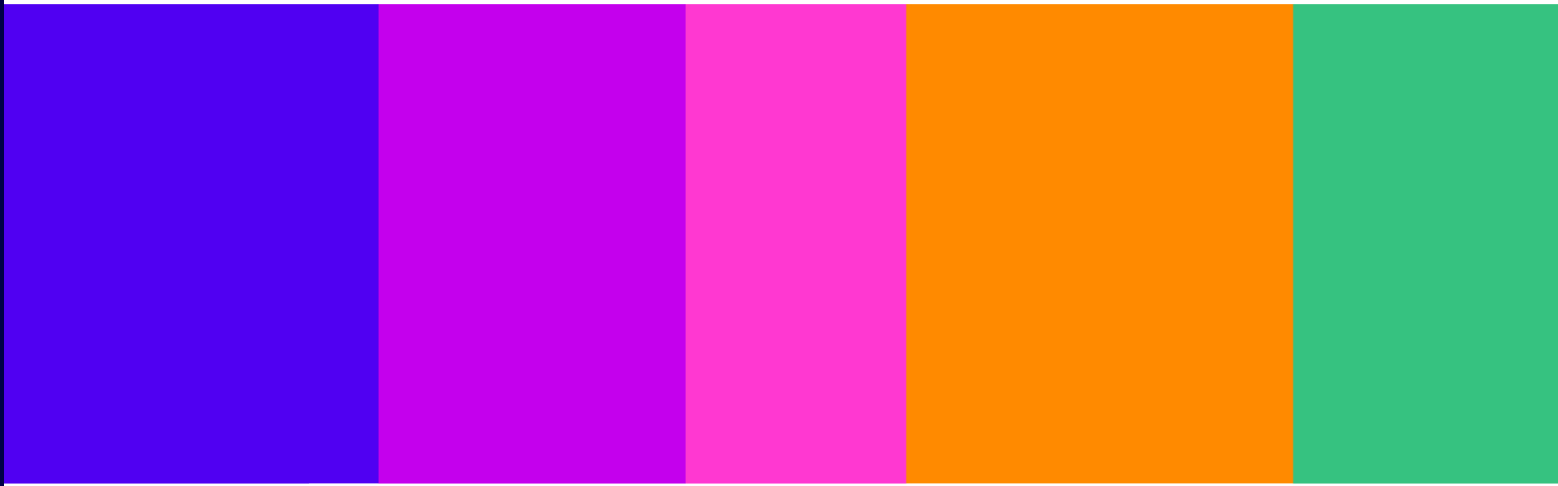


Review of Ofcom's market-based approach to mobile spectrum management

Response to Government

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1. Overview

- 1.1 The use of wireless technology has continued to evolve rapidly in recent years with smartphones taking a central role in our work and social lives. The mobile sector is expected to continue to be an important economic driver supporting cloud-based applications, and other infrastructure, business, and personal applications as deployment of 5G increases and 6G emerges.
- 1.2 The radio spectrum (the invisible waves that enable wireless technology), is a valuable and limited resource essential to delivering these wireless services. The fast-paced evolution in mobile technology means it is increasingly important to ensure that we manage the spectrum supporting these services in a way that enables the greatest benefits to consumers and businesses, now and in the future.
- 1.3 In this context our core duty is to ensure the optimal use of spectrum, which we balance with other duties relevant to our spectrum management functions, particularly our principal duty of furthering the interests of citizens and consumers (where appropriate by promoting competition); our duty to have regard to the desirability of encouraging investment and innovation in relevant markets; encouraging the availability and use of high-speed data transfer services throughout the UK; as well as the promotion of competition when managing the radio spectrum.
- 1.4 At the Government's request, we have undertaken a review of the approach we have taken to date in allocating mobile spectrum licences and setting their fees. In undertaking this review, we have considered a broad range of information including: the potential alternatives and international experience in allocating and charging for mobile spectrum, our past Annual Licence Fees ("ALFs") decisions and historic spectrum trades as well as responses to the related consultations. We have had regard to emerging approaches in allocating and charging for spectrum, third party international spectrum data, as well as any other factors that might suggest a case for revisiting our approach. We have also spoken to the mobile operators and reviewed submissions from them and their advisors discussing these issues. This is in addition to reviewing research by Analysys Mason on behalf of the Spectrum Policy Forum.¹
- 1.5 We start by summarising our current approach and then consider the advantages and disadvantages of our approach and the approaches used in other countries.
- 1.6 Given the complexity involved in spectrum allocation, as well as the changing nature of the technologies it supports, our approach is to make use of 'market mechanisms' where possible to help us secure the optimal use of spectrum. For mobile licences, this has included applying spectrum pricing both at the initial allocation stage (via auctions) and subsequently, at the end of the initial period, through ongoing licence fee payments.
- 1.7 Allocating mobile spectrum by auction allows us to identify the user with the highest value for it (and therefore, the likely most efficient user). However, with evolving market forces and technology the most efficient user of any asset can change over time. For this reason,

¹ Analysys Mason, [Review of market mechanisms as applied to mobile spectrum in the UK](#), November 2022.

we have tended to auction licences with an ‘initial’ term of 15-20 years, following which we can either charge fees to ensure the continued efficient use of the relevant spectrum, or revoke the relevant licences if there may be a more efficient use or user for the spectrum and then reallocate it.

- 1.8 In the case of mobile spectrum licences, the fees we charge at the end of the initial term of a licence are known as annual licence fees. In setting ALFs we estimate the market value of the relevant spectrum in the round, using benchmarks from UK and international auctions and applying our regulatory judgement, as appropriate, having regard to our statutory duties. ALFs are intended to incentivise licensees to hold licences only if they are the highest-value users of the spectrum. An operator who is not willing to pay the market price for spectrum should have an incentive to return some or all of it to Ofcom, or to sell it to a more efficient user (i.e. spectrum trading²).
- 1.9 We currently charge ALFs for three mobile spectrum bands (900 MHz and 1800 MHz since 2018; and 2100 MHz since 2022). The ALFs for this spectrum total around £320 million per annum and are paid to His Majesty’s Treasury.
- 1.10 As part of our review, we have examined the four main approaches to allocating and charging for mobile spectrum that are used, or have been used, in the UK and other comparable countries:
- a) ‘command and control’ approaches, where the regulator decides how to allocate spectrum amongst its stakeholders;
 - b) auctions of ‘indefinite’ licences³, with ALFs after an initial term;
 - c) auctions of ‘indefinite’ licences, with licence obligations after the initial term (which could be negotiated with stakeholders or determined by the national regulatory authority); and
 - d) auctions of ‘fixed term’ licences, which can be reallocated at the end of their term.
- 1.11 There are some commonalities in the approach to spectrum management across countries:
- a) First, the UK and other comparable countries have moved away from a ‘command and control’ approach in which the regulator specifies which technologies and services can access the radio spectrum. Giving users greater flexibility in a more market-based approach is regarded as more likely to secure the optimal use of spectrum (as users are deemed to have better knowledge of their own needs and constraints) and to support a competitive market amongst mobile operators who have different commercial strategies and where demand for spectrum outstrips supply.
 - b) Second, mobile spectrum is a valuable and limited resource, essential to delivering important wireless services. Consequently, mobile spectrum is not given away free-of-charge by regulators or governments in other jurisdictions. They either charge fees directly, impose costs indirectly through licence obligations, or a combination of these approaches.

² For spectrum trading to result in an efficient allocation, there needs to be a reasonably liquid market for spectrum licences. In paragraph 3.7 of this document, we provide our views on this.

³ By indefinite, we mean that the licensee expects to hold the licence in perpetuity unless the licence is revoked.

- 1.12 Setting aside a command and control approach for the reasons described above, the other approaches listed in paragraph 1.10 each have advantages and disadvantages:
- a) *Auctions of 'indefinite' licences, with ALFs after an initial term.* ALFs at market value are likely to promote an efficient allocation of spectrum, but setting ALFs requires the regulator to exercise judgement using several benchmarks (none of which are perfect) and taking evidence in the round to set fee levels.
 - b) *Auctions of 'indefinite' licences, with licence obligations after the initial term.* Imposing licence obligations rather than fees could be a way to achieve specific public policy outcomes like greater mobile coverage, but the effect of such obligations on the optimal use of spectrum is more difficult to establish. Licence obligations also typically require resource-intensive monitoring, enforcement, and replacing or updating with new obligations over time when the previous obligations expire.
 - c) *Auctions of 'fixed term' licences, which can be reallocated at the end of their term.* Fixed term licences can help ensure an efficient outcome by enabling the regulator to periodically reallocate the spectrum. They also avoid the need to set ALFs. However, the prospect of periodic reallocation can create uncertainty for licensees when compared with indefinite licences, potentially impacting on their investment incentives. Although the evidence that licence duration impacts investment levels is currently limited.⁴
- 1.13 A straightforward alternative to indefinite licences with ALFs would be to award 'fixed term' licences, which we reallocate at the end of their term, as we will do in the case of our upcoming auction of mmWave spectrum. This approach is most likely to be appropriate for spectrum whose long-term use is uncertain at the time it is initially allocated (meaning a potential reallocation at the end of the initial term is more likely to be warranted).
- 1.14 We could also consider the future use of licence obligations (e.g. improved investment or coverage), instead of or in addition to fees. However, doing so would mean setting requirements on the basis of policy choices rather than market forces. This could distort the market and make an efficient allocation less likely. In addition, any future use of licence obligations would need to be weighed carefully against the on-going monitoring costs involved and evidence of the success of other such schemes.
- 1.15 We have also reflected on whether we should review the levels of ALFs. However, there is a separate process to review the level of ALFs where we decide the evidentiary threshold is met. Mobile operators can submit evidence and request a review, if they consider there is a case for revising the fees. If we believe there is sufficient evidence that there is a material misalignment between ALFs and the underlying market value, we can take a decision to review.
- 1.16 Finally, it is for Government to decide whether the receipts raised by ALFs should be used for any specific use, such as to directly promote investment in mobile networks. For example, this could be achieved by using ALF receipts to provide a standalone investment fund for which mobile network operators ("MNOs") could bid. In comparison to the other options outlined above, this more direct approach to promoting investment would preserve the incentives for efficient allocation of spectrum created by ALFs, while at the same time

⁴ See Ofcom's research on the impact of [mobile spectrum licence duration on mobile network operators' investment incentives](#).

promoting investment in mobile networks, if this were deemed a public policy objective that would not be achieved by market forces alone.

