.87 For all the reasons set out in this section, we have decided to set ALFs at market value for UKB's 3.4 and 3.6 GHz spectrum with reference to a conservative estimate of the market clearing price i.e. £37.8 million per 5 MHz. This is equivalent to an annual fee of £0.435 million per MHz (expressed in April 2018 prices).

5. Implementation

Level of annual licence fees for 3.4 GHz and 3.6 GHz spectrum

5.1 In the preceding sections we concluded that setting ALFs for UKB's 3.4 and 3.6 GHz spectrum on the basis of market value, specifically a conservative estimate of the market clearing price in the April 2018 auction, will best meet our statutory duties. Based on a conservative estimate of the market clearing price in the 2018 auction, the annual fees are £0.435m per MHz (in April 2018 prices, i.e. before adjustment for CPI inflation).

Implementation

5.2 This section sets out how we will implement the revised fees for UKB's spectrum, including:

a) Phasing in;

b) Application of revised fees; and

c) Payment date.

Phasing in

December 2018 consultation

5.3 We proposed that there should not be a phasing-in period for UKB's 3.4 GHz licence fees but that there should be a phasing period for its 3.6 GHz licence fees. For the 3.6 GHz licence we said that, in addition to the fees payable by UKB on 31 December 2018 and 31 December 2019 under the 2011 Regulations, UKB would be required to pay 50% of the difference between those fees and the proposed higher level of fees until the end of June 2020.

5.4 In relation to UKB's 3.4 GHz licence, we explained that we had previously said (in our October 2014 statement on UKB's 3.4 GHz licence variation) that this licence would be subject to an annual fee following the expiry of the initial term of the licence in July 2018[71].

5.5 For the 3.6 GHz licence however, we noted that we were proposing to introduce new fees for this licence at an earlier date than previously indicated. We also noted that the 3.6 GHz spectrum is subject to some short-term constraints which would limit Three's ability to roll-out mobile services until these were removed. The majority of these constraints will be removed by June 2020.

Responses to consultation

5.6 Vodafone agreed that the fees for 3.4 GHz should be introduced in full as soon as possible but said that it was wholly disproportionate to award a 50% discount for the 3.6 GHz

[71] Ofcom, *Variation of UK Broadband's 3.4 GHz Licence:* Statement, October 2014, https://www.ofcom.org.uk/__data/assets/pdf_file/0018/74610/uk_broadband_statement.pdf

spectrum until the short-term constraints on the use of the spectrum end in 2020. It argued that incumbent users were mainly clustered at the top end of the band, i.e. in the frequency ranges 3680 – 3800 MHz and that, as such, these users place no restrictions on UKB's 3.6 GHz deployments.[72]

5.7 Vodafone suggested that a 10% discount until 2020 would be more appropriate, reflective of the additional administrative burden placed on UKB in having to coordinate deployment via Ofcom, and that Ofcom should publish a detailed analysis of its justification for any discount in excess of 10%. Finally, it said that such justification could not incorporate: 1) any element of an introductory glidepath due to the step change in ALFs because this step change is merely reflective of UKB having been undercharged historically, or 2) any considerations of device/ecosystem availability because it said this is already factored into the 3.4 GHz benchmark pricing which was used to set the ALF.[73]

5.8 Telefónica agreed with our proposed approach to phasing in, providing that the reduction in relation to 3.6 GHz spectrum is proportionate to the scale of the restrictions.[74] BT supported the phasing in proposals[75] and Three did not comment on this subject.

Our assessment

5.9 As set out in our December 2018 Consultation, our proposal to phase in fees for UKB's 3.6 GHz licence was in relation to two factors: 1) the short-term constraints on the spectrum and 2) the fact that we are introducing fees earlier than previously indicated. As such, our proposal was not set with the sole aim of reflecting the extent of the short-term constraints. Rather, we exercised our judgment in balancing the two factors highlighted above. This judgment is not, in our view, amenable to a precise analysis. We continue to consider that the phasing in of fees at the level and for the duration proposed is a reasonable judgment in the specific circumstances of this case.

5.10 We have therefore decided to implement the phasing-in proposal outlined in our consultation. Three will therefore be required to pay, in addition to its current fees (under the 2011 Regulations), 50% of the difference between the level of fees currently payable under the 2011 Regulations and the new higher level of fees until the end of June 2020. Fees at the full rate will be payable from 30 June 2020 onwards.

5.11 We have implemented this in practice by specifying two payments for Three:

a) The first payment, set out in regulation 5, will be payable in five monthly instalments between 31 July 2019 and 30 November 2019. It will require Three to pay 50% of the difference between the fees it pays under the existing 2011 Regulations and the new

[72] Page 20, Vodafone response to December 2018 consultation.
[73] Page 21, Vodafone response to December 2018 consultation.
[74] Page 24, Telefónica response to December 2018 consultation.
[75] Section 4, BT response to December 2018 consultation.

higher level of fees, for the rest of 2019.[76] This will be in addition to any payments due under the 2011 Regulations in respect of that same period, as the 2011 Regulations will remain in force throughout this period.

b) The second payment, set out in regulation 6, will be due on 31 December 2019. It will require Three to pay the sum of: (i) its current fees, as per the 2011 Regulations;[77] (ii) 50% of the difference between its current fees and the new higher level of fees, pro-rated from 1 January to 30 June 2020; and (iii) the full difference between its current fees and the new higher level of fees, pro-rated from 1 July to 31 December 2020.

5.12 We have set both payments in these regulations as fixed sums, by reference to the new higher level of fees expressed in April 2019 prices (which is £0.444 million per MHz)[78], as this considerably simplifies the regulations covering the phase-in period.

Application of the revised fees

December 2018 consultation

5.13 We said that the fees in the draft regulations would remain applicable until we amend or revoke them. We considered that there was benefit in a period of certainty for licensees and therefore proposed not to review ALFs in the five years after implementation save in very exceptional circumstances. We noted that this meant we did not intend to review the level of ALFs after the forthcoming auction of 700 MHz and 3.6-3.8 GHz spectrum.

Responses to consultation

5.14 Three agreed that Ofcom should not revisit ALFs after the award of 700 MHz and 3.6-3.8 GHz spectrum. It said the long-term value of 3.4 GHz and 3.6 GHz spectrum is likely to be the same. It argued that using results from the upcoming 700 MHz and 3.6-3.8 GHz auction to set the level of UKB's ALFs would distort its bidding incentives because it could increase its own ALF by bidding in the auction, while giving rivals incentives to bid beyond their valuations to raise UKB's ALF.[79]

5.15 BT recognised the benefits of having certainty but thought that the risk to licensees would only be in respect of ALFs being revised upwards. It suggested Ofcom should potentially

[76] UKB has already paid its fee for 2019 of £821,088, for its licence covering spectrum at 3605-3689 MHz and 3925-4009 MHz. For the purposes of calculating this top-up component, we have assumed that this implies a current fee for its 3.6 GHz spectrum (i.e. the 3600-3680 MHz frequencies) equivalent to £4,887.43 per MHz.
[77] At this point, the 2011 Regulations will have been amended such that they no longer prescribe the fees payable in respect of UKB's 3.6 GHz spectrum. Instead, and for simplicity, the fees that otherwise would have fallen payable in respect of that spectrum under the 2011 Regulations on 31 December 2019 (which would be £8,436 per MHz for this year, based on the relevant coordination requirements) will be rolled into the amount due under Ofcom's new regulations.
[78] This is based on the most recent CPI value that is available (May 22 release version). See https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7bt/mm23.
[79] Paragraphs 1.7-1.18, Three response to December 2018 consultation.

revise ALFs downwards shortly after the 2020 700 MHz and 3.6-3.8 GHz auction if this auction suggested a lower opportunity cost than in the 2018 auction.[80]

5.16 Telefónica said that Ofcom's proposal not to review the fees after the 700 MHz and 3.6 GHz spectrum auction would be unjustified and unlawful. It referred back to Ofcom's decision to vary UKB's 3.6 GHz spectrum licence to grant it new rights to use spectrum between 3600-3605 MHz and said this was only consistent with the Authorisation Directive as long as fees for this spectrum would be set on the basis of the 700 MHz and 3.6-3.8 GHz auction results. It also said that if we rule out any revision to ALFs following the auction, this will make it easier for Three to engage in strategic bidding (e.g. to frustrate defragmentation or increase the resale value of existing holdings), which could result in an inefficient spectrum allocation.[81]

Our assessment

5.17 The fees we are setting now will as a matter of law apply until we amend or revoke them. As set out in our December 2018 consultation, we also consider that there is benefit for licensees in a period of certainty on fees. This remains our general position.

