Annual licence fees for 900 MHz and 1800 MHz spectrum

Statement

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About this document

The Government directed Ofcom in 2010 to revise the fees for 900 MHz and 1800 MHz spectrum licences to reflect the full market value of those frequencies. The fees are paid by the mobile operators (EE, H3G, Telefónica and Vodafone) who use some of the spectrum to provide 2G and 3G services, including voice calls, and some for 4G mobile services.

This document sets out our decision on the revised fees for these 900 MHz and 1800 MHz spectrum licences.

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Section 1

Executive Summary and Introduction

Executive Summary

1.1 This statement sets out Ofcom's final decisions on revisions to the annual licence fees ('ALFs') to be paid by the holders of licences to use radio spectrum in the 900 MHz and 1800 MHz bands (the 'ALF spectrum'). It implements the Government's directions to Ofcom of December 2010[1] to revise ALFs to reflect full market value, after completion of the UK 4G auction.

ALFs for 900 MHz and 1800 MHz

1.2 Our decision is to set new base ALF levels as follows (expressed in March 2013 prices, the date of the completion of the 4G auction):

a) **900 MHz**: **£1.128m per MHz per annum**

b) **1800 MHz**: **£0.815m per MHz per annum**

1.3 These new base ALFs have been derived through the following steps, using the analytical framework shown at Figure 1.1.[2]

Step 1: UK market value of spectrum in the 4G auction

1.4 We have considered the bids in the UK 4G auction and reached the following conclusions:

a) **800 MHz:** we consider that an appropriate forward-looking market value for the 800 MHz band for the purpose of ALF, net of expected DTT co-existence costs, is £30m per MHz. The corresponding value gross of expected DTT co-existence costs is **£33m per MHz**.

b) **2.6 GHz:** we consider that an appropriate market value for the 2.6 GHz band for the purpose of ALF is **£5.5m per MHz**.

Step 2a: International benchmarks

1.5 We have considered auction prices for 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz in European countries from 2010 onward to derive UK-equivalent absolute spectrum values by band. We have then used these prices, in combination with our estimates of the UK market value of 800 MHz and 2.6 GHz (from Step 1), to derive a set of benchmarks for the value in the UK of:

a) **900 MHz**, based on its value relative to 800 MHz in countries where both bands have been auctioned; and

[1] The Wireless Telegraphy Act 2006 (Directions to OFCOM) Order 2010 (S.I. 2010 No. 3024).
[2] References to "Steps" correspond to the steps set out in Figure 1.1 in this section below.

b) **1800 MHz**, based on a measure of where the value of 1800 MHz lies between the values of 800 MHz and 2.6 GHz in the country concerned, using the 'distance method'.

1.6 We have categorised the available benchmarks into three tiers, which reflect how informative of UK market values we consider them to be, and we have assessed whether there is a risk that each benchmark is an understated or overstated estimate of the UK value of the relevant band. In summary, we have derived the following relative value benchmarks:

a) **900 MHz**: three Tier 1 benchmarks (Austria, Germany (2015 auction) and Ireland), two Tier 2 benchmarks (Portugal and Spain) and three Tier 3 benchmarks (Denmark, Greece and Romania);

b) **1800 MHz**: five Tier 1 benchmarks (Austria, Germany (2015 auction), Ireland, Italy and Sweden), one Tier 2 benchmark (Germany, 2010 auction) and five Tier 3 benchmarks (the Czech Republic, Greece, Portugal, Romania and the Slovak Republic).

Step 2b: Impact of geographic coverage obligation

1.7 A geographic coverage obligation was agreed between the licensees and the Government in December 2014. We have considered the impact of this obligation on the market value of ALF spectrum, in light of representations made to us by the licensees.

1.8 We have concluded that the geographic coverage obligation is unlikely to have a material effect on the market value of either 900 MHz or 1800 MHz spectrum for the purpose of ALF. Accordingly, we have decided not to amend the lump-sum values for either 900 MHz or 1800 MHz in light of the geographic coverage obligation.

Step 2c: Lump-sum values of ALF spectrum

1.9 We have reached a view on the lump-sum value of 900 MHz and 1800 MHz in the UK, based on the relative value benchmarks described above. Our assessment considers these benchmarks in the round, reflecting our view of their respective quality and risk of understatement or overstatement, rather than for example taking a simple or weighted average of the benchmarks. We have applied cross-checks to our estimates, including the absolute values of 900 MHz and 1800 MHz spectrum in countries from our benchmarking dataset. We have concluded that:

a) **900 MHz:** we consider that an appropriate lump-sum value for 900 MHz spectrum for the purpose of ALF is **£18m per MHz**[3];

b) **1800 MHz:** we consider that an appropriate lump-sum value for 1800 MHz spectrum for the purpose of ALF is **£13m per MHz**[4].

[3] This is 55% of the lump-sum value for 800 MHz, gross of expected DTT co-existence costs.
[4] This implies that the difference in value between 1800 MHz and 2.6 GHz is 27% of the difference in value between 800 MHz and 2.6 GHz.

Step 3: Discount Rate

1.10 To convert the above lump-sum values into an equivalent annual rate, we apply a post-tax discount rate of 1.8% and a tax adjustment factor of 1.064 (to reflect the more favourable tax treatment of annual fees compared to a lump-sum payment).

Implementation of revised ALFs

1.11 We consider that the revised ALFs should take effect from the same common effective date (CED) for all licensees. We have decided to set the CED to be the earliest date practicable after the new fees regulations are made implementing the revised ALFs. Specifically, we have set a CED of **31 October 2015**.

1.12 Further, we have decided that the revised ALFs should be phased-in in two steps with one half of the increase coming into effect on the CED, and the second half of the increase becoming effective exactly one year following the CED. At this point (i.e. one year following the CED) all licensees will move onto the same annual payment date.

Introduction

Ofcom's task

1.13 Under section 5 of the Wireless Telegraphy Act 2006 (the 'WT Act'), the Secretary of State may by order give general or specific directions to Ofcom about the carrying out by us of our radio spectrum functions, including the setting of spectrum licence fees in accordance with sections 12 and 13 of the WT Act.

1.14 In December 2010, following the publication of its 'Digital Britain' report, the Secretary of State made directions to Ofcom under section 5 WT Act (the 'Government Direction') [5] setting out a package of measures that Ofcom is required to undertake. In relation to the 900 MHz and 1800 MHz licences, these measures were:

a) to vary the licences so that they authorise the provision of 3G and 4G services (GSM and UMTS systems) (Article 4);

b) to vary the licences to extend the notice period for revocations for spectrum management reasons from one year to five years (Article 5(1) and (2));

c) to make the licences fully tradable by amending the Wireless Telegraphy (Spectrum Trading) Regulations 2008 (Article 7); and

d) to revise the fees charged for the licences, after completion of the UK 4G auction (Article 6(1) and 6(2)).

1.15 The last remaining measure to be implemented under the Government Direction in relation to the 900 MHz and 1800 MHz licences is the revision of ALFs. The Government Direction requires Ofcom to revise the level of ALFs for the 900 MHz and 1800 MHz Public Wireless Networks licences so that they reflect the full market value of the frequencies in those bands. In doing so, Ofcom is required to have particular regard to the sums bid in the UK 4G auction.

1.16 The UK 4G auction concluded in March 2013. Since then, we have conducted a number of consultations:

a) In October 2013[6] (the 'October 2013 consultation'), we set out proposals for revised ALFs. We received responses from EE, H3G, Telefónica and Vodafone. These mobile network operators ('MNOs') all hold Public Wireless Networks licences in one or both of the 900 MHz and 1800 MHz bands and so have a direct interest in the relevant ALF. We also received responses from BT, GSMA, Enders Analysis, the Scottish Government and Prospect;

b) In April 2014, we consulted on the methodology to derive a discount rate consistent with CPI inflation.[7] This discount rate is used in our methodology to

[5] The Wireless Telegraphy Act 2006 (Directions to OFCOM) Order 2010 (S. I. 2010 No. 3024). The Government's actions in the run up to the Government Direction are set out in section 1 of our August 2014 consultation.
[6] http://stakeholders.ofcom.org.uk/consultations/900-1800-mhz-fees/
[7] http://stakeholders.ofcom.org.uk/consultations/900-1800-mhz-fees-cpi/

convert lump-sum values for the 900 MHz and 1800 MHz bands into annual fees. The MNOs, but no other stakeholders, responded to this further consultation;

c) In May 2014, we published an update, and invited comments, on European auctions that had taken place since the time of the October 2013 consultation.[8] The results of European spectrum auctions for the 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz bands are used to inform our estimates of the lump-sum values for the 900 MHz and 1800 MHz bands in the UK. The MNOs, but no other stakeholders, submitted comments on this update;

d) In August 2014[9] (the 'August 2014 consultation'), we set out revised proposals, focusing on those areas which had changed from the October 2013 consultation. We received responses from the MNOs, BT and the Scottish Government.

1.17 On 17 December 2014, the Government and the MNOs signed a Statement of Commitment in which each MNO agreed to implement 90% geographic voice coverage throughout the UK by no later than 31 December 2017. That commitment has been given legal effect through the variation of each of the MNOs' 900 MHz and 1800 MHz licences to include a new coverage obligation to this effect. This is referred to in this document as the 'geographic coverage obligation'.[10]

1.18 In an exchange of letters with the Secretary of State of 17 December 2014 we confirmed our view that all interested parties should be given a reasonable opportunity to comment on whether they consider that the geographic coverage obligation, taking account of the associated incremental costs incurred by the MNOs, should impact future ALFs.[11]

1.19 On 19 February 2015, we published a further consultation (the 'February 2015 consultation')[12] to afford all interested parties that opportunity to comment. We decided that the clearest way of consulting stakeholders was to set out the position that we had reached towards the end of 2014 on the revised levels of ALF before considering the impact of the geographic coverage obligation, as well as our initial views on whether, and if so how, the geographic coverage obligation affects the market value of the ALF spectrum. In consulting on the impact of the geographic coverage obligation, we invited stakeholders' views on both the approach we put forward to assessing the impact of the geographic coverage obligation on ALF, and our initial views on this point.

1.20 The MNOs, but no other stakeholders, submitted comments in response to the February 2015 consultation.

1.21 On 9 July 2015, we published an update, and invited comments, on the German auction for the award of licences for the 700 MHz, 900 MHz, 1800 MHz and 1.4 GHz

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[8] http://stakeholders.ofcom.org.uk/consultations/900-1800-mhz-fees/update-note/
[9] http://stakeholders.ofcom.org.uk/binaries/consultations/annual-licence-fees-900-MHz-1800-MHz/summary/condoc.pdf
[10] There is also a different coverage obligation in the 800 MHz spectrum licence acquired in the 4G auction by Telefónica.
[11] http://media.ofcom.org.uk/content/posts/news/2015/Letter_to_Secretary_of_State.pdf
[12] http://stakeholders.ofcom.org.uk/binaries/consultations/annual-licence-fees-further-consultation/summary/alf-further-consultation.pdf

bands, that concluded on 19 June 2015. We received comments from BT, EE, Telefónica, Vodafone and Deutsche Telekom.

Impact Assessment

1.22 In the August 2014 consultation, we made a statement for the purposes of section 7(3)(b) of the Communications Act 2003, setting out that we considered it was unnecessary for us to carry out an impact assessment of the type argued for by stakeholders in response to our October 2013 consultation[13]. We explained that we considered this unnecessary because we did not have any discretion to decide whether or not to set ALFs at full market value, since we had been directed by the Government to do so and we were required to implement that direction.

1.23 Notwithstanding that we set out our decision on this point in the August 2014 consultation, all of the licensees argued again in their responses to the August 2014 and February 2015 consultations that we should conduct a full impact assessment.

1.24 In response to the February 2015 consultation, the licensees claimed, in particular, that we should carry out an impact assessment in relation to the impacts of future release of spectrum for mobile use (EE[14]), the geographical coverage obligation (H3G[15], Vodafone[16]), the discount rate used for annualisation (Vodafone[17]) and the length of the phase-in period (H3G)[18]. Telefónica said that its position on the issue of impact assessment remained as stated in its previous response[19].

1.25 None of the comments provided in response to the August 2014 and February 2015 consultations have caused us to change our decision in relation to impact assessments as set out in the August 2014 consultation. Further, having now concluded that the geographic coverage obligation is unlikely to have a material effect on the market value of either 900 MHz or 1800 MHz spectrum for the purpose of ALF, we remain of the view as set out in the February 2015 consultation that it is unnecessary for us to carry out an impact assessment in that regard.

Analytical framework

1.26 Our task under the Government Direction is to revise ALFs to reflect the full market value of the frequencies concerned. However, we recognise that we have little direct relevant market evidence of the UK value of the 900 MHz and 1800 MHz spectrum bands for which we are setting revised fees. For example, there has been no UK

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[13] In response to our October 2013 consultation, a number of stakeholders said that we should carry out a full impact assessment of our proposals for revising ALFs. In essence, their view was that we should not revise ALFs to reflect full market value unless we could demonstrate that taking this approach to setting ALFs (and the specific levels of ALF that we proposed) was necessary to promote efficient use of spectrum, and that the potential benefits in terms of spectrum efficiency would outweigh any potential adverse effects on consumer prices, investment in infrastructure, innovation and competition. They considered that unless we carried out such an impact assessment any decision we made would be unlawful.

[14] EE's response to the February 2015 consultation, p. 21 and 24.

[15] H3G's response to the February 2015 consultation, p. 18.

[16] Vodafone's response to the February 2015 consultation, p. 94 (paragraph 99) and p. 97 (paragraph 108).

[17] Vodafone's response to the February 2015 consultation, p. 52-53 and p. 86 (paragraph 72).

[18] H3G's response to the February 2015 consultation, p. 18.

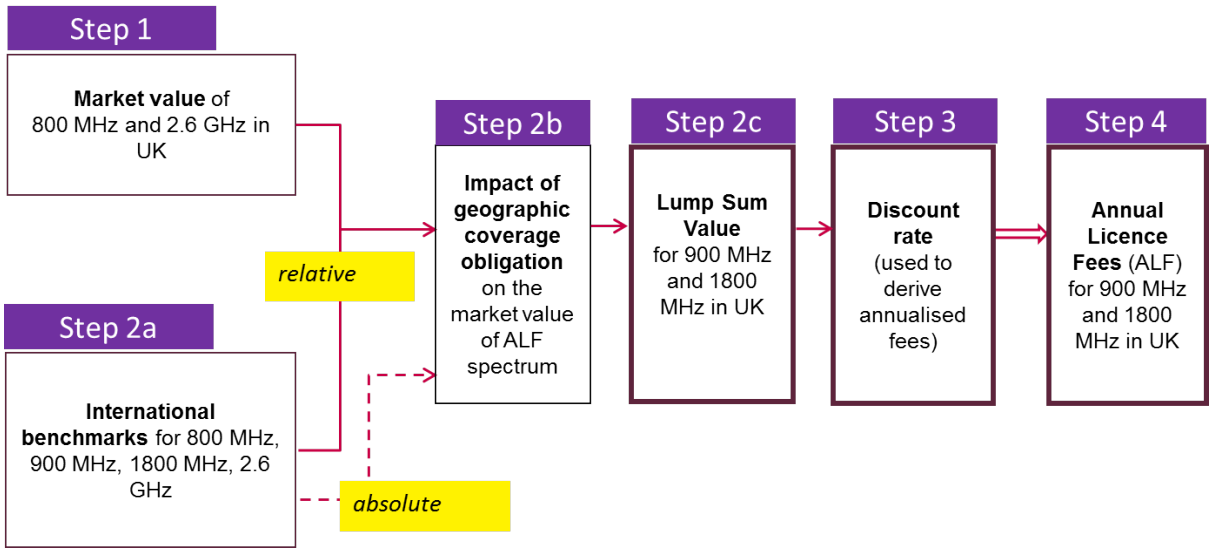
[19] Telefónica's response to the February 2015 consultation, paragraph 51.

auction of spectrum in either of these bands. The available evidence is instead for the market value of *other bands* in the UK, or for these bands in *other countries* where they have been auctioned. Accordingly, we recognise there is therefore inherent uncertainty in deriving ALFs for the 900 MHz and 1800 MHz bands at full market value. Nevertheless, in order to implement the Government Direction we must conclude on an appropriate amount for ALFs.

1.27 Given the available evidence, the framework we have decided to use for deriving an appropriate level of ALF is illustrated in Figure 1.1. We set this framework out in the February 2015 consultation, and it builds on our proposals in the October 2013 consultation[20] and our revised proposals in the August 2014 consultation. None of the respondents disagreed with this high-level framework of analysis in response to those consultations, although Vodafone, and subsequently also EE (in response to the February 2015 consultation), argued that we should have put more weight on network cost modelling (we discuss Vodafone's and EE's arguments in Annex 9).

1.28 In line with the approach set out in the February 2015 consultation, the only modification we have made to the analytical framework is to show where we have incorporated the assessment of the impact on ALF of the geographic coverage obligation into our overall analytical framework. In response to the February 2015 consultation, Vodafone argued that we should identify the impact of the geographic coverage obligation in step 1 of our framework. We address this argument in Section 4 (at paragraph 4.57).

Figure 1.1: Framework of steps 1 to 4



Source: Ofcom

1.29 There are two distinct aspects to our derivation of fees:

a) the derivation of the lump-sum value of spectrum in each of the 900 MHz and 1800 MHz bands in the UK; and

b) the conversion of those lump-sum values into annual fees.

[20] See paragraphs 2.8 to 2.18 in the October 2013 consultation.

1.30 We organise our analysis of these aspects into four analytical steps.

1.31 Steps 1 and 2 relate to the derivation of lump-sum values for the 900 MHz and 1800 MHz bands in the UK.

1.32 In **step 1** we estimate the UK market value of the 800 MHz and 2.6 GHz bands (the 'auction bands'), based on analysis of the sums bid in the 4G auction (to which the Government Direction requires us to have particular regard).

1.33 In **step 2** we derive the lump-sum values of the 900 MHz and 1800 MHz bands (the 'ALF bands').

a) In **step 2a** we use evidence on the *relative* value of the ALF bands, 900 MHz and 1800 MHz, to the auction bands, 800 MHz and 2.6 GHz. This includes, in particular, international benchmark evidence on auctions conducted in other European countries in recent years. We also consider the evidence of the *absolute* values of the ALF bands in the relevant benchmark countries. However, in line with the updated analysis presented in the August 2014 consultation (and set out again in the February 2015 consultation), we place the primary emphasis on the relative values, as explained in Section 3.

b) As discussed above, we have consulted on the impact of the geographic coverage obligation on ALF. Having considered stakeholders' responses, our approach to this remains to consider the impact of the obligation on the market value of ALF spectrum as part of our analysis to derive the lump-sum values for the ALF spectrum, as shown as **step 2b** in Figure 1.1. We recognise that MNOs may incur incremental costs to meet the geographic coverage obligation. However, despite this, in our view, there is unlikely to be a material impact on the market value of ALF spectrum. In summary, the reasons for this are as follows:

   i) the market value of spectrum for the purpose of ALF depends on the value to the marginal operator, this being the highest-value operator that does not hold that specific spectrum, since this determines the opportunity cost; and

   ii) each MNO has the geographic coverage obligation regardless of whether or not it acquires additional ALF spectrum.

c) In **step 2c** we estimate lump-sum values by combining an analysis of the value of 900 MHz and 1800 MHz spectrum *relative* to the auction bands in the relevant benchmark countries (from step 2a) with our estimates (from step 1) of the market value for those auction bands in the UK. This is the point in our analytical steps where we also take into account our conclusions on the impact of the geographic coverage obligation (from step 2b).

1.34 In **step 3** we consider the choice of an appropriate discount rate and tax adjustment factor to convert the lump-sum values for the 900 MHz and 1800 MHz bands in the UK into annual licence fees.

1.35 In **step 4** we set out the ALFs at full market value for 900 MHz and 1800 MHz spectrum using the analysis under steps 1, 2 and 3.

Approach to interpreting the available evidence

1.36 As we explained in our February 2015 consultation, where there are choices of methodology in steps 1, 2 and 3 in our analysis, we consider in each relevant section

in this document which methodology, on balance, we prefer over the alternative(s), and why.

1.37 We have applied our preferred methodologies to the available evidence, noting the challenges in interpreting some of that evidence, and exercising our regulatory judgment where necessary.

1.38 In the August 2014 consultation we said that we should exercise any necessary regulatory judgement by adopting a conservative approach when interpreting the evidence.[21] We said that 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.

1.39 All the current licensees agreed in their responses to the August 2014 consultation that we should adopt a conservative approach when interpreting the evidence. BT did not disagree that we should adopt a conservative approach, but commented that "taking a conservative approach is not the same as deliberately setting ALF below Ofcom's view of the appropriate level". As we explained in the February 2015 consultation, we agree with BT's comment.

1.40 In response to the August 2014 consultation, all the current licensees argued that, in practice, we had not been conservative, or that we had not been sufficiently conservative. Telefónica said that there was a large range of plausible estimates for both 900 MHz and 1800 MHz and we should ultimately select ALFs based on the lower end of the estimates of full market value. EE, Telefónica and Vodafone argued that we should conduct a full impact assessment in order to ensure that we adopt a conservative approach. Vodafone also claimed that we need a framework to consider whether we are sufficiently conservative in our treatment of the evidence.

1.41 As we set out in the February 2015 consultation, we consider that licensees have misunderstood what we mean by adopting a conservative approach when interpreting the evidence. We have always recognised that there is inherent uncertainty in deriving ALFs for the 900 MHz and 1800 MHz bands to reflect full market value. Nevertheless, in order to implement the Government Direction we must conclude on an appropriate amount for ALFs going forward, and that process necessarily involves us exercising regulatory judgement when considering the evidence.

1.42 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.

[21] See paragraph 1.34 of the August 2014 consultation.

1.43 In their responses to the February 2015 consultation, stakeholders argued again that our analysis was not sufficiently conservative. We do not however consider that they have made any new, substantive arguments in addition to the points raised in their responses to the previous consultations, which we have already taken into account.

Implementation of the Government's direction by statutory instrument

1.44 Ofcom sets licence fees by way of regulations made under section 12 WT Act. The current fees payable for the 900 MHz and 1800 MHz licences are prescribed in Schedule 2 to the Wireless Telegraphy (Licence Charges) Regulations 2011 (the 'Fees Regulations')[22].

1.45 In order for us to revise the current fees we need to make a statutory instrument which amends Schedule 2 of the Fees Regulations and prescribes the revised fees.

1.46 Section 122 of the WT 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.

1.47 On 1 August 2014, we published a notice explaining how we would give effect to Ofcom's revised proposals to implement the Government's direction to revise ALF levels if our final decisions, following the overall consultation process, were in line with our revised proposals. This notice was given in accordance with section 122(4) and (5) of the WT Act and contained a draft of the statutory instrument that we proposed to make. We did not receive any comment on the specific provisions of the draft statutory instrument attached to our notice[23].