- 1.17 In summary, all approaches to managing the continued efficient allocation of spectrum involve trade-offs, with each alternative having its own advantages and challenges. Whilst allocating spectrum using auctions of indefinite licences with ALFs requires the availability of sufficient benchmarks to set fees and the application of regulatory judgement, we consider that ALFs constitute a valuable part of our spectrum management toolkit. We also note that historically MNOs and other commercial mobile spectrum users in the UK have not favoured alternatives to ALFs (deployment or investment obligations and/or fixed term licences), albeit we understand that there is currently some support for an investment fund⁵.
- 1.18 We retain an open mind on the best way to secure the optimal allocation of spectrum on a case-by-case basis, which means that we are open to using alternative approaches as with our planned fixed term licences for mmWave spectrum.

⁵ Such as the fund set out in: Analysys Mason/Oxera report, [Ensuring future wireless connectivity needs are met – final report for DCMS](#), May 2022

2. Introduction

Context for this review

- 2.1 UK mobile telecoms services are an important sector in their own right, generating retail revenues of around £12.9bn in 2022.⁶ In addition, wireless communications are playing an increasingly central role in many other sectors of the economy. A study by economic consultants on behalf of the Department for Culture Media and Sport suggested that 5G mobile technology would deliver additional economic benefits to the UK of around £3bn to 10bn per annum over 15 years.⁷ The radio spectrum is crucial to delivering these services and benefits. Internationally, the mobile sector is pressing regulators to allocate more spectrum for mobile use for 5G and subsequently 6G technology, and some commentators believe this pressure is likely to continue for at least the next decade.⁸
- 2.2 The radio spectrum is a finite⁹ and valuable national resource, for which there are a large and growing number of competing potential uses and users. The radio frequencies used for the provision of mobile services are especially valuable, because they have been harmonised internationally for this purpose (enabling the development of compatible equipment and devices), and because of their physical properties (lower frequency bands in the 300 MHz to 4 GHz range can send signals over a wide area).

Ofcom's duties and objectives

- 2.3 Ofcom is responsible for authorising and managing the use of radio spectrum in the UK, which we do in accordance with our statutory duties. These duties include, in this context, our core duty to secure the optimal use for wireless telegraphy of the electro-magnetic spectrum. We balance this with other duties relevant to our spectrum management functions, particularly our principal duty of furthering the interests of citizens and consumers (where appropriate by promoting competition); our duty to have regard to the desirability of encouraging investment and innovation in relevant markets; encouraging the availability and use of high-speed data transfer services throughout the UK; as well as the promotion of competition when managing the radio spectrum.
- 2.4 Given the complexity involved in spectrum allocation, as well as the changing nature of the technologies it supports, we rely, where possible, on market mechanisms to help us achieve our duties.
- 2.5 Where there is excess demand for spectrum, one of the market-based approaches we take is Administered Incentive Pricing (“AIP”) - ALFs are AIP for mobile spectrum. The AIP approach to spectrum pricing is to set fees at market value, or equivalently at the opportunity cost of

⁶ Ofcom's [Communications Market Report 2023](#).

⁷ Analysys Mason and Cambridge Econometrics on behalf of the Department for Culture Media and Sport, [Realising the Benefits of 5G](#), August 2021.

⁸ Analysys Mason, [Ensuring that the wireless industry has sufficient spectrum will get more complicated](#), November 2022.

⁹ Multiple users cannot generally use the same frequencies without causing interference to one another.

the spectrum, to replicate the price signal licensees would receive in a well-functioning market for spectrum. If a licensee is not the highest value user of the spectrum (i.e. its private valuation is below market value and hence below the licence fee), it should have an incentive to relinquish some or all of its spectrum holdings. This means the spectrum is made available to the highest-value user, either through trading or reallocation by Ofcom.

2.6 For mobile spectrum, our ‘market-based’ approach includes:

- a) **Auctions:** Where there is high demand for spectrum, auctions allow us to identify the user with the highest value for it and therefore, the likely most efficient user. We typically allocate ‘indefinite’ licences authorising use of mobile spectrum by auction. In the past, we have auctioned licences authorising use of the spectrum for an initial term of 15-20 years, with the user incurring ALFs thereafter. Our approach to auction design has evolved over time to reflect the impact of the physical characteristics of particular spectrum bands on the economics of the spectrum and the competitive landscape.¹⁰ We note that there is broad international consensus that auctions are a key part of any effective approach to managing mobile spectrum.
- b) **Trading:** Ofcom allows licensees to trade their mobile spectrum on commercial terms. In principle, a well-functioning market for spectrum could emerge with licensees engaging in trading at any point after the initial award and lead to an on-going efficient allocation of spectrum.
- c) **ALFs:** The most efficient user of a spectrum licence may change over the course of a licence’s initial term. If the use-case at the time of auction is likely to remain efficient after the initial term, we charge ALFs to ensure the continued efficient use of the relevant spectrum (the mechanism behind this is explained in paragraph 2.5 above).
- d) **Revocation and reallocation:** If the allocation is unlikely to remain efficient after the initial term or at any point thereafter, we can revoke the relevant licence subject to the notice period (typically five years) and then re-allocate the spectrum, if appropriate.¹¹ We might do this, for example, if the spectrum band has been internationally harmonised for an alternative use case.

2.7 Our approach to ALFs is to set fees at estimated market value, or equivalently at the opportunity cost of the spectrum, to replicate the price signal MNOs would receive in a well-functioning market for spectrum. If a licensee is not the highest value user of the spectrum (i.e. its private valuation is below market value and hence below the licence fee), it should have an incentive to relinquish some or all of its spectrum holdings, which can then be made available to the highest-value user.

2.8 It is worth reflecting on why we set ALFs despite MNOs having the opportunity to trade their spectrum. In well-functioning markets, participants can observe the prevailing market price for their assets (in this case spectrum licences). This acts as a signal of the opportunity cost of holding the licence, enabling the licensee to make decisions such as how much spectrum to hold or trade, and how much to invest in complementary or substitute assets. In principle,

¹⁰ For example, high frequency spectrum (such as mmWave) does not travel far. This means that it is more appropriate for the products in the auction to be sub-national. This compares to earlier mobile spectrum auctions of lower frequency spectrum which had products which were national in scope.

¹¹ Revocation can only happen once the initial term has expired, although the process for revocation can begin before this.

in such a spectrum market it may not be necessary for a regulator to set fees to achieve an efficient allocation of spectrum.

- 2.9 However, a market that is liquid enough to allow price discovery in spectrum licences has not emerged in the UK – nor have we seen regular trading in any other country. When we set out our spectrum pricing policy in 2010, we considered that ALFs were likely to be needed in the absence of such a liquid market.¹²
- 2.10 Whilst AIP has been in place for many years and is applied to spectrum across many sectors, ALFs for mobile licences were only set at estimated market value more recently: in 2018 (for the 900 and 1800 MHz bands¹³), and at the end of 2021 (for the 2100 MHz band). Other mobile spectrum bands are not currently subject to ALFs, typically because they were awarded with a 20-year initial term and have not yet reached the end of that term.
- 2.11 The development of our approach to ALFs has been the subject of extensive consultation with mobile operators and other stakeholders. For example, we published five consultations before making an initial decision on 900 MHz and 1800 MHz ALFs in 2015, with a further consultation before finally setting ALFs for these bands in 2018.
- 2.12 Currently mobile operators pay ALFs for a total of around 330 MHz of spectrum in three bands, summarised in Table 1. By way of context, mobile sector retail revenues were £12.9bn in 2022¹⁴ and the annual fees are currently around £318 million. We expect to set licence fees for 40 MHz of spectrum in the 1400 MHz band, the licences for which have reached the end of their initial term. We do not expect to set additional ALFs until other licence bands reach the end of their initial term in 2033.

Table 1: Current ALFs¹⁵ (£m)

	900 MHz	1800 MHz	2100 MHz	Total
BT/EE	-	90	27	117
Vodafone	47	12	20	79
VMO2	47	12	13	72
Three	-	30	20	50
Total	95	144	80	318

Note: Figures may not sum due to rounding.

¹² As explained above, ALFs are the name for AIPs as applied to mobile spectrum. In the [Strategic Review of Spectrum Pricing](#) we referred to AIPs.

¹³ Prior to this, substantially lower fees applied, which were not based on market value.

¹⁴ Ofcom's [Communications Market Report 2023](#).

¹⁵ These are 900 MHz and 1800 MHz fees as invoiced in October 2023. 2100 MHz fees are estimated based on October 2023 Consumer Price Index ("CPI"), subject to CPI variance in November 2023, to be invoiced in January 2024.

This review

- 2.13 At the Government's request, we have undertaken a review of the approach we have taken to date in allocating mobile spectrum licences and setting the related fees, considering the potential alternatives and international experience, as well as any other relevant factors.
- 2.14 We recognise that all approaches to managing the continued efficient allocation of spectrum involve trade-offs, with each alternative having its own advantages and challenges. Consequently, our review considers whether any relevant factors suggest that, as a matter of principle, the balance of trade offs implied by our current mobile spectrum policy needs to be revisited either in terms of our overall approach, or the implementation of our current policy.
- 2.15 In undertaking this review, we have considered a broad range of information including: the potential alternatives and international experience in allocating and charging for mobile spectrum, our past ALF decisions and historical spectrum trades as well as responses to the related consultations. We have had regard to emerging approaches in allocating and charging for spectrum, third party international spectrum data, as well as any other factors that might suggest a case for revisiting our approach. We have also spoken to the mobile operators and reviewed submissions from them and their advisors discussing these issues. This is in addition to reviewing research by Analysys Mason on behalf of the Spectrum Policy Forum.¹⁶
- 2.16 In the remainder of this document, we set out in more detail how we currently approach licence fees for mobile spectrum, the possible alternative approaches we could take to securing the efficient use of spectrum, including those taken by other countries, and our views on the advantages and limitations of the different approaches available. This analysis is accompanied by annexes on: an overview of our approach to setting fees including the use of CPI to adjust ALFs for inflation (Annex 1); alternatives to indefinite licences with ALFs after initial term – international examples (annex 2)¹⁷; evidence on UK investment levels compared to international comparators (Annex 3) and key themes that were raised in stakeholder submissions in the course of our review (Annex 4)¹⁸.
- 2.17 We have not, as part of this review, assessed the specific levels of the ALFs we currently charge because there is an existing, separate, process for doing this. We will review ALFs if we judge that there is sufficient evidence of a material misalignment between our fees and the underlying market value of the relevant spectrum.