5.18 Some stakeholders noted the potential for our forthcoming auction for 700 MHz and 3.6-3.8 GHz spectrum to provide a relevant benchmark for the market value of the 3.4 and 3.6 GHz spectrum and suggested that we should make provision to revise the fees after the auction if necessary in light of the auction outcome.

5.19 We always retain the ability to revise fees in the future in appropriate circumstances, including after the forthcoming auction of 700 MHz and 3.6-3.8 GHz spectrum, if we consider there is evidence to suggest a revision to fees is warranted, i.e. if there is strong evidence that a material misalignment has arisen between the level of the fees and the value of the spectrum.

Payment date

December 2018 consultation

5.20 For the 3.4 GHz licence fees, we proposed that the payment date would be the last day of the month following the month in which we publish our final statement.

5.21 For the 3.6 GHz licence fees, we proposed to align the payment date with the existing annual payment date under the 2011 Regulations, i.e. 31 December.

Responses to consultation

5.22 Vodafone noted that the current proposal will result in ALFs for different bands having different annual payment dates and that this will become complex both for operator and

[80] Section 3.3, BT response to December 2018 consultation.
[81] Pages 3 and 17, Telefónica response to December 2018 consultation.

Ofcom finance departments. It suggested that Ofcom should harmonise ALF payment dates to a single date and that this should be 31 October.[82]

Our assessment

5.23 Vodafone's proposed approach has merit and would make payment cycles simpler to administer. However, the current licence holder has not requested that we harmonise payment dates and implementing this proposal would likely require additional licence variations which we would need to consult on. We remain open to considering future requests from current or future licensees to harmonise their payment dates.

[82] Page 21, Vodafone response to December 2018 consultation.

A1. Identification of lump-sum market values

Introduction

A1.1 In this annex, we explain how we have taken account of stakeholder responses to the December 2018 consultation in relation to the lump-sum market value for UKB's 3.4 GHz and 3.6 GHz spectrum. This supports Step 1 of the framework (described in Figure 3.1) and the discussion of lump-sum market values in Section 3.

December 2018 consultation

A1.2 As explained in section 3 (paragraphs 3.34 to 3.36), in the 2018 auction, we noted that there is a difference between the market clearing price and the marginal opportunity cost *to other users*. This distinction between market clearing price and marginal opportunity cost to other users reflected the specific results of the 2018 auction, namely, the fact that Three continued to bid in the auction (as it was entitled to do) and so set the market clearing price. However, as Three was the marginal bidder and is the ultimate owner of the UKB spectrum, the marginal opportunity cost of UKB's spectrum to other users is lower.

Responses to consultation

A1.3 Responses to the December 2018 Consultation on market value can be grouped into three main areas:

a) The basis on which to measure market value, in particular the appropriate way to measure value at the margin; how to treat existing holdings; and the relevant increment of spectrum;

b) Whether bids in the 2018 auction understate or overstate market value; and

c) Other sources of evidence on the market value of 3.4 and 3.6 GHz spectrum.

Market value estimates

A1.4 BT said that, if any ALFs are applied, the marginal opportunity cost of spectrum to other users (i.e. £31.1 million per 5 MHz) should be used to set ALFs for this spectrum.[83]

A1.5 Vodafone and Telefónica said that the market clearing price (£37.8 million per 5 MHz) is the best estimate of market value of this spectrum. Vodafone said there is every reason to believe this represents a conservative valuation, noting that Three's valuation for its total spectrum holdings would significantly exceed its marginal valuation for an additional 5 MHz block. A report for Vodafone by Charles River Associates noted that, had we auctioned Three's total UKB holding and Three was to win that amount of spectrum, then

[83] Section 3.2, BT response to December 2018 consultation.

the market clearing price could have been higher as Three would have had to outbid all the other operators to win such a large amount of spectrum.[84]

A1.6 Three said that opportunity cost cannot depend on the private value of the holder of the spectrum, which it said would be the case if we used the market clearing price to set ALF.[85]

A1.7 Three said we had not correctly identified the marginal opportunity cost of its UKB spectrum to other users because we had not removed Three's winning bid for 20 MHz of 3.4 GHz from the calculation. Three said this meant our estimate reflected the marginal opportunity cost of the spectrum that Three won in the auction, rather than of its prior UKB spectrum holdings. Absent Three's winning bid for 20 MHz, Three said the correct marginal opportunity cost is set by the next highest bid after Telefónica's highest losing bid for 15 MHz. This was Vodafone's bid for an extra 10 MHz, at **£29.6 million per 5 MHz**.[86]

A1.8 Three said that, as this figure is independent of Three's bids in the 2018 auction, it has the further advantages of (i) not extracting more revenue than a competitive auction; and (ii) not distorting bidding incentives in future auctions.[87]

A1.9 Three also said that the relevant marginal increment of 3.4 GHz that we used to calculate the marginal opportunity cost to other users was different to the increment we had used to calculate the market value of 800 MHz and 2.6 GHz spectrum in our decision on 900 MHz and 1800 MHz ALFs.[88]

A1.10 Furthermore, Three argued that we had overestimated the market value of its UKB 3.4 GHz and 3.6 GHz spectrum by focusing on *marginal* opportunity cost. It said this will overstate the market value of Three's UKB total spectrum holdings because rivals' values for more 3.4 GHz spectrum than they won at auction is diminishing. Three argued that optimal spectrum use for a 120 MHz spectrum block requires pricing based on opportunity cost, rather than marginal opportunity cost, and that this was the measure advocated in the SRSP.[89]

A1.11 Three said we should implement an opportunity-cost based approach to setting ALFs by:[90]

[84] Pages 12-13, and pages 5-6 of Annex A (report by Charles Rivers Associates), Vodafone response to December 2018 consultation. Page 7, Telefónica response to December 2018 consultation.
[85] Paragraphs 1.54-1.58, Three response to December 2018 consultation.
[86] Section 1 paragraph 1.31, Three response to December 2018 consultation and Section 3 of Power Auctions report. Note that this represents a conservative estimate of the marginal opportunity cost to another user in the scenario described by Three, as we know that this value lies somewhere between £29.6 million per 5 MHz and £31.1 million per 5 MHz (i.e. the price at which Vodafone reduced demand in the auction for the last time).
[87] Section 4, Three response to December 2018 consultation. See also Section 3 of Power Auctions report prepared for Three.
[88] Paragraphs 1.36-1.39, Three response to December 2018 consultation.
[89] Section 5, Three response to December 2018 consultation.
[90] Section 6, Three response to December 2018 consultation.