1.48 Having carefully considered the responses to the overall consultation process, we have now made the statutory instrument prescribing the revised fees, which comes into force on 15 October 2015. We are satisfied that the final statutory instrument is in all material respects the same as that on which we consulted (save as to the actual level of revised ALFs themselves and the specific date when these revised ALFs take effect) such that no further consultation on it would have been required.

1.49 The statutory instrument, entitled 'The Wireless Telegraphy (Licence Charges for the 900 MHz frequency band and the 1800 MHz frequency band) (Amendment and Further Provisions) Regulations 2015', will be available on the government's *legislation.gov.uk* website[24]. A copy in draft form is annexed to this statement for indicative purposes. The government's *legislation.gov.uk* website is the only authorised source for published statutory instruments.

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[22] S.I. 2011/1128. Under the Fees Regulations, the holders of such licences must pay to Ofcom, at regular interval of 12 months, £142,560 for each 2 x 200 kHz national channel in the 900 MHz band and £110,880 for each 2 x 200 kHz national channel in the 1800 MHz band.

[23] EE said that, where applicable, its comments on the August 2014 consultation also apply to the parallel consultation on Ofcom's notice.

[24] http://www.legislation.gov.uk/

Section 2

UK market values of 800 MHz and 2.6 GHz spectrum for the purpose of ALF

Introduction

2.1 This section sets out our final assessment of the full market value for the purpose of ALF of the auction bands, 800 MHz and 2.6 GHz, using bids in the 4G auction. This is step 1 in the analytical framework we set out in Section 1. Supporting material for the issues discussed in this section is set out in Annex 6. In setting out our final assessment, and the reasons for it, we have followed the structure of our February 2015 consultation, which included addressing stakeholders' comments to our August 2014 consultation. At the relevant points throughout our analysis, we have specified how we have taken account of any new points raised by stakeholders' in response to our February 2015 consultation.

2.2 The rest of this section:

- introduces our analysis by outlining the key concepts, methods and some complicating factors to be addressed;
- provides an overview of our proposals in the August 2014 and February 2015 consultations and the stakeholder responses;
- derives the market value of each of the 800 MHz and 2.6 GHz bands for the purpose of ALF through analysis of:
  - auction prices;
  - opportunity costs in the 4G auction for the purpose of ALF (including the Additional Spectrum Methodology, ASM, and the decomposition method put forward by Vodafone);
  - Linear Reference Prices (LRPs); and
  - marginal bidder analysis;
- provides our comments on stakeholders' responses to the August 2014 and February 2015 consultations at the relevant points throughout our analysis; and
- summarises our conclusion on the market values of the 800 MHz and 2.6 GHz spectrum bands for the purpose of ALF.

Key concepts, methods, and complicating factors in our analysis of market value for the purpose of ALF

Market value and opportunity cost

2.3 As explained in our February 2015 consultation (paragraph 2.27), we define full market value for the purpose of ALF as the market-clearing price in a well-functioning market, or the forward-looking marginal opportunity cost of the spectrum. This is the

same as in the August 2014 consultation (paragraph 2.9), although we have added an explicit reference to the opportunity cost being forward-looking for the avoidance of doubt. It is also consistent with our definition of full market in the October 2013 consultation (and the earlier consultation documents preceding the 4G auction).[25] In this document we use the terms "full market value", "market value" and "marginal opportunity cost" interchangeably.

2.4 Taking Vodafone's holdings of 900 MHz as an example, we are not seeking to establish Vodafone's value of its 900 MHz licence. Instead it is the value that is denied to other operators by Vodafone continuing to hold this spectrum that is relevant to the opportunity cost. In particular, it is the value to the other operator that would gain the highest value if it were to acquire Vodafone's 900 MHz frequencies (or part of them).

2.5 When assessing the full market value of 800 MHz and 2.6 GHz spectrum in this context, we recognise that we are doing so for a specific purpose. We are deriving the market value to serve as a basis for the ALF of different spectrum bands, 900 MHz and 1800 MHz, when combined with the other steps in our analysis (such as benchmarking and annualisation). As explained below, this 'read-across' from the spectrum bands in the 4G auction (800 MHz and 2.6 GHz) to the ALF bands (900 MHz and 1800 MHz) has important implications for the relevant market values, especially of the 800 MHz band.

2.6 The auction prices in the 4G auction of 800 MHz and 2.6 GHz spectrum represent the starting point of our analysis. They are a potential source of information on market value and we are required by the Government Direction to have particular regard to bids made in the auction from which the prices are derived. Given the bids made in the auction, the auction prices for non-reserved spectrum were derived as the higher of the (i) reserve prices and (ii) highest losing bids for "additional spectrum" (i.e. for more spectrum than that bidder won in the auction), for (constituent elements of) the specific package of spectrum won by that winning bidder. Where the auction prices comprised losing auction bids, they reflected the opportunity cost in the 4G auction of that spectrum package to other bidders (i.e. to bidders other than the winning bidder whose price is being derived), relative to their own winning packages. To the extent that auction prices were based on reserve prices, they did not reflect a losing bid by a bidder, and so they may not provide the most relevant information on opportunity cost.

2.7 The winning spectrum packages reflect operators' existing, post-auction spectrum holdings. This means that the opportunity cost in the auction addresses the question of the value that bidders expressed in the auction for more spectrum in addition to their existing, post-auction holdings.[26] This is especially relevant to ALF, as it informs the opportunity cost of the ALF spectrum, i.e. the value denied by the licensees of 900 MHz and 1800 MHz spectrum to the non-holders of that spectrum. The

[25] See, for example, paragraph 2.8 in the October 2013 consultation, and paragraph 10.3 in the March 2011 consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues, http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/summary/combined-award.pdf.

[26] We note the announcements about possible mergers involving particular MNOs. Our view on the implications of such merger activity for the purpose of ALF is set out in paragraph 2.22 below. For the avoidance of doubt, our quantified analysis throughout this document is based on the existing (post-auction but pre-merger) spectrum holdings of the MNOs.

opportunity cost is the (highest) value that the non-holders could obtain by adding some of this ALF spectrum to their holdings.

High-level overview of methods

2.8 We provide in this sub-section a high-level comparison between the different methods which we use in our assessment of market value:

a) Prices in the 4G auction, which are based on opportunity cost of the spectrum, given the highest losing bids for additional spectrum (where they exceed the reserve price);

b) Opportunity costs in the 4G auction, which reflect highest losing bids for additional spectrum in the absence of reserve prices. For this analysis we use the Additional Spectrum Methodology and the decomposition method (put forward by Vodafone) to attribute amounts for multi-band packages between the constituent bands;

c) Linear Reference Prices, which seek to estimate the linear prices that are closest to market-clearing prices (by a linear price we mean the same price per MHz in a given band, such as 800 MHz, to all operators and for all block sizes); and

d) Marginal bidder analysis to analyse opportunity cost by assessing the bids of the highest losing bidder for additional spectrum.

2.9 We use these methods in our analysis of the market value of both 800 MHz and 2.6 GHz spectrum. In particular, we derive candidate value(s) from the opportunity costs in the auction, which we compare against the LRPs, and we use the marginal bidder analysis either as a cross-check (in the case of 800 MHz) or to select the market value figure from within the range of candidate values (in the case of 2.6 GHz). The differences in the detail of our analytical steps for the 800 MHz and 2.6 GHz bands reflect differences in the circumstances, notably the absence for the 2.6 GHz band of most of the complicating factors that arise in the analysis of the 800 MHz band.

2.10 Whilst the methods are not identical, they share a substantial degree of overlap and commonality. To compare and contrast the methods at a high level, it is helpful to consider their application to the 2.6 GHz band, for which the analysis is less complicated:

a) Prices for 2.6 GHz in the 4G auction are generally in the range between £5.1m and £5.7m per MHz, determined by the highest losing bids.

b) Opportunity costs in the 4G auction are between £5.1m and £5.7m, similar to the auction prices, because these prices were not set by the reserve price of 2.6 GHz spectrum.

c) LRP with the revenue constraint set at the level of the auction revenue is £4.99m per MHz for the 2.6 GHz band, whilst the LRP without the revenue constraint is £5.7m per MHz. Since there is no linear price at which the market clears for any of the bands in the 4G auction, given the synergies in the bids made in the auction, both of these LRPs would involve excess demand or excess supply in the spectrum bands. The linear price that avoids excess supply and minimises excess demand is £5.5m per MHz.

d) A conservative interpretation of the evidence from the marginal bidder analysis is a market value of £5.5m per MHz.

2.11 It is not a coincidence that the figures derived from the range of methods are similar. They share a similar purpose: to assess opportunity cost. The evidence they use is the same: bids in the 4G auction. The way they assess this evidence is not identical, but in all of the methods the winning bids and packages are of central importance as reference points:

a) Prices in the 4G auction are determined as the higher of reserve prices and the incremental bid value[27] for additional spectrum in the highest losing bids compared to that bidder's winning package.

b) Opportunity costs in the auction are the incremental bid value for additional spectrum in the highest losing bids compared to the winning packages of the bidders submitting these highest losing bids.

c) LRPs are determined by the relevant constraining bids, which can include losing bids by all bidders. The choice of the constraining bids depends on their attractiveness to the bidder compared to its winning package at the linear prices.

d) The results of the marginal bidder analysis depend on the incremental bid value for additional spectrum in the highest losing bids (or lowest winning bid) of the marginal bidder compared to its winning package.

2.12 We consider it desirable that differences between bidders' losing bids and their winning bids play such a key role in the methods that we use. As set out above at paragraph 2.7, because the winning spectrum packages reflect the operators' existing, post-auction spectrum holdings, values for additional spectrum compared to the winning bids assess the most relevant opportunity cost for the purpose of ALF. Also, the winning packages themselves reflect the outcome of a competitive auction which cleared the market, matching demand to the available supply of spectrum.

2.13 Some stakeholders argued that a weakness of the marginal bidder analysis is that it depends on a single specified losing bid relative to the marginal bidder's winning bid, whereas LRPs are determined by a wider range of losing bids. Given the key role of winning bids and packages in all of the methods, we do not consider this to be a feature of the marginal bidder analysis that is of concern. For example, (in the absence of rearrangements) the auction price of operator 1's winning package is similarly determined by a single losing bid from the highest losing bidder ("operator 2") relative to operator 2's winning bid (and this applies in respect of each component of operator 1's winning package). Indeed, on the contrary, we consider the fact that LRPs are in practice influenced by the difference between two losing bids by a

[27] The incremental bid value is the bidder's difference in bid value between two different packages for a specified increment of spectrum. For example, Telefónica made a bid of £1,219.003m for a package of 2x10 MHz of 800 MHz spectrum (with coverage obligation). It also made a bid of £1,347.003m for a larger package of 2x10 MHz of 800 MHz *plus* 2x10 MHz of 2.6 GHz spectrum. Therefore, the specified increment of spectrum between these two packages is 2x10 MHz of 2.6 GHz, and the incremental bid value is £128m or £6.4m per MHz. Furthermore, the smaller package described above was Telefónica's winning package, and the increment in the larger package was the highest losing bid in the auction for 2.6 GHz spectrum.

bidder, and not just by the difference to its winning bid, can be regarded as a disadvantage of the LRP method for the reasons set out above.[28]

2.14 We also note that some of the analysis proposed by stakeholders in their responses involves estimating opportunity cost relative to a different assumed allocation of spectrum in the 4G auction than the actual winning packages (e.g. H3G's analysis of market value in the absence of spectrum reservation). A disadvantage of such analysis is that it takes us away from the reference point of the existing, post-auction spectrum holdings.

2.15 The methods are not identical. In the 2.6 GHz band this is reflected in the results of the methods not being the same, even though they all lie within a fairly narrow range between £4.99m and £5.7m per MHz. But the sources of difference between the methods are much more prominent in the analysis of the 800 MHz band due to the greater importance of various complicating factors than for the 2.6 GHz band. These complicating factors, which are outlined below, lead to substantial differences between some of the results from the different methods for the 800 MHz band.

Complicating factors in our analysis of market value for the purpose of ALF

2.16 Although we noted above that the 4G auction prices are the starting point for our analysis, various complicating factors mean that it is not in our view appropriate to take the auction prices themselves as the most appropriate estimates of market value for the purpose of ALF, especially for the 800 MHz band.

2.17 First, there is the effect on the auction prices for 800 MHz spectrum of **reserve prices** set by Ofcom:

a) Spectrum **reservation** for H3G meant that its auction price for 2x5 MHz in the 800 MHz band was set at the reserve price, below the opportunity cost of this spectrum as a deliberate consequence of the different pricing rule which applied to reserved spectrum.

b) The reserve price also affected the auction price of the 800 MHz spectrum won by EE, Telefónica and Vodafone.

2.18 Second, there are the implications for forward-looking opportunity cost of **changes in circumstances** since the 4G auction:

a) We consider that the **overall spectrum cap** of 210 MHz which applied in the 4G auction should be treated as **non-binding on a forward-looking basis**. This is because of the upcoming availability of additional mobile spectrum, including the 1.4 GHz, 2.3 GHz and 3.4 GHz bands. In our consultation on the forthcoming award of 2.3 GHz and 3.4 GHz bands in November 2014 we proposed an overall spectrum cap, but at the much higher level of 310 MHz. There is a significant implication for the market value of 800 MHz for the purpose of ALF, because the auction prices and opportunity costs of 800 MHz in the auction were affected by the bids of EE whose winning package was at the overall cap. This meant that the opportunity costs in the auction of 800 MHz were reduced, compared to the forward-looking opportunity cost, by EE's value for additional spectrum, reflecting a trade-off between more 800 MHz spectrum and less 2.6 GHz spectrum.

[28] See Annex 6 for details of the relevant constraints which characterise the LRPs in practice.

b) We also take account of the possibility that forward-looking market values today are lower than at the time of the 4G auction in 2013 due to **greater certainty of availability** of mobile spectrum in the future, compared to expectations at the time of the auction.[29] We take this into account as one of the possible reasons for our choice of the level of ALFs to be conservative when interpreting the evidence (see Section 1).[30]

2.19 Third, there are the implications for market value of **differences between 800 MHz spectrum in the 4G auction and 900 MHz**, given that our purpose is to derive a market value for 800 MHz to serve as a basis for the value of the 900 MHz band:

a) The pattern of value for additional 800 MHz spectrum may be different from the pattern for 900 MHz given the importance of synergies arising from technical efficiencies in contiguous blocks of 2x10 MHz and 2x20 MHz. In particular, the evidence suggests that EE's value in the auction for an additional 2x5 MHz in the 800 MHz band (to add to the 2x5 MHz it won) included a **contiguity premium**. However, EE has no current holdings of 900 MHz, which means that its value for 2x5 MHz of 900 MHz in addition to its existing spectrum holdings would be its first spectrum in that band to which it may be that no contiguity premium applies. Consequently, when deriving an opportunity cost for a 2x5 MHz increment of 800 MHz for the purpose of ALF, we exclude a contiguity premium.[31]

b) A further important implication is that the opportunity cost of **the 2x5 MHz of 800 MHz that EE won in the auction is not informative** for the purpose of ALF. In the 4G auction, EE was the only material losing bidder for additional 800 MHz spectrum. Telefónica and Vodafone were not permitted to bid for additional 800 MHz spectrum, given that they won 2x10 MHz taking them up to the level of the sub-1 GHz cap in the auction of 2x27.5 MHz (since each had pre-existing holdings of 2x17.4 MHz in the 900 MHz band). H3G chose not to place material bids in the auction for more 800 MHz spectrum than the 2x5 MHz it won. This meant that the opportunity cost of EE's 2x5 MHz of 800 MHz spectrum in the 4G auction to other bidders, i.e. from highest losing bids other than EE's, was very low (only £2.5m per MHz). However, for ALF we are seeking to derive the opportunity cost of the 900 MHz spectrum which is held by Telefónica and Vodafone. On the available evidence of the bids in the 4G auction, the opportunity cost for sub-1 GHz spectrum is set by EE. The opportunity cost in the auction of EE's 2x5 MHz of 800 MHz spectrum to other bidders excludes EE's own bids. As such, it excludes the most informative values for the opportunity cost of 900 MHz.

2.20 Fourth, there are the implications for opportunity cost of other differences in circumstances between the 4G auction and the ALF bands. The 4G auction was a package auction in which three different spectrum bands were available (800 MHz,

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[29] We respond in Annex 9 to stakeholder comments about the impact of future spectrum availability on market values.

[30] It is not clear to us that there is a way to derive a sufficiently reliable quantified estimate of this specific effect. Telefónica (p. 14, paragraph 43) said that the German Auction would provide a "concrete evidence point of how spectrum values have changed, based on newly available spectrum bands." We address this point in Annex 9, paragraphs A9.29 to A9.30.

[31] This approach might understate forward-looking opportunity cost because it does not take account of carrier aggregation, which might allow an operator to obtain a proportion of the contiguity premium with two non-contiguous blocks of 2x5 MHz. We explain this point in further detail in paragraph 2.162 below.

paired 2.6 GHz and unpaired 2.6 GHz – for the avoidance of doubt, in this section we use the term "2.6 GHz" to refer to the paired band except when expressly stated). When deriving auction prices or the opportunity cost in the auction, the value derived typically includes the value of rearranging spectrum between bidders. The highest losing bid for additional spectrum might not exactly match the winning package whose price is being derived. For example, EE's highest losing bids for additional 800 MHz spectrum were for packages with less 2.6 GHz spectrum than in its own winning package. This raises two issues:

a) To derive a value for 800 MHz alone, we need to add back the value of this 'lost' 2.6 GHz spectrum.

b) For the auction prices and opportunity costs in the auction, we add back the value of rearrangements. The 2.6 GHz spectrum 'released' by EE (in its highest losing bid compared to its winning package) is rearranged to other bidders when identifying the combination of highest losing bids for the 800 MHz spectrum won in the auction by each of H3G, Telefónica and Vodafone (which we also refer to as the "price-setting combination of packages"). It is rearranged to the bidders (other than EE) who made losing bids for additional 2.6 GHz spectrum.

For the purpose of ALF, such rearrangements could require interdependent, multi-party trades which might be difficult to achieve, given that they would (now) have to take place outside a multi-band auction. Therefore, in the marginal bidder analysis we seek to estimate the opportunity cost of 800 MHz and 2.6 GHz for the purpose of ALF without the value of **rearrangements**.

2.21 Fifth, we are interested in the opportunity cost for the **relevant marginal increment** of spectrum:

a) For the 800 MHz band we consider increments of both 2x5 MHz and 2x10 MHz. These correspond to the blocks of 800 MHz spectrum won in the 4G auction.

b) For the 2.6 GHz band the two highest losing bids in the auction by Telefónica and H3G were both for 2x10 MHz (although in the marginal bidder analysis we also consider the lowest winning bid for 2x5 MHz at the margin). The blocks of 2.6 GHz spectrum won in the 4G auction were larger at 2x15 MHz (Niche), 2x20 MHz (Vodafone) and 2x35 MHz (EE).

2.22 Sixth, two proposed **mergers** between participants in the UK 4G auction are currently being considered by the relevant competition authorities – BT's proposed acquisition of EE, and the proposed acquisition of O2 (Telefónica) by Hutchison Whampoa (parent company of mobile operator H3G). We have considered since the February 2015 consultation whether, if either merger took place, this would have implications for our estimate of the market value of 900 MHz and 1800 MHz spectrum for the purpose of ALF.

a) In general terms it is possible that the marginal operator for either ALF band could have a higher or lower valuation for additional spectrum following one or other of the mergers. As well as changes in market structure, the distribution of spectrum holdings between mobile operators would change:

i) The merging parties would have a larger customer base and larger combined spectrum holdings than separately (e.g. both H3G and Telefónica have holdings of 1800 MHz spectrum). However, noting that our marginal bidder analysis of 800 MHz spectrum focuses on EE as the marginal bidder, EE's

holdings of sub-1 GHz spectrum would not be affected by the BT/EE merger (as BT's spectrum holdings are in the paired and unpaired 2.6 GHz bands). Even so, there could be other relevant considerations, e.g. cross-band effects arising from changes in spectrum holdings could affect values positively due to synergies or negatively due to substitutability.

ii) Each operator would face one or more competitors who would have larger spectrum holdings. This could, for example, increase their value of additional spectrum, which they might need to maintain their competitive strength (other things being equal).

b) We do not have reliable evidence on how operators' spectrum valuations would be affected by changes in market structure, the distribution of spectrum holdings or other relevant considerations related to the mergers.[32]

c) To date neither merger has been approved, and it is possible that the relevant competition authority could prohibit either merger, or impose conditions such as divestment of spectrum.

d) Given the complications and the absence of reliable evidence, we consider it reasonable not to assume a specific change or direction of change in the value of relevant spectrum in light of either proposed merger.

August 2014 and February 2015 consultations and stakeholder responses

Our analysis and proposals in the August 2014 consultation

2.23 In the August 2014 consultation we explained that, whilst the auction revenue was derived properly for the purpose of the 4G auction and appropriately reflected the bids made in the auction, for the related but different question of market value for the purpose of ALF, in our view it was too low. Therefore, we considered that the results of the method of revenue-constrained LRPs, which attributes the auction revenue between the different bands in the auction, were also too low as a basis for ALF.

2.24 In summary our specific reasons were:

- the pricing rule in the auction for the reserved spectrum which was won by H3G intentionally resulted in an auction price below opportunity cost;
- EE's auction price at the reserve price was below opportunity cost for the purpose of ALF, because EE itself was the only losing bidder for 800 MHz spectrum; and

[32] In our analysis of benchmarks from auctions in other EU countries, we consider countries with three national mobile operators and countries with four national mobile operators. There does not seem to be a clear pattern that auction prices in countries with three operators are either consistently lower or higher than prices in countries with four operators. However, given in particular the relatively small number of countries in each category and the range of factors that could cause auction prices to differ between countries, we do not draw a clear conclusion from the absolute value benchmark evidence in this regard.

- the auction prices of Telefónica and Vodafone for 800 MHz were affected by a packing issue, which led to each operator's first 2x5 MHz being priced at the reserve price even though in general there was excess demand for the spectrum at the reserve price.

2.25 We considered the following three methods to estimate market value of 800 MHz and 2.6 GHz for the purpose of ALF:

- LRPs without revenue constraint;
- ASM; and
- marginal bidder analysis.[33]

2.26 Our preferred method was the marginal bidder analysis, for the following reasons:

a) The results of the method of LRPs without revenue constraint were reduced by bids that were constrained by the overall spectrum cap in the 4G auction. We considered that we should not treat the overall cap in the 4G auction as a binding constraint on a forward-looking basis.

b) The results of ASM involved effects in both directions which we considered were better removed for the purpose of ALF:

   o package rearrangements which may not be achievable outside a multi-band auction; and

   o treating the overall spectrum cap in the auction as a binding constraint.

c) We argued that these effects, which represented disadvantages of the two methods as described above, could be accounted for in the marginal bidder analysis, including through careful interpretation of the results. We considered spectrum increments of both 2x5 MHz and 2x10 MHz. On balance, for the 800 MHz band our view was that the market values using a 2x10 MHz increment were more appropriate as a basis for ALF, given the synergies in block size reflected in auction bids.