¹⁶ Analysys Mason, [Review of market mechanisms as applied to mobile spectrum in the UK](#), November 2022.

¹⁷ Annex 2 describes the approaches taken to securing the efficient allocation of spectrum in other countries. While we have taken account of these approaches in undertaking our review, there are limitations to the conclusions that can be drawn from these approaches. This is because drawing clear links between the approach taken in a particular country and the corresponding market outcomes is inherently difficult.

¹⁸ We engaged with mobile network operators as part of our review. While many of these comments concerned issues outside the scope of our review, we set out our initial response to the key issues raised in Annex 4.

3. Options for ensuring an efficient allocation of spectrum

Ofcom's current approach: auctions of indefinite licences with ALFs

- 3.1 In the previous section, we discussed our approach to using auctions of indefinite licences with ALFs. Here we summarise the benefits and limitations of this approach.
- 3.2 There are several important benefits to our approach:
- a) *Efficient allocation.* The combination of auctions of indefinite licences and ALFs after the initial term help to ensure that spectrum is allocated efficiently. ALFs set at the opportunity cost of the spectrum give licensees who are not the highest value user the incentive to relinquish some or all of their spectrum holdings, which can then be made available to the highest-value user. Relying on market-based approaches, such as auctions and ALFs, means that Ofcom is not required to 'choose winners'.
 - b) *Efficient investment.* ALFs encourage licensees to make efficient investment decisions, for example in considering the trade-off between their levels of spectrum holdings and their network investments.
- 3.3 An example of this approach working effectively is Arqiva's national 28 GHz spectrum licence. Earlier this year Arqiva returned most of its 28 GHz national licence in anticipation of the introduction of AIPs to the band.¹⁹ We are now considering the optimal use of the spectrum, including for additional satellite gateways.²⁰ In this case, AIPs incentivised the return of spectrum that was being underutilised and can now be made available for new uses.
- 3.4 Whilst indefinite licences with ALFs are an important part of our spectrum management policy, they have limitations:
- a) ALFs are intended to replicate the price signal that MNOs would receive in a well-functioning market. Therefore, setting ALFs inherently requires Ofcom to exercise judgement in light of our statutory duties, using several benchmarks (none of which is perfect), and taking evidence in the round. This means we have to balance the risk of spectrum inefficiency from either:
 - i) setting ALFs above market value, resulting in licensees returning their licences or part of their licences despite being the highest value user of the spectrum, or
 - ii) setting ALFs below market value, resulting in licences being retained by licensees who are not the highest value users of the relevant spectrum.

¹⁹ Ofcom, [Amending Arqiva's 28 GHz spectrum access licence](#), March 2023.

²⁰ Ofcom, [Expanding spectrum access for satellite gateways in the 28 GHz band](#), August 2023.

In exercising our discretion in light of our statutory duties, considering the potential impact of setting fee levels, we have generally placed more weight on the former of these risks than the latter, and accordingly have tended to set ALFs conservatively.²¹

- b) New auction data from UK and international auctions is becoming increasingly rare, making it challenging to set the initial levels of new ALFs. Data limitations can potentially exacerbate the issues described in paragraph 3.4a). However, this risk may not materialise in practice, as we expect the next major ALFs to be set by Ofcom will be for the 800 MHz and 2.6 GHz bands in 2033.

3.5 There are additional criticisms of indefinite licences with ALFs which we believe have less merit:

- a) ALFs may be unnecessary because an efficient allocation can be achieved through trading.
- b) ALFs could be a barrier to MNOs trading spectrum.
- c) ALF levels could be 'too high' and have decoupled from the market value of the spectrum.

3.6 In principle, a dynamic market for spectrum would reveal the opportunity cost of spectrum and could potentially remove the need for ALFs. However, experience in the UK and internationally is that a dynamic market has not emerged and in practice trading has been limited. There are several reasons why this is the case, some of which may be specific to the spectrum being licensed.²² There are two general reasons we believe are particularly important:

- a) Firstly, a licensee may be reluctant to trade because indefinite spectrum licences can have a high option value relative to the income from a trade. That is, the licence holder would need to be willing to accept a one-off payment in return for giving up the right to use or trade the spectrum at any point during the remaining 'indefinite' life of the licence. The 'indefinite' nature of the licence, and the potential that it may increase in value over time, means the value of the option could be higher than the income from the one-off payment in many cases.
- b) Secondly, in a mobile spectrum licence trade, the licensee typically needs to be willing to trade the licence to a direct competitor. In some circumstances, the spectre of increasing a competitor's potential capability (e.g. coverage or capacity) and therefore ability to win market share is likely to be unattractive to the licensee. This could weaken a licensee's incentive to trade.

3.7 We have also considered whether ALFs, in themselves, may be a barrier to trading. This could be because a potential acquirer considers the level of future ALFs to be uncertain²³ or because the cost of ALFs, in themselves, eliminate the gains from trade. In light of UK and

²¹ By conservatively, we mean that, in light of uncertainty about the 'true' market value of spectrum, we have set fees lower than our central estimate of the spectrum's value.

²² For example, the transaction costs and managerial effort involved in trading small spectrum holdings, even when the spectrum has no current or future use for the licensee, may outweigh the benefits of a trade.

²³ The future levels of ALFs may be said to be uncertain because they are inflation-linked and the future path of inflation is uncertain. However, firms throughout the economy, including MNOs, manage inflation risk in the ordinary course of business and there is nothing unusual about how inflation is applied to ALFs. Inflation-linking therefore does not appear to create a risk which MNOs should find challenging to manage as part of their business activities.

international experience, it is hard to place much weight on this argument: despite the multiple different approaches to spectrum management and fees policy used internationally, we are not aware of any country where a dynamic spectrum trading market has emerged.²⁴ Indeed, other than like-for-like spectrum swaps²⁵, there has only ever been one mobile spectrum trade in the UK despite most mobile spectrum not currently being subject to ALFs.²⁶

- 3.8 A final potential limitation of ALFs we have considered is whether ALFs have evolved to be ‘too high’ and therefore no longer reflect the market value of the underlying spectrum such that we should review the levels of ALFs. However, there is a separate process to review the level of ALFs if we consider there is sufficient evidence that there is a material misalignment between ALFs and the underlying market value. Mobile operators can submit this kind of evidence and request a review, if they consider there is a case for revising the fees.

Auctions of ‘indefinite’ licences with licence obligations

- 3.9 In a small number of jurisdictions, for example France and Portugal, the regulator has awarded mobile spectrum with an indefinite licence term and no direct fee.²⁷ Instead, the licensee is subject to obligations, such as coverage or other investment commitments, as part of its licence. In some of these countries, obligations have been set at the start of the licence with renewal subject to confirmation that the obligations are still being met.²⁸ In other countries²⁹, obligations have been set at the end of the initial period with renewal conditional on the licensee agreeing to meet the obligations.
- 3.10 The on-going costs of meeting licence obligations means that spectrum is not being made available to MNOs ‘free-of-charge’. Instead, fees are replaced with indirect costs i.e. the costs of investment.
- 3.11 An advantage of this approach is that policy objectives relating to investment or innovation can be achieved through including them in licence obligations. In principle, a well-functioning market should lead to investment and innovation being delivered at the socially optimal level. However, licence obligations may be regarded as a potentially useful tool for Government when, for example, it believes that there is a market failure which has led to under-investment or that there are wider social benefits from investment which are not captured by market values.

²⁴ Our analysis of international trades excludes transfers through acquisition of a mobile network operator, divestment of spectrum as a merger condition by the relevant regulator, and sale of spectrum by a firm which is not a mobile operator.

²⁵ These kinds of swaps cannot be impacted by the level of ALFs or the uncertainty about the future levels of ALFs because all spectrum involved in the trade would be subject to ALFs.

²⁶ BT/EE’s sale of 25 MHz of 2.6 GHz spectrum to VMO2 in 2020.

²⁷ In some of these cases the licence is fixed term but the licence has been extended in return for coverage obligations, and the licensee may have an expectation that its licence will continue to be renewed over time.

²⁸ This is the case for some spectrum licences in the USA, albeit the licences are fixed term, require that the spectrum continue to be used, and have a presumption of renewal. See Section II.A of report in [FCC Reforms License Renewal Rules for Wireless Spectrum](#), 2017.

²⁹ See examples for [France](#) and [Portugal](#).