a) Implementing a **non-linear ALF** i.e. a different lump-sum market value for each block of UKB 3.4 GHz spectrum, mirroring the highest losing bids from Three's rivals for an additional 120 MHz of 3.4 GHz spectrum in the 2018 auction.[91] However, Three recognised it may not be practical to implement in this case, due to the industry's desire to defragment the 3.4-3.8 GHz band (which could require Three to trade multiple UKB spectrum blocks simultaneously).

b) Using the **average opportunity cost** i.e. excluding Three's bids from our calculations of market value and calculating the weighted average of rivals' incremental bid values for UKB's 120 MHz. This would imply a lump-sum value of **£19.1 million per 5 MHz**.[92]

Whether bids in the 2018 auction understate or overstate market value

A1.12 Vodafone and Telefónica suggested reasons why operators' bids in the 2018 auction may understate their true market value for 3.4 GHz spectrum:

a) A report for Vodafone by Charles Rivers Associates suggested that multi-unit uniform price auctions such as the 2018 auction incentivise early **demand reduction**. This is because increasing a bid for a spectrum block increases the probability of the bidder winning that block, but also increases the price for infra-marginal blocks for which they are also bidding.[93]

b) Vodafone also suggested that auction bids might understate market value because of operators' **budget constraints.**[94] Specifically, Vodafone suggested that Telefónica's bids for 3.4 GHz spectrum may have been constrained by its short-term need to prioritise acquiring 2.3 GHz spectrum for 4G.

c) Telefónica said that the per MHz market value of a contiguous 100 MHz block of 3.4 GHz spectrum is potentially larger than for smaller non-contiguous blocks of 40-50 MHz, but operators likely recognised that they could not win more than 60 MHz (given the presence of at least three strong bidders competing for 150 MHz) and may have conditioned their bids accordingly. The auction therefore did not reveal the true value of a 100 MHz block of 3.4 GHz spectrum.[95]

A1.13 On the other hand, Telefónica said that Three's auction bids might overstate its intrinsic value for that spectrum if they reflected **strategic considerations** (e.g. risk mitigation due

[91] See also Section 5 of the Frontier Economics report prepared for Three.
[92] See Figure 8 of Three response to the December 2018 consultation. This is a weighted average of the 9 highest incremental bid values for 3.4 GHz spectrum by EE, Telefónica and Vodafone, over and above the 3.4 GHz spectrum which they each won in the 2018 auction. Three excluded Telefónica's highest losing bid of £31.1 million per 5 MHz for 15 MHz because it said that Telefónica would have won this spectrum had Three not participated in the auction.
[93] Pages 2-3, Annex A (report by Charles Rivers Associates), Vodafone response to December 2018 consultation. In Annex A, it is suggested that Telefónica may have estimated, at the point of dropping demand from 11 to 8 blocks, that it was unlikely to win more than 40 MHz (8 blocks) in total but risked escalating the price it had to pay for the eight blocks it won.
[94] Page 12, Vodafone response to December 2018 consultation.
[95] Pages 9-10, Telefónica response to December 2018 consultation.

to uncertainty with regard to renewal of its 3.6 GHz holdings; or blocking rivals from securing larger contiguous blocks to enhance its position in the retail mobile market).[96]

A1.14 Stakeholders also commented on the implications of the timing of the 2018 auction and the forthcoming auction of 700 MHz and 3.6-3.8 GHz spectrum, although they disagreed on the implications for whether 3.4 GHz bidding overstated or understated market value:

a) BT said that 2018 auction bids might overstate market value due to **"artificial scarcity"** because Ofcom chose not to award the full band in a single auction;[97]

b) BT and Three also argued that the 3.4 GHz spectrum in the 2018 auction was critical to launching 5G services, creating a **first-mover advantage** which is unlikely to apply to 3.6 GHz spectrum in 2020. Three submitted some modelling by Frontier Economics which estimated that this may have inflated 2018 auction prices for 3.4 GHz spectrum by 10-15%.[98]

c) Telefónica and Vodafone suggested that auction bids might understate market value because, when bidding in the 2018 auction, the bidders expected (i) more 3 GHz spectrum to be made available in the forthcoming 700 MHz and 3.6-3.8 GHz auction (i.e. 160 MHz rather than the 120 MHz that Ofcom has proposed); and (ii) that Ofcom would take action to defragment the 3.4 GHz – 3.6 GHz band.[99]

Other sources of evidence on market value for 3.4 GHz and 3.6 GHz

A1.15 Stakeholders generally agreed that the 2018 auction provides the most relevant evidence for estimating the market value of Three's 3.4 GHz and 3.6 GHz spectrum. However, BT suggested a comparison of the 3.4 GHz auction price with other UK spectrum bands indicates that there was a "premium" paid for this spectrum, above market value.[100]

Our assessment

Market value estimates

A1.16 As set out in the December 2018 consultation, and explained in Section 3, we have identified from bids in the 2018 auction:

a) A conservative estimate of the market clearing price of £37.8 million per 5 MHz, based on Three's losing bid for **10 MHz** more than it won; and

b) A conservative estimate of the marginal opportunity cost to other users of £31.1 million per 5 MHz, based on Telefónica's losing bid for **15 MHz** more than it won.

[96] Page 10, Telefónica response to December 2018 consultation.
[97] Section 3.1, BT response to December 2018 consultation.
[98] Section 3.1, BT response to December 2018 consultation. Section 7, Three's response to December 2018 consultation.
[99] Pages 11-12, Vodafone response to December 2018 consultation. Page 10, Telefónica response to December 2018 consultation.
[100] Section 3.1, BT response to the December 2018 consultation.

A1.17 Our view remains that both these values could provide a measure of the market value of Three's UKB spectrum. Three said that opportunity cost cannot depend on the value to the holder of the spectrum. As explained in our December 2018 Consultation, we consider that the market clearing price represents the marginal opportunity cost of the spectrum in the auction. Three was prepared to pay £37.8 million per 5 MHz for more 3.4 GHz spectrum than it ultimately obtained, meaning this is the marginal value that Three has foregone in not obtaining additional 3.4 GHz spectrum, which we consider represents a reasonable figure for the marginal opportunity cost for Three of its holdings of 3.4GHz spectrum.

A1.18 Three has proposed the following alternative lump-sum market value estimates:

a) A revised estimate of the marginal opportunity cost to other users of £29.6 million per 5 MHz, described by Three as a "corrected" marginal opportunity cost to other users;[101]

b) A non-linear profile of lump-sum values, ranging from £9 million to £29.6 million per 5 MHz, for each 5 MHz block of the 120 MHz of spectrum released by Three; and

c) An average opportunity cost across the 120 MHz of UKB spectrum of £19.1 million.[102]

A1.19 We have considered these estimates in more detail below. For the reasons set out under the following sub-headings, we conclude that these alternatives do not provide a more appropriate basis for setting ALFs for UKB's 3.4 GHz and 3.6 GHz spectrum than the two measures we identified in our December 2018 consultation.

Revised marginal opportunity cost to other users

A1.20 We disagree with Three that we have incorrectly calculated the marginal opportunity cost to other users. For the purposes of setting ALF, we consider that this measure should reflect the next highest value of Three's UKB spectrum to an organisation other than Three, *relative to post-auction spectrum holdings*. This requires us to take account of Three's winning bid for the 20 MHz of 3.4 GHz spectrum which it won in the 2018 auction. By assuming a hypothetical auction outcome in which Three did not participate and Telefónica won more 3.4 GHz spectrum than it did, Three understates the value of an increment of UKB spectrum to the next highest value user (i.e. Telefónica).