2.27 Our preferred figures, which we suggested were conservative estimates of market values (net of expected DTT co-existence costs) derived from our marginal bidder analysis, were:

- 800 MHz band: £32.63m per MHz; and
- 2.6 GHz band: £5.5m per MHz.

Our analysis and proposals in the February 2015 consultation

2.28 In the February 2015 consultation, in light of stakeholders' responses to our August 2014 consultation, we proposed some further modifications to our analysis. Our analysis considered auction prices, opportunity costs in the auction, LRPs and the

[33] For a high-level description of these methods, see paragraph 2.8 above. Further details are set out later in this section and in Annex 6.

marginal bidder analysis. It is summarised in paragraphs 2.53 to 2.58 below for 800 MHz spectrum and paragraphs 2.207 to 2.208 for 2.6 GHz spectrum (which are unchanged from the February 2015 consultation).

Stakeholder responses

2.29 In this sub-section we set out a summary of the responses from stakeholders on our analysis and proposals in the August 2014 and February 2015 consultations. We provide our comments on these responses in the detailed discussion in later sub-sections (in some cases supplemented by additional material in Annex 6).

Sums paid in the auction provide a ceiling on market value

2.30 In response to our August 2014 consultation, stakeholders argued that the sums paid in the 4G auction provided a ceiling on the market value of that spectrum:

a) Vodafone[34] said that it is implausible that the value of spectrum is greater than the sums paid in the auction, unless there has been a material increase in the value of UK spectrum since the auction. Vodafone made the same point also in response to our February 2015 consultation. It also argued[35] that setting ALFs too high created a risk that is not mirrored by the risk of setting them too low, which suggested putting no weight on any approach that gives results above the actual prices in the auction.

b) EE[36] said that reserve prices are very likely to overstate the market value and so the total revenue achieved in the auction must be seen as an upper bound of ALFs.

c) H3G[37] said that we should take account of the revenue equivalence theorem[38] and treat the auction revenue as an upper bound on estimates of market value. It also argued[39] that the auction prices were made artificially higher than full market value by the presence of spectrum reservation. Consequently, it suggested a downward adjustment needed to be made to the resulting value estimates to offset what it saw as the positive revenue effect of the spectrum reservation in the auction.

2.31 Vodafone[40] and Telefónica[41] suggested that there was no packing issue affecting the auction prices of 800 MHz spectrum if reserve prices were sufficiently low. They argued that the packing issue arose as a result of choices Ofcom made in the auction rules including setting relatively high reserve prices and applying those reserve prices on a lot by lot basis. Telefónica[42] said that, even if there was a packing issue, it did not agree with the use of hypothetical bids to try to compensate for this issue.

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[34] Vodafone's response to the August 2014 consultation, p. 8; and response to the February 2015 consultation, p. 12.
[35] Vodafone's response to the August 2014 consultation, p. 12.
[36] EE's response to the August 2014 consultation, p. 15.
[37] H3G's response to the August 2014 consultation, Annex A (Power Auctions report), p. 5 and p. 8.
[38] See footnote 77 for a description of the revenue equivalence theorem.
[39] H3G's response to the August 2014 consultation, Annex A (Power Auctions report), p. 12.
[40] Vodafone's response to the August 2014 consultation, p. 10.
[41] Telefónica's response to the August 2014 consultation, p. 35, paragraph 83.
[42] Telefónica's response to the August 2014 consultation, p. 35, paragraph 84.

The possibility of lumpy outcomes reflected the inherent lumpiness of demand for spectrum in some bands.

2.32 In response to our February 2015 consultation:

a) Vodafone[43] said that "[t]he virtue of a marginal bidder analysis lies in revealing whether or not the value to the marginal bidder is lower than the average sum paid. Neither the marginal bidder analysis nor the opportunity cost approach can be reasonably used to suggest that the value to the marginal bidder is greater than the average sum paid in the Auction"; and

b) Telefónica[44] said that it considered that the price that it paid in the auction is an anchor point for the upper bound of this range. In Telefónica's view, if we were to set the value of 800 MHz above this upper bound, then that would mean that the auction outcome did not achieve the market price.

2x5 MHz is the relevant increment for determining market value, not 2x10 MHz

2.33 In response to our August 2014 consultation, Vodafone[45] considered it more likely that, when setting ALFs based on a larger marginal increment, Vodafone/Telefónica would inefficiently relinquish 2x5 MHz (or less), which it claimed could not be used more efficiently by EE. It said that there was no good technical reason to choose a 2x10 MHz increment. Also, it contended that choosing a marginal increment of 2x10 MHz was inconsistent with Ofcom's recognition in the August 2014 consultation that, in the face of uncertainty, it needed to act conservatively.

EE's bids were inflated by strategic bidding

2.34 In response to our August 2014 consultation, Telefónica, H3G and Vodafone made the following comments:

a) Telefónica[46] claimed that EE's bid structure was not reflective of its true valuations. It contended that EE had little chance of winning the package of 2x20 MHz of 800 MHz and 2x20 MHz of 2.6 GHz (on which Ofcom's proposed value from the marginal bidder analysis was based). It would have required outbidding Telefónica or Vodafone on their 2x10 MHz in the 800 MHz band which was unlikely. Telefónica claimed that a bid for 2x15 MHz would have been more likely to win which is why EE did not submit a bid for it.

b) Telefónica also said that EE's bids included large synergies for incremental spectrum, in particular for large packages. It suggested that EE's small bids understated value and larger bids were inflated, so incremental values overstated market value.

c) H3G (Power Auctions report)[47] set out an analysis suggesting that EE had a small (or "near zero") chance of winning the package of 2x20 MHz of 800 MHz

[43] Vodafone's response to the February 2015 consultation, p. 12.
[44] See Telefónica's response to our February 2015, paragraph 87 on p. 30.
[45] See Vodafone's response to our August 2014 consultation, p. 13-21, and Annex 1, p. 5-6.
[46] See Telefónica's response to the August 2014 consultation, p. 25.
[47] See p. 30-36 in Annex A, Power Auction's report as part of H3G's response to the August 2014 consultation.

and 2x20 MHz of 2.6 GHz, and it claimed that EE only submitted a bid for this package to set prices paid by other bidders.

d) Vodafone[48] said that setting ALFs based on marginal values which potentially contained strategic premiums could result in inefficient re-allocations, potentially leading to spectrum being relinquished even though there is no higher value user. It claimed[49] that there was evidence that an element of strategic value (strategic premium) was reflected in EE's bidding as packages approached the spectrum cap. This was because bids for larger packages were more likely to be included in the price determination for other bidders.

2.35 In response to our February 2015 consultation, we received further comments from Telefónica.[50] Specifically, Telefónica said that the question is whether EE's bid for 2x5 MHz of 800 MHz is a reliable data point in light of EE's incentives and behaviour in the auction. In considering this question, Telefónica made the following points:

a) Telefónica interpreted our statement in paragraph A8.122 of the February 2015 consultation as meaning that the CCA is less vulnerable to strategic bidding than other formats and disagreed with this view.[51] Rather, according to Telefónica, CCAs often introduce strong incentives for strategic bidding, and these can and have distorted the price outcomes of recent multi-band auctions. In support of this view, Telefónica submitted two reports it had commissioned, one by Professor Maarten Janssen for CEG and the other by NERA Economic Consulting. NERA commented on the UK 4G auction in particular, suggesting the possibility of price driving and strategic investment, but considered that the extent to which strategic investment may have affected bids, allocation and pricing was ambiguous.

b) Telefónica also said that "EE's letter tells us very little about the extent to which it engaged in strategic bidding"[52] because:

i) it is not clear that EE used the same valuation assumptions across all its bids;

ii) Telefónica suspects, from EE's bid profile, that its valuations had an element of strategic value, and it is "hardly surprising" that EE claims otherwise; and

iii) EE's letter does not rule out the possibility that it may have engaged in price driving.

c) According to Telefónica, EE's bids for 2x20 MHz of 800 MHz would have carried minimal risk up to very high price levels, because it could confidently predict that Vodafone would not bid for fewer than 2 lots while Telefónica, even if budget constrained, would prioritise two lots and never drop below one lot, because it was generally understood that Vodafone and Telefónica's plans to share network rollout cost would require them each to buy 800 MHz. In Telefónica's view, this is

[48] See Vodafone's response to the August 2014 consultation, p. 8.
[49] See Vodafone's response to the August 2014 consultation, Annex 1, p. 8, and Annex 1.1, p. 12-14.
[50] See Telefónica's response to the February 2015 consultation, p. 22-25.
[51] See Telefónica's response to the February 2015 consultation, paragraph 72, p. 22. Telefónica referred to EE's letter of 13 November 2014, which is available at http://stakeholders.ofcom.org.uk/binaries/consultations/annual-licence-fees-further-consultation/Letter_to_Ofcom_from_EE.pdf.
[52] See Telefónica's response to the February 2015 consultation, paragraph 77, p. 22.

supported by the fact that each placed large supplementary bids for 800 MHz and did not place supplementary bids for fewer than two lots.[53]

Ofcom should take the overall cap in the 4G auction of 210 MHz as a binding constraint

2.36 In response to our August 2014 consultation, Vodafone and EE made the following comments:

a) Vodafone[54] argued that, to depart from the overall cap in the auction, Ofcom would be pre-judging a competition assessment. It claimed that, in any case, we had failed to set out any competition assessment to support our approach that the overall cap should be treated as non-binding on a forward-looking basis;

b) EE[55] said that Ofcom cannot dismiss the spectrum cap constraint upon EE when establishing marginal value. It also argued that, even if EE is not prevented from acquiring more 900 MHz spectrum due to the future release of spectrum that release itself drives spectrum values down due to greater availability of spectrum.

2.37 In response to the February 2015 consultation, Vodafone[56] said that the relevant question is whether Ofcom's spectrum caps in the auction would be a constraint on EE's current acquisition of additional sub-1 GHz spectrum. According to Vodafone, in order for the marginal bidder EE to acquire additional sub-1 GHz spectrum, then another operator would be relinquishing that spectrum and its post auction holdings of sub-1 GHz spectrum would be reduced. Vodafone claimed that "Ofcom's 2012 competition assessment concluded that in order to be credible national wholesalers, both O2 and Vodafone would need to acquire 2*10MHz of 800MHz", citing paragraphs 4.132 and 4.134 of our July 2012 statement on the future assessment of mobile competition.[57]

2.38 Furthermore, Vodafone said that by applying a 310 MHz provisional cap whose increase from the 2012 cap of 210 MHz relates to the release of 2.3 GHz and 3.4 GHz spectrum, we are equating sub-1 GHz spectrum with 2.3 GHz and 3.4 GHz spectrum. In Vodafone's view, this could not be correct as the utility of the 2.3 GHz and 3.4 GHz to a mobile operator is much less than sub-1 GHz, 1800 MHz or even 2.6 GHz paired spectrum.

2.39 Also, Vodafone said that our April 2015 consultation on inclusion of 1.4 GHz and other bands in the Mobile Trading Regulations[58] seemed to suggest that we would consider the impact on competition if an operator, e.g. EE, were to acquire some of the 1.4 GHz spectrum. Vodafone contrasted this position with "our apparent refusal" to conduct an analysis on changes in sub-1 GHz spectrum holdings by considering the likelihood of EE being allowed to acquire sub-1 GHz spectrum. According to

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[53] See Telefónica's response to the February 2015 consultation, paragraph 74, p. 23.
[54] See Vodafone's response to the August 2014 consultation, p. 17 and 21.
[55] See EE's response to the August 2014 consultation, p. 16-18.
[56] See Vodafone's response to the February 2015 consultation, p. 13-15.
[57] http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/statement.pdf
[58] In paragraph 1.7 of our April 2015 consultation we said: "We have not, at this stage, established any specific concerns which might result from any particular operator acquiring the 1452-1492 MHz spectrum but recognise that issues could arise which warrant further consideration. To the extent that competition concerns arise in respect of a given trade, we can consider them at the time that any trade occurs."

Vodafone, given the higher value and present utility of sub-1 GHz spectrum over 1400 MHz, this is an "apparent contradiction".

Ofcom's implementation of the marginal bidder approach included subjective decisions

2.40 In response to our August 2014 consultation, H3G, Telefónica and EE made the following comments.

a) H3G[59] said that our marginal bidder analysis omitted relevant information, in particular, because we limited our attention to paired 2.6 GHz spectrum (C lots) while ignoring bids for unpaired 2.6 GHz spectrum (E lots). It also criticised our reasoning in the August 2014 consultation for the selection of £32.63m per MHz as an estimate of the market value of the 800 MHz band in the marginal bidder analysis.

b) Telefónica[60] suggested that our analysis failed to take into account that the value of 900 MHz spectrum would not be inflated by the contiguity premium in the same way 800 MHz was in the 4G auction (even when looking at the value of a 2x10 MHz increment).

c) EE[61] argued that the marginal bidder analysis was highly subjective, extremely unreliable and overstated the market value of 800 MHz. It contended that the absence of information on how EE or other bidders would have bid for additional 800 MHz spectrum should in itself have been a signal that the adoption of the marginal bidder analysis was prone to significant error and unreliable results. EE also suggested that the marginal bidder analysis:

i) failed to provide market values of frequencies as a whole, as it ignores effects across bands;

ii) focused on an arbitrary marginal increment of spectrum;

iii) over-estimated the intrinsic value placed on additional 800 MHz spectrum given that EE's bids in the 4G auction contained significant complementarities (contiguity premium and complementarity premium); and

iv) significantly weakened bidders' incentives to reveal their true opportunity cost in future auctions.

Ofcom's implementation of the opportunity cost approach is based on arbitrary assumptions

2.41 In response to our February 2015 consultation, Telefónica and Vodafone made the following comments.

[59] See p. 37-40 in Annex A, Power Auction's report as part of H3G's response to the August 2014 consultation.
[60] See p. 28-29 in Telefónica's response to the August 2014 consultation.
[61] See p. 5 in EE's response to the August 2014 consultation.

a) Telefónica[62] said that the new valuation approach of 800 MHz spectrum is an arbitrary combination of two data points, the larger of which, £38.4m per MHz, is an outlier with no credibility. Its view is that the resulting valuation of 800 MHz spectrum is excessively high. It said that the opportunity cost of £38.4m per MHz:

   i) was never proposed by anyone as a candidate value for 800 MHz spectrum;

   ii) was derived from a set of bids that could not have been winning bids, given the bidding strategy adopted by H3G;

   iii) depends on a specific bid by EE that includes a substantial contiguity premium for a second 800 MHz lot that is not relevant to 900 MHz; and

   iv) may have been distorted by strategic factors with respect to EE's bid structure.

b) Vodafone[63] said that our opportunity cost results include contiguity premiums in bids for 800 MHz spectrum, which would not be applicable when operators are valuing spectrum in the 900 MHz band, "which is obviously not contiguous with the 800 MHz spectrum band".

c) Vodafone[64] also said that our estimated opportunity costs are based on the potential for significant rearrangement of spectrum under a combinatorial approach, which allows for an optimal reallocation of spectrum. It argued that such reallocation is not possible in an ALF regime.

Ofcom's approach to valuing 800 MHz and 2.6 GHz is not conservative and considers each band in isolation

2.42 In response to the February 2015 consultation, Telefónica provided a list of arguments why in its view our market value estimates for 800 MHz and 2.6 GHz spectrum may not be conservative.[65]

2.43 In relation to 800 MHz spectrum, it[66] said that:

a) In its view, our estimate for 800 MHz spectrum places undue weight on a specific high price point, rather than assessing all evidence points in the round. It said that a more rounded assessment of all evidence points suggests a market value of no less than £24.2m (LRP with no reserve price bids) and no more than £31.2m (LRP without revenue constraint), a broad range that should be narrowed to between £24.2m and £27.5m (Telefónica's auction price).

b) The market value of £30m per MHz for 800 MHz spectrum is above the LRP with revenue constraint (£26.9m per MHz) and Telefónica's auction price (£27.5m per

[62] See Telefónica's response to the February 2015 consultation, p. 19-21, paragraphs 63-66.
[63] See Vodafone's response to our February 2015 consultation, p. 11.
[64] See Vodafone's response to the February 2015 consultation, p. 11.
[65] See also EE's response to the February 2015 consultation, p. 25-27. Our response to EE's claim that "ALFs calculated by reference to current spectrum holdings risks overstating efficient long-term ALFs" can be found in Appendix 2 of Annex 6 of this statement.
[66] See Telefónica's response to the February 2015 consultation, paragraph 82 on p. 25 and Table 1, p. 26-28.

MHz), while the sums paid in the auction should represent an upper bound on the market value.

c) The risk of understatement due to using zero reserve prices and not taking account of the potential for at least a proportion of the contiguity premium to be realised is second order compared to our decision to adopt a method based on a specific high price point.

d) When making adjustment for DTT co-existence costs and value of avoiding the coverage obligation, we added on 100% of its calculated value, notwithstanding evidence that operators had different views regarding these values and ambiguity over the extent they were really incorporated into bids.

e) CCA may create incentives for overbidding (Telefónica submitted NERA and Janssen's papers as supporting documents to this argument). Given the strategic incentives for EE to overbid on 800 MHz, it seems more likely that EE made bids for larger amounts of 800 MHz that it did not want or expect to win but could afford in the unlikely event that they were successful.

2.44 With respect to 2.6 GHz spectrum, Telefónica[67] said that a plausible range for full market value lies somewhere between £4.95m and £5.5m per MHz, which correspond to the low estimate under LRP and an upper bound set by the level of reserve price at which a 2.6 GHz lot would have gone unsold. In its view an estimate at the upper bound of the plausible range is not a conservative approach.

2.45 In response to the February 2015 consultation, Vodafone[68] said that by considering each band in isolation, rather than the market value of the ALF bands "as a whole", the Ofcom marginal bidder analysis and the opportunity cost outcome are inconsistent with the multi-band design of the UK auction, in which bidders were encouraged to express complementarities for the packages of 800 MHz and 2.6 GHz, and do not meet the requirements of the Government Direction.[69]

Stakeholders suggested different estimates of market value than proposed by Ofcom

2.46 In response to the August 2014 consultation, BT[70] agreed with our proposed market values both for 800 MHz and 2.6 GHz spectrum, while EE[71], H3G[72], Telefónica[73] and Vodafone[74] suggested lower estimates. See Table 2.1 for a summary of preferred methods and suggested values by stakeholders.

2.47 EE said that the LRPs with revenue constraint was the most appropriate and reliable method.

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[67] See Telefónica's response to the February 2015 consultation, paragraph 88, p. 30.
[68] See Vodafone's response to the February 2015 consultation, p. 12-13.
[69] Vodafone also argued in response to the July 2015 update on the German auction that, according to the express terms of the Government Direction, the valuation in the UK for the purposes of ALF must be sequential rather than simultaneous. Our response to this argument is in Appendix 2 of Annex 6 of this statement.
[70] See BT's response to the August 2014 consultation, paragraph 1.
[71] See EE's response to the August 2014 consultation, section 3.4, p. 30.
[72] See H3G's response to the August 2014 consultation, Table 2, p. 7.
[73] See Telefónica's response to the August 2014 consultation, paragraph 10, p. 5.
[74] See Vodafone's response to the August 2014 consultation, paragraph 1.a in p. 3 (800 MHz spectrum), and Annex 1, p. 3 (2.6 GHz spectrum) of its response.

2.48 H3G[75] derived its suggested values from a variation of LRPs with an adjusted, lower revenue constraint, and values by band reflecting pro-rating compared to the structure of LRPs without revenue constraint.

Table 2.1: Summary of preferred methods and suggested values by stakeholders (in £m per MHz)

	BT	EE	H3G	Telefónica	Vodafone
Preferred method	Ofcom's August 2014 consultation (marginal bidder analysis)	LRP with revenue constraint	LRPs with revenue adjusted (below the auction revenue)	Broad assessment of all plausible methodologies	Marginal bidder analysis (with mean/median bid values)[76]
Suggested values for 800 MHz	£32.63m	£26.89m	£25.04m	£25m	£17.9m – £21.4m
Suggested values for 2.6 GHz	£5.5m	£4.99m	£3.57m	£4.95m	£5.5m

Source: Ofcom from responses to the August 2014 consultation

2.49 Telefónica[77] said that there were a number of plausible methodologies, each with strengths and weaknesses, and a reasonable approach was to look at these as a whole, and make a judgement based on a weighted assessment of these approaches.

2.50 Vodafone's preferred method was its marginal bidder analysis (which is materially different from Ofcom's) on the basis that it could separate intrinsic value from (contiguity and strategic) premium values. As a second choice, it supported the use of the decomposition approach, which decomposes by band the opportunity cost imposed by each bidder.[78]

2.51 In response to the February 2015 consultation, Telefónica[79] and Vodafone[80] reiterated the market values suggested in their responses to the August 2014 consultation.

2.52 Taking account of the above, we now set out our analysis of the full market value for the purpose of ALF of, first, the 800 MHz band and, thereafter, the 2.6 GHz band. We derive our estimate of market value of 800 MHz spectrum using a range of methods and evidence, and by applying our regulatory judgement. For the 2.6 GHz band, we use the same range of methods and we also use our judgement, but the evidence is

[75] See H3G's response to the August 2014 consultation, Annex A Power Auctions report, p. 45.
[76] Vodafone proposed to use the same method and values as in its response to the October 2013 consultation.
[77] See Telefónica's response to the August 2014 consultation, p. 17.
[78] Vodafone (Annex 1, p. 9, response to the August 2014 consultation) said that a market value of £5.5m per MHz for 2.6 GHz spectrum was fairly reasonable for the reason that a market price cannot possibly exceed the highest price at which it is possible to sell all available lots. Also, it said that £5.5m per MHz was broadly in line with our claim of being conservative.
[79] See Telefónica's response to the February 2015 consultation, paragraph 55, p. 17.
[80] See Vodafone's response to the February 2015 consultation, p. 9 (value of 800 MHz spectrum) and p. 16 (value of 2.6 GHz spectrum).

less varied because fewer of the complicating factors identified above are relevant. We address stakeholders' comments throughout the analysis which follows.

Market value of the 800 MHz band for the purpose of ALF

Summary of our analysis

2.53 In this sub-section we summarise our analysis of the market value of the 800 MHz band for the purpose of ALF, which we then set out in greater detail in the subsequent sub-sections. Except where expressly stated, all market value figures for 800 MHz spectrum in this section are expressed net of expected DTT co-existence costs, reflecting the observed bids in the 4G auction for 800 MHz spectrum. In the concluding sub-section at paragraph 2.203 we set out the market value which is gross of expected DTT co-existence costs. We consider in turn below each of the following analytical steps.