- 3.12 However, auctions of ‘indefinite’ licences with licence obligations after the initial term have limitations:
- a) Firstly, because this approach is led by policy objectives rather than market forces, the impact of this approach on achieving an efficient allocation of spectrum is difficult to establish. In addition, it can potentially create distortions in the market if the cost of meeting the obligations varies across MNOs because of the nature of their spectrum holdings.³⁰
 - b) Secondly, monitoring whether licensees have met their allocations can be resource-intensive and costly.
 - c) Thirdly, setting the obligations requires a significant degree of judgement to decide on the nature of the obligation and the ‘right’ level of investment or coverage. This can be challenging because regulated firms may have more and better information about the costs of meeting obligations than the regulator/government. Moreover, because obligations are often time-limited, the regulator/government will need to repeatedly make this judgement over time. When a regulator/government makes these kinds of decisions repeatedly over time, the regulatory regime moves closer to ‘command and control’, and the likelihood of an efficient allocation decreases accordingly.
- 3.13 Overall, whilst we see the potential benefits of this approach, a key limitation is that it is less likely than a market-based approach to result in an efficient allocation of spectrum. If the policy objective is to promote investment or innovation above the level that the market will deliver, we suggest that Government is better placed to address the potential market failures that might have led to this outcome (for example through an investment fund or other subsidy). This way the efficient allocation of spectrum (achieved through market mechanisms, such as auctions with indefinite licences and ALFs) could be decoupled from these public policy objectives. We believe that variations on this approach suffer similar limitations – for example, a discounted ALF dependent on the licensee meeting investment or coverage obligations would not provide a price signal at the level necessary to ensure an efficient allocation of spectrum.
- 3.14 Analysys Mason/Oxera, in their report to DCMS as part of the WIS, proposed an approach to addressing potential undersupply of investment.³¹ They suggested that the Government could use ALF receipts to promote investment through an investment fund. The use of ALF receipts is, of course, a matter for Government rather than Ofcom. However, if Government considers it appropriate to devote some or all of its ALF receipts to supporting network investment, we consider that doing so via a standalone fund would be preferable to replacing ALFs with obligations.

³⁰ For example, MNOs with larger holdings of lower frequency spectrum – which travels further because of its physical properties - may find it less costly to meet coverage obligations.

³¹ Analysys Mason and Oxera, [Ensuring future wireless connectivity needs are met – final report for DCMS](#), May 2022.

Fixed term licences with reallocation

- 3.15 Another option is to award mobile spectrum licences with a fixed term and reallocate the spectrum at the end of the term. This approach is used in many jurisdictions. Indeed, it was obligatory for the German regulator to take this approach up until recently.³²
- 3.16 This approach has several benefits. Fixed term licences are particularly beneficial when a spectrum band's future most efficient user or use-case is uncertain. This is because the spectrum can be reallocated at the end of the term (e.g. by re-auction) to ensure the spectrum remains efficiently allocated.³³ An additional benefit is that the reallocation at the end of the term does not involve judgement on the part of the regulator to set a fee, particularly if the regulator decides to reallocate the spectrum by auction.
- 3.17 With that said, fixed term licences are not without their challenges. Primary amongst these is that the regulator needs to apply its judgement to decide on the duration of the licence term. This is a challenging exercise. It involves weighing the risk that the licence term is 'too long' and therefore reallocation to the efficient user is not timely, on the one hand, against the amount of time needed by the licensee to ensure it can recoup its investments, on the other. In practice this risk may be limited: research recently commissioned and published by Ofcom was unable to find evidence that longer duration licences lead to higher levels of investment, based on a cross-country analysis.³⁴
- 3.18 On balance, our view is that there are merits to fixed term licences with reallocation and that in some circumstances these can outweigh the limitations. We are planning to use this approach for the first time in our mmWave award.
- 3.19 We have chosen fixed term licences with reallocation for the mmWave award because of the uncertainty about the requirements for future use cases of this spectrum. This uncertainty means there is a risk that the initial allocation of licences (which will allow use of the spectrum in cities and high-density areas) may not reflect the most efficient allocation of mmWave spectrum in the longer term and could prevent investment by more efficient users. A fixed term licence will also give Ofcom the opportunity to review the balance of spectrum between citywide and shared access licences at the end of the licence term. This review will help secure an optimal reallocation of the spectrum and potentially provide an opportunity for market entry.

Other approaches

- 3.20 We have also previously considered alternative market-based tools which may be relevant to spectrum management, and remain open to the potential use of such tools in future. Examples include: reverse or incentive auctions, in which licence holders are given the opportunity to relinquish their licences in exchange for a payment which is determined by an

³²The new [Telecommunications Act](#) (see sections 92 and 99) in Germany allows Bnetza to carry out an administrative renewal of spectrum as long as it considers that there is no excess demand. For example, if a deviation from the current assignment would be unlikely if an auction took place.

³³ For example, by the time the fixed term has expired the band may be internationally harmonised for a different use and this alternative use may then be the socially optimal use for the band.

³⁴ CRA on behalf of Ofcom, [Spectrum Licence Duration and Capital Investment: An empirical assessment](#), February 2023.

auction; depreciating licences, where a licensee declares a price at which it would sell its spectrum rights and pays fees based on a percentage of this price; foothold auctions, where a licence is reaucted but the existing licensee is given an advantage in the auction and compensation if it is outbid; and congestion triggers, where market-based licence fees only apply when a particular measure of excess demand for the spectrum is met.³⁵

- 3.21 In our view, while these alternative tools have some advantages over existing tools, some are untested (e.g. depreciating licences) and others are only beneficial in certain circumstances (e.g. incentive auctions). They may therefore be applicable after more research and testing has been done, or when the right circumstances emerge. We would encourage stakeholders to engage with us about their views of the merits of these approaches. We also note that some of these options would require legislative change before they could be used in the UK.

Conclusion

- 3.22 In summary, all approaches to managing the continued efficient allocation of spectrum involve trade-offs, with each alternative having its own advantages and challenges that we consider, through consultation with stakeholders, in the run up to deciding on the approach.
- 3.23 Whilst allocating spectrum using auctions of indefinite licences with ALFs requires the availability of sufficient benchmarks to set fees and the application of regulatory judgement, we continue to believe that it is a valuable part of our spectrum management toolkit. We retain an open mind, however, on the best way to secure the optimal allocation of spectrum on a case-by-case basis. This means that we are prepared to use alternative approaches, for example, for our next award (for mmWave spectrum) we will auction fixed term licences.
- 3.24 We note that historically MNOs and other commercial mobile spectrum users in the UK have not been in favour of alternatives to ALFs (deployment or investment obligations and/or fixed term licences), albeit we understand that there is currently some support for an investment fund.³⁶

³⁵ See paragraph 7.24 of Ofcom, [Supporting the UK's wireless future](#), Consultation, December 2020.

³⁶ Such as the fund set out in: Analysys Mason/Oxera report, [Ensuring future wireless connectivity needs are met – final report for DCMS](#), May 2022

A1. Approach to setting ALFs in previous decisions

Introduction

- A1.1 This annex provides background on some aspects of our approach to setting ALFs in previous decisions. We begin by briefly describing our overall approach, particularly as we applied this to the most recent ALF decision on 2100 MHz spectrum. Next, we describe:
- a) How ALFs have been set conservatively.
 - b) How we have accounted for possible changes in spectrum value following auctions.
 - c) Our use of CPI inflation.

Summary of our overall approach

- A1.2 We have set fees for three mobile spectrum bands, 900/1800/2100 MHz. To do so, we considered the evidence on the market value of mobile spectrum determined via auctions in the UK, alongside international evidence. It is worth noting that the sums bid at auction represent a long-term valuation of the spectrum across the initial term (usually 20 years) of the licence. Our objective in setting fees based on auction evidence is to determine an equivalent long-term value in the absence of an award, which is then annualised as the fee. It is not therefore necessarily appropriate to frequently revisit the fee due simply to the passage of time.
- A1.3 Our approach to date in determining the ALF can be summarised as follows:
- a) We estimate the lump-sum market value of UK spectrum bands that have been auctioned in recent years.
 - b) We consider auction prices for bands in European countries, from which we derive the relative value, to the UK, of the spectrum in these benchmark countries. We use these relative values, in combination with our estimates of the UK market value to derive a set of benchmarks for the lump-sum market value in the UK.
 - c) We assess this benchmark evidence to reach a view on the lump-sum market value of the UK spectrum.
 - d) To convert the lump-sum value into an equivalent annual payment, we apply an annualisation rate, derived from a post-tax discount rate (which takes into account the degree of risk-sharing between licensees and the Government) and a tax adjustment factor (reflecting the more favourable tax treatment of annual fees compared to lump sum auction payments).
 - e) Next we consider, in light of our statutory duties, what the likely impact of setting fees at that level would be, and whether, as a consequence of that assessment, there is any reason for us to set fees at a different level.
- A1.4 When we set ALFs for 900 MHz and 1800 MHz spectrum in 2018, neither of those bands had been auctioned in the UK. We therefore used the results of the 2013 UK auction of 800 MHz and 2.6 GHz spectrum, alongside the results of auctions involving 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz spectrum in other European countries, to derive our estimates of the value of these bands.

A1.5 The 2100 MHz spectrum was auctioned in the UK in 2000 and we did not think it appropriate to use this 20-year-old auction result to inform our forward-looking view of the market value of this spectrum. As there was no directly relevant UK auction evidence since 2000 to inform the market value of the 2100 MHz spectrum, we again used the results of recent UK auctions of mobile spectrum in other bands alongside other relevant evidence, including the results of auctions in other European countries (in each case, where available).

Considering recent UK awards when setting fees - 2100 MHz example

A1.6 The table below illustrates that there can be significant variation in the prices bid for similar spectrum bands, reflecting the fact that auction values are in practice affected to a significant extent by factors specific to the particular award, market developments and timing. This feature in turn illustrates the complexity of the challenge we have in determining the appropriate market value for spectrum, and the fact there is no one "correct" value that can be mechanically derived from the data we have.³⁷

Auction prices from recent UK mobile spectrum awards (April 2021 prices)

Spectrum band	Auction date	Price (per MHz)
700 MHz	March 2021	£14.1m
800 MHz	March 2013	£37.0m
2.3 GHz	April 2018	£5.4m
2.6 GHz	March 2013	£6.2m
3.4 GHz	April 2018	£7.9m
3.6 GHz	March 2021	£4.2m

How did the UK evidence inform our assessment?

A1.7 Notwithstanding the significant price variation for similar mobile spectrum bands, the UK auction results above indicate that sub-1 GHz spectrum is more highly valued than higher-frequency spectrum. In setting 2100 MHz fees we included all the above evidence noting however that:

- a) We did not think it appropriate for the value for the higher-frequency spectrum to have a strong influence on the resulting value we set for 2100 MHz - given that the latter is a mainstream coverage band; we recognised it is more similar to the lower frequency spectrum used for coverage and should be influenced to a greater extent by the value of spectrum at this end of the range.
- b) Although the prices bid in the 3 GHz band were lower for the later award, we considered, in these particular circumstances, that both awards provided relevant

³⁷ For comparison (also in April 2021 prices), we set ALFs of £19.8m/MHz for 900 MHz spectrum (£19m/MHz in 2018 prices), £14.6m/MHz for 1800 MHz prices (£14m/MHz in 2018 prices) and £10.5m/MHz for paired 2100 MHz spectrum – see paragraphs 4.9 and 4.95 of Ofcom, [Annual Licence Fees for 2100 MHz Spectrum](#), December 2021.

evidence ie the later award did not supersede the earlier award in terms of value of the band and we placed equal weight on both outcomes.