A1.21 Three said that a value of £31.1 million per 5 MHz is the marginal opportunity cost to other users of the 3.4 GHz spectrum acquired in the 2018 auction, not the marginal opportunity cost of its (prior) UKB spectrum holdings. According to Three, it would have every incentive to sell the 20 MHz of spectrum acquired at auction first, as this spectrum is not in use. Regardless of the likely order of Three's divestment, the fact remains that Telefónica has expressed a value of at least £31.1 million per 5 MHz for an additional 15 MHz of 3.4 GHz

[101] As explained in footnote 86, this is a conservative estimate.

[102] Three further proposed that if we applied its discount factor to account for what it considered to be the first-mover advantage in respect of 5G services, the adjusted lump-sum value for the purposes of setting ALFs would become £17.2 - £17.8 million per 5 MHz (see paragraph 1.165 of its response to the December 2018 consultation). We address and reject this adjustment later in this annex.

spectrum beyond that which it acquired at auction. This represents the opportunity cost of that increment of UKB spectrum to the next highest-value user.

A1.22 We have also considered the purported advantages of Three's "corrected" estimate of the marginal opportunity cost to other users. Three said that including winning bids in the calculation of marginal opportunity cost to other users extracts more revenue than a competitive auction. It presented a hypothetical example by Power Auctions (on behalf of Three) to support its argument. However, this example does not take the existing spectrum holdings as given. As discussed above, we consider this is necessary for identifying the correct marginal opportunity cost because we are seeking to value the marginal opportunity cost of UKB spectrum, given the post-auction holdings of 3.4 GHz spectrum.

A1.23 Three also said that using Ofcom's measures of market clearing price or marginal opportunity cost to other users will distort bidding incentives. We have long recognised the interplay between ALFs and incentives for market mechanisms, and our approach to setting ALFs is designed with this interplay in mind. Specifically:

a) We have said in our SRSP that we will not use observed market valuations (such as from auctions) mechanically to set ALFs (AIP Principle 8). While we have used 2018 auction bids as the basis for setting ALFs for 3.4 GHz and 3.6 GHz spectrum, we have carefully considered (later in this annex) which bids from this auction are most appropriate for the purposes of estimating market value, and whether there are grounds to adjust our market value estimates in light of any risk of bids understating or overstating intrinsic values for this spectrum. We have also considered whether there are other meaningful evidence sources that we could rely on. For spectrum licences in other bands which become liable for ALFs in the next few years, we will similarly consider a range of evidence from available sources when determining the appropriate level of any fees.

b) In terms of revisions to existing fees, we have explained in Section 5 that we always retain the ability to revise fees in the future in appropriate circumstances, including after the forthcoming auction of 700 MHz and 3.6-3.8 GHz spectrum, if we consider there is evidence to suggest a revision to fees is warranted. However, we also consider that there is benefit for licensees in a period of certainty on fees. This remains our general position, and we intend to retain the fees as set unless there is strong evidence that a material misalignment has arisen between the level of the fees and the value of the spectrum.

A1.24 We also disagree with Three that our choice of marginal increment (i.e. 10 – 15 MHz of 3.4 GHz spectrum) is inconsistent with our decision on 900 MHz and 1800 MHz ALFs. For that decision, we generally focused on 2x5 MHz and 2x10 MHz increments and derived market value estimates for these increments using the specific 4G auction bid information available to us:

a) For 2.6 GHz spectrum, our point estimate of market value from the range of evidence from the auction was based on the results of marginal bidder analysis.[103] This is because we could directly observe bids from marginal bidders for spectrum additional to their winning packages (i.e. Telefónica and Three's bids for 2x10 MHz of 2.6 GHz), which we said allowed us to explore the opportunity cost for the relevant marginal increment. We said this suggests that the 2.6 GHz market value should be the highest losing bid for this increment of spectrum (i.e. £6.4 million per MHz from Telefónica, in March 2013 prices), but for the complicating fact that there was no linear market clearing price (i.e. this price would involve less demand than in the winning allocation by another bidder, Niche). This is why we ultimately set market value using the incremental bid value for the last 2x5 MHz of the 2x15 MHz block that Niche won in this auction (£5.5 million per MHz, in March 2013 prices).[104] In contrast, the highest losing bids in the (uniform price) 2018 auction were consistent with demand matching supply.

b) We were not able to directly observe bids for marginal 800 MHz spectrum, which is one reason why we only used marginal bidder analysis as a cross check on our market value estimates in that case. In any event, as part of our analysis of 800 MHz bids, we focused on increments of 2x5 MHz and 2x10 MHz, where 2x5 MHz was the smallest possible increment in the auction.

Non-linear profile of lump-sum values

A1.25 We recognise that the optimal price for spectrum could in theory be non-linear. However, a non-linear structure of ALFs would be significantly more complicated to implement than a linear ALF (i.e. a uniform per MHz fee). As Three recognises, it is not clear that such an approach would be practical to implement in circumstances where Three simultaneously traded (or swapped) its UKB spectrum to other operators. Non-linear ALFs would also increase the administrative burden associated with managing this spectrum, particularly given the prospect of swaps or trades and hence the prospect of the spectrum being held by more than one licensee. As explained in Section 4, we generally consider that it is preferable that operators pay the same ALF for equivalent spectrum (on a per MHz basis). For these reasons, we do not consider that it would be appropriate to set ALFs based on a non-linear profile of lump-sum market values.

Average opportunity cost of UKB spectrum

A1.26 We disagree with Three that the next-best approach is to set a linear ALF based on the average opportunity cost of UKB's total holdings. As set out in the SRSP, the purpose of AIP is to provide users with a sustained long-term signal of the value of the spectrum as indicated by its opportunity cost in the next highest use. We consider that this is best

[103] Marginal bidder analysis analyses opportunity cost by assessing bids of the highest losing bidder for additional spectrum.
[104] See paragraphs 2.223 to 2.226, Ofcom, Statement on 900 MHz and 1800 MHz ALFs, September 2015, https://www.ofcom.org.uk/__data/assets/pdf_file/0033/79764/statement.pdf.

achieved by setting ALFs according to the market value of the smallest increment that could credibly be traded, as this will provide MNOs with the appropriate signals to only hold onto spectrum for which they are the highest value user.

A1.27 In contrast, if we set ALFs according to average opportunity cost, there is a risk that Three may not have strong incentives to trade a portion of its UKB spectrum holdings, even where it is not the highest value user for that portion of spectrum. In other words, this approach would risk leaving efficiency-enhancing reallocations of marginal blocks of spectrum unrealised. For this reason, we disagree with Three's statement that "*ALFs based on market clearing price or marginal opportunity cost would serve no other purpose than raising revenue from Three*".

A1.28 One of the reasons why Three said we should use opportunity cost (by which we understand it to mean the average opportunity cost for its entire holding of UKB spectrum) is "*because ALF is supposed to proxy for the price that would emerge in a well-functioning market…lump-sum values for ALF purposes should never exceed opportunity cost*".[105] We disagree with this because, in a well-functioning market, where discrete increments of spectrum can be bought or sold (rather than an operator's entire holdings), we would expect the price of that spectrum to be set at the margin.

A1.29 We recognise that, if Three *did* release a significantly larger quantity of its UKB spectrum, a linear ALF which is set according to the marginal value of a smaller increment might exceed non-holders' aggregate value for the spectrum released (as we would expect non-holders to have diminishing values for additional increments of spectrum). However, Three's values for 3.4 GHz ALF spectrum are also likely to be diminishing, which suggests that Three's value for infra-marginal spectrum is *increasing* in the amount of spectrum being released. The corresponding risk of inefficiency from spectrum lying unused is therefore low.