2.54 **Auction prices** for 800 MHz spectrum (£22.5m per MHz for EE and H3G, £27.5m per MHz for Telefónica, and £27.5m or £30.4m per MHz for Vodafone[81]).

2.55 **Opportunity cost in the 4G auction for the purpose of ALF** of 2x5 MHz and 2x10 MHz increments:

a) Initially, we examine the opportunity costs in the auction of the winning packages of H3G and Telefónica respectively. These packages only included 800 MHz spectrum, so there is no need to decompose a multi-band package amount between the constituent bands. We use these opportunity costs to derive a candidate market value of £30m per MHz as a weighted average of the opportunity costs of these increments: £38.4m per MHz for 2x5 MHz (H3G) and £26.45m per MHz for 2x10 MHz (Telefónica).

b) We also take into account other information on opportunity cost in the auction. We consider the opportunity cost in the auction of the 800 MHz spectrum won by EE (£2.5m per MHz) and decompositions for 800 MHz spectrum of the amount for the multi-band package of spectrum won in the auction by Vodafone (about £26m per MHz), using ASM and the decomposition method. The opportunity cost of EE's 2x5 MHz is not informative of the market value for the purpose of ALF (as discussed at paragraph 2.19b) above); and the opportunity cost of Vodafone's 2x10 MHz is consistent with our candidate value (when averaged with the higher marginal opportunity cost of H3G's 2x5 MHz increment).

2.56 **Linear Reference Prices.** In addition, we compare the candidate market value of £30m per MHz against the following LRPs for 800 MHz: (i) with the auction revenue as a constraint (£26.9m per MHz); (ii) without revenue constraint (£31.2m per MHz); and (iii) with a linear price which avoids excess supply and minimises excess demand (£31m per MHz). We consider that the revenue-constrained LRPs are too low for the purpose of ALF because the auction revenue understates the relevant forward-looking opportunity cost. Especially in these circumstances, we consider that the other LRPs, from (ii) and (iii), provide useful reference points. In our view the LRPs are broadly consistent with the candidate market value of £30m per MHz or suggest it might understate full market value.

[81] We report multiple figures for Vodafone, because there is more than one way to decompose its multi-band package price between the constituent bands.

2.57 **Differences in circumstances from the 4G auction, and the marginal bidder analysis**. We consider the implications for opportunity costs for the purpose of ALF of differences in circumstances from the 4G auction, specifically: (i) treating the overall cap in the 4G auction of 210 MHz as non-binding on a forward-looking basis; (ii) excluding a contiguity premium when estimating the opportunity cost of a 2x5 MHz increment; and (iii) excluding the value of rearrangements. The first factor, non-binding overall cap, implies higher opportunity cost for the purpose of ALF. The second factor, excluding a contiguity premium, implies lower opportunity cost. The third factor, excluding rearrangements, on its own also implies lower opportunity cost:[82]

a) Our proposed market value for the 800 MHz band in the August 2014 consultation (£32.6m per MHz) was derived from the marginal bidder analysis. We continue to believe this method is informative of market value for the purpose of ALF and, in principle, it allows us to examine the implications of the differences in circumstances from the 4G auction. However, in the light of stakeholder responses on the difficulties in practice of obtaining sufficiently reliable estimates of market value from the marginal bidder analysis for the 800 MHz band, we do not now consider it appropriate to derive a specific quantified estimate from the marginal bidder analysis.

b) Instead we use the perspective of the marginal bidder analysis as a cross-check[83] on the candidate market value of £30m per MHz that we derive from our consideration of opportunity cost in the auction, considering both 2x5 MHz and 2x10 MHz increments. In our view the differences in circumstances from the 4G auction imply significant changes to the marginal opportunity costs of 2x5 MHz and 2x10 MHz increments:

- For a 2x5 MHz increment (H3G's spectrum), the marginal bidder analysis suggests that the forward-looking marginal opportunity cost relevant to ALF is lower than the opportunity cost in the 4G auction of £38.4m per MHz (due to excluding a contiguity premium).

- For a 2x10 MHz increment (Telefónica's spectrum) the marginal bidder analysis suggests that the forward-looking marginal opportunity cost relevant to ALF is higher than the opportunity cost in the 4G auction of £26.45m per MHz (due to the overall cap in the 4G auction of 210 MHz being non-binding on a forward-looking basis).

Taking these implications into account, in our view the available evidence from the marginal bidder analysis suggests that £30m is a reasonable estimate of the

[82] By "on its own" we mean comparing the position with rearrangements with the position without rearrangements, holding constant other features such as the overall spectrum cap. We explain below that, in the price-setting combination, rearrangements of 2.6 GHz spectrum from EE to other bidders reduced the opportunity cost in the 4G auction compared to the forward-looking value, i.e. when the overall cap in the auction is treated as non-binding on a forward-looking basis (see paragraphs 2.111 to 2.113). But with the overall cap of 210 MHz binding, as in the auction, excluding rearrangements would reduce the opportunity cost.

[83] The nature of this cross-check is that we use a different perspective or method to analyse the same underlying evidence of bids in the 4G auction as we used in deriving the candidate market value (given that reliable, independent evidence which is informative of the market value is not available). Similarly, when we refer to a cross-check of the candidate market value against LRPs, we mean a comparison against a different method of analysing the same underlying evidence.

market value of the 800 MHz band for the purpose of ALF or tends to suggest it might understate market value.

2.58 Taking account of the evidence and analysis in the preceding analytical steps and applying our regulatory judgement, our conclusion is that an appropriate market value of the 800 MHz band for the purpose of ALF is **£30m per MHz**. In our view, this is more likely to understate market value than to overstate it (for reasons set out in detail below and summarised in paragraph 2.205). In the following sub-sections we consider each of the analytical steps in greater detail.

Auction prices

2.59 As explained in the preceding summary, our starting point is to consider the auction prices for spectrum acquired in the 800 MHz band. EE and H3G each won 2x5 MHz of 800 MHz spectrum in the 4G auction. Both paid an auction price for this spectrum at the reserve price of £225m (or £22.5m per MHz). Vodafone and Telefónica each won 2x10 MHz of 800 MHz spectrum in the auction:

a) Telefónica's auction price was £550m including a discount of £31m for the coverage obligation.[84] This implies a price without the discount for the coverage obligation of £581m (or £29.05m per MHz). All references to the coverage obligation in the UK in this section (and in Sections 3 to 4 and Annexes 6 to 8) mean the coverage obligation on the 2x10 MHz of 800 MHz spectrum won in the 4G auction by Telefónica (which we refer to in Section 6 as the "800 MHz coverage obligation").

b) Vodafone won a package of spectrum in all three bands in the auction, so its auction price for 800 MHz depends on how its package price is decomposed between the bands. There is no uniquely correct way to derive this decomposition and a range of figures can be derived using different approaches. In the August 2014 and February 2015 consultations we suggested two alternative decompositions with associated prices for 800 MHz as follows (see Annex 6):

   i) £608.5m (or £30.425m per MHz).

   ii) £550.5m (or £27.525m per MHz).[85]

2.60 The reserve price for 800 MHz of £22.5m per MHz influenced the auction prices of all four winners of 800 MHz spectrum – see Table 2.2. This table shows auction prices for Vodafone and Telefónica for each of the two 2x5 MHz amounts in the 2x10 MHz blocks they won in the auction (as in Table 2.3 in the August 2014 consultation).

2.61 The prices were affected by various rules which applied in the 4G auction:

a) The reserve price for 800 MHz of £225m per 2x5 MHz (or £22.5m per MHz).

[84] For the derivation of the discount for the 800 MHz coverage obligation, see paragraph 2.28 in the August 2014 consultation and paragraph A6.117 in Annex 6, the latter referring to the difference in LRPs between A1 and A2 as £31m.
[85] In Annex 6 we also set out a third decomposition of £27.113m per MHz.

b) Spectrum reservation for a fourth national wholesaler, which was the 2x5 MHz in the 800 MHz band obtained by H3G (as the only eligible operator that opted in to compete for reserved spectrum).

c) The cap on sub-1 GHz spectrum of 2x27.5 MHz, taking into account both pre-auction holdings and spectrum acquired in the auction. The 2x10 MHz of 800 MHz won by each of Vodafone and Telefónica took them up to the maximum level permitted under this cap, given that each also holds 2x17.4 MHz in the 900 MHz band (for which we are setting the level of ALF in this document).

d) The cap on overall holdings of mobile spectrum of 210 MHz ("the overall cap") taking into account both pre-auction holdings and spectrum acquired in the auction. The 80 MHz of spectrum won in the auction by EE (comprising 2x5 MHz of 800 MHz and 2x35 MHz of 2.6 GHz) took it up to the maximum permitted under this overall cap, given its holdings of 2x20 MHz in the 2.1 GHz band and 2x45 MHz in the 1800 MHz band (for which we are setting the level of ALF in this document).

Table 2.2: Auction price attributable to 800 MHz

	EE	H3G	Telefónica	Vodafone	Total / average per MHz
First 2x5 MHz	£225m	£225m	£225m	£225m	
Second 2x5 MHz	n/a	n/a	£325m	£383.5m*	
Auction price	£225m	£225m	£550m	£608.5m	£1608.5m
Amount of spectrum	2x5 MHz	2x5 MHz	2x10 MHz	2x10 MHz	2x30 MHz
Average	£22.5m per MHz	£22.5m per MHz	£27.5m^ per MHz	£30.425m per MHz	£26.81m per MHz

Source: Ofcom

* This figure is derived using ASM. With other decompositions of Vodafone's multi-band package price between bands, other amounts attributable to 800 MHz are possible.

^ This figure includes the discount for the coverage obligation – without the discount, the average price would be £29.05m per MHz.

2.62 At the relevant points in the discussion below we explain in more detail the implications of these auction rules for the opportunity cost for the purpose of ALF.

Opportunity costs in the 4G auction for the purpose of ALF

2.63 We now consider the underlying opportunity costs of 2x5 MHz and 2x10 MHz increments. We do so in a way which does not depend on the reserve price since the reserve price was a figure set by Ofcom, not by auction bids.

2.64 To do so, we focus initially on the opportunity cost of the 2x5 MHz of 800 MHz spectrum won by H3G and the 2x10 MHz won by Telefónica. The winning packages of these two bidders only included 800 MHz spectrum and do not raise the same complications that arise for the 800 MHz spectrum won by EE and Vodafone (which requires us to decompose amounts for multi-band packages between the constituent bands). We then consider some possible decompositions of the opportunity costs in the auction of EE's and Vodafone's spectrum. Further details of the derivation of

these opportunity costs are set out in Annex 6. Thereafter we explain how we derive our candidate value for 800 MHz spectrum.

Opportunity cost in the 4G auction of H3G's 2x5 MHz of 800 MHz spectrum was £38.4m per MHz

2.65 The opportunity cost to other bidders of the 2x5 MHz of 800 MHz spectrum won in the 4G auction by H3G was £384m (or **£38.4m per MHz**). This opportunity cost comprised EE's value for additional 800 MHz spectrum (i.e. for more than the 2x5 MHz it won in the 4G auction) and the value of rearrangements of 2.6 GHz spectrum from EE to other bidders. The components of the opportunity cost were:

a) £310.5m – EE's incremental bid value (IBV)[86] for an additional 2x5 MHz of 800 MHz and 2x5 MHz less of 2.6 GHz compared to its winning package; plus

b) £128m – Telefónica's IBV for an additional 2x10 MHz of 2.6 GHz compared to its winning package; less

c) £52.5m – Niche's IBV for 2x5 MHz less of 2.6 GHz and an additional 5 MHz of unpaired 2.6 GHz compared to its winning package; less

d) £2m – Vodafone's IBV for 5 MHz less of unpaired 2.6 GHz compared to its winning package.

2.66 We now describe the reason that losing bids for 2.6 GHz spectrum are involved in determining the opportunity cost in the 4G auction of 800 MHz spectrum. Note that the description below relates not to bidders' actual winning packages, but to the price-setting combination (i.e. the packages that constitute the combination of highest losing bids for the 2x5 MHz of 800 MHz spectrum won in the auction by H3G):

a) EE made no losing bid for an additional 2x5 MHz of 800 MHz spectrum on its own. This is because its winning package (2x5 MHz of 800 MHz and 2x35 MHz of 2.6 GHz) was at the overall spectrum cap. Therefore, the driver of the opportunity cost of £384m is the losing bid by EE for a package with an additional 2x5 MHz of 800 MHz but also 2x5 MHz less of 2.6 GHz (i.e. a package of 2x10 MHz of 800 MHz and 2x30 MHz of 2.6 GHz) at an incremental bid value of £310.5m compared to its winning package. But £310.5m is an understatement of the opportunity cost of 800 MHz, because it is reduced by EE's lost value of 2x5 MHz of 2.6 GHz.

b) We need to find the highest losing bid for this 2x5 MHz of 2.6 GHz to add back the lost value of this spectrum and so obtain the opportunity cost of the 2x5 MHz of 800 MHz spectrum. The highest losing bid for 2.6 GHz spectrum is Telefónica's losing bid for 2x10 MHz, not 2x5 MHz, at an incremental bid value of £128m.

[86] As noted above, the IBV is the bidder's difference in bid value between two different packages for a specified increment of spectrum. £310.5m is the IBV between EE's bids for the package of: (i) 2x10 MHz of 800 MHz and 2x30 MHz of 2.6 GHz (bid of £1,360m); and (ii) 2x5 MHz of 800 MHz and 2x35 MHz of 2.6 GHz (its winning package at a bid of £1,049.5m). The increment of spectrum is the difference in spectrum between these two packages, i.e. an additional 2x5 MHz of 800 MHz and 2x5 MHz less of 2.6 GHz.

c) Therefore, we also need to find the lowest winning bidder to give up 2x5 MHz of 2.6 GHz to put together with the 2x5 MHz from EE and yield a supply of 2x10 MHz of 2.6 GHz to match the highest losing bid from Telefónica for 2x10 MHz. This bidder is Niche, but the smallest bid value is sacrificed by taking Niche's losing bid which involved an additional 5 MHz of unpaired 2.6 GHz as well as 2x5 MHz less of paired 2.6 GHz spectrum at an incremental bid value of £52.5m.

d) There is now a 'spare' 5 MHz of unpaired 2.6 GHz spectrum and the highest losing bidder for this is Vodafone at an incremental bid value of £2m.

2.67 H3G did not pay this opportunity cost of £384m as its auction price; instead, it paid the reserve price, which was £159m lower at £225m. This was because H3G benefited from the competition measure in the 4G auction of reserved spectrum for which it was not required to pay the opportunity cost. There was a specific auction pricing rule that deliberately set a price below opportunity cost for reserved spectrum; and in practice, it was the reserve price.[87] For the purpose of ALF, it is the opportunity cost of H3G's spectrum which is relevant, not the reserve price.[88]

2.68 In contrast, in its response H3G argued that spectrum reservation made auction prices and opportunity costs artificially higher than full market value to other winners of unreserved 800 MHz spectrum by restricting the amount of spectrum available to them. By making assumptions about how H3G's bids would have been different in the absence of spectrum reservation (and assuming unchanged bids by other bidders), it argued that: (i) the auction outcome would have been different, with EE winning 2x10 MHz in the 800 MHz band and H3G not winning any 800 MHz

[87] The way that H3G chose to bid guaranteed it would win reserved spectrum at the reserve price (£22.5m per MHz), given the specific auction pricing rule. Further information on this point can be found in a paper written by Ofcom's Director of Competition Economics, Geoffrey Myers, in his personal capacity: "The innovative use of spectrum floors in the UK 4G auction to promote competition", Centre for the Analysis of Risk and Regulation, London School of Economics, Discussion Paper 74, November 2013, ISSN 2049-2718, http://www.lse.ac.uk/researchAndExpertise/units/CARR/pdf/DPs/DP74-Geoffrey-Myers.pdf.

[88] We note that in Figure A8.6 in the October 2013 consultation we reported Vodafone's decomposition approach (from its submission in June 2013) with nominal reserve prices (set at £1,000), which includes a figure for the opportunity cost of H3G's spectrum in the presence of the competition constraint (i.e. spectrum reservation) of £13.7m per MHz. However, for the avoidance of doubt, £13.7m per MHz is not the full opportunity cost to other bidders of the spectrum won by H3G. Instead, it is related to the choice of reserved spectrum (or "spectrum floor") won by H3G. As explained in the paper cited at footnote 46:

> "H3G won the spectrum floor of 1xA1 [2x5 MHz of 800 MHz] instead of 4xC [2x20 MHz of 2.6 GHz] because the incremental value in its bids of £165m exceeded the additional opportunity cost to other bidders of £107.156m. (This was an "additional" opportunity cost because it was additional to other bidders' loss in bid value of £276.844m from H3G winning 4xC instead of them winning that as well as all of the other spectrum in the auction.)" [page 19]

The figure of £13.7m per MHz is the core price (collective opportunity cost) related to the Vickrey price (individual opportunity cost) of £107.156m, or £10.7m per MHz, in the quotation above. For a further discussion of core and Vickrey prices in the context of the decomposition method, see Annex 6. The significant point, however, is that the full opportunity to other bidders of the spectrum won by H3G is the sum of the two figures in the quotation above, £107.156m plus £276.844m, i.e. £384m or £38.4m per MHz.

spectrum; and (ii) opportunity cost-based auction prices would have been 12%-15% lower in the absence of reserved spectrum.[89]

2.69 However, in our view H3G's response is not addressing the relevant question:

a) First, for the purpose of ALF we are most interested in the opportunity cost relative to existing, post-auction spectrum holdings. By assuming a change in the auction outcome without spectrum reservation, H3G's estimates of new opportunity cost-based prices are not relative to current spectrum holdings. In particular, the opportunity cost in the hypothetical scenario put forward by H3G is relative to EE holding more 800 MHz spectrum than it actually has. This reduces the size of the opportunity cost. In contrast, our figures for the opportunity cost in the auction of 800 MHz are all relative to existing, post-auction spectrum holdings.

b) Second, we do not consider it appropriate for the purpose of ALF to estimate auction prices in the absence of spectrum reservation. Such reservation was an important competition measure in the 4G auction, imposed to promote competition. Whether or not the opportunity cost of unreserved spectrum to other bidders is higher as a consequence, the relevant value for the purpose of ALF should be with the competition measure in place. In our view, therefore, for the purpose of ALF we are interested in the opportunity cost in the auction of unreserved spectrum in the presence of spectrum reservation, which meant in practice that bidders other than H3G only obtained 2x25 MHz in the 800 MHz band, not the entire band of 2x30 MHz.

2.70 As set out at paragraph 2.61 above, there were three competition measures in the auction: (i) spectrum reservation; (ii) sub-1 GHz cap; and (iii) overall cap. We noted above at paragraph 2.18 that in our view the overall cap of 210 MHz that applied in the auction should be treated as being non-binding on a forward-looking basis. This is because of a change in regulatory circumstances since the 4G auction, specifically the forthcoming availability of more mobile spectrum, such as in the 2.3 GHz and 3.4 GHz bands. This change in circumstances does not affect the rationale in the 4G auction for the other competition measures.[90] We used spectrum reservation because we considered that a fourth national wholesaler, which turned out to be H3G, needed a minimum spectrum holding to be a credible competitor. This is not invalidated by the forthcoming availability of more mobile spectrum. In addition, the further mobile spectrum is in bands that are above 1 GHz, so it does not change the reason we imposed the sub-1 GHz cap in the 4G auction.

Opportunity cost in the 4G auction of Telefónica's 2x10 MHz of 800 MHz spectrum can be estimated as at least £26.45m per MHz (without the discount for the coverage obligation)

2.71 The opportunity cost of Telefónica's 2x10 MHz of spectrum in the 4G auction in the absence of reserve prices can be estimated by deriving what the prices would have been if the reserve price had been set at zero and assuming the same bids as in the

[89] See p. 12-29 in Annex A, Power Auction's report as part of H3G's response to the August 2014 consultation.

[90] See Assessment of future mobile competition and award of 800 MHz and 2.6 GHz, Statement, July 2012, http://stakeholders.ofcom.org.uk/consultations/award-800mhz-2.6ghz/statement/ ("July 2012 statement on 4G auction").

actual auction. This assumption of no change in the bids may lead to an underestimate of the opportunity cost, because it is possible that additional or different bids would have been made at incremental bid values below the actual reserve prices (whereas there was no point in making such bids in the actual auction as they could not have affected the winning allocation or prices). For example, purely for the purpose of illustration we note that, if EE had been willing to submit bids for 2x15 MHz of 800 MHz with an IBV for the third 2x5 MHz just below £225m, the results would have been similar to what we see with the reserve price.

2.72 Using this approach, we derive an opportunity cost in the 4G auction, including the discount for the coverage obligation, of at least £498m (or £24.9m per MHz). This is lower than Telefónica's actual auction price of £550m, because we are removing the effect of the reserve price (in the manner described above).

2.73 ALF spectrum is not subject to a coverage obligation similar to the 800 MHz coverage obligation which applies to the spectrum acquired in the auction by Telefónica. Therefore, we are interested for the purpose of ALF in a market value of 800 MHz spectrum in the absence of such a coverage obligation and so without the discount (we consider separately in Section 6 the impact of the geographic coverage obligation). As set out at paragraph 2.59a) above, the discount for the coverage obligation in the auction was £31m. Adding this back, we derive an estimate of the opportunity cost in the auction of Telefónica's 2x10 MHz of at least £529m or at least **£26.45m per MHz**. When we discuss below the opportunity cost of Telefónica's 2x10 MHz of 800 MHz spectrum, we mean the value without the discount for the coverage obligation, except where expressly stated otherwise.

Other information on opportunity costs in the 4G auction, relating to EE's and Vodafone's 800 MHz spectrum, does not significantly change the estimates for 2x5 MHz and 2x10 MHz increments

2.74 One way to obtain the opportunity costs in the auction of the 800 MHz spectrum in the multi-band packages won by EE and Vodafone is to use ASM.[91] The results of ASM for the 800 MHz spectrum won by all four winners in the 4G auction are shown in Table 2.3. The figures shown are for the incremental value (except in the two rows labelled as averages). So, for example, the ASM results with Telefónica as the excluded bidder are £35.6m per MHz for the first 2x5 MHz and £17.3m for the second 2x5 MHz in the 2x10 MHz block acquired by Telefónica (with an average of these incremental values of £26.45m per MHz).

2.75 The ASM results for H3G's and Telefónica's spectrum (i.e. when each is the "excluded bidder") are the same as the opportunity costs in the auction reported above: £38.4m and £26.45m per MHz respectively. We now discuss in turn the ASM results for EE and Vodafone.