A1.8 At this stage of our evaluation, we concluded that the value of the 2100 MHz spectrum would lie somewhere between the value of the higher frequency spectrum bands and sub-1 GHz spectrum - that is, somewhere between £4.2m per MHz and £37.0m per MHz. We also considered it unlikely to be valued at significantly more than the lowest value sub-1 GHz auction price (£14.1m per MHz) and unlikely to be valued at significantly less than the highest value higher frequency band auction price (£7.9m per MHz). We also expected the value of the paired 2100 MHz spectrum to be relatively close to the value of the 1800 MHz spectrum given both bands are mainstream coverage bands with similar propagation characteristics and established equipment ecosystem.

International evidence

A1.9 We identified European countries where their auctions provided potentially useful information on the relative value of the different spectrum bands to help inform our view on where the value of the 2100 MHz was likely to sit relative to spectrum bands which had been auctioned in the UK.

A1.10 Consistent with our approach in 900 MHz and 1800 MHz ALFs, we categorised these benchmarks into three tiers. These categorisations reflect how informative of relative UK market values we considered them to be, with Tier 1 the most informative and Tier 3 the least informative.

A1.11 Our criteria for placing a relative benchmark in Tier 1 were that:

- a) the auction prices appear likely to have been primarily determined by a market-driven process of bidding in the auctions (generally this means the prices were not set by reserve prices);
- b) based on the evidence available to us, the relative prices in the auction are at least as likely to be based on bidders' intrinsic valuations of spectrum as on strategic bidding; and
- c) the outcome appears likely to be informative of forward-looking relative spectrum values in the UK, having regard to country-specific circumstances and auction dates.

Finalising the fee

A1.12 Looking at all the estimates we had, we noted that 10 of the 17 benchmarks were between £9.6m per MHz and £14.3m per MHz. The four benchmarks below £9.6m per MHz were all benchmarks which use the UK 3.6 GHz auction results, and the corresponding benchmarks using the UK 3.4 GHz auction results were between £9.9m and £11m per MHz. We considered both sets of these results to be informative, but we were cautious about placing significant weight on either set of values in isolation.

A1.13 We therefore considered that the value should be above £9.6m per MHz. We considered that a value below that level would be an overly conservative interpretation of the evidence and would involve putting undue weight on some of the benchmarks using the UK 3.6 GHz auction results. We did not consider that a value above £14m per MHz would be appropriate given the risk of overstatement of the six benchmarks above £14m per MHz and we considered this would be inconsistent with taking a conservative approach to interpreting the evidence. We also did not consider that the data provided a strong reason to suggest the

value should be above the average of our Tier 1 benchmarks, particularly in light of our conservative approach to interpreting the evidence. The average of the Tier 1 benchmarks was £11.2m. However, we also did not consider it appropriate to go too far below the average given the number of benchmarks we have and that a significant number point to a value above the average. Taking account of the evidence from the UK and international relative benchmarks, we concluded that a lump-sum market value estimate of the 2100 MHz spectrum of £10.5m per MHz (in April 2021 prices) was appropriate.

Setting ALFs conservatively

A1.14 Our Spectrum Pricing policy is to set licence fees on the basis of opportunity cost (or equivalently market value) where there is excess demand for the spectrum. However, where there is uncertainty in our estimate of opportunity cost, we consider the risks from setting fees too high, or too low, in light of the specific circumstances.³⁸

A1.15 Setting ALFs entails applying our regulatory judgement to the available evidence in each specific case. In setting ALFs for 900 MHz and 1800 MHz spectrum³⁹ we adopted a conservative approach in adopting the evidence. This was for the following key reasons:

- a) *“Asymmetry of risk as between the effects on spectrum efficiency from inadvertently setting ALFs either above or below market value, given the uncertainty about the correct estimates for market value.*
- b) *“Possibility that forward-looking market values today could be lower than at the time of the auctions from which we derive our key evidence, due to greater certainty of future availability of mobile spectrum, compared to expectations at the time of the 4G auction.”*

A1.16 We described our conservative approach as follows:⁴⁰

“Where there are alternative approaches to interpreting the available evidence that we consider could be appropriate for the purpose of deriving revised ALFs that reflect full market value, we have taken into account whether the alternative approaches are more likely to understate full market value or to overstate it. We have generally preferred approaches which we consider are more likely to understate full market value than to overstate it, where such a choice arises.”

A1.17 The estimated ALFs for 900 MHz and 1800 MHz spectrum were informed by the auction prices of 800 MHz spectrum.⁴¹ We identified a number of reasons why our estimate of this auction price was conservative – i.e. was more likely to understate market value than to overstate it.⁴² In addition, we took a conservative approach to interpreting the benchmarks which we derived from auction prices. In particular:

³⁸ See Paragraph 1.9 and page 4 of Ofcom, [SRSP: The revised Framework](#), December 2010.

³⁹ See paragraphs 1.37 to 1.43 of Ofcom, [Annual licence fees for 900 MHz and 1800 MHz spectrum](#), September 2015.

⁴⁰ Paragraph 1.42 of Ofcom, [Annual licence fees for 900 MHz and 1800 MHz spectrum](#), September 2015.

⁴¹ And, in the case of 1800 MHz ALFs, also of 2.6 GHz spectrum.

⁴² See paragraph 2.205 of Ofcom, [Annual licence fees for 900 MHz and 1800 MHz spectrum](#), September 2015.

- a) We identified a lump sum value of £18m per MHz for 900 MHz spectrum.⁴³ We commented⁴⁴ that: *“In particular, we consider this estimate is conservative because (a) it is below the average of Tier 1 benchmarks [which was £21.8m per MHz i.e. around 20% higher than our estimate], (b) it is below both Tier 2 benchmarks, and (c) it is below all but one of the Tier 1 and Tier 2 benchmarks.”*
- b) In the case of 1800 MHz spectrum, we noted⁴⁵ that: *“In light of our view that we should adopt a conservative approach to interpreting the evidence, and the risk of overstatement in three of the seven benchmarks, we consider that in looking at the Tier 1 benchmarks alone an appropriate estimate of UK market value would be between the average (£18.3m per MHz) and the lowest of these seven benchmarks (i.e. Italy at £13.2m per MHz). The midpoint between these two values is £15.7m per MHz.”* In view of additional reasons for taking a conservative approach, we identified a lump-sum value of £14m per MHz – in this case the average of our “Tier 1” benchmarks was 30% higher than our preferred estimate.

A1.18 In our 2100 MHz statement, we also adopted a conservative approach to estimating market value, in light of the asymmetry of risk between setting ALFs too low vs too high.⁴⁶

A1.19 In applying our conservative approach in this case, we considered that the value should be above the average of our Tier 1 benchmarks (which was £11.2m per MHz). However we also did not consider it appropriate to be too far below the average, given the number of benchmarks we had, and that a significant number pointed to a value above the average. On this basis we estimated the value as £10.5m per MHz.⁴⁷

Changes in market conditions following auctions

A1.20 In setting ALFs we have considered whether the auction prices used in our lump-sum value estimates continue to reflect the current value of the spectrum concerned and engaged with stakeholder submissions on this question.

A1.21 Our decision on ALFs for 900 MHz and 1800 MHz spectrum (published in 2018) considered evidence as to whether the value of mobile spectrum had changed since the auction of 800 MHz and 2.6 GHz spectrum in 2013. Our view was that these lump-sum values should be held constant in real (inflation-adjusted) terms. This view was informed by data on mobile revenues, profits (EBITDA) and mobile contract price rises over the intervening period. In particular we noted⁴⁸ that:

“We remain of the view that 800 MHz and 2.6 GHz lump-sum values should be maintained constant in real terms (i.e. increase in line with inflation). First, we note that mobile revenues have been broadly flat in real terms, although there was a small decline from 2013 to 2014 (see Figure A3.3 for more details). Second, MNO profits are likely to be a better indicator of value for mobile spectrum licences than

⁴³ This estimate was not revised between our 2015 decision and our 2018 decision, except that it was adjusted for inflation from £18m to £19m in 2018 prices.

⁴⁴ Paragraph 5.45 Ofcom, [Annual licence fees for 900 MHz and 1800 MHz spectrum](#), September 2015.

⁴⁵ Paragraph 4.63, Ofcom [Annual Licence Fees for 900 MHz and 1800 MHz frequency bands](#), December 2018.

⁴⁶ Paragraph 4.68 and footnote 65 of Ofcom, [Annual Licence Fees for 2100 MHz Spectrum](#), December 2021.

⁴⁷ Paragraphs 4.94 and 4.95 of Ofcom, [Annual Licence Fees for 2100 MHz Spectrum](#), December 2021.

⁴⁸ Paragraphs 4.17 and 4.18 of Ofcom, [Annual Licence Fees for 900 MHz and 1800 MHz frequency bands](#), December 2018.

revenue and, as shown in section 5, real EBITDA for the 4 MNOs was at least as high in 2017 as in 2013.[...] Third, all four MNOs use a measure of inflation to increase contract prices each year and do so by reference to RPI [...], which has exceeded CPI in each year over the period 2013 to 2018.[...]