A1.30 Overall, we conclude that setting ALFs according to marginal opportunity cost is likely to be a more efficient price signal, compared with using the average opportunity cost: in particular, the average across UKB's entire 120 MHz of UKB spectrum as Three has suggested. We also consider that the marginal increments that underpin the market value estimates in the December 2018 consultation remain appropriate.

Whether bids in the 2018 auction understate or overstate market value

A1.31 Before addressing specific arguments made by respondents (or consultants on their behalf) about bidding in the 2018 auction, we note that respondents – all of whom participated in this auction – have not provided documentary evidence to demonstrate how their bids were actually derived. Rather, their submissions have focused on possible factors which may have affected their (or other operators') bids. On this basis, we are more cautious in considering the arguments presented than if we had documentary submissions showing, for instance, how they had shaded their bids or had bid more than intrinsic value.

[105] Paragraph 1.111 of Three response to December 2018 consultation.

Possible reasons why bids might understate market value

A1.32 We recognise that bidders in a uniform-price multi-unit auction can have an incentive to shade their bids for additional spectrum, due to the impact of these bids on the infra-marginal blocks for which they are also bidding. This means that bids in the 2018 auction could understate bidders' true marginal valuations. Having said this, the magnitude of the effect could have been mitigated. For example, Ofcom designed the bid information disclosure during the 2018 auction in such a way as to reduce strategic bidding incentives, including for strategic demand reduction.[106] Another possible limitation on strategic bidding incentives was identified by Power Auctions (on behalf of Three). Power Auctions reasoned that the effect of strategic demand reduction would be blunted when spectrum is auctioned in two sequential processes (as with 3.4 GHz and 3.6 GHz spectrum).[107]

A1.33 Auction bids may also be lower than intrinsic values for other reasons, for example, due to budget constraints. Vodafone submitted a report prepared by Charles Rivers Associates setting out a possible interpretation of Three and Telefónica's bids in the 2018 auction.[108] The report suggested that this was consistent with Three price-driving in the 2.3 GHz band, to force early demand reduction in 3.4 GHz spectrum by a budget-constrained Telefónica.

A1.34 In response to Telefónica, for the reasons explained in paragraphs A1.26-A1.30 above, we are not seeking to estimate the value of 100 MHz of 3.4 GHz spectrum. Although we recognise that operators suggest that the per MHz value of a contiguous 100 MHz block of 3.4-3.8 GHz spectrum is potentially higher than for smaller blocks, the bids in the 2018 auction remain our best available estimate of the marginal value of this spectrum.

A1.35 In relation to future expectations of spectrum availability, we do not consider there is clear evidence that operators' values in the 2018 auction were reduced, due to their future expectations about 3.6 GHz availability or changes to the 3.4 GHz band. For example, Telefónica said that it expected more spectrum to be auctioned (implying that its bids in the 2018 auction could be understated), but did not provide specific evidence of this. Our own publications prior to the 2018 auction (of 3.4 GHz spectrum) made clear the amount of spectrum that could be expected at 3.6 GHz in future. In particular, our October 2017 Statement on mobile services in the 3.6-3.8 GHz band stated our intention to award just the remaining 116 MHz in this band (i.e. excluding UKB 3.6 GHz spectrum).[109] Before the

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[106] See for instance paragraph 8.44, Ofcom, *Award of the 2.3 GHz and 3.4 GHz bands*, Statement, July 2017, https://www.ofcom.org.uk/__data/assets/pdf_file/0022/103819/Statement-Award-of-the-2.3-and-3.4-GHz-spectrum-bands-Competition-issues-and-auction-regulations.pdf. Specifically, bidders only knew excess demand in multiples of 20 MHz. We considered this would make it less likely that bidders bring the auction to an early end by reducing their demand.

[107] Power Auctions set out a stylised model which it said showed that this effect, combined with a flatter bid function in the first auction, will cancel out the impact of strategic demand reduction. However, it is not clear that this conclusion would necessarily hold in practice, given other considerations that may affect bidding (e.g. the possibility of budget constraints, as discussed next).

[108] Annex A (report by Charles Rivers Associates), Vodafone response to December 2018 consultation.

[109] Ofcom, *Improving consumer access to mobile services at 3.6GHz to 3.8GHz*, Statement, October 2017, https://www.ofcom.org.uk/__data/assets/pdf_file/0019/107371/Consumer-access-3.6-3.8-GHz.pdf.

2018 auction, we made no commitment to award any more than this amount of spectrum, nor did we publicly state an intention to defragment the 3.4-3.6 GHz band.

Possible reasons why bids might overstate market value

A1.36 We considered the risk of strategic investment in the 3.4 GHz band in our July 2017 PSSR Statement. We said that, while there is some risk of this, the potential pay-offs from such a strategy are uncertain because it is unclear when other bands will be useable for 5G and whether consumers will be willing to pay materially more for 5G services between the date of 3.4 GHz becoming usable and 2022.[110] We also considered that some specific features of the 2018 auction design – including the uniform price rule and the information policy that we adopted – reduced the risk of strategic investment (though we recognised that, on their own, they were unlikely to fully prevent any risk of strategic investment).[111]

A1.37 Regarding implications of the timing of the 2018 auction and the forthcoming award of 700 MHz and 3.6-3.8 GHz spectrum:

a) *We do not consider that bids are likely to have overstated intrinsic spectrum value as a result of artificial scarcity.* In response to BT, we note that there was a clear expectation at the time of the 2018 auction that we intended to make 3.6 GHz spectrum available for mobile use. We also set out an intention to auction this spectrum in 2019 if possible.[112] As such, we would expect operators to have reflected this in their bids for 3.4 GHz spectrum.

b) *There is not clear evidence that bids in the 2018 auction reflected a premium (relative to intrinsic value) to launch 5G services.* Frontier Economics (on behalf of Three) said that bids might have overstated long-term values because a failure to acquire 3.4 GHz spectrum would allow other operators to gain an enduring advantage in 5G. It estimated this premium may be up to 10-15%. However, this result was based on several assumptions, including:

[110] Paragraph 6.102, Ofcom, *Award of the 2.3 GHz and 3.4 GHz bands*, Statement, July 2017, https://www.ofcom.org.uk/__data/assets/pdf_file/0022/103819/Statement-Award-of-the-2.3-and-3.4-GHz-spectrum-bands-Competition-issues-and-auction-regulations.pdf.
[111] See paragraphs A10.29 to A10.50, *Award of the 2.3 GHz and 3.4 GHz bands*, Statement.
[112] See for instance paragraph 5.7 of our October 2017 Statement on *Improving consumer access to mobile services at 3.6GHz to 3.8GHz*.

i) *Uptake of 5G services in 2019.* Specifically, Frontier Economics assumes 12% of mobile subscribers use a 5G service in 2019. While we recognise that operators have announced plans to launch 5G services during 2019, only BT/EE has so far launched a commercial 5G service (on 30 May) and planned rollout will occur over time on a regional basis, beginning with rollout to six cities. Furthermore, while we expect the 5G device ecosystem to develop during 2019 and beyond, there is a limited number of devices currently available that support 5G services.[113] We note that Frontier Economics' assumption is based on 4G penetration in 2014, but the first year in which all UK mobile operators offered some 4G services was in 2013 (a year in which, according to Frontier Economics' model, 4G penetration was only 1%).[114]

ii) *Failing to acquire 3.4 GHz spectrum in the 2018 auction will depress an operator's market share until 2023.* We do not consider that Frontier Economics has provided clear evidence that any such impact would persist for 5 years. Frontier Economics referred to EE having a higher 4G market share (35%) than its overall market share (30%), having launched 4G services 6-12 months before competitors. However, this may be due to other factors than a first-mover advantage in 4G, e.g. better network coverage or performance.[115] In addition, we set out in our July 2017 PSSR Statement some reasons that we considered would mitigate any competition impact of an asymmetric distribution of 3.4 GHz spectrum; in particular, the possibility that operators using 4G could compete sufficiently well at least for a period of time against rivals offering 5G.[116]