[91] In the August 2014 consultation we described ASM as addressing the question of what would have happened, given the bids made in the auction, if hypothetically there had been more spectrum available in the auction. For example, in computing ASM with Vodafone as the excluded bidder, we excluded Vodafone's auction bids from the analysis and considered the value of additional 800 MHz to the other bidders. In this way ASM estimated a value that the other three bidders, but not Vodafone, placed on additional 800 MHz. In the August 2014 consultation we used ASM to derive a proxy for the value of the same amount of 900 MHz spectrum from Vodafone's holdings. However, another interpretation of the results for 2x10 MHz of 800 MHz with Vodafone as the excluded bidder is the value to other bidders of the spectrum won by Vodafone. This is the opportunity cost in the 4G auction of the 800 MHz spectrum won by Vodafone.

Table 2.3: ASM results for 800 MHz spectrum interpreted as opportunity costs in the 4G auction (in £m per MHz)

Excluded bidder	First 2x5 MHz	Second 2x5 MHz
EE	£2.499m	n/a
H3G	£38.4m	n/a
Telefónica - incremental	£35.6m	£17.3m
Telefónica – average (2x10 MHz)	£26.45m	
Vodafone - incremental	£38.35m	£14.5m
Vodafone – average (2x10 MHz)	£26.425m	

Source: Ofcom

Very low opportunity cost to other bidders in the 4G auction of EE's 2x5 MHz of 800 MHz is not informative of market value for the purpose of ALF

2.76 The ASM result for EE as the excluded bidder in Table 2.3 suggests that the opportunity cost in the auction to other bidders of the 2x5 MHz of 800 MHz spectrum won by EE was very low at only £2.5m per MHz, given the bids made in the auction. This would also have been the price in the absence of reserve prices, assuming no change in the bids made.

2.77 The reason why this opportunity cost in the auction to other bidders - i.e. to bidders other than EE - is so low is that EE was the only material losing bidder for additional 800 MHz spectrum:

a) Telefónica and Vodafone were not permitted to bid in the auction for additional 800 MHz spectrum, i.e. more than the 2x10 MHz they each won (see paragraph 2.19b) above).

b) H3G chose not to place material bids in the auction for more 800 MHz spectrum than the 2x5 MHz it won. The opportunity cost in the auction of £2.5m per MHz reflects H3G's bid for the 2x10 MHz of 800 MHz with coverage obligation which was at a low incremental bid value of £25m (or £2.5m per MHz) compared to its winning package of 2x5 MHz of 800 MHz (without coverage obligation).[92]

2.78 As explained in paragraph 2.19b) above, the opportunity cost in the auction of EE's 2x5 MHz of 800 MHz spectrum to other bidders excludes EE's own bids (by definition) and as such it excludes the most informative value for the opportunity cost of sub-1 GHz spectrum. Therefore, we regard the opportunity cost to other bidders in the 4G auction of EE's 2x5 MHz in the 800 MHz band as not being informative of market value for the purpose of ALF.

[92] The £25m was the difference in reserve prices between these packages (consistent with H3G's apparent bidding strategy – see the paper referred to in footnote 63 for further details). The opportunity cost in the auction shown in Table 2.3 also deducts the small incremental bid value of £0.001m per MHz of Telefónica between 2x10 MHz with and without coverage obligation. See Annex 6 for details.

Other appropriate decompositions of the package amount of Vodafone's spectrum won in the auction are similar to the opportunity cost in the auction of Telefónica's 2x10 MHz

2.79 The opportunity cost to other bidders of Vodafone's 2x10 MHz depends on the decomposition of the package amount by band, given that Vodafone won a multi-band package.

2.80 In its response Vodafone provided three decompositions for the 800 MHz spectrum in its winning package, using the decomposition method[93] which identifies what the auction prices would have been for smaller sub-packages of the winning package:[94]

a) £528.5m (or £26.425m per MHz).

b) £521.761m (or £26.088m per MHz).

c) £461.183m (or £23.059m per MHz).

2.81 The first decomposition is the same as the ASM result of £26.425m per MHz, shown in Table 2.3 above. It is very similar to the opportunity cost in the auction of the 2x10 MHz won by Telefónica of £26.45m per MHz.

2.82 The second decomposition of £26.088m per MHz, is similar to the ASM result of £26.425m per MHz as it is lower by only about 1%. It is similarly only about 1% lower than the opportunity cost in the auction of the 2x10 MHz won by Telefónica.

2.83 The third decomposition is materially lower than the ASM result, by about 13%. However, in our view this third decomposition is likely to understate market value. We have detailed concerns about the methodological basis on which it is derived, which we set out in Annex 6. As explained in Annex 6, once we adjust for these concerns, this third decomposition becomes the same as the ASM result (i.e. £26.425m per MHz).

2.84 Taking this into account, we consider that the appropriate decompositions of the opportunity cost in the auction of Vodafone's spectrum package for 2x10 MHz of 800 MHz spectrum are similar to the opportunity cost in the auction of the 2x10 MHz won by Telefónica (of £26.45m per MHz).

<u>Average opportunity cost in the 4G auction of 2x5 MHz and 2x10 MHz increments provides a candidate market value of £30m per MHz</u>

2.85 The opportunity costs of 2x5 MHz and 2x10 MHz increments discussed above reflect incremental value in addition to bidders' winning packages, i.e. their value for 800 MHz spectrum in addition to their existing, post-auction spectrum holdings. This makes them, in principle, relevant opportunity costs in the auction for the purpose of ALF (although we also need to assess the implications of relevant differences in circumstances from the 4G auction, which we consider in a later sub-section using the marginal bidder analysis).

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[93] The calculation method consists in adding a sufficiently high extra hypothetical bid for a smaller sub-package of the winning package such that Vodafone would win the smaller sub-package. Then, we compare the opportunity cost of winning the smaller sub-package with the opportunity cost of winning a larger package which includes lots for an additional band. The difference corresponds to the opportunity cost of the lots in that additional band. Further details are set out in Annex 6.
[94] Annex 1.2, p. 19, in Vodafone's response.

2.86 One option would be to take as our range of candidate market values the range between the opportunity costs in the 4G auction of a 2x5 MHz increment (£38.4m per MHz) and a 2x10 MHz increment (about £26m per MHz). We could then assess this range as we undertake the further analytical steps outlined in the summary above, using such further information and analysis to inform our choice of market value from within this range (or as a basis to reject the candidate range). This is indeed the approach we adopt when we assess the market value of the 2.6 GHz band in a later sub-section.

2.87 However, given the complicating factors in the analysis for the 800 MHz band, we do not consider this approach would be informative. First, the range between the opportunity cost in the auction of a 2x5 MHz and a 2x10 MHz increment is wide: the higher figure for a 2x5 MHz increment of £38.4m per MHz is about 45% and £12m per MHz above the lower figure of about £26m per MHz for a 2x10 MHz increment. Second, for reasons explained in greater detail below, the other information or analysis is either not sufficiently relevant or reliable to assist us in choosing an appropriate estimate of market value from within this wide range (e.g. we do not obtain a sufficiently reliable quantified estimate from our marginal bidder analysis).

2.88 A second option would be to take as our candidate value one or other of the opportunity costs in the auction, either for a 2x5 MHz or a 2x10 MHz increment.

2.89 However, we do not adopt this approach - instead we prefer the third option of taking an average of the opportunity costs in the 4G auction of 2x5 MHz and 2x10 MHz increments. In principle, we are interested in the marginal opportunity cost for the relevant increment, not an average. However, we develop a candidate market value using the average of these marginal opportunity costs for two reasons.

2.90 First, for the 800 MHz band, it is not clear whether 2x5 MHz or 2x10 MHz should be regarded as the more relevant marginal increment and there is a case for either. We discuss this issue in greater detail, including stakeholders' responses, in Annex 6. A more pragmatic approach in the circumstances is to consider the average of these marginal opportunity costs.

2.91 Our second reason is the implications of differences in circumstances from the 4G auction relevant to ALF. As set out in greater detail in a later sub-section, when we take account of these differences in circumstances using the marginal bidder analysis, we expect:

a) the opportunity cost of a 2x5 MHz increment to be significantly lower than £38.4m per MHz (due to excluding a contiguity premium); and

b) the forward-looking opportunity cost of a 2x10 MHz increment to be significantly higher than £26m per MHz (due to treating the overall cap in the 4G auction of 210 MHz as being non-binding on a forward-looking basis).

2.92 This means that, if we were to take the lower marginal opportunity cost in the 4G auction of about £26m per MHz for a 2x10 MHz increment as the candidate market value, we would reject it as being too low for the purpose of ALF when we take account of the relevant differences in circumstances from the 4G auction. Similarly, if we were to take the higher marginal opportunity cost in the 4G auction of £38.4m per MHz for a 2x5 MHz increment as the candidate market value, we would reject it as being too high for the purpose of ALF.

2.93 However, we consider that in neither case would we have a sufficiently reliable quantified estimate to use in place of the rejected market value figure. Therefore, in practice, the average opportunity cost in the auction of about £30m per MHz provides a better candidate market value than either of the marginal opportunity costs in the 4G auction.

2.94 To derive this average of £30m per MHz, we take the weighted average of the opportunity costs in the auction for a 2x5 MHz increment and a 2x10 MHz increment, placing twice as much weight on the per MHz figure for 2x10 MHz because it involves twice as much spectrum as 2x5 MHz. We set out above one figure for a 2x5 MHz increment (£38.4m per MHz for the spectrum won by H3G) and three alternative figures for a 2x10 MHz increment (£26.088m, £26.425m or £26.45m per MHz for the spectrum won by Vodafone or Telefónica). Using these alternative figures for a 2x10 MHz increment, the three corresponding alternative weighted averages of the opportunity costs in the auction of a 2x5 MHz increment and a 2x10 MHz increment are £30.19m, £30.42m and £30.43m per MHz. Given the complicating factors in the analysis outlined above (at paragraphs 2.17 to 2.21), we round down to derive our candidate market value of the 800 MHz band for the purpose of ALF of **£30m per MHz**.

2.95 We agree with Telefónica's comment in response to our February 2015 consultation (reported at paragraph 2.41 above) that H3G's opportunity cost at £38.4m per MHz was not proposed by any stakeholder as an estimate of market value for 800 MHz, and neither are we proposing to do so. In our analysis we expressly recognise that the value of £38.4m per MHz includes a contiguity premium and so overstates the market value (e.g. see paragraphs 2.91a) and e). However, we do not agree that it is an outlier with no credibility, as it represents the opportunity cost in the auction of a 2x5 MHz increment.[95]

2.96 We disagree with Telefónica when it says (in response to our February 2015 consultation) that the £38.4m per MHz was derived from a set of bids that could not have been winning bids. First, we note that the calculations of the opportunity costs in the UK auction are based on losing bids (relative to winning bids). This is because losing bids provide information on bidders' valuations for additional spectrum (see paragraph 2.6 above). This applies not only to the £38.4m per MHz figure, but also to the other (lower) figures discussed above. Second, the losing bids relevant to the £38.4m per MHz could have been winning bids if H3G (or other bidders) had bid differently. The fact that they did not bid differently is why such bids did not win and why, as losing bids, they comprise the opportunity cost of the 2x5 MHz won by H3G.

2.97 Below we consider the candidate value of £30m per MHz against the estimates and insights from the other parts of our analysis: initially the LRPs, and thereafter the marginal bidder analysis.

Linear reference prices

2.98 LRPs provide another method to analyse the market value of 800 MHz spectrum in the 4G auction. LRPs seek to provide the best estimates of linear market-clearing prices (i.e. the same per MHz price for all spectrum in a given band), using

[95] It is the opportunity cost in the auction of the 2x5 MHz won by H3G. Table 2.3 shows that the opportunity costs in the auction of the first 2x5 MHz won by Telefónica and Vodafone are similar at £35.6m and £38.35m per MHz respectively.

information on losing bids as well as winning bids. No linear market-clearing prices exist in the case of the 4G auction, because of the synergies in some of the bids, so the LRP method only provides an estimate of linear prices that are closest to market-clearing. Further details of the LRPs are set out in Annex 6.

Revenue-constrained LRPs

2.99 We consider first the revenue-constrained LRPs as they reflect the actual auction revenue which is decomposed into linear prices by band. This method yields an LRP for 800 MHz of £26.89m per MHz.

2.100 In effect, the revenue-constrained LRPs are a revenue attribution method, i.e. a way to decompose the auction revenue into amounts by band (such that multiplying the LRPs by the amount of spectrum in each band would give a total equal to the auction revenue). The revenue-constrained LRPs provide an alternative to the decomposition of auction prices discussed in paragraph 2.59 above. But, whereas that approach yielded multiple alternative figures (in the case of the spectrum won by Vodafone) and different figures for 800 MHz spectrum won by different operators, the revenue-constrained LRPs identify a single figure for each band. In the context of ALFs such an approach has some advantages in principle:

a) It decomposes auction revenue or opportunity cost into linear prices – ALFs will be applied as linear prices.

b) The decomposition into amounts by band identifies the closest linear prices to market-clearing, given the revenue constraint.[96]

c) There is also the potential advantage that the LRP takes account of a wider range of losing bids than other methods, as well as the winning bids, which may allow cross-band effects to be more fully reflected. However, as noted at paragraph 2.13 above, this could also be seen as a disadvantage.

2.101 In practice, in the specific circumstances of the 4G auction, we maintain the view we set out in the August 2014 and February 2015 consultations that these revenue-constrained LRPs are too low as estimates of market value for the purpose of ALFs, because the auction revenue understates the opportunity cost relevant to ALF. This is for three reasons.

H3G's auction price is below market value for the purpose of ALF

2.102 First, H3G's auction price is in our view substantially below market value for the purpose of ALF because it is the reserve price (£22.5m per MHz) for reserved

[96] In its response H3G said that the linear clearing prices will create revenue that is generally higher than the Vickrey revenue and so restricting clearing prices to generate Vickrey revenue and at the same time approximately clear as many markets as possible pushes the LRPs in some unknown direction. H3G argued that, by separating the two objectives, a pro-rating procedure can be carried out in a controlled way that preserves some of the desirable properties of the clearing prices while adjusting their absolute levels to satisfy the revenue constraint (see p. 41-45 in Annex A, Power Auction's report as part of H3G's response to the August 2014 consultation). We do not consider that H3G's pro-rating procedure is a better approach to derive linear prices when applying a revenue constraint than the LRP algorithm which takes into account losing bids, minimises the excursions and so provides an improved fit with the auction bids.

spectrum, not the opportunity cost of that spectrum (£38.4m per MHz). We have discussed this issue above at paragraphs 2.65 to 2.70.

EE's auction price is not informative of market value

2.103 Second, EE's auction price or opportunity cost in the auction is not in our view informative of the market value of 800 MHz for the purpose of ALF. We have discussed this issue above at paragraphs 2.19b) and 2.86 to 2.88.

Telefónica's and Vodafone's auction prices are similar to or below forward-looking market value

2.104 Third, we considered in the August 2014 and February 2015 consultations that Vodafone's and Telefónica's auction prices were below market value due to a packing issue. The packing issue was that EE made no bids in the auction for an additional 2x10 MHz of 800 MHz spectrum (i.e. for packages including 2x15 MHz of 800 MHz spectrum, given that its winning bid was for 2x5 MHz). But EE made bids well above the reserve price for an additional 2x5 MHz (packages including 2x10 MHz) and for an additional 2x15 MHz (packages including 2x20 MHz). This meant that part of the auction price of Vodafone and Telefónica was the reserve price, not a losing bid (see Table 2.2), even though in general there was excess demand for 800 MHz spectrum at the reserve price.

2.105 Some stakeholders argued that the absence of bids from EE was a reflection of EE's incremental value for a third 2x5 MHz of 800 MHz being lower than the reserve price. Telefónica and Vodafone argued that there was no packing issue, as without reserve prices the price-setting combination does not involve any unsold 800 MHz spectrum. Instead the opportunity cost reflects EE's value for an additional 2x15 MHz of 800 MHz spectrum, with 2x5 MHz being rearranged from H3G to EE (and 2x15 MHz in the 2.6 GHz band being rearranged from EE to other bidders plus rearrangements of other 2.6 GHz spectrum).

2.106 In our analysis of Vodafone's and Telefónica's auction prices we now distinguish more clearly between: (i) opportunity costs in the auction; and (ii) differences in circumstances from the 4G auction.

2.107 *Opportunity cost in the auction*. We agree that a reasonable inference from the available evidence is that EE's incremental bid value for a third 2x5 MHz of 800 MHz was below the reserve price. We set out above opportunity costs in the 4G auction of Vodafone's and Telefónica's 2x10 MHz in the 800 MHz band which are below the respective auction prices. For example, we can compare the opportunity costs in the 4G auction of £26.425m and £26.45m per MHz for Vodafone and Telefónica respectively in Table 2.3 against the auction prices of £30.425m and £29.05m per MHz respectively in Table 2.2.[97]

2.108 In our view, the observation that these opportunity costs in the 4G auction are below the auction prices reflects the existence of the packing issue we described in the August 2014 and February 2015 consultations.[98] In general, there was excess demand for 800 MHz at the reserve price. But the *pattern* of that excess demand

[97] We refer here to the opportunity cost and auction price for Telefónica without the discount for the coverage obligation so it is a like-for-like comparison.
[98] See paragraphs 2.31-2.42 of the August 2014 consultation and paragraph 2.100 of the February 2015 consultation.

from EE, for an additional 2x5 MHz or an additional 2x15 MHz, did not fit together well with the size of the 2x10 MHz blocks of 800 MHz spectrum won by each of Telefónica and Vodafone. This does not mean we should ignore the absence of bids from EE for an additional 2x10 MHz of 800 MHz spectrum (given the reserve price). But it does imply that careful interpretation is needed, in the factual context that the opportunity cost in the auction of 2x5 MHz and 2x15 MHz increments of 800 MHz spectrum are both significantly higher than for a 2x10 MHz increment. The opportunity cost in the auction of a 2x15 MHz increment is about £30m per MHz.[99]

2.109 *Differences in circumstances from the 4G auction*. We consider that the opportunity cost in the 4G auction of Vodafone and Telefónica is below market value for the purpose of ALF because, for the purpose of ALF, we treat the overall cap in the 4G auction of 210 MHz as being non-binding on a forward-looking basis.

2.110 The opportunity cost in the auction is determined by the highest losing bids for the specific package being considered. In essence, the opportunity cost in the 4G auction is reduced compared to the forward-looking value by EE's highest losing bid involving a trade-off between additional 800 MHz and less 2.6 GHz spectrum, because its winning package was at the overall cap in the auction of 210 MHz. This trade-off, when identifying the combination of highest losing bids, results in a significant reduction in value compared to the forward-looking opportunity cost, because the bids from EE for 2.6 GHz spectrum were significantly higher than from other bidders.

2.111 An illustration of the significance of this effect on opportunity cost is provided by a disaggregation of the opportunity cost in the auction of £38.4m per MHz for a 2x5 MHz increment into:

a) EE's incremental bid value for an additional 2x5 MHz of 800 MHz spectrum of £46.1m per MHz; less

b) lost bid value from rearrangements in the 2.6 GHz band due to EE's trade-off at the overall cap of £7.7m per MHz.[100]

2.112 In other words, on a forward-looking basis with the overall cap in the 4G auction treated as non-binding, EE would not face the trade-off which triggers the lost bid value from rearrangements in the 2.6 GHz band from EE to other bidders, and the opportunity cost of 800 MHz spectrum would be significantly higher. For a 2x10 MHz increment, as won by each of Telefónica and Vodafone, there is a greater amount of 2.6 GHz spectrum rearranged from EE to other bidders (2x15 MHz) in the price-

[99] See the ASM results reported in Table A6.8 in Annex 6: £30.72m per MHz for a 2x15 MHz increment with Vodafone as the excluded bidder; and £29.48m per MHz with Telefónica as the excluded bidder.

[100] EE's incremental bid value of £31.05m per MHz, which is a key component of the opportunity cost of £38.4m per MHz (see paragraph 2.65 above), can be disaggregated using observed bids into +£46.1m per MHz for an additional 2x5 MHz of 800 MHz spectrum and -£15.05m per MHz for a reduction of 2x5 MHz of 2.6 GHz spectrum. The figure of £46.1m per MHz is derived as EE's bid for the package in the price-setting combination of £1,360m (2x10 MHz of 800 MHz and 2x30 MHz of 2.6 GHz) less its bid of £899m for the package with 2x5 MHz less of 800 MHz; and the figure of -£15.05m per MHz is EE's bid for this package less the bid for its winning package of £1,049.5m which includes an additional 2x5 MHz of 2.6 GHz. The net incremental bid value to other bidders for 2x5 MHz of 2.6 GHz is £7.35m - see paragraphs 2.65b) to d). In this disaggregation, therefore, the lost bid value from rearrangements in the 2.6 GHz band is £7.35m less £15.05m per MHz, i.e. -£7.7m per MHz.

setting combination. This means there is an even larger reduction in the opportunity cost of 800 MHz spectrum from rearrangements of 2.6 GHz spectrum than is the case for a 2x5 MHz increment compared to the forward-looking value (see also paragraphs 2.173 to 2.174 below).

2.113 In the marginal bidder analysis we treat the overall cap in the 4G auction of 210 MHz as being non-binding. In the context of the ALF bands this means that, on a forward-looking basis, EE does not have to face a stark trade-off between acquiring 900 MHz spectrum and giving up some of its existing spectrum holdings. When considering market value for 800 MHz and 2.6 GHz as a basis for the value of spectrum in the ALF bands, this corresponds to value-reducing rearrangement in the 2.6 GHz band being avoided when assessing the forward-looking opportunity cost relevant to ALF of 800 MHz spectrum. Instead the opportunity cost in the marginal bidder analysis reflects EE's value for additional 800 MHz on its own.

2.114 We explain below that the evidence from the marginal bidder analysis is consistent with a market value of a 2x10 MHz increment of £30m per MHz or tends to suggest that it may understate market value. This compares to Telefónica's auction price (without the discount for the coverage obligation) of £29.05m per MHz and Vodafone's auction price of £27.1m, £27.5m or £30.4m per MHz (depending on the decomposition, as set out above and in further detail in Annex 6). Therefore, based on the marginal bidder analysis, the forward-looking opportunity cost of 800 MHz spectrum for the purpose of ALF is likely to be similar or at least as high as the auction prices paid by Telefónica and Vodafone.

Our view on revenue-constrained LRPs

2.115 Overall, therefore, we consider that the 4G auction prices are below forward-looking market value when considered for the specific purpose of ALF. The consequence is that revenue-constrained LRPs are too low as estimates of market value for the purpose of ALF. For similar reasons we disagree with the comments of Vodafone and Telefónica (reported at paragraph 2.32 above) that the auction prices represent an upper bound on market value.

LRPs without revenue constraint

2.116 LRPs without revenue constraint seek to identify the best estimate of linear market-clearing prices, taking as given the bids made in the 4G auction (but not constraining the sum of the LRPs). The LRP without revenue constraint for the 800 MHz band is £31.2m per MHz.