We recognise that stakeholders have argued that the real value of spectrum has fallen over time. We have assessed the impact of technical and commercial developments on real spectrum values in Annex 3. Where we consider that specific developments since 2015 may have affected the market value of spectrum, we have taken account of them in our overall interpretation of the benchmarking evidence below. We consider this approach is more appropriate than holding values constant in 2013 nominal terms, which would constitute a largely arbitrary real terms adjustment that is unlikely accurately to reflect the magnitude of market developments". Our 2021 decision on ALFs in the 2100 MHz band noted that this band had been subject to an auction in 2000. However, our view was that it would not be appropriate to use the results of this auction in setting ALFs.⁴⁹ Rather, we considered that auction prices from three recent mobile awards were relevant evidence for determining the market value of 2100 MHz spectrum. Those awards took place in 2013 (800 MHz and 2.6 GHz), April 2018 (2.3 GHz and 3.4 GHz) and 2021 (700 MHz and 3.6 GHz).⁵⁰ The spectrum prices for these auctions were inflation-adjusted to 2021 prices.

- A1.22 We considered whether we should put more weight on the results of more recent auctions, particularly in light of the fact that the value of 3.6 GHz spectrum in the 2021 auction was considerably lower (£4.2m per MHz) than the value of 3.4 GHz spectrum in the 2018 auction (£7.9m per MHz). We did not consider that there was strong evidence to suggest that the long-term value of the 3.4-3.8 GHz band changed between the two auctions such that the more recent auction should be presumed to be more informative. As a result we placed equal weight on both auction outcomes when making our assessment.⁵¹
- A1.23 We also considered submissions from Frontier Economics that in general more weight should be given to more recent auctions. However, we remained of the view that older auctions were informative of forward-looking market value.⁵² We noted that none of the MNOs had raised concerns about including auctions from before 2015 in the evidence base we used to derive lump-sum values.⁵³

Use of CPI inflation

- A1.24 Our approach to setting ALFs for the 900 MHz, 1800 MHz and 2100 MHz bands was to calculate the lump-sum value of spectrum based on auction evidence, convert those lump-sum estimates into an annual payment, and adjust for inflation using the Consumer Prices Index ("CPI").⁵⁴ The CPI adjustment makes the fees constant in real terms, i.e. it takes account of changes in the economy-wide value of money over time. The CPI adjustment is

⁴⁹ See paragraph 3.22 and footnote 59 of Ofcom, [Annual Licence Fees for 2100 MHz Spectrum](#), December 2021.

⁵⁰ Paragraph 4.7 and Table 4.1 of Ofcom, [Annual Licence Fees for 2100 MHz Spectrum](#), December 2021.

⁵¹ Paragraphs 4.12 to 4.18 of Ofcom, [Annual Licence Fees for 2100 MHz Spectrum](#), December 2021.

⁵² Paragraph 4.61 of Ofcom, [Annual Licence Fees for 2100 MHz Spectrum](#), December 2021.

⁵³ Paragraph 4.63 of Ofcom, [Annual Licence Fees for 2100 MHz Spectrum](#), December 2021.

⁵⁴ See, for example, paragraphs 4.73 to 4.83 of Ofcom, [Annual Licence Fees for 900 MHz and 1800 MHz frequency bands](#), December 2018

not designed to make the ALF payments cash-neutral for MNOs – i.e. it is not intended to track increases or decreases in their revenues over time.

- A1.25 We have consulted extensively with stakeholders regarding our approach to annualising lump-sum estimates of the value of spectrum in order to derive ALFs.
- A1.26 In consultation responses on 900 MHz and 1800 MHz, stakeholders supported the use of CPI inflation rather than (higher) Retail Price Index inflation.^{55,56}
- A1.27 As noted above, when setting ALFs for 900 MHz and 1800 MHz spectrum in 2018, we decided that it was appropriate to base these on 2013 auction prices, inflated by CPI to 2018 prices. Our view was informed by our understanding of market developments since 2013, and also by the fact that MNOs had used an inflation measure (RPI) to increase customer contract prices each year, which was above CPI inflation. We note that all four MNOs increased in-contract prices above inflation (either by CPI+3.9% or RPI+3.9%) in April 2023.
- A1.28 More generally, in setting ALFs our aim is to put the ALF-payer in an equivalent position to someone paying the lump sum value at auction. As we noted in our decision on ALFs for 900 MHz and 1800 MHz spectrum:⁵⁷

“...in spreading a lump sum over a 20-year period, we use a discount rate at which the present value of the resulting payment stream equals our estimate of the lump-sum value today. An appropriate discount rate depends on, among other things, the uncertainty associated with this future ALF payment stream. One significant uncertainty relates to how changes in the market value of the spectrum over time are reflected in the ALFs. The discount rate which will leave MNOs indifferent between paying ALF 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 on ALFs, and, therefore, it is an important consideration in determining an appropriate discount rate.

- A1.29 An auction winner has the advantage that its payment, being one-off, is not subject to the risk of higher ALFs in future, whether because of inflation or because of a re-assessment of market values of ALF. As noted above, the discount rate we applied to ALFs takes account of uncertainty as to the future value of ALFs.

⁵⁵ See, for example, paragraph 9 of Ofcom, [Annual licence fees for 900 MHz and 1800 MHz spectrum](#), September 2015

⁵⁶ RPI is no longer classified as a national statistic. See Commons Library, [Economic indicators – B1: Inflation](#), November 2023.

⁵⁷ Annex A5.7. [Annual Licence Fees for 900 MHz and 1800 MHz frequency bands: Annexes](#), December 2021.

A2. Alternatives to indefinite licences with ALFs after initial term – international examples

Introduction

- A2.1 This annex considers the pros and cons of alternative approaches to mobile spectrum management. It notes international examples of each approach (where we have identified such examples), and also examples of the UK adopting elements of these approaches in the past.

Alternative approaches

Approach	Pros and Cons	International examples	Related UK examples
Indefinite licences with obligations after the initial term			
<p>1. <i>Abolish ALFs; licences subject to investment commitments or other licence obligation after initial term</i></p>	<p>Pros:</p> <ul style="list-style-type: none"> Investment commitments can be targeted to specific policy priorities, such as 5G standalone (“5G SA”). <p>Cons:</p> <ul style="list-style-type: none"> Complexity of pursuing two policy goals (efficient spectrum holdings and investment) with the same tool. Operator who can easily meet investment commitments may have less incentive to hold spectrum efficiently. Promoting additional investment may not always be efficient (e.g. at end of investment cycle / new technology fully rolled out) – could lead to gold-plating of investment. 	<ul style="list-style-type: none"> France set out to improve coverage and offered renewal in exchange for investment commitments (900 MHz, 1800 MHz and 2.1 GHz, licences renewed in 2018). Portugal has an established mechanism to identify gaps in coverage and traditionally addresses them through conditions for spectrum renewals, e.g. offered renewal in exchange for investment commitments (900 MHz and 1800 MHz licences of two MNOs renewed in 2021). US “safe harbour” – i.e. some licences are renewed as long as licence conditions have been met and spectrum remains in use. US has had faster deployment of 5G SA and faster take-up of 5G, but there may be other reasons for this. No evidence of an effective secondary market for mobile spectrum in the US – we have seen only three trades between mobile operators, of regional licences. 	<p>Ofcom has used/considered licence obligations in the past:</p> <ul style="list-style-type: none"> In 2012, Ofcom awarded a 2x10 block of 800 MHz spectrum with a coverage obligation. In 2014, after DCMS reached an agreement with MNOs to improve mobile coverage, Ofcom agreed to extend its timeline for reaching a final decision on revised ALFs by four to seven months. In 2020, Ofcom considered adding coverage obligations to licences in the award of 700 MHz and 3.6-3.8 GHz spectrum, but these proposals prompted MNOs to propose more comprehensive coverage obligations through the Shared Rural Network (“SRN”) agreement, which we agreed would be more comprehensive than our proposals.

Approach	Pros and Cons	International examples	Related UK examples
<p><i>2. Discounts or rebates on ALF payments in return for meeting investment targets</i></p>	<p>Pros:</p> <ul style="list-style-type: none"> • Targeted increases in investment on policy priorities (e.g. on 5G SA) <p>Cons:</p> <ul style="list-style-type: none"> • Complexity and risk of insufficient incentive to hold spectrum efficiently (as above). • Promoting additional investment may not always be efficient. If at some point there were no longer a public policy case for incentivising investment through ALF discounts or rebates firms would effectively revert to paying ALF at full market value. 	<ul style="list-style-type: none"> • In Czech Republic government/NRA wanted to ensure continuity of the 2G network and extended 2.1 GHz licences with a discount that took into account the cost of maintaining the 2G network operational until 2028. 	<p>See above.</p>
<p><i>3. ALFs at full value with an industry investment fund managed by DSIT</i></p>	<p>Pros:</p> <ul style="list-style-type: none"> • ALFs used to promote optimal use of spectrum, rather than pursuing multiple objectives. • Investment commitments can be targeted to specific policy priorities, such as 5G SA. • Firms compete for funds based on their ability to meet investment commitments. <p>Cons:</p> <ul style="list-style-type: none"> • Auditing challenges. 	<ul style="list-style-type: none"> • We have not identified international examples of independent investment vehicles, funded with spectrum fees. 	<p>In the UK, the SRN is an example of a separate programme to improve coverage.</p>

Approach	Pros and Cons	International examples	Related UK examples
	<ul style="list-style-type: none"> • Fund may be claimed by firms which were already planning extensive investment, leading to no additional benefit. 		
Fixed term licences			
<p>4. <i>Fixed term licence with re-award</i></p>	<p>Pros:</p> <ul style="list-style-type: none"> • Can help ensure an ongoing efficient allocation of spectrum (as spectrum reallocated periodically). <p>Cons:</p> <ul style="list-style-type: none"> • Some MNOs have said that it is more difficult to invest when there is less certainty of ongoing access to spectrum. However, the international empirical evidence on this point is mixed. • Spectrum awards entail a substantial administrative burden on stakeholders and Ofcom. • There is a risk that licence end dates may not be in alignment with investment cycles – MNOs may be reluctant to undertake new investment in the years before a licence re-award. • Adds risk to mobile operators (see Norway example). 	<ul style="list-style-type: none"> • Germany previously had mandatory re-awards of spectrum (e.g. 900 MHz & 1800 MHz re-award, along with 700 MHz and 1400 MHz, in 2015 and 2.1 GHz re-award along with 3.6 GHz in 2019), but now only does so if there is evidence of excess demand for the spectrum. The authority is currently considering if there is need for an auction to renew 800 MHz, 1800 MHz and 2.6 GHz licences, which expire in 2025, and has said that it is considering extending them for a further five years. • Re-awards in Germany (2019) and Ireland (2022) led to a rebalancing of 2.1 GHz holdings. • Netherlands re-awarded 2.1 GHz licences as part of the 700 MHz, 1400 MHz and 2.1 GHz award in 2020. • Greece re-awarded 2.1 GHz licences as part of the 700 MHz, 2.1 GHz, 3.6 GHz and 26 GHz award in 2020, although spectrum sold at reserve price. • In 2013, Tele2 exited the market in Norway after it failed to acquire LTE and 	<p>In the forthcoming mmWave award (26 GHz and 40 GHz), Ofcom is awarding 15-year fixed-term licences, reflecting the fact that new use cases are still emerging which may affect the long-term value (and optimal allocation) of the award.</p>