[113] We note in particular that press reports suggest the next iPhone release will not support 5G. See for instance https://www.cnet.com/news/2020-iphone-11-worth-the-wait-touch-id-5g-phone/ and https://5g.co.uk/phones/.
[114] This is broadly consistent with Ofcom data, which showed 4G subscriptions (including machine to machine) comprised 1% of total subscriptions in Q3 2013, rising to 3% by the end of 2013. Take-up increased significantly in Q1 2014 (i.e. within a year of 4G launch) to 15%, but this was mainly due to Three automatically upgrading its packages rather than from subscriber-led demand for 4G. See Figure 4.2, Ofcom, Communications Market Report (2015), https://www.ofcom.org.uk/__data/assets/pdf_file/0022/20668/cmr_uk_2015.pdf.
[115] See for instance Annex 9 of our consultation on Award of the 700 MHz and 3.6-3.8 GHz spectrum bands, December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0021/130737/Annexes-5-18-supporting-information.pdf. Research from Roometrics showed BT/EE outperforms the other MNOs in terms of overall mobile performance. Focusing on 4G performance specifically, Ofcom research shows EE has the highest landmass data coverage of the four operators, as well as the fastest average download speeds and lowest latency. We also note that ✂.
[116] See paragraphs 6.94-6.99, Ofcom, *Award of the 2.3 GHz and 3.4 GHz bands*, Statement. We also said that existing spectrum bands are likely to become suitable for 5G in due course. This process is likely to accelerate if it becomes clear that consumers place a high incremental value on 5G services.

iii) *3.4 GHz spectrum value reflects a period of delayed usage.* To the extent that operators acquired 3.4 GHz spectrum before it could be fully deployed for 5G use, this could provide a reason why bids understated the long-term intrinsic value of this spectrum. This is because the benefits from this spectrum (in terms of incremental profits) would be further into the future and hence more heavily discounted compared with being able to deploy 5G services sooner after licence acquisition (which may be the case with 3.6 GHz spectrum auctioned next year). While Frontier Economics' model does account for delayed availability of this spectrum by calculating an NPV in 2018, and assuming additional profits are zero in this year, it does not compare this with a scenario in which spectrum can be used immediately.

A1.38 Therefore, while it is possible that auction bids may have included a premium to launch 5G services as soon as possible, the evidence is not conclusive. Even if there were such an effect, any premium would likely be significantly less than the 10-15% estimated by Frontier Economics.[117]

Overall view

A1.39 We recognise that there are reasons as to why bids in the 2018 auction could understate or overstate bidders' long-term intrinsic values for a marginal amount of 3.4 GHz spectrum. However, taking these offsetting effects in the round, we do not consider that there is sufficient evidence to conclude that the market value estimates (based on the 2018 auction outcome) should be revised upwards or downwards. As such, we continue to use the results from the 2018 auction as the best available evidence for estimating the lump-sum market values for 3.4 GHz and 3.6 GHz spectrum.

Other sources of evidence on market value for 3.4 GHz and 3.6 GHz

A1.40 We have considered whether there are other sources of meaningful evidence on the market value of 3.4 GHz and 3.6 GHz spectrum, beyond the results of the 2018 auction, which could lead us to refine our estimate of the lump-sum market value of this spectrum. Specifically, we have considered: auctions of similar spectrum in the UK; and auctions of 3.4-3.8 GHz spectrum in other countries.

a) Other UK spectrum awards:

[117] By way of illustration, we have adapted Frontier Economics' model to assume that 5G penetration follows 4G penetration one year later than Frontier Economics has modelled. We also updated the discount rate to be consistent with the cost of capital used in the upper polar case in our annualisation methodology (which, on the pre-tax real basis used in Frontier's model, is equivalent to 5.5%), and we adjusted the time period so that it reflects a 20-year licence duration. We find in this scenario that the premium from acquiring spectrum early is less than 4%. Furthermore, if the market share impact of failing to acquire 3.4 GHz spectrum persists for 3 years rather than 5 years, the premium falls to less than 1%.

i) We auctioned 2.3 GHz spectrum alongside 3.4 GHz spectrum in the 2018 auction. This sold for less than 3.4 GHz, at £25.7 million per 5 MHz compared to our market value estimates of £31.1 million (based on a conservative estimate of the marginal opportunity cost to other users) or £37.8 million (based on a conservative estimate of the market clearing price) per 5 MHz for 3.4 GHz spectrum. However, as the 3.4-3.8 GHz band has been identified as the primary band for the introduction of 5G in Europe, we consider that it could plausibly be valued more highly by operators than 2.3 GHz spectrum.

ii) The most recent UK spectrum award prior to the 2018 auction was the March 2013 4G auction of 800 MHz and 2.6 GHz. Our conservative estimate of lump-sum market value for the 2.6 GHz (FDD) band was equivalent to £29.5 million per 5 MHz in April 2018 prices.[118] This is close to our market value estimate for 3.4 GHz spectrum based on the marginal opportunity cost to other users, but further below the market clearing price. However, as mentioned above, the 3.4-3.8 GHz band has been identified as the primary band for the introduction of 5G in Europe, and so we consider that it could plausibly be valued more highly by operators than 2.6 GHz spectrum. Unpaired (TDD) 2.6 GHz spectrum sold for substantially less, but the usefulness of TDD spectrum for 4G technologies in 2013 was less well established.[119]

b) International benchmarks: There have been recent auctions of 3.4-3.8 GHz spectrum in other EU and non-EU countries. However, as set out in our December 2018 consultation, we consider that these auctions are less informative of the market value of the UKB 3.4 and 3.6 GHz spectrum than the 2018 auction. No respondent to our consultation disagreed with this.

A1.41 We therefore do not consider that evidence from other spectrum awards gives us sufficient reason to depart from our estimates of market value based on bids for 3.4 GHz spectrum in the 2018 auction.

Overall view

A1.42 For the reasons set out in this annex, we remain of the view that the market clearing price and the marginal opportunity cost to other users, as identified in the 2018 auction, are the most relevant measures of lump-sum market value for the purposes of setting ALFs for UKB's 3.4 GHz and 3.6 GHz spectrum.

[118] See paragraph 4.19 of the December 2018 Statement on 900 MHz and 1800 MHz ALFs. The estimated UK market value of 2.6 GHz is £5.9 million per MHz, or £29.5 million per 5 MHz (in April 2018 prices). In our 2015 Statement, we also considered values ranging from £4.99 million per MHz and £6.4 million per MHz (in March 2013 prices), which are equivalent (in April 2018 prices) to £26.8 million per 5 MHz and £34.3 million per 5 MHz.

[119] The estimated market value of 800 MHz (which was auctioned at the same time as the 2.6 GHz spectrum) is £35.5 million per MHz in April 2018 prices i.e. £177.5 million per 5 MHz. However, we do not consider this is informative of 3.4 GHz values as it is low frequency spectrum which may be particularly valuable in providing wireless network coverage.