2.117 H3G's response in effect argued that the relevant question for market value is the outcome in a uniform-price auction (in this context we use the terms "uniform price" and "linear price" interchangeably). It suggested that the LRPs without revenue constraint are inappropriate because it would not expect such prices to be achieved in a uniform-price auction. This is because the bids made in the 4G auction were dependent on the non-linear, second-price rule that applied. With the different pricing rule of linear (uniform) prices, H3G, drawing on the revenue equivalence theorem and the existing economic literature, argued we might expect bidders to have made different bids, in particular to have shaded their bids.

2.118 However, we do not consider that the LRPs without revenue constraint are an attempt to estimate the outcome of a linear (or uniform) price auction, as H3G suggested (nor is this our interpretation of full market value). Instead the conceptual underpinning for these LRPs is a competitive equilibrium in which all operators are

price takers. Furthermore, we do not know how bidders would behave in a linear-price version of the 4G auction. For example, the conditions for the revenue equivalence theorem do not hold in the circumstances relevant to the 4G auction[101]; and the economic literature that H3G referred to does not consider the relevant circumstances of bidders with values that include synergies.

2.119 We do not consider that the LRP without revenue constraint is a definitive estimate of market value. But we maintain our view in the August 2014 and February 2015 consultations that it provides a useful reference point, especially in the specific circumstances of the 4G auction with revenue-constrained LRPs that understate market value for the purpose of ALFs. This LRP of £31.2m per MHz exceeds our candidate market value of £30m per MHz by £1.2m per MHz or 4%.

Linear price that avoids excess supply and minimises excess demand

2.120 We have also considered a variation of the LRPs without revenue constraint. As noted above, there are no linear market-clearing prices, and this means that the LRP method identifies linear prices that can involve excess demand or excess supply in each of the bands (see Annex 6 for further details). We have identified a set of linear prices that avoids excess supply in any band and minimises the excess demand. We describe this method and the derivation of the results in greater detail in Annex 6.

2.121 The linear price for the 800 MHz band with this method is £31m per MHz, which in our view also provides a useful reference point for a similar reason as for the LRP without revenue constraint.

2.122 This linear price of £31m per MHz exceeds our candidate market value of £30m per MHz by £1m per MHz or 3%.

Our conclusion on cross-check of candidate value against LRPs

2.123 Given our further analysis, we now have three linear prices for the 800 MHz band relating to bids in the 4G auction:

a) LRP with revenue constraint of £26.89m per MHz;

b) LRP without revenue constraint of £31.2m per MHz; and

c) Linear price that avoids excess supply and minimises excess demand of £31m per MHz.

2.124 In our view, the revenue-constrained LRP is below market value for the purpose of ALF. Especially in these circumstances, we consider that the latter two results provide useful reference points. We note that they both exceed our candidate market value of £30m per MHz. Therefore, we consider that the LRPs are broadly consistent with the candidate market value or suggest it may understate full market value.

[101] The revenue equivalence theorem states that, under the specific assumptions of risk neutral bidders with independent valuations, the expected revenues from any Bayesian incentive compatible mechanism yielding efficient outcomes are the same. However, the bidders in the 4G auction may not have been risk neutral, nor had independent valuations. Furthermore, a uniform price version of the 4G auction would not have been an incentive compatible mechanism. Therefore, the revenue equivalence theorem does not apply.

Differences in circumstances from 4G auction, and marginal bidder analysis

Reasons for deviating from opportunity costs in 4G auction

2.125 There are specific reasons for deviating from the opportunity costs in the 4G auction due to differences in the circumstances applicable to ALF spectrum compared to the 4G auction.

Treating the overall cap in the 4G as non-binding on a forward-looking basis

2.126 First, the opportunity cost of 800 MHz spectrum in the 4G auction significantly understates the relevant forward-looking opportunity cost due to the impact of the overall cap on EE. This is relevant because of our view of the change in regulatory circumstances since the 4G auction, such that it is more appropriate to treat the overall cap as non-binding on a forward-looking basis, given the forthcoming availability of further mobile spectrum.

2.127 As we explained in the August 2014 and February 2015 consultations, the overall spectrum cap of 210 MHz only formally applied at the time of the 4G auction. On a forward-looking basis as more mobile spectrum becomes available (e.g. 1.4 GHz, 2.3 GHz and 3.4 GHz bands), we would not expect EE to be precluded from acquiring some more spectrum. To put the point starkly, treating the overall spectrum cap in the 4G auction as binding on a forward-looking basis would imply that EE would not be permitted to acquire any spectrum in the auction for the spectrum in the 2.3 GHz and 3.4 GHz bands planned for late 2015 or early 2016. Or, more directly relevant for this document, it would also imply that EE would not be permitted to acquire any 900 MHz spectrum (without also relinquishing an equal amount of spectrum in other bands of spectrum that it currently holds). In our view, it would not be a reasonable assumption for the purpose of ALF to restrict EE only to its current overall spectrum holdings, given that more spectrum will soon be available for mobile use (although our view is not dependent on the precise date of this award).

2.128 Consistent with this view, in November 2014 we published proposals on an overall spectrum cap to apply in the forthcoming award for 2.3 GHz and 3.4 GHz spectrum.[102] In May 2015, we published a further consultation seeking views of stakeholders on the option of withholding some of the available spectrum from the 2.3 and 3.4 GHz award (i.e. around 60 MHz of the 190 MHz of spectrum available). We proposed that there should be no spectrum cap in circumstances where we decide to proceed with an initial award of a reduced amount of spectrum without delay.[103] The cap proposed in November 2014 is 310 MHz, compared to the overall spectrum cap which applied in the 4G auction of 210 MHz.[104] Therefore, if we were to

[102] Public Sector Spectrum Release, Award of the 2.3 GHz and 3.4 GHz bands, Consultation, 7 November 2014, http://stakeholders.ofcom.org.uk/binaries/consultations/2.3-3.4-ghz-auction-design/summary/2_3_and_3_4_GHz_award.pdf (the "November 2014 PSSR award consultation").

[103] Public Sector Spectrum Release, Award of the 2.3 GHz and 3.4 GHz bands, Statement and Consultation, 26 May 2015, http://stakeholders.ofcom.org.uk/binaries/consultations/2.3-3.4-ghz-auction-design/statement/statement.pdf. See, in particular, paragraphs 1.10 and 3.12.

[104] We explained why our competition assessment for the 4G auction did not rely on the 1.4 GHz, 2.3 GHz and 3.4 GHz bands in paragraphs A2.74-A2.76 and A2.80-A2.84 in the July 2012 Statement on 4G auction. The reasons why we consider these bands relevant for the purpose of the spectrum cap

apply the spectrum cap that we proposed in November 2014, this would permit EE to acquire up to 100 MHz of spectrum in addition to its current holdings (or up to 55 MHz, taking account of BT's spectrum holdings, if the auction were to take place after completion of the BT/EE merger). Alternatively, if we were to award a reduced amount of spectrum without any cap, this could permit EE to acquire up to around 130 MHz of spectrum in addition to its current holdings. In our marginal bidder analysis we consider EE being able to acquire a further 10 or 20 MHz of additional 800 MHz spectrum as a proxy for 900 MHz (reflecting increments of 2x5 MHz and 2x10 MHz respectively) without having to trade off this additional spectrum for less 2.6 GHz spectrum.[105]

2.129 Some respondents disagreed with our approach to the overall cap. For example, Vodafone argued that it pre-judged a competition analysis if EE were to acquire 900 MHz spectrum, and that in any case we had not set out any competition analysis to support our view.

2.130 However, as noted above, since the August 2014 consultation we have published the November 2014 PSSR award consultation, in which we set out a competition analysis to support our proposal for an overall cap of 310 MHz.[106]

2.131 In its response to our February 2015 consultation, Vodafone provided further comments on our approach (reported at paragraphs 2.37 to 2.39 above). It referred to two paragraphs of our July 2012 competition assessment statement:

a) In paragraph 4.132 we said that: "If Telefónica needed spectrum to be credible, then what it would need would depend on why it was not credible with its existing spectrum. If it needed a larger share of spectrum or the ability to offer services that had LTE specific advantages even in the near term, such as better latency, then it is likely to be sufficient to obtain at least 2x10 MHz of either 800 MHz or 2.6 GHz spectrum, or the 2x15 MHz of 1800 MHz spectrum. An extra 2x10 MHz would give Telefónica 16% of total paired spectrum after the Auction. With this

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proposed in the forthcoming award are set out in paragraphs 7.53-7.63 in the November 2014 PSSR award consultation.

[105] One possible complication is that, by acquiring 2x5 MHz or 2x10 MHz of additional spectrum, EE could in future be constrained by any future spectrum caps which Ofcom might set in future spectrum awards. EE would be constrained if any such future caps proved to be a binding constraint on EE. If this were the case, then there might be an opportunity cost to EE of acquiring the additional spectrum. In the limit, for example, it could mean that EE would only be able to acquire an equivalent amount less of spectrum in the future award than it wished. In such circumstances, there could be a case to reduce the estimate of EE's value of the additional 800 MHz spectrum by the potentially lost value to EE of an equivalent amount of spectrum in the future award. However, first, it is not clear to us that the relevant circumstances necessarily apply for such a reduction in the estimate. Second, we do not consider that we have evidence to usefully quantify the size of any reduction.

[106] Consistent with our analysis of competition measures for the 4G auction, there are three types of competition concern regarding spectrum holdings, aligned with the three competition measures in the auction (see paragraphs 2.61 and 2.70 above): (i) spectrum reservation to seek to ensure minimum spectrum holdings for at least four credible national wholesalers; (ii) sub-1 GHz cap; and (iii) overall cap. The rationale for the two spectrum caps was to mitigate the risk of highly asymmetric holdings of respectively sub-1 GHz and overall spectrum after the auction leading to lower competitive intensity (see paragraph 1.10 in our July 2012 statement on 4G auction). In the November 2014 PSSR award consultation we explicitly considered the first and third concerns. As to the distribution of sub-1 GHz spectrum, EE's existing holdings are only 2x5 MHz at 800 MHz, so if it were to acquire some 900 MHz spectrum: first, its holdings would still be well below the level of the sub-1 GHz cap; and second, there would tend to be a reduction in the asymmetry of sub-1 GHz spectrum holdings.

additional spectrum, we consider that Telefónica is likely to have sufficient spectrum to be credible, especially given its share of sub-1 GHz spectrum. We consider it unlikely that Telefónica would also need to be able to provide the highest peak data rates with early LTE to be credible, but if so we consider that bandwidth of 2x15 MHz in any auctioned band including 2.6 GHz would be sufficient.";

b) In paragraph 4.134 we said that: "Despite [Vodafone having] a larger amount of 2.1 GHz spectrum, we consider that the assessment for Telefónica above is also broadly applicable for Vodafone. The strengths and weaknesses of Vodafone's spectrum are largely the same as for Telefónica. Our conclusion, therefore, is also the same."

2.132 We do not consider that these paragraphs bear the interpretation which Vodafone gave them, i.e. that "in order to be credible national wholesalers, both O2 and Vodafone would need to acquire 2*10MHz of 800MHz." Rather, we left open the possibility that neither operator needed additional spectrum to be credible. We also suggested that if the need for additional spectrum was to offer services with LTE advantages, this could be met with 2.6 GHz or 1800 MHz spectrum – i.e. without acquiring sub-1 GHz spectrum (and we considered it unlikely that either operator would need more spectrum for other reasons). In practice, our 4G auction allowed Vodafone or Telefónica to win 800 MHz spectrum, but it was not designed to ensure that they would do so.

2.133 For the purpose of an overall spectrum cap, the amount of spectrum held in qualifying bands is treated equally regardless of whether it is sub-1 GHz spectrum or in a higher-frequency band. Any concerns about holdings in specific bands, such as sub-1 GHz, are addressed through other measures. In the 4G auction we imposed both an overall spectrum cap and a cap on sub-1 GHz spectrum.

2.134 Although EE was constrained by the overall spectrum cap in the 4G auction, it was not constrained in the same way by the sub-1 GHz cap. In fact EE was able to, and did, submit bids for packages including significantly more 800 MHz spectrum than the 2x5 MHz it won. With a higher overall spectrum cap, such as the 310 MHz we proposed in November 2014 for the award of the 2.3 GHz and 3.4 GHz bands, our assessment of competition for the 4G auction provides no reason why EE should not acquire more sub-1 GHz spectrum.

2.135 Nor does that assessment provide any reason why EE should be prevented from acquiring 1.4 GHz spectrum. While, as a matter of principle, we do not rule out the possibility of competition concerns if EE sought to acquire 1.4 GHz spectrum at some point in the future, we do not consider it reasonable (for the present analysis) to assume that it would be prevented from doing so.

2.136 We discuss further below the implications for market value of the overall cap in the 4G auction of 210 MHz being treated as non-binding on a forward-looking basis.

Excluding a contiguity premium

2.137 Our second reason to deviate from the opportunity costs in the 4G auction arises because we are using our figure for the market value of 800 MHz to inform the market value of 900 MHz. This suggests that, for an increment of spectrum of 2x5 MHz, there is a case for a lower value which **excludes a contiguity premium** that is reflected in EE's value for additional 800 MHz spectrum in the 4G auction (see paragraph 2.19a) above).

Excluding the value of rearrangements

2.138 Third, we consider it is reasonable to exclude the value of **rearrangements** (see paragraph 2.20).

Marginal bidder analysis can take account of these differences in circumstances

2.139 In principle, the marginal bidder analysis allows us to take account of the differences in circumstances from the 4G auction identified above. The marginal bidder analysis involves examining the bids from bidders for more spectrum than they won in the auction. It focuses, in a band-by-band assessment, on the bidder that had the highest value for additional 800 MHz spectrum (EE) or additional 2.6 GHz spectrum (Telefónica) for which it was a losing bidder. As such, it uses information on highest losing bids.

2.140 In response to the February 2015 consultation Vodafone criticised our opportunity cost results for including contiguity premiums and the value of rearrangements (reported at paragraph 2.41b)-c) above). We agree with Vodafone that contiguity premiums and rearrangements are included in our analysis of the opportunity costs *in the 4G auction*. However, we expressly recognise that they provide reasons for deviating from the opportunity costs in the 4G auction – see the second and third reasons above. We take them into account in our marginal bidder analysis and our conclusions.

2.141 Our starting point in the marginal bidder analysis is to consider the value bidders expressed for more spectrum in addition to their post-auction spectrum holdings, i.e. relative to their winning packages. This is especially relevant for the purpose of ALF as explained above (see paragraphs 2.7 and 2.12). Our discussion of the marginal bidder analysis is structured as follows:

a) First, we outline the significant practical difficulties in applying the marginal bidder analysis to the 800 MHz band.

b) Second, we discuss the suggestions made by stakeholders about strategic bidding by EE.

c) Third, we consider marginal opportunity costs for a 2x5 MHz increment.

d) Fourth, we consider marginal opportunity costs for a 2x10 MHz increment.

e) Thereafter, we assess the analysis put forward by Vodafone to suggest that treating the overall cap in the 4G auction of 210 MHz as being non-binding does not lead to higher market values.

f) Finally, we explain our conclusion on using the marginal bidder analysis as a cross-check to the candidate market value of £30m per MHz.

2.142 We comment on stakeholder responses about the marginal bidder analysis at the relevant points in the discussion below (or, in some cases, our comments are set out in Annex 6).

Practical difficulties

2.143 We now outline the practical difficulties in applying the marginal bidder analysis to the 800 MHz band, which are discussed in greater detail in the later sub-sections below.

Before describing these difficulties, we show in Table 2.4 the main evidence we use in the marginal bidder analysis. This table shows the demand for 800 MHz in the 4G auction of the highest losing bidder for additional 800 MHz spectrum, EE.

2.144 The figures in this table are EE's incremental bid values for different amounts of 800 MHz spectrum in packages with varying amounts of 2.6 GHz spectrum. For example, the first column shows EE's incremental bid values for 2x5 MHz of 800 MHz (with each row showing the bid value in a package also including the specified amount of 2.6 GHz spectrum). The second column shows the incremental bid value for a further 2x5 MHz (i.e. for a package including a contiguous block of 2x10 MHz of 800 MHz spectrum). EE made no bids for 2x15 MHz blocks in the third column, but it did bid for 2x20 MHz blocks in the fourth column. Table 2.4 shows the average incremental bid value for the third and fourth 2x5 MHz taken together in the 2x20 MHz block.

2.145 EE's winning package is shown in the bottom left-hand corner of Table 2.4. We are especially interested in EE's value to acquire additional 800 MHz spectrum, which are the neighbouring cells highlighted in the bottom row of Table 2.4 (bordered by a solid line).

Table 2.4: EE's demand (IBVs) for 800 MHz spectrum[107] in £m per MHz

Packages with:	First 2x5 MHz (1xA1)	Second 2x5 MHz (2xA1)	Third 2x5 MHz (3xA1)	Fourth 2x5 MHz (4xA1)
No 2.6 GHz (0xC)	£23.0m	£42.0m	£26.33m	
2x5 MHz of 2.6 GHz (1xC)	dnb	dnb	dnb	dnb
2x10 MHz of 2.6 GHz (2xC)	£23.0m	£60.5m	£29.02m	
2x15 MHz of 2.6 GHz (3xC)	£23.0m	£55.59m	£26.65m	
2x20 MHz of 2.6 GHz (4xC)	£23.0m	£50.55m	£32.63m	
2x25 MHz of 2.6 GHz (5xC)	£23.0m	£49.12m	dnb	np
2x30 MHz of 2.6 GHz (6xC)	£27.5m	£46.1m	np	np
2x35 MHz of 2.6 GHz (7xC)	£35.3m*	**np**	**np**	np

Source: Ofcom

dnb EE did not bid for this package
np EE was not permitted to bid for this package by the overall spectrum cap in the 4G auction of 210 MHz
* EE's winning package

2.146 The first practical difficulty is that the marginal bidder analysis may yield different figures for different marginal increments of 2x5 MHz and 2x10 MHz, and there is a case for using either increment. We discuss the choice of marginal increment in

[107] Table 2.4 only shows EE's IBVs for 800 MHz spectrum without coverage obligation (lot category A1), not the IBVs for 800 MHz spectrum with coverage obligation (A2). It also only shows IBVs for packages including 800 MHz and paired 2.6 GHz (lot category C), as in EE's winning package, not packages with unpaired 2.6 GHz spectrum (E). In lot categories A1 and C, the size of each lot was 2x5 MHz.

Annex 6, and in later sub-sections we consider the implications of the marginal bidder analysis for both increments of 2x5 MHz and 2x10 MHz.

2.147 Second, in practice, the marginal bidder analysis involves the use of proxies and assumptions, because the most relevant information is not directly observed. EE's winning package was at the overall spectrum cap that applied in the 4G auction. This cap meant that EE could acquire at most 2x40 MHz in the auction, i.e. no more than eight 2x5 MHz lots which could comprise any combination of 800 MHz and 2.6 GHz spectrum. The packages that, as a result of the cap, EE was not permitted to bid for are the cells showing "np" in the bottom right-hand section of Table 2.4, which are bordered by the dotted line. Therefore, in practice, the marginal bidder analysis involves using bid data to estimate proxies for bids that EE was not permitted to make in the auction, which (as noted above) are the highlighted cells in the final row of Table 2.4. Similarly, in practice to estimate the relevant value excluding a contiguity premium involves proxy estimates, not directly observed bids (as discussed in more detail below).

2.148 Third, there is a range of drivers of bid values which complicates the interpretation of the available evidence (see the further discussion in paragraphs 2.179 to 2.185 below).

2.149 Some of these practical difficulties were emphasised by stakeholders in their responses. As set out in our February 2015 consultation, taking account of responses (and in contrast to the August 2014 consultation) we no longer derive quantified estimates for the market value of 800 MHz from the marginal bidder analysis. The most important reasons for the difference in our approach compared to the August 2014 consultation, which we discuss further below, are as follows (reflecting the absence of directly observed bids):

a) We take account of the value of both 2x5 MHz and 2x10 MHz increments (whereas in the August 2014 consultation, we only relied on the 2x10 MHz increment). However, it is difficult to obtain a sufficiently reliable quantified estimate of a 2x5 MHz increment excluding a contiguity premium.

b) We now use a wider range of evidence to inform the value of a 2x10 MHz increment (whereas in the August 2014 consultation, we only used one specific EE incremental bid value).

2.150 Therefore, instead of a quantified analysis using the marginal bidder analysis, we use it to apply a cross-check. In particular, we consider whether the candidate market value of £30m per MHz derived above appears reasonable from the perspective of the marginal bidder analysis.

Suggestions about strategic bidding by EE

2.151 In their responses H3G, Telefónica and Vodafone suggested that EE's bids were inflated by strategic bidding and argued that this needed to be taken into account in the marginal bidder analysis (or that it provided a reason for not relying on this method).

2.152 We distinguish between stakeholders' arguments about strategic investment and price driving:

a) Strategic investment is where a bidder, with the aim of foreclosing downstream competition, bids above its intrinsic value of spectrum to prevent it being acquired

by the bidder's downstream competitors.[108] A possibility for strategic investment, consistent with arguments put forward by Vodafone, relates to EE's incremental bid value of £35.3m per MHz in its winning bid for its first 2x5 MHz of 800 MHz in a package with 2x35 MHz of 2.6 GHz (see the first column in the bottom row of Table 2.4), which took EE up to the limit of the overall spectrum cap.

b) Price-driving is where a bidder overstates its true demand to raise the auction prices paid by other bidders. A suggestion of price driving put forward by H3G[109], Telefónica[110] and Vodafone[111] relates to EE's incremental bid value of £32.63m per MHz for a third and fourth 2x5 MHz lots of 800 MHz in addition to a package of 2x10 MHz of 800 MHz and 2x20 MHz of 2.6 GHz (which we used as our proposed market value for the 800 MHz band in the August 2014 consultation). These respondents argued that EE had little or no chance of this being a winning bid and so it was inflated to increase prices paid by competitors (although we note that, in the event, it did not in fact set any auction prices).

2.153 We comment in Annex 6 on the detail of the arguments put forward by H3G, Telefónica and Vodafone, explaining why we do not agree with their suggestions.

2.154 We also asked EE to provide its response to these arguments. EE explained that it did not engage in strategic bidding:

> "… we can confirm that all of EE's bids made in the auction were within our valuation for the relevant spectrum, i.e. within what Ofcom refers to as "intrinsic value". Furthermore, our valuations did not incorporate any elements relating to the value of depriving other parties usage of the spectrum concerned (e.g. by weakening a competitor) nor to increasing the costs of our competitors"[112]

2.155 Bids at or below intrinsic value do not constitute price driving. Bids that do not include valuations relating to weakening competition do not constitute strategic investment.