Approach	Pros and Cons	International examples	Related UK examples
		<p>additional 3G spectrum in the 800, 900 and 1800 MHz renewal auction.</p>	
<p>5. <i>Fixed term licence with administrative renewal:</i></p> <ul style="list-style-type: none"> - for a one-time fee, or - in exchange for investment commitments, or - with no additional fee. 	<p>Pros</p> <ul style="list-style-type: none"> • Security of tenure may support investment climate (similar to indefinite licences) • Depending on prevailing macro conditions, MNOs may prefer up-front rather than an annualised payment (though they have not generally requested this for ALFs) <p>Cons</p> <ul style="list-style-type: none"> • Effectively makes the licence indefinite, so equivalent to either the current system or to options considered below, depending on the fee/commitment conditions. 	<ul style="list-style-type: none"> • Czech Republic renews licences for a one-time fee (based on a process of expert valuation). • Italy has used market-value fees for renewal (for example Vodafone’s extension of 2.1 GHz for eight years in 2021 for a one-time fee). • US licence renewals do not entail a fee, but are subject to spectrum usage and network build requirements (see above for more details). 	<p>The UK has not adopted this approach to date.</p>
<p>ALFs below market value</p>			
<p>6. <i>Discounted ALFs (e.g. 50% of market value) without any investment obligations</i></p>	<p>Pros:</p> <ul style="list-style-type: none"> • Improved MNO cashflows could potentially support investment, although could also just lead to higher profits or be invested in other markets/locations. <p>Cons</p> <ul style="list-style-type: none"> • Weakens role of ALFs in promoting efficient spectrum allocation. 	<ul style="list-style-type: none"> • Spain has eliminated one-off fees for renewal/extension but maintained annual spectrum taxes. Government’s aim was to “(...) give greater stability in the use of the spectrum, foster the deployment of telecommunications networks and incentivise investment”. A consultation is ongoing to extend all existing licences without any one-off fee, which currently represent ca. 30-40% of total spectrum costs. 	<p>Ofcom has recently set (non-mobile) licence fees for the 10 GHz, 28 GHz and 32 GHz bands, at a discount to estimated value, in light of uncertainty about future demand for the spectrum.</p>

Approach	Pros and Cons	International examples	Related UK examples
<p><i>7. Least Cost Alternative (fees are set based on the opportunity cost of the spectrum, calculated as the lowest-cost alternative to producing the same output if spectrum were not available)</i></p>	<p>Pros</p> <ul style="list-style-type: none"> • Established methodology (Ofcom uses for fixed links) • Could provide evidence of market value in future if there are no recent auctions to refer to. <p>Cons</p> <ul style="list-style-type: none"> • Relies on engineering assumptions rather than evidence from the market. • Does not account for changes in market demand: estimates cost of achieving current output with less spectrum. In particular does not reflect potential higher demand from alternative / emergent use cases. • Arguably makes more sense where an alternative to using spectrum is available (e.g. fibre is an alternative to fixed links). • At least as complex to implement as ALFs. 	<ul style="list-style-type: none"> • Australia used this approach to set fees for 800 MHz and 1800 MHz spectrum in 2011. New Zealand did so for 800 MHz and 900 MHz in 2007. • Netherlands used LCA for 900 MHz in 2006. It now renews mobile spectrum licences by auction. • Czech Republic methodology for “expert valuation” (see row 5) could involve network cost modelling. 	<p>Ofcom has used this approach in non-mobile bands (typically bands with fixed links), and previously for some mobile bands (prior to implementing ALFs).</p>
<p><i>8. Indefinite licences without ALFs (or fixed term with expectation of straightforward and costless renewal)</i></p>	<p>Pros</p> <ul style="list-style-type: none"> • Indefinite licences ensure security of tenure for licensees. • This approach creates an asset in the MNOs balance sheet that can be traded (although we have not seen evidence of active trading in any country). • Improved cashflows relative to use of ALFs. <p>Cons</p>	<p>None identified.</p>	<p>The UK has not adopted this approach to date.</p>

Approach	Pros and Cons	International examples	Related UK examples
	<ul style="list-style-type: none"> • Open to criticism for gifting a valuable public asset to private companies in perpetuity. • Relies on effective trading to ensure continued efficient spectrum allocation. • Gives licensees a strong incentive to resist any future change of use/revocation of the spectrum, if a higher-value alternative use case emerges. • Risk that some/all savings are used for unintended purposes (e.g. not for investment but to increase dividends or pay down debt). • Initial awards/auctions were carried out on the assumption that licences would require ALFs after the initial 20-year period. 		

A3. UK and international mobile investment

Introduction

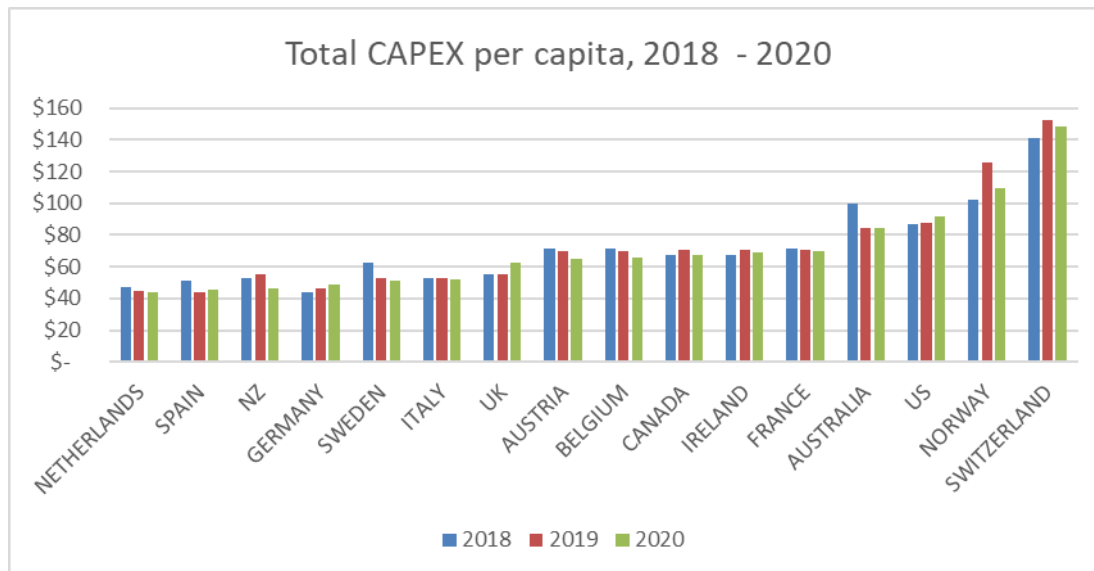
A3.1 This annex provides evidence on the UK’s investment levels, in terms of capital expenditure (“capex”) and 5G rollout, compared to international comparators. The UK uses the approach of auctioning indefinite licences and setting ALFs at opportunity cost following the initial licence term, whereas other countries use a range of different approaches. Our analysis illustrates that mobile investment levels and 5G performance in the UK are broadly comparable to other countries – i.e. we do not see evidence that the UK’s approach to mobile spectrum management has had a negative effect on investment or 5G performance.

Capital expenditure

A3.2 Figure 1 compares capex per capita in selected countries for 2018-2020. Relatively high capex is seen in certain countries, particularly Switzerland, Norway, the US and Australia.

A3.3 Across all three years, the UK’s capex per capita is in the middle range, slightly below France but above Spain, Germany and Italy.

Figure 1



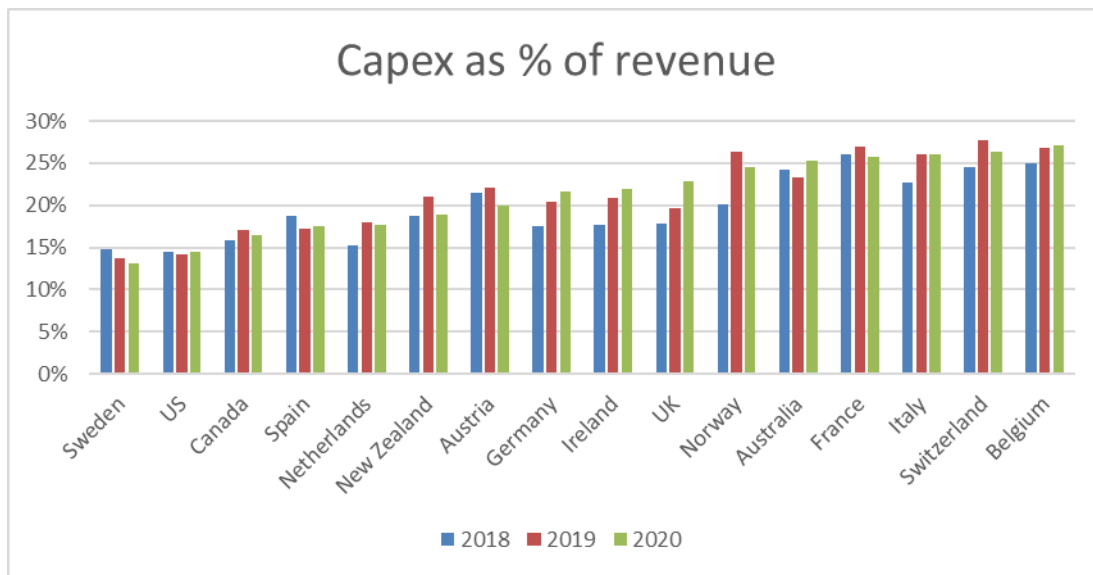
Source: OMDIA WCIS Spotlight Series Service.