A2. Annualisation

Introduction

A2.1 In this annex, we set out the approach we have used to convert the lump-sum value of spectrum into annual fees. This is Step 2 of the framework described in Figure 3.1 in Section 3.

A2.2 Following the approach established for ALFs on 900 and 1800 MHz spectrum, we spread the lump-sum market value over a period of time consistent with that used in the estimation of the lump-sum market value and adopt an ALF profile that is flat in real terms (i.e. adjusted for CPI inflation). In order to convert the lump-sum market value to an annual fee, we require an annualisation rate. This annualisation rate depends on three key parameters: the discount rate (which we explain below); the time period for annualisation; and the corporate tax rate (which is used to adjust the annual fees so as to reflect the more favourable tax treatment of annual fees compared to a lump-sum payment – specifically in the form of a tax adjustment factor (TAF)).

A2.3 The discount rate depends on, among other things, the uncertainty associated with the future ALF payment stream. One significant uncertainty relates to changes in the market value of the spectrum over time. The discount rate which will leave licensees indifferent between paying ALFs and paying a lump-sum depends on the extent to which they (rather than the government) are exposed to the effect of such changes in market value over time through the level of ALF.

A2.4 As set out in our 2018 900 MHz and 1800 MHz ALF Statement,[120] we consider that the appropriate discount rate would sit somewhere between a lower polar case of the cost of debt (as an approximation of the case where the licensee would bear the risk associated with the variation in the market value of the spectrum) and, as an upper polar case, the weighted average cost of capital (WACC, which is an approximation of the case where the government would bear the full risk of variation in the market value of the spectrum). We use a risk-sharing adjustment to determine where between these two polar cases the appropriate discount rate would lie.

A2.5 In summary the annualisation rate converts the lump-sum value (LSV) in the base year to an annual licence fee in year t (ALFt) as follows:

*ALFt = LSV * Annualisation rate * CPI inflation adjustment*

[120] Paragraph 4.79, Ofcom, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018. https://www.ofcom.org.uk/consultations-and-statements/category-2/annual-licence-fees-900-1800-mhz.

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A2.6 The post-tax real discount rate that we proposed to use was 1.0% (rounding to one decimal place), the TAF was 1.049 and, with a 20-year period, the resulting annualisation rate was 5.75%. These values were the same as those used in the 2018 900 MHz and 1800 MHz ALF statement.[121]

Responses to consultation

A2.7 Vodafone stated that it was "important that the approach taken for setting ALFs is consistent across the mobile spectrum bands." Vodafone agreed with our annualisation approach on the basis that we had taken a consistent approach to that used for the 900 MHz and 1800 MHz bands.[122]

A2.8 Telefónica agreed that we should adopt exactly the same methodology to annualisation as used for the 900 MHz and 1800 MHz bands, and if there were to be any changes in approach, they should in principle be applied to 900 MHz and 1800 MHz ALFs.[123] However, it considered that we had overstated the discount rate for two main reasons.

a) First, Telefónica stated that we failed to apply a liquidity adjustment to the cost of debt in the WACC for the upper polar case.[124] Telefónica noted that the only difference between the upper and the lower polar case is the allocation of cash flow risk, but that the liquidity risk adjustment in the lower polar case is unrelated to the cash flow profile but rather reflects an adjustment for the type of investor. Telefónica stated that "corporate bond investors require a liquidity risk premium, because they may want to divest prior to the bond reaching its maturity date. The liquidity risk premium compensates the bond investor for the risk that if she wishes to sell the bond at a time of poor market liquidity, she may have to choose between selling the bond at a discount or deferring the sale. Telefónica argued that the government bears no comparable risk, neither in the hypothetical scenario corresponding with the lower polar case nor in the hypothetical scenario corresponding with the upper polar case."[125]

b) Second, Telefónica considered that we had overstated the degree of risk-sharing. Telefónica disagreed with our response to the analysis of asset volatilities – which is one of the inputs into an option pricing model submitted by NERA on behalf of Telefónica in response to our June 2018 900 MHz and 1800 MHz ALF consultation.[126]

A2.9 BT and Three did not comment on our approach to annualisation.

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[121] Table 4.1, Ofcom, of *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018, https://www.ofcom.org.uk/consultations-and-statements/category-2/annual-licence-fees-900-1800-mhz.
[122] Page 14, Vodafone response to the December 2018 consultation.
[123] Paragraph 48, Telefónica response to the December 2018 consultation.
[124] Paragraph 50, Telefónica response to the December 2018 consultation.
[125] Paragraph 53, Telefónica response to the December 2018 consultation.
[126] Paragraph 56, Telefónica response to the December 2018 consultation. Telefónica argues that Ofcom relies too heavily on the BT Group asset volatility and longer time periods of analysis. Our response on the NERA analysis of asset volatilities was contained in the December 2018 900 MHz and 1800 MHz ALF Statement, paragraph A5.107 to A5.110.

Our assessment

A2.10 We have decided to maintain the same approach to annualisation as in the December 2018 900 MHz and 1800 MHz ALF Statement. We have also used the same values for the discount rate and the annualisation rate.

A2.11 Accordingly, we use the following formula to calculate the ALF (which is the full version of that summarised at paragraph A2.5 above). This formula assumes the ALF is an annuity payment with payments made at the beginning of the year.

$$ALF_t = LSV * TAF * \underbrace{\left[\frac{r}{1-(1+r)^{-t*}}\right] * \left[\frac{1}{(1+r)}\right]}_{\text{Annualisation rate}} * \left[\frac{CPI_t}{CPI_{t0}}\right]$$

A2.12 Where:

- ALF_t is the value of ALF in year t;
- LSV is the lump-sum value of spectrum in the base year (i.e. April 2018);
- TAF is the adjustment factor that reflects the tax advantages of ALF over lump-sum payments[127];
- r is the real post-tax discount rate;
- t* is the length of period over which we spread the LSV for the purposes of calculating the ALF, i.e. 20 years (which corresponds to the initial term of the 2018 auction licences);
- CPI_{t0} is the level of the CPI (all items) index in April 2018 and CPI_t is the latest available figure for the same index published in the Consumer Price Inflation Reference Tables by the UK Statistics Authority.
- We refer to the expression on the right-hand side of the formula which is multiplied by the LSV to derive the base level of ALF (i.e. before updating for inflation) as the "annualisation rate".

A2.13 Those stakeholders which commented on our approach to annualisation said that it was important to maintain consistency with the way the fees were derived for the 900 MHz and 1800 MHz bands. We agree that this is an important consideration, and we have decided to maintain the same approach, including the same values for the inputs into the annualisation rate.[128]

[127] The TAF is calculated as: TAF = 1 + [(PV of tax benefits of ALF – PV of tax benefits of the amortisation of LSV) / LSV]
[128] Note also that in our 2019 PIMR and BCMR Draft Statement, published on 24 May 2019, we set out our latest view of the cost of capital for BT Group and the 'Other UK Telecoms' part of BT (which includes its mobile activities). We have estimated the pre-tax nominal cost of new debt at 2.8%, which is the same as the nominal pre-tax cost of debt we used in the 2018 900 MHz and 1800 MHz ALF Statement to derive the lower polar case. Other common parameters to the cost of capital for Other UK Telecoms are (to the nearest 0.1%) consistent with the parameter values used for a UK mobile operator in the 900 MHz and 1800 MHz ALF Statement (i.e. the nominal risk-free rate of 1.5%, nominal equity risk premium

A2.14 As a key input into the annualisation rate, we use a real post-tax discount rate of 1.0%. This is derived as a weighted average of the discount rates in the lower polar case (of -0.1%) and the upper polar case (of 4.2%[129]), using a risk-sharing adjustment factor of 25% to determine where the final discount rate sits between the two polar cases.