2.156 In assessing allegations of strategic bidding, we have not relied on an assumption that the CCA format prevents such bidding. Rather, we have reached our view based on a consideration of the evidence relating to the auction in question. We consider the two reports submitted by Telefónica in our assessments of Austria and Ireland in Annex 8.

2.157 Regarding Telefónica's comments about EE's letter to us on the subject of strategic bidding (reported in paragraph 2.35b) above):

a) Telefónica has not explained what it meant by "different valuation assumptions" – for example, different assumptions might reflect different intrinsic valuation circumstances applicable to different spectrum packages.

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[108] We distinguish here between intrinsic value and strategic investment value to a bidder. Intrinsic value is the bidder's value of the spectrum in the absence of strategic considerations.
[109] See p. 10 of H3G's response to our August 2014 consultation.
[110] See p. 5 of Telefónica's response to our August 2014 consultation.
[111] See p. 8 of Vodafone's response to our August 2014 consultation.
[112] EE's Letter to Ofcom, 13 November 2014 (responding to an Ofcom letter of 28 October 2014). http://stakeholders.ofcom.org.uk/binaries/consultations/annual-licence-fees-further-consultation/Letter_to_Ofcom_from_EE.pdf.

b) Telefónica has not provided evidence to suggest to us that EE's bid profile is evidence of strategic behaviour.[113] An alternative interpretation is that the bid profile seeks to reflect relative intrinsic valuations of different packages within a budget constraint (and this interpretation is consistent with EE's letter).

c) Telefónica argued that, while EE states that its valuations did not include any element of increasing rivals costs, "EE uses the term "valuations" here and says nothing about bid amounts".[114] However, EE had already said that all of its bids were within its valuations for the relevant spectrum, whereas price driving involves bids above intrinsic valuations.

d) In summary, we do not consider Telefónica has supported its argument that EE's letter tells us very little about the extent to which EE engaged in strategic bidding.

2.158 Telefónica argued that bids by EE for 2x20 MHz of 800 MHz would have "minimal risk" of winning. We have commented in detail on similar points made by stakeholders in paragraphs A6.140-A6.150. As to Telefónica's suggestion relating to the number of 800 MHz lots that EE could have confidently predicted Vodafone and Telefónica would have bid for, even if this claim were correct, it does not relate to the monetary level of Vodafone's and Telefónica's bids for 800 MHz spectrum. Therefore, it is not clear how well EE could have gauged the risk of winning its bids for 2x20 MHz of 800 MHz.

2.159 Based on the available evidence, we do not consider that we should ignore or adjust EE's bids because of the suggestions about strategic bidding made by various stakeholders.

Marginal bidder analysis of opportunity cost of 2x5 MHz increment

2.160 The differences in circumstances relating to the overall cap, contiguity premium and rearrangements imply that the opportunity cost in the auction set out above for a 2x5 MHz increment of £38.4m per MHz is likely to be too high compared to the value of 2x5 MHz to serve as a basis for 900 MHz. Although there are effects in different directions, as explained below, the exclusion of a contiguity premium seems likely to lead on balance to a lower value, even taking into account the overall cap in the 4G auction being non-binding on a forward-looking basis.

2.161 For a 2x5 MHz increment, from the marginal bidder analysis we expect the market value of 800 MHz for the purpose of ALF to be somewhat below £35.3m per MHz to the extent there is a declining marginal value of spectrum. £35.3m per MHz is EE's incremental bid value for the 2x5 MHz of 800 MHz spectrum which it won in the auction. This is a relevant reference point, because it was EE's first acquisition of sub-1 GHz spectrum and, as such, does not include a contiguity premium. However, to the extent that there is a declining marginal value of spectrum[115] (and in the absence of other effects on value), we would expect the value of an additional 2x5 MHz without contiguity premium to be lower than £35.3m per MHz. The candidate

[113] We note that NERA (April 2015), p. 26, said that "[t]his is hard to prove based on the bid data alone (…)". Also, on p. 28, it said that "[i]t is apparent that there were strong strategic incentives for price driving in the clock round but off-setting incentives in the supplementary round."
[114] See Telefónica's response to the February 2015 consultation, paragraph 76, p. 24.
[115] As explained in paragraph A6.69 of the August 2014 consultation, we include the "coverage premium" when discussing the underlying marginal value of sub-1 GHz spectrum.

market value of £30m is £5.3m per MHz (or 15%) lower than £35.3m. We consider this is a reasonable allowance for a declining marginal value of spectrum.

2.162 In principle, the contiguity premium, or a proportion of it, might be obtained using carrier aggregation. This enables a network to operate a single carrier using spectrum from different frequency bands. For example, both EE and Vodafone have deployed carrier aggregation between respectively 1800 MHz / 2.6 GHz and 800 MHz / 2.6 GHz bands.[116] The relevant carrier aggregation in the context of ALF would be between two 2x5 MHz blocks from each of the 800 MHz and 900 MHz bands. With the current technology we would not expect such carrier aggregation to realise the same technical efficiencies as could be achieved with a contiguous 2x10 MHz block in the same band. But there would be the potential for at least a significant proportion of the contiguity premium to be realised, depending on these technical issues and the extent of availability of suitable handsets. By not reflecting this potential, our analysis of the value of a 2x5 MHz increment may understate full market value on a forward-looking basis.

2.163 Regarding Vodafone's comments about our considering each band "in isolation", we note that our approach to deriving ALFs relies on deriving band-specific prices from the 4G auction. This by definition requires identifying, from package bids, the values expressed for each band. However, we have had regard to the effect of complementarities, for example by considering how the amount of 2.6 GHz in a package affects a bidder's valuation of packages with more 800 MHz. Therefore, we disagree that our marginal bidder analysis is inconsistent either with the multi-band design of the 4G auction or the requirements of the Government Direction.

2.164 We also note that Vodafone has previously argued in support of using a marginal bidder analysis which considers each band separately.

Vodafone's marginal bidder analysis

2.165 Vodafone's marginal bidder analysis decomposed EE's incremental bid values for 800 MHz spectrum into two parts: (i) generic value and (ii) premium value (e.g. contiguity premium or a premium related to strategic bidding). In order to decompose the incremental bid values, Vodafone used two alternative methods. Both methods assumed that the generic value of spectrum declines linearly but that the premium value is constant going from 1 to 2 blocks, as going from 3 to 4 blocks. Method A assumed the premium is constant in *absolute* terms, whereas method B assumed it is a constant *proportion* of the total value. The rate of decline is measured between EE's values for its first and second 2x10 MHz blocks of 800 MHz.

2.166 We have concerns about the reliability of Vodafone's model (as we discuss further below from paragraph 2.188). Here we consider two issues: the value taken as the starting point, and the estimate of declining marginal value.

2.167 Vodafone's marginal bidder analysis[117] used as a starting point the average value for EE's first 2x5 MHz of 800 MHz in its various package bids (see the first column of Table 2.4), i.e. the mean of £24.9m or the median of £23m per MHz. This is the

[116] See paragraphs 5.100-5.102 in Ofcom's Infrastructure Report 2014, December 2014, http://stakeholders.ofcom.org.uk/binaries/research/infrastructure/2014/infrastructure-14.pdf.
[117] See Vodafone's response to August 2014 consultation, Annex 1.1.

largest reason for the difference between our marginal bidder analysis and the figures that Vodafone obtained from its version of the marginal bidder analysis.

2.168 In our view, £35.3m per MHz provides a more appropriate starting point to estimate the full market value of 800 MHz spectrum for the purpose of ALF than either the mean of £24.9m or the median of £23m per MHz, as used by Vodafone. The key difference is that £35.3m per MHz is the incremental bid value for 800 MHz spectrum in EE's winning bid in the auction. The mean or the median relate to values for 800 MHz spectrum on average in smaller packages, i.e. to less spectrum than EE actually holds. We have also addressed above the suggestion by Vodafone that this bid of £35.3m per MHz was inflated by strategic bidding.

2.169 We show in Table 2.5 the rate of decline in the marginal value of spectrum derived by applying Vodafone's approach of methods A and B, described above. Vodafone focused on the declining marginal value with mean and median values. We also show in the table the rate of declining marginal value, when methods A and B are applied to EE's bids for differing amounts of 800 MHz in packages with specific amounts of 2.6 GHz spectrum. Since the method involves comparing the rate of decline between EE's values for its first and second 2x10 MHz blocks of 800 MHz, this cannot be applied to packages with more than 2x20 MHz of 2.6 GHz spectrum. In those packages there is an absence of bids by EE for a second 2x10 MHz block of 800 MHz (because the overall cap in the auction did not allow EE to make such bids). The figures for declining marginal value in Table 2.5 can be compared to the gap of £5.3m between our starting point of £35.3m and our candidate value of £30m per MHz.

Table 2.5: Declining marginal values (in £m per MHz) using Vodafone's methods A and B

	Method A	Method B
Mean	£5.4m	£3.5m
Median	£5.1m	£3.2m
Packages with no 2.6 GHz	£3.1m	£2.2m
Packages with 2x10 MHz of 2.6 GHz	£6.4m	£3.5m
Packages with 2x15 MHz of 2.6 GHz	£6.3m	£3.7m
Packages with 2x20 MHz of 2.6 GHz	£2.1m	£1.3m

Source: Ofcom using Vodafone's response to the August 2014 consultation

2.170 We need to exercise caution in interpreting the figures in Table 2.5, given our concerns about Vodafone's model. However, we note that most of the figures in Table 2.5 are significantly smaller than the £5.3m gap between our starting point of £35.3m and our candidate value of £30m per MHz.

Marginal bidder analysis of opportunity cost of 2x10 MHz increment

2.171 The opportunity cost in the auction set out above for a 2x10 MHz increment of about £26m per MHz is likely to be too low compared to the forward-looking market value of 2x10 MHz to serve as a basis for 900 MHz. This is because the overall cap in the 4G auction of 210 MHz being non-binding on a forward-looking basis implies a higher value.

2.172 As explained above at paragraphs 2.110 to 2.114, the auction prices and opportunity cost of 800 MHz spectrum in the 4G auction were reduced, compared to the forward-

looking values, by EE's incremental values for additional 800 MHz spectrum reflecting a trade-off with less 2.6 GHz spectrum at the overall cap of 210 MHz.

2.173 In the discussion above we provided an illustration of the reduction in bid value for a 2x5 MHz increment. Here we provide an illustration for a 2x10 MHz increment. The opportunity cost in the 4G auction of Telefónica's 2x10 MHz in the 800 MHz band (excluding the discount for the coverage obligation) was £529m or £26.45m per MHz. This opportunity cost comprised EE's value for additional 800 MHz spectrum and the value of rearrangements of 2.6 GHz spectrum from EE to other bidders, as follows:

a) £748.5m – EE's IBV for an additional 2x15 MHz of 800 MHz and 2x15 MHz less of 2.6 GHz compared to its winning package; less

b) £165m – H3G's IBV for an additional 2x20 MHz of 2.6 GHz and 2x5 MHz less of 800 MHz compared to its winning package; less

c) £52.5m – Niche's IBV for 2x5 MHz less of 2.6 GHz and an additional 5 MHz of unpaired 2.6 GHz compared to its winning package; less

d) £2m – Vodafone's IBV for 5 MHz less of unpaired 2.6 GHz compared to its winning package.

2.174 To illustrate the amount of bid value that is lost, compared to the forward-looking value, by rearrangements due to EE's trade-off at the overall cap in the 4G auction, we can disaggregate EE's IBV of £748.5m into an IBV:

a) for an additional 2x15 MHz of 800 MHz spectrum (£1,158m); and

b) for a similar reduction in 2.6GHz spectrum (-£409.5m) due to a trade-off at the overall cap.[118]

This IBV for additional 800 MHz spectrum is £38.6m on a per MHz basis, much higher than the opportunity cost in the auction of £26.45m per MHz.[119]

2.175 Whilst we expect an increase in opportunity cost compared to that observed in the 4G auction, it is not straightforward to derive a reliable quantified estimate. For a 2x10 MHz increment, we now explain why we no longer consider that our estimate in the August 2014 consultation from the marginal bidder analysis of £32.63m per MHz is sufficiently reliable (as we did in our February 2015 consultation).

2.176 In particular, a reasonable representation of the value we are seeking to estimate is EE's incremental value for an additional 2x10 MHz of 800 MHz spectrum relative to its winning package which included 2x5 MHz. This is the average of the two highlighted (bordered) cells in the bottom row of Table 2.4. However, as shown in

[118] The IBV for 2x15 MHz of additional 800 MHz spectrum of £1,158m is the difference between EE's bid of £1,798m for the package of 2x20 MHz of 800 MHz and 2x20 MHz of 2.6 GHz and its bid of £640m for the package of 2x5 MHz of 800 MHz and 2x20 MHz of 2.6 GHz. The IBV for the reduction of 2x15 MHz of 2.6 GHz spectrum of -£409.5m is the difference between EE's bid of £640m for the latter package and its bid of £1,049.5m for its winning package of 2x5 MHz of 800 MHz and 2x35 MHz of 2.6 GHz.

[119] In this illustration of the value lost from rearrangements, the difference between £38.6m and £26.45m per MHz may reflect rearrangements in the 800 MHz band (from H3G to EE) as well as rearrangements in the 2.6 GHz band.

that table, EE did not make these bids in the 4G auction (indeed it was not permitted to do so, because of the overall cap of 210 MHz that applied in the auction). Therefore, there is an absence of directly observed bids for the relevant increment of spectrum of 2x10 MHz in addition to EE's winning package.

2.177 Evidence from directly observed bids is set out in Table 2.6 which shows the same information as in Table 2.4 but in a slightly different format. It sets out EE's directly observed bids for its first and second 2x10 MHz blocks in packages with different amounts of 2.6 GHz spectrum. The value we wish to estimate for the 2x10 MHz increment, additional to EE's winning package, is shown by the highlighted (bordered) cell in the bottom row of the table.

2.178 To the extent there is a declining marginal value of spectrum, we might expect EE's values for the first 2x10 MHz of 800 MHz to be above the value of the 2x10 MHz increment to EE's winning package; and the values for the second 2x10 MHz to be below the relevant opportunity cost.

2.179 There are likely to be other relevant considerations, when interpreting the available evidence. For example, in the August 2014 consultation and in Annex 6 we suggest that cross-band effects and financial constraints might also be relevant to incremental bid values.

Table 2.6: EE's demand (IBVs) for 2x10 MHz blocks of 800 MHz spectrum in £m per MHz

Packages with:	First 2x5 MHz (1xA1)	Second 2x5 MHz (2xA1)	Third 2x5 MHz (3xA1)	Fourth 2x5 MHz (4xA1)
No 2.6 GHz (0xC)	£32.50m		£26.33m	
2x5 MHz of 2.6 GHz (1xC)	dnb		dnb	
2x10 MHz of 2.6 GHz (2xC)	£41.75m		£29.02m	
2x15 MHz of 2.6 GHz (3xC)	£39.30m		£26.65m	
2x20 MHz of 2.6 GHz (4xC)	£36.77m		£32.63m	
2x25 MHz of 2.6 GHz (5xC)	£36.06m		dnb	np
2x30 MHz of 2.6 GHz (6xC)	£36.80m		np	np
2x35 MHz of 2.6 GHz (7xC)	£35.3m*	**np**		np

Source: Ofcom

dnb EE did not bid for this package
np EE was not permitted to bid for this package by the overall spectrum cap in the 4G auction of 210 MHz
* EE's winning package

Cross-band effects

2.180 In its response EE[120] referred to a "complementarity premium" in its bids, which meant that the value of a larger package of both 800 MHz and 2.6 GHz spectrum was significantly higher than the sum of the values of the two corresponding smaller, single-band packages. This is a **cross-band effect**, in this case a synergy value between spectrum in different bands (although there can also be cross-band effects reflecting substitutability between bands). For example, using EE's definition of a complementarity premium, the bid for its winning package included such a premium of £123m, because it bid:

a) £1,049.5m for a multi-band package of 2x5 MHz of 800 MHz and 2x35 MHz of 2.6 GHz (EE's winning package), which is larger than the sum of:

b) £230m for a single-band package of 2x5 MHz of 800 MHz; and

c) £696.5m for a single-band package of 2x35 MHz of 2.6 GHz.

2.181 It is not straightforward reliably to derive the cross-band effect associated with the unobserved values we wish to estimate.

2.182 EE noted that we conducted the marginal bidder analysis on EE's bids by holding constant the number of lots of 2.6 GHz spectrum at four (i.e. 2x20 MHz). It said that by doing so we were incorrectly assigning to the marginal 2x10 MHz of 800 MHz certain amounts of value (i.e. the complementarity premium) which relate to EE's valuation of the package as a whole. It claimed that this calculation is over and above EE's intrinsic value for the additional 800 MHz spectrum. Also, EE proposed three options to take into account the complementarity premium when estimating the value of 800 MHz for the purpose of ALF.

2.183 We disagree that a complementarity premium should be excluded when assessing the full market value of 800 MHz for the purpose of ALF. The complementarity premium we include in our marginal bidder analysis is an important feature in the spectrum value analysis given the pattern of bids in the 4G auction and it reflects observed cross-band effects. In our analysis we consider incremental bid values which include only complementarities that are causally related to (i.e. realised by) that spectrum increment. In our view, removing the complementarity premium from our analysis would understate full market value.

Budget constraints

2.184 We noted the evidence of **budget constraints** in the August 2014 consultation, and the consequent risk that some auction bids may understate the full market value of the spectrum.[121] Since then, EE has also told us that its bids were influenced by a financial constraint ("budget cap").[122] In a combinatorial clock auction (the auction format used for the 4G auction), a bidder can respond to a budget cap in different ways. One way is to reduce the number of packages it bids for. Another is to include bids for packages in which it is interested, and avoid any bid that exceeds its financial constraint. If so, the bidder will express IBVs which differ from its true incremental

[120] EE's response to the August 2014 consultation, p. 24-28.
[121] See paragraph 2.88 of the August 2014 consultation.
[122] Letter from Inge Hansen of EE to Geoffrey Myers of Ofcom, 13 November 2014.

values for the spectrum. For example, it may compress all IBVs below true values; or it may reduce IBVs for some packages by more than others, perhaps maintaining some IBVs at or close to true values.

2.185 The range of ways in which a bidder may respond to a budget cap complicates the interpretation of the available evidence and makes it more difficult reliably to derive the unobserved bid values we wish to estimate.

Our view from marginal bidder analysis of 2x10 MHz increment

2.186 Given the various issues discussed above, we have not derived a specific quantified estimate of EE's value for a 2x10 MHz increment of 800 MHz spectrum additional to its existing, post-auction holdings (reflecting its winning package) which we consider would be sufficiently reliable to serve as a basis for ALF.

2.187 However, we note that all EE's incremental bid values for 2x10 MHz blocks of 800 MHz in packages with larger amounts of 2.6 GHz of at least 2x20 MHz (compared to its winning package of 2x35 MHz) are significantly in excess of £30m per MHz – see Table 2.6. Therefore, we consider that the available evidence is consistent with our candidate market value of £30m per MHz or tends to suggest that it may understate full market value.

Vodafone's marginal bidder analysis

2.188 We noted in the August 2014 consultation that, if Vodafone's model is used to estimate the value of a 2x10 MHz increment, it implied a value between about £32m and £35m per MHz. The contiguity premium implied by Vodafone's model accounted for roughly half of this value (between 44% and 51%).[123]

2.189 The results implied by Vodafone's model for a 2x10 MHz increment are therefore consistent with our candidate market value of £30m per MHz being an understatement. However, we do not place significant weight on this point because we have concerns about the reliability of Vodafone's model. We noted in the August 2014 consultation that, when Vodafone's model with its proposed parameter values (e.g. for the size of the contiguity premium) is compared to EEs actual bids, it provided an inaccurate prediction of those bids. This suggested to us either that the model and/or the parameter values were unreliable. For example, the model used by Vodafone might omit material drivers of bid values, such as cross-band effects or budget constraints; or the assumptions made by Vodafone in order to derive parameter values might be incorrect. We also noted that the size of the contiguity premium implied in Vodafone's model of more than £30m per MHz was especially inaccurate for some of EE's actual bids, e.g. it was significantly overstated for the largest packages which were most relevant for the purpose of ALF.

2.190 Vodafone[124] said that its model did not seek to predict each and every bid by EE. It argued that, most significantly, the model estimated usage value of generic spectrum, and excluded the separate elements associated with a contiguity premium or strategic bidding. Departures from the model were likely to occur in bids for the largest packages, which were most subject to strategic investment or price driving.

[123] See paragraphs 2.89 to 2.93 of the August 2014 consultation.
[124] See Vodafone's response to the August 2014 consultation, Annex 1, p. 12.

2.191 We remain concerned about the reliability of the model proposed by Vodafone, as illustrated by the errors when the model is use to predict EE's observed bids. We do not consider that Vodafone's suggestion that strategic bidding explains these errors addresses our concerns about omitted drivers of bid value or incorrect parameter values, especially given our assessment above of the evidence on strategic bidding by EE.

Overall cap and hypothetical analysis in Vodafone's response

2.192 Vodafone provided a hypothetical analysis of what might have happened if the overall cap in the 4G auction had been higher at 220 MHz or 230 MHz, by making assumptions about hypothetical bids by EE for larger packages. It argued this analysis showed that relaxing the overall cap makes no significant difference to the opportunity costs of 800 MHz spectrum.[125]

2.193 However, in our view, Vodafone's analysis poses the wrong question and consequently draws the wrong inference for the purpose of ALF. The relevant question is not what would have happened in the 4G auction had the overall cap been different. The overall cap was set at 210 MHz and we are not suggesting this was incorrect. Instead our view is that there has been a change in regulatory circumstances since the 4G auction with the forthcoming availability of additional mobile spectrum, such as at 1.4 GHz, 2.3 GHz and 3.4 GHz. This means that, *on a forward-looking basis*, an overall cap set as low as 210 MHz is no longer appropriate.

2.194 One issue, therefore, is that Vodafone's hypothetical analysis assumes a different outcome in the 4G auction than actually occurred, and then it assesses opportunity costs relative to the hypothetical winning packages in the auction, not the actual winning packages (which reflect existing post-auction spectrum holdings). For example, in Vodafone's hypothetical analysis (with an assumed overall cap at 230 MHz, 20 MHz higher than the actual cap in the 4G auction) EE is assumed to win a package of 2x5 MHz of 800 MHz and 2x45 MHz of 2.6 GHz spectrum. This is 2x10 MHz more of 2.6 GHz spectrum than EE actually won.

2.195 The consequence is that, in Vodafone's hypothetical analysis, the opportunity costs still reflect EE making a trade-off between more 800 MHz and less 2.6 GHz spectrum, because EE's assumed winning package is at the level of the assumed overall cap of 230 MHz. In contrast, in our view the significance of the overall cap of 210 MHz being non-binding is that EE would not need to face this stark trade-off on a forward-looking basis (see paragraphs 2.127 to 2.128). Without the trade-off, using Vodafone's assumptions about EE's hypothetical bids, the opportunity cost is significantly higher at more than £30m per MHz, as we now explain.

2.196 Table 2.7 shows some of the hypothetical bids for EE which are assumed by Vodafone in its analysis (in italics and red font). If we apply the marginal bidder analysis, the opportunity costs of 2x5 MHz and 2x10 MHz increments relative to EE's actual winning package in the 4G auction (which reflects its current, post-auction holdings), are as follows as shown in the highlighted (bordered) cells:

a) 2x5 MHz increment: £43.425m per MHz

b) 2x10 MHz increment: (£43.425m + £22.5m) ÷ 2 = £32.96m per MHz

[125] Annex 1.3 in Vodafone's response to the August 2014 consultation.

2.197 The opportunity cost of a 2x10 MHz increment (on which Vodafone focused) is about 10% higher than the candidate market value of £30m per MHz in this hypothetical analysis of EE's values for additional 800 MHz spectrum. The opportunity cost of a 2x5 MHz increment is substantially higher than £30m per MHz (by 45%), although this figure includes a contiguity premium.

Table 2.7: Marginal bidder analysis including hypothetical bids for EE assumed in Vodafone's response (in £m per MHz)

Packages with:	First 2x5 MHz (1xA1)	Second 2x5 MHz (2xA1)	Third 2x5 MHz (3xA1)	Fourth 2x5 MHz (4xA1)
No 2.6 GHz (0xC)	£23.0m	£42.0m	*£22.5m*	*£30.162m^*
2x5 MHz of 2.6 GHz (1xC)	dnb	dnb	dnb	dnb
2x10 MHz of 2.6 GHz (2xC)	£23.0m	£60.5m	*£22.5m*	*£35.548m^*
2x15 MHz of 2.6 GHz (3xC)	£23.0m	£55.59m	*£22.5m*	*£30.8m^*
2x20 MHz of 2.6 GHz (4xC)	£23.0m	£50.55m	*£22.5m*	*£42.752m^*
2x25 MHz of 2.6 GHz (5xC)	£23.0m	£49.12m	*£22.5m*	*£49.487m*
2x30 MHz of 2.6 GHz (6xC)	£27.5m	£46.1m	*£22.5m*	*£52.369m*
2x35 MHz of 2.6 GHz (7xC)	£35.3m*	*£43.425m*	*£22.5m*	dnb
2x40 MHz of 2.6 GHz (8xC)	*£34.199m*	*£41.552m*	dnb	dnb
2x45 MHz of 2.6 GHz (9xC)	*£37.447m*	dnb	dnb	dnb

Source: Ofcom using Annex 1.3 of Vodafone's response

* EE's winning package

^ These IBVs are implied by actual bids by EE observed in the auction given the assumption about the hypothetical IBV for the third A1 (for which EE did not place any actual bids)

dnb EE did not bid for this package and no hypothetical bid is assumed by Vodafone

2.198 Clearly there are limits to a hypothetical analysis of EE's value for additional 800 MHz spectrum (and Vodafone itself recognised limitations in its assumptions about EE's hypothetical bids). However, in our view, this exercise is consistent with our analysis of the implications of the overall cap of 210 MHz which applied in the 4G auction being non-binding on a forward-looking basis. It is not inconsistent with our candidate market value of £30m per MHz. Indeed, to the extent that such hypothetical analysis is informative, it tends to suggest that £30m per MHz may understate full market value for the purpose of ALF.

Our conclusion on using the marginal bidder analysis as a cross-check on the candidate market value of £30m per MHz

2.199 In principle, the marginal bidder analysis allows us to take account of differences in circumstances from the 4G auction which are relevant to ALF spectrum: (i) treating the overall cap in the 4G auction of 210 MHz as non-binding on a forward-looking basis; (ii) excluding a contiguity premium when assessing the market value of a 2x5 MHz increment; and (iii) excluding the value of rearrangements. However, the practical difficulties, in particular the absence of directly observed bids by EE for the

most relevant packages, mean that we do not derive sufficiently reliable quantified estimates from our marginal bidder analysis.

2.200 Nevertheless, we consider it is still informative to apply a cross-check on the reasonableness of our candidate market value of £30m per MHz using the perspective of the marginal bidder analysis for each of 2x5 MHz and 2x10 MHz increments:

a) 2x5 MHz increment: we expect the market value to be below £35.3m, allowing for a declining marginal value of spectrum. Our candidate value is £5.3m per MHz or 15% below this level, which we consider provides a reasonable allowance.

b) 2x10 MHz increment: EE's incremental bid values are significantly in excess of £30m per MHz for 2x10 MHz blocks of 800 MHz in packages with at least 2x20 MHz of 2.6 GHz spectrum (compared to its winning package of 2x35 MHz).

2.201 We conclude that the cross-check using the marginal bidder analysis suggests that £30m per MHz is a reasonable figure for the market value of 800 MHz for the purpose of ALF or tends to suggest that it may understate market value.

Decision on market value of the 800 MHz band for the purpose of ALF

2.202 For the reasons set out above (and summarised at paragraphs 2.53 to 2.57 above, we conclude that an appropriate market value of 800 MHz spectrum for the purpose of ALF, **net of expected DTT co-existence costs, is £30m per MHz**.

2.203 This is an amount which is net of expected DTT co-existence costs, reflecting the observed bids in the 4G auction for 800 MHz spectrum. Such costs do not apply to the ALF bands, 900 MHz and 1800 MHz. Therefore, for the purpose of ALF we are interested in the market value of the 800 MHz band gross of expected DTT co-existence costs. As set out in detail in Annex 6, our conclusion from the evidence is that the gross value is £3m per MHz higher than the net amount. This is because of the way that the marginal bidder for 800 MHz spectrum, EE, took account of expected DTT co-existence costs in its auction bids, which affect in a similar way each of the auction prices, opportunity costs in the auction, LRPs and marginal bidder analysis.[126] Our conclusion, therefore, is that an appropriate market value of 800 MHz spectrum for the purpose of ALF, **gross of expected DTT co-existence costs, is £33m per MHz**.

2.204 We recognise that the analysis of the forward-looking market value of the 800 MHz band for the purpose of ALF involves significant complicating factors, which we summarised above at paragraphs 2.17 to 2.21. One consequence of this is that some of the methods we examine (auction prices, opportunity costs in the auction and LRPs) do not in themselves each take account of all the relevant considerations. Another is that, whilst in principle the marginal bidder analysis could take into account the relevant differences in circumstances from the 4G auction, the difficulties in practice mean that we do not derive a quantified estimate from our marginal bidder analysis that in our view is sufficiently reliable. In addition, we do not have a quantified estimate of the implications for forward-looking market value of greater certainty of availability of mobile spectrum in the future, compared to expectations at the time of the auction.

[126] See also Annex 6, paragraphs A6.178-A6.186.

2.205 This means it is not straightforward to make a definitive assessment of the risk of understatement or overstatement in our market value figure of £30m per MHz (net of expected DTT co-existence costs). Nevertheless we consider there are a number of reasons why £30m per MHz is more likely to understate market value than to overstate it, including the following:[127]

a) Assuming zero reserve prices may yield an underestimate of the opportunity costs in the auction for Telefónica's and Vodafone's 2x10 MHz blocks - see paragraph 2.71 above.

b) £30m per MHz is below the LRP without revenue constraint (£31.2m per MHz) and the linear price that avoids excess supply and minimises excess demand (£31m per MHz) - see paragraphs 2.119 and 2.122 above.

c) We take no account of the potential for at least a proportion of the contiguity premium to be realised even with a 2x5 MHz increment through carrier aggregation between spectrum in the 800 MHz and 900 MHz bands - see paragraph 2.162 above.

d) For a 2x10 MHz increment, all EE's incremental bid values for 2x10 MHz of 800 MHz in packages with at least 2x20 MHz of 2.6 GHz are above £30m per MHz - see paragraph 2.187 above.

e) The evidence of budget constraints in the 4G auction suggests there is a risk that some auction bids, including those by EE (the marginal bidder for additional 800 MHz spectrum), may understate the full market value of the spectrum - see paragraph 2.184 above.

2.206 In response to the February 2015 consultation Telefónica provided a list of reasons why in its view our market value estimate for 800 MHz spectrum was not conservative (reported at paragraph 2.43 above). We have the following comments on this list:

a) We have explained above why we do not agree that we place undue weight on a specific higher price point and consider that our analysis properly assesses all evidence points in the round.

b) We have also explained above why we do not take auction prices, including Telefónica's auction price, as an upper bound.

c) We note that Telefónica seems to accept that there is a risk of understatement due to using zero reserve prices and not taking account of the potential for at least a proportion of the contiguity premium to be realised, even if it considers the implications are second order (compared to other effects).

d) When making adjustments for expected DTT co-existence costs and value of avoiding the coverage obligation, we add on 100% of its calculated value to the relevant marginal bidder in each case. In our view this evidence relating to the marginal bidder is more relevant to market value than the evidence of different values to other operators that are not the relevant marginal bidders.

[127] Leaving aside the implication of greater certainty of availability of future spectrum, which is one of our reasons for being conservative in interpreting the evidence. A possible reason why our estimate might overstate market value is set out in footnote 81 above.

Market value of the 2.6 GHz band for the purpose of ALF

Summary of our analysis

2.207 Our decision regarding the 2.6 GHz spectrum is that £5.5m per MHz is an appropriate estimate. To derive the market value of the 2.6 GHz band, we consider the same analytical steps as in our analysis of 800 MHz spectrum:

a) Auction prices for 2.6 GHz spectrum. These generally fall in the range of £5.1m to £5.7m per MHz (although there are decompositions of Vodafone's package auction price which are lower at £3.8m and £4.3m per MHz).

b) Opportunity cost in the auction for 2.6 GHz spectrum. We use these opportunity costs to derive a range of candidate market values of £5.1m to £5.7m per MHz.

c) Linear reference price for 2.6 GHz: (i) with the auction revenue as a constraint (£4.99m per MHz); (ii) without revenue constraint (£5.7m per MHz); and (iii) linear price which avoids excess supply and minimises excess demand (£5.5m per MHz). We compare the range of candidate market values against these LRPs, taking into account that the revenue-constrained LRPs understate opportunity costs in the 4G auction.

d) Differences in circumstances from the 4G auction. We use the marginal bidder analysis to consider the implications for marginal opportunity costs of the relevant marginal increment, and we exclude the value of rearrangements. As in the August 2014 and February 2015 consultations, when interpreting the evidence we derive a conservative estimate of £5.5m per MHz.

e) Taking account of the evidence and analysis in the preceding analytical steps, we conclude that an appropriate market value of the 2.6 GHz band for the purpose of ALF is **£5.5m** per MHz.

2.208 There are a couple of differences in the detail of how we apply these analytical steps for 2.6 GHz compared to 800 MHz spectrum. These reflect the absence for the 2.6 GHz band of most of the complicating factors that arise in the analysis of 800 MHz set out above. For reasons set out in greater detail below:

a) We derive a range of candidate values from the opportunity costs in the auction (not a single candidate value); and

b) We derive sufficiently reliable quantified estimates from the marginal bidder analysis for the 2.6 GHz band, which we use to inform our choice of market value from within the range of candidate values.

Auction prices

2.209 There were three winners in the auction of 2.6 GHz spectrum: EE (2x35 MHz), Vodafone (2x20 MHz) and Niche (2x15 MHz). These bidders all won a multi-band package. We derive more than one figure for 2x20 MHz and 2x15 MHz blocks because there are alternative decompositions of Vodafone's and Niche's package prices by band.

2.210 The auction prices of this spectrum in £m per MHz were as follows (see Table A6.6 in Annex 6 for further details):

a) 2x15 MHz (Niche): £5.12m or £5.28m per MHz.

b) 2x20 MHz (Vodafone): £3.81m, £4.25m, £5.46m or £5.70m[128] per MHz.

c) 2x35 MHz (EE): £5.20m per MHz.

Opportunity costs in the 4G auction

2.211 Unlike the 800 MHz band, auction prices for 2.6 GHz spectrum are also generally reflective of opportunity costs in the 4G auction, as they were not affected by the reserve price for the 2.6 GHz band. However, there are some differences of detail in the decompositions of the package amounts of Niche and Vodafone (which are affected by the reserve price for 800 MHz).

2.212 The opportunity costs in the auction were as follows (see Table A6.23 in Annex 6 for further details):

a) 2x15 MHz (Niche): £5.11m or £5.28m per MHz.

b) 2x20 MHz (Vodafone): £5.29m, £5.46m or £5.70m per MHz.

c) 2x35 MHz (EE): £5.20m per MHz.

Candidate market values

2.213 The first option to derive candidate market values is to take the range of opportunity costs in the 4G auction as the basis for our range of candidate market values; and then to assess this range against each of LRPs and the marginal bidder analysis, using that further analysis to inform our choice of market value. This is the approach we adopt for the 2.6 GHz band.

2.214 The second option would be to take one specific opportunity cost as the candidate market value. The third option would be to derive a candidate value by taking an average of different measures of opportunity cost. We used this third approach in the context of the 800 MHz band above.

2.215 The reasons we consider it appropriate to adopt the first approach for the 2.6 GHz band, despite rejecting it as not being informative for the 800 MHz band, reflect the material differences in circumstances between the analysis of market value for 2.6 GHz compared to 800 MHz spectrum:

a) Unlike the 800 MHz band, the range of the opportunity cost in the auction is relatively narrow, £5.1m to £5.7m per MHz.

b) For the 2.6 GHz band, again unlike the 800 MHz band, the further analysis, in particular the marginal bidder analysis, is sufficiently reliable for us to obtain a quantified estimate that assists us in deriving an appropriate estimate of market value from within this range.

[128] The two highest losing bids for 2.6 GHz spectrum were for 2x10 MHz increments by Telefónica (£128m) and H3G (£100m). These two highest losing bids together constitute this decomposition of Vodafone's auction price for its 2x20 MHz block of 2.6 GHz spectrum (£228m or £5.70m per MHz).

2.216 Therefore, we take as our range of candidate values for the market value of the 2.6 GHz band the range given by the decompositions of opportunity costs in the auction of £5.1m to £5.7m per MHz.

Linear reference prices

2.217 The range of candidate values compares to LRPs as follows (see Annex 6 for further details of the derivation of these linear prices).

2.218 The revenue-constrained LRP (at actual auction revenue) is £4.99m per MHz. This is below our range of candidate market values, but we consider that the auction revenue, and hence also the revenue-constrained LRPs, understate opportunity cost relevant to ALF (for the reasons set out above, when discussing the 800 MHz band at paragraphs 2.101 to 2.115). Consistent with this view, we note that the revenue-constrained LRP at £4.99m per MHz lies below nearly all of the other evidence we use, including the auction prices for 2.6 GHz spectrum.

2.219 Our view that the revenue-constrained LRPs understate opportunity cost in the auction is the key reason why we consider that the value of 2.6 GHz spectrum suggested by each of EE (£4.99m), Telefónica (£4.95m) and H3G (£3.57m) understates market value (see Table 2.1 above or Table 2.9 below for a summary of stakeholders' suggested values). EE derived its suggested value from the revenue-constrained LRP; Telefónica used it (in conjunction with the estimates from other approaches); and H3G derived its figure from an analysis using an even lower revenue constraint (we have explained our reasons for disagreeing with H3G's approach at paragraph 2.69 and footnote 72 above, in the context of the 800 MHz band).

2.220 The LRP without revenue constraint is £5.7m per MHz. This is at the top-end of our range of candidate values.

2.221 The linear price that avoids excess supply and minimises excess demand is £5.5m per MHz. This lies within our range of candidate values.

2.222 We conclude that the above cross-check against LRPs is consistent with our range of candidate market values.

Marginal bidder analysis

2.223 For the marginal bidder analysis, in contrast to the 800 MHz band, we can directly observe bids from the marginal bidders for 2.6 GHz for spectrum additional to their winning packages. This suggests that the practical difficulties which mean that we do not derive sufficiently reliable estimates from the marginal bidder analysis for 800 MHz do not apply to the same extent to the 2.6 GHz band. Furthermore, the marginal bidder analysis can explore the marginal opportunity cost of 2.6 GHz for the relevant marginal increment.

2.224 In our view the marginal bidder analysis of 2.6 GHz in the August 2014 and February 2015 consultations remains valid – see paragraphs 2.205 to 2.208 of the February 2015 consultation, which are repeated below.

2.225 The highest losing bidder for the 2.6 GHz band was Telefónica at £6.4m per MHz for a 2x10 MHz block. This suggests that the marginal increment for 2.6 GHz is 2x10 MHz, not a smaller 2x5 MHz increment. The next highest losing bid was also for a 2x10 MHz block (by H3G at £5m per MHz).

2.226 It might also suggest that the market value of 2.6 GHz spectrum should be £6.4m per MHz, the highest losing bid. However, there is a material complication – there is no linear market-clearing price, given the bids made in the auction (as is also the case for the 800 MHz band).

2.227 A price below £6.4m per MHz would imply excess demand in the band, because it would fail to choke off the demand for 2x10 MHz by Telefónica, the highest losing bidder. But whilst a higher price would achieve that, it would also involve less demand than in the winning allocation by one of the winners, Niche, by 2x5 MHz, leading to excess supply in the band. This is because Niche's IBV for the last 2x5 MHz in the 2x15 MHz block it won in the auction was only £5.5m per MHz.

2.228 This means that any price above £5.5m per MHz would lead to this reduced demand by Niche of 2x5 MHz. Below £6.4m per MHz it would be more than offset by the extra demand for 2x10 MHz by Telefónica, leading to excess demand in the band (by 2x5 MHz). But a higher price than £6.4m per MHz would result in excess supply for the band (of 2x5 MHz).[129] Therefore, in our view, there is a risk that £5.5m per MHz may understate market value. Nevertheless we prefer this estimate because we consider that we should adopt a conservative approach when interpreting the evidence.

2.229 Telefónica's view set out in paragraph 2.44 above is that £5.5m per MHz should be seen as an upper bound on market value, set by the level of reserve price at which a 2.6 GHz lot would be unsold. The unsold lot would arise from Niche's reduced demand by 2x5 MHz.

2.230 However, as explained above, despite the unsold lot, overall there would be excess demand at a reserve price of £5.5m per MHz, not excess supply. Niche's reduced demand by 2x5 MHz would be more than offset by Telefónica's demand for 2x10 MHz in its losing bid at £6.4m per MHz. The lot would be unsold only because Telefónica's demand for two lots would not fit the remaining supply of one lot. Given the excess demand at £5.5m per MHz, we therefore disagree with Telefónica that it represents an upper bound on market value. Instead we consider it is a conservative estimate of market value of 2.6 GHz spectrum.

Decision on market value of the 2.6 GHz MHz band for the purpose of ALF

2.231 The result of the marginal bidder analysis of £5.5m per MHz lies within our range of candidate values. We consider that the marginal bidder analysis is sufficiently reliable for 2.6 GHz spectrum. We conclude that an appropriate market value of the 2.6 GHz band for the purpose of ALF is £5.5m per MHz.

Decision on market values of 800 MHz and 2.6 GHz for the purpose of ALF

2.232 For the reasons set out above (summarised in paragraphs 2.53 to 2.58), we conclude that an appropriate forward-looking market value for the 800 MHz band for the purpose of ALF, net of expected DTT co-existence costs, is £**30m** per MHz. The corresponding value gross of expected DTT co-existence costs is £**33m** per MHz.

[129] A set of non-linear prices was needed to clear the market for the 2.6 GHz band, given the bids made in the 4G auction.

2.233 For the reasons set out above (see paragraphs 2.207 to 2.231), we conclude that an appropriate market value for the 2.6 GHz band for the purpose of ALF is £**5.5m** per MHz.

2.234 We consider these estimates are more likely to understate than overstate market value for the reasons set out in paragraphs 2.205 and 2.228.[130]

2.235 Tables 2.8 and 2.9 provide a summary of the figures from our analytical steps and our conclusions.

[130] We also note the comparison between these market values and the auction prices for 800 MHz and 2.6 GHz spectrum in other EU countries which we assess in our benchmarking analysis. These absolute values (on a UK-equivalent basis) are set out in Table 3.1 in Section 3. It shows that £33m per MHz for 800 MHz spectrum is lower than the absolute value of 800 MHz in ten countries (Austria, Spain, Ireland, Germany, Italy, Czech Republic, Romania, Portugal, Slovak Republic and Greece) and only higher than the absolute value in two countries, in both of which we consider that the value is at risk of being understated (Sweden and Denmark). For the 2.6 GHz band, £5.5m per MHz is lower than the absolute values in three countries (Romania, Denmark and Portugal) and higher than the absolute value in seven countries (Slovak Republic, Spain, Italy, Greece, Czech Republic, Austria and Germany). However, we do not draw a clear conclusion from this comparison, e.g. given the range of factors that could cause auction prices to differ between countries.

Table 2.8: Market value of 800 MHz spectrum in £m per MHz (net of expected DTT co-existence costs)[131]

	Decision	EE	H3G	Telefónica	Vodafone	BT
Decision for 800 MHz	**£30m**					
Spectrum won in 4G auction		2x5 MHz	2x5 MHz	2x10 MHz	2x10 MHz	n/a
4G auction prices for 800 MHz		£22.5m*	£22.5m*	£27.5m^	£27.1m, £27.5m or £30.4m	n/a
Opportunity cost in 4G auction	£30m~	£2.5m#	£38.4m	£26.45m	£26.1m or £26.4m	n/a
LRP with revenue constraint	£26.89m					
LRP without revenue constraint	£31.2m					
Linear price avoiding excess supply	£31.0m					

Source: Ofcom

* Reserve price
^ This figure includes the discount for the coverage obligation – without the discount, the average price would be £29.05m per MHz
~ Average of 2x5 MHz and 2x10 MHz increments
# We consider this opportunity cost is not informative for the purpose of ALF

[131] Purely for ease of comparison with the discussion of various figures throughout this section, Table 2.8 shows figures for the value of 800 MHz net of expected DTT co-existence costs.

Table 2.9: Market value of 2.6 GHz spectrum in £m per MHz

	Decision	EE	H3G	Telefónica	Vodafone	BT
Decision for 2.6 GHz	**£5.5m**					
Spectrum won in 4G auction		2x35 MHz			2x20 MHz	2x15 MHz
4G auction prices for 2.6 GHz		£5.2m	n/a	n/a	£3.8m, £4.3m, £5.5m or £5.7m	£5.1m or £5.3m
Opportunity cost in 4G auction		£5.2m	n/a	n/a	£5.3m, £5.5m or £5.7m	£5.1m or £5.3m
LRP with revenue constraint	£4.99m					
LRP without revenue constraint	£5.7m					
Linear price avoiding excess supply	£5.5m					

Source: Ofcom