A3.4 Capex per capita may vary between countries for a range of reasons. One is that the cost of network deployment may be higher in some countries because of their geography. A recent study by Plum Consulting for Ofcom noted that “Network deployment and costs are heavily influenced by the specific geographical characteristics of each market.”⁵⁸

⁵⁸ Plum Consulting [Mobile Strategy Review - International Case Studies \(ofcom.org.uk\)](https://www.ofcom.gov.uk/consult/condocs/mobilestrategy/mobilestrategy-international-case-studies), January 2022.

- A3.5 Another reason for variation in capex across countries is the level of concentration in the market. Research by Ofcom found there is no evidence that mobile consolidation has a positive impact on investment and quality based on average download speeds.⁵⁹
- A3.6 While some countries such as the USA and Canada have higher capex per capita than the UK, this can also come with mobile customers paying more for their services. As Figure 2 shows, the US and Canada score lower than the UK in terms of capex as a percentage of revenue, reflecting the fact that average revenue per user (ARPU) in those countries is around double that of the UK. Figure 2 also shows that the UK is within the range of countries on this metric rather than an outlier. The UK substantially increased its capex as a percentage of revenue from 2018 to 2020.⁶⁰

Figure 2



Source: OMDIA WCIS Spotlight Series Service.

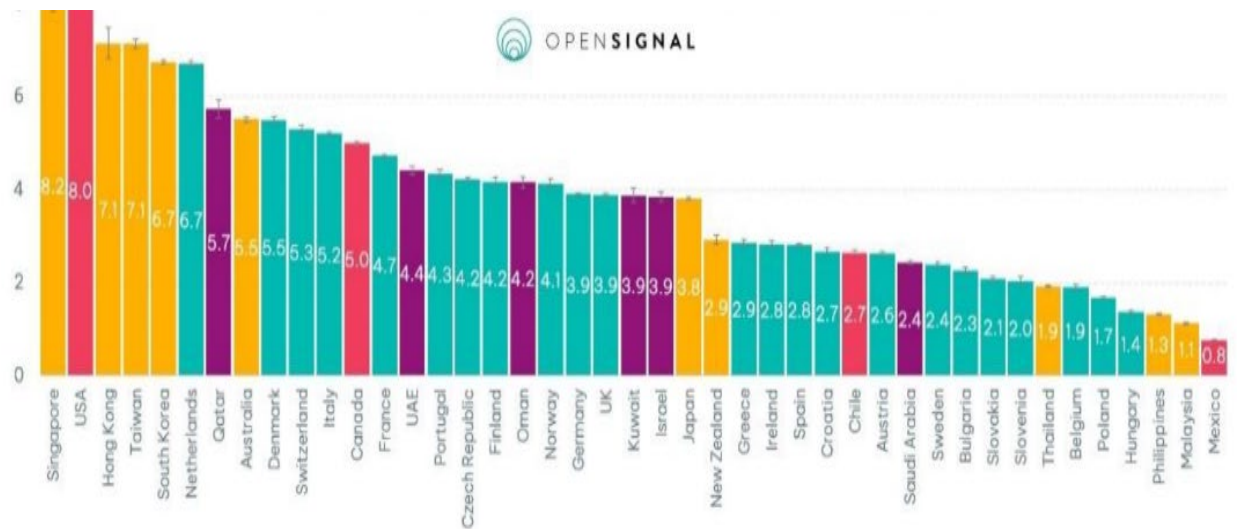
5G rollout

- A3.7 OpenSignal has compiled data on 5G coverage internationally, as shown in Figure 3. In global terms, the USA and Asia Pacific have been the strongest performers in rolling out 5G coverage. The UK is towards the middle range globally and in Europe, below Italy and France, similar to Germany, and above Spain.

⁵⁹ Ofcom, [Market structure, investment and quality in the mobile industry](#), December 2020.

⁶⁰ This reflected a decline in UK revenues from 2018-19, followed by a 15% increase in capex from 2019-2020 over similar revenues in each year.

Figure 3



Source: OpenSignal

A3.8 Considering these results in light of Figure 1 above, there is a tendency for countries with a higher relative capex to perform more strongly on 5G coverage, with the USA, Australia and Switzerland towards the top of the range in both measures. However, there are exceptions to this – the Netherlands performs strongly on 5G coverage despite having the lowest capex per capita among the countries in Figure 1. Norway lags Italy and France on 5G coverage despite having a substantially higher capex per capita than each of those countries. These differences indicate that capex is one of a number of factors which determines current 5G coverage.

A4. Comment on mobile network operators' views

Introduction

A4.1 This annex summarises the key themes that were raised in stakeholder submissions in the course of our review, and our high-level response to these points.

Operators' views and our response

View	Our response
Mobile operators have a sufficient incentive to hold spectrum licences efficiently because they can trade spectrum and this possibility means they take account of the opportunity cost of their spectrum. Operators say that evidence of UK and international mobile spectrum trades shows that there is a sufficiently extensive market to reveal the opportunity cost.	<p>We have looked in detail at evidence of mobile spectrum trading in other jurisdictions. Arms-length trading of spectrum between mobile operators is a rare event in any country, and we have seen only one such trade in the UK.⁶¹ This is despite there being a range of fees regimes operating internationally.</p> <p>ALFs are a direct cost to holding spectrum, and in our view this creates a stronger incentive to trade spectrum than the hypothetical opportunity cost of trading, particularly absent a market for spectrum.⁶²</p> <p>While ALFs have not been in place for many years, we have already seen one recent example of under-used spectrum being returned in response to the introduction of AIP-based licence fees.</p>

⁶¹ In some cases operators have “swapped” identical blocks of spectrum at different frequency ranges within a band so that each has a larger continuous block of spectrum. This can be seen as a special case – if trading were to ensure an ongoing efficient allocation of spectrum we would expect trades which resulted in a change in total spectrum holdings – i.e. higher-value users acquiring additional spectrum from lower-value users.

⁶² See also paragraph 5.21 of Ofcom’s Statement on 2100 MHz ALFs, https://www.ofcom.org.uk/data/assets/pdf_file/0027/229428/1900_2100-mhz-statement.pdf

Annual licence fees create a barrier to trading.

As noted, the evidence for trading is limited, and this is the case whether or not ALFs are in place. We have not seen evidence that ALFs have a chilling effect on trade in general.

In one instance (3.6 to 3.8 GHz), some operators suggested that ALFs were preventing a like-for-like spectrum swap from taking place.⁶³ We consider such like-for-like spectrum swaps to be a special case - if trading were to ensure an ongoing efficient allocation of spectrum we would expect trades which resulted in a change in total spectrum holdings – i.e. higher-value users acquiring additional spectrum from lower-value users.

Annual Licence Fees have not been set sufficiently conservatively.

We set ALFs conservatively to avoid the risk of spectrum licences being returned and the spectrum being unused. We have seen no such returns of spectrum by mobile operators (although one spectrum licence was returned in response to AIPs by a non-mobile operator⁶⁴).

Mobile data traffic has continued to increase in recent years, and there is an ongoing international movement to make additional spectrum available for mobile uses. We would not generally expect to see a material fall in prices for an input (in this case spectrum), where there is strong demand for downstream services and there are constraints on the supply of the input.

We note that while operators have cited as part of this review recent auction results as evidence of declining market value, there is a separate process through which mobile operators can submit evidence and request a review of the level of ALFs.

The UK is the only country that sets ALFs at full market value.

Other jurisdictions adopt a range of different approaches to spectrum management. In some cases licences are re-auctioned (by definition at full market value) at the end of their initial terms. In others, licences are subject to ongoing coverage or investment obligations. We have not seen any instance of a regulator allowing mobile operators to hold spectrum licences indefinitely at no cost or equivalent obligation.

See our annex comparing ALF alternatives with international comparisons for further information.

⁶³ We changed the terms of the relevant licences in October 2022, effectively removing ALFs; to date no trading of these licences has taken place.

⁶⁴ <https://www.ofcom.org.uk/consultations-and-statements/category-3/consultation-arqivas-28-ghz-spectrum-access-licence>

ALFs reduce the ability or incentive of mobile operators to invest in UK mobile services such as 5G SA.

We consider that ALFs help to support efficient investment incentives, by encouraging operators to take account of the value of spectrum in their investment plans.⁶⁵

MNOs together invested an average of £2.7bn per year in the UK from 2017 to 2021, and they plan further significant investment in the coming years. By comparison, current ALF payments across all operators are around £340m per year.⁶⁶

The UK is behind some other countries in 5G SA deployment. A number of reasons have been suggested for this, including the removal of Huawei equipment from UK mobile networks.⁶⁷ We have not seen any evidence that ALFs have slowed the deployment of 5G SA.

Firms have a range of options to an increase in cashflow, such as investing in different countries or markets, increasing dividends, reducing debt, increasing salaries etc. As Analysys Mason has commented: *“A simple discount or the removal of ALFs, without further obligations to reinvest the funds, may have a limited impact on the level of investment.”*⁶⁸ We agree that there is no guarantee that any increased cashflow from a removal/reduction of ALFs would be invested in UK mobile networks.

See also Annex 3: UK and International mobile investment.

⁶⁵ See also paragraphs 5.34 to 5.37 of Ofcom’s Statement on 2100 MHz ALFs.

⁶⁶ Ofcom’s Future Approach to Mobile Markets, paragraphs 1.9-1.10.

https://www.ofcom.org.uk/data/assets/pdf_file/0036/248769/conclusions-mobile-spectrum-demand-and-markets.pdf.

⁶⁷ <https://www.ispreview.co.uk/index.php/2023/07/uk-disappoints-in-global-comparison-of-5g-mobile-broadband-speeds.html>.

⁶⁸

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1148897/ensuring_future_wireless_connectivity_needs_are_met.pdf [similar quote on page 269]