A2.15 We now respond to the points raised by Telefónica, which was the only stakeholder to comment on specific assumptions in this calculation.

Liquidity risk premium adjustment

A2.16 In the lower polar case, the main risk the government requires compensation for is the default risk of the licensee. To estimate the required compensation, we have used corporate bond yields as a starting point. However, in the December 2018 900 MHz and 1800 MHz ALF Statement we accepted that there is some empirical evidence that corporate bond yields also capture other factors, such as compensation for liquidity risk, although we acknowledged that this was an area of ongoing research and estimates of the liquidity premium need to be treated with caution.[130] Unlike corporate bond investors, the government (or Ofcom on its behalf) is not, under present arrangements, in a position to resell the ALF cash flows. As such, we recognised that the government may not need to be compensated for the liquidity risk that might be implicitly captured in bond yields used to derive the discount rate in the lower polar case.[131] Hence, we made a downward adjustment to observed corporate bond yields to reflect this effect in the lower polar case.

A2.17 In response to the December 2018 consultation, Telefónica argued that the same adjustment should be applied to the cost of debt used to derive the cost of capital in the upper polar case.

A2.18 In the upper polar case, the government is fully sharing in the risk of the operating cash flows of the licensee, and hence requires compensation for the full risk associated with these cash flows. The cost of capital for a typical licensee is therefore the relevant benchmark to capture this compensation. In the capital asset pricing model (CAPM), which we use to estimate the cost of capital, the risk premium above the risk-free rate reflects the compensation required by investors for bearing systematic risk.[132]

A2.19 We consider that, in the upper polar case, the government is in a position akin to other investors fully participating in the cash flow risk of the licensee. This is because, in the upper polar case, the ALF payments would be set up in such a way that they would vary in line with the future after-tax cash flows of the licensee (e.g. through some form of net

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of 7.3%, equity beta of 1.02 and gearing of 40%). See Annex 21 of the *2019 PIMR and BCMR Draft Statement,* https://www.ofcom.org.uk/__data/assets/pdf_file/0021/149340/pimr-bcmr-llcc-draft-statement-annexes-1-25.pdf.

[129] The post-tax real cost of capital of 4.2% is derived from a nominal pre-tax cost of capital of 7.6% using CPI inflation of 2% and a tax rate of 17.1%.

[130] Paragraphs A5.43 to A5.53, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018.

[131] Paragraph A5.48, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018.

[132] Systematic risk is cash flow risk which cannot be diversified away by holding a portfolio of assets.

revenue sharing arrangement between the licensees and the government) and the government would be fully exposed to the underlying systematic risk.[133] We do not see compelling reasons why the systematic risk exposure (and hence the required compensation for risk) would differ between the government and another investor fully participating in the cash flow risk of the business. Our estimated compensation for risk only includes compensation for systematic risk (as captured within the CAPM). The liquidity risk premium adjustment applied in the lower polar case arises because of our use of corporate bond yields as a starting point for proxying the risk if ALF payments were set up so that they were completely fixed regardless of circumstances, and licensees could not avoid paying the ALF by handing back the spectrum.

A2.20 In standard corporate finance theory, systematic risk is a function of business risk and is not dependent on capital structure. This means that, as an alternative basis for capturing the relevant risk, we could have used an all-equity cost of capital (the cost of capital for an all-equity financed firm) in the upper polar case. This would be measured by the risk-free rate plus the asset beta multiplied by the market risk premium. Since in practice operators typically use some debt finance in their capital structure, and following the approach from the 2015 and 2018 decisions for 900 MHz and 1800 MHz ALFs, in the December 2018 consultation we used a gearing assumption in the discount rate in the upper polar case. To one decimal point, both the all-equity cost of capital and the partial equity cost of capital (i.e. based on both debt and equity financing) produce a post-tax real rate of 4.2%.

A2.21 We also note that Telefónica's own advisors (NERA) did not make a liquidity risk premium adjustment when presenting their estimates of the WACC in the upper polar case (as part of submissions into the June 2018 900 MHz and 1800 MHz ALF consultation).[134] This is despite NERA arguing for a liquidity risk premium adjustment in the lower polar case.

A2.22 In conclusion, we have not adjusted the discount rate in the upper polar case for liquidity risk.

Risk-sharing adjustment

A2.23 As explained above, the risk-sharing adjustment determines where the final discount rate sits between the lower and the upper polar cases. A non-zero risk-sharing adjustment means there is a likelihood of future fee reviews that could increase or decrease the ALFs.

A2.24 In both our 2015 and 2018 decisions on 900 MHz and 1800 MHz ALFs, we did not think it sensible to try to assign specific probabilities to when a review (or reviews) might take place. We considered some stylised examples to gain insight into the question but acknowledged that ultimately we needed to exercise judgement. Taking a conservative approach to interpreting the evidence, we decided a risk-sharing adjustment of 25% was appropriate.[135]

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[133] Paragraph A5.65, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018.
[134] Table 3.1, NERA report for Telefónica, *Deriving ALFs from Lump-Sum Valuations – A Response to Ofcom's 2018 Consultation*, August 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0014/120326/telefonica-annex.pdf
[135] Paragraph A5.100, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018.

A2.25 Telefónica previously argued for an option-pricing approach (developed by NERA) to identify the level of risk-sharing. In the December 2018 900 MHz and 1800 MHz ALF Statement, we considered the arguments and the methodology proposed by Telefónica in response to the preceding consultation. As part of our review of this methodology, we provided a critique of the asset volatilities used by NERA (a key input into its modelling) and suggested that alternative interpretation of the data could support a risk-sharing adjustment of 25% within NERA's own framework.[136]

A2.26 Telefónica's latest response does not change our previous assessment of the NERA framework and the specific points raised since are sufficiently addressed in Annex 5 of the December 2018 900 MHz and 1800 MHz ALF Statement.

A2.27 In conclusion, we remain of the view that the risk-sharing adjustment is a matter of regulatory judgement. An option pricing model does not substitute for that judgement and risks concealing the underlying risk arising from the review regime for ALFs.[137] Therefore, we maintain the same risk-sharing adjustment, and the discount rate, as used in the December 2018 900 MHz and 1800 MHz ALF Statement.

Annualisation rate summary

A2.28 Table A2.1 summarises the parameter values used in the annualisation rate.

Table A2.1: Summary of parameters for the annualisation rate

	Values
Length of period over which we spread the LSV for the purposes of calculating ALF (t*)	20 years
Real post-tax discount rate (r)	1.0%
Adjustment factor that reflects tax advantages over lump-sum payments (TAF)	1.048[138]
Annualisation rate	5.75%

Source: Ofcom

[136] The asset volatility analysis we presented in Table A5.4 of the December 2018 900 MHz and 1800 MHz ALF Statement was merely used to illustrate the point that an option pricing framework was sensitive to the parameter values of the model, further corroborating our judgement that we did not consider option pricing to be a superior framework to guide our decision. See Paragraphs A5.107 to A5.111, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018.

[137] Paragraphs A5.111 and A5.127, *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* Statement, December 2018.

[138] We have updated the TAF since the December 2018 consultation. The TAF of 1.048 is slightly lower than the TAF of 1.049 used in the December 2018 900 MHz and 1800 MHz ALF Statement and in the December 2018 consultation because the average tax rate over the 20 year period starting from 2019/20 is slightly lower than over the 20 year period starting from 2018/19. However, this change has no impact on the annualisation rate (rounded to two decimal points) or on the base value of ALF (to three decimal points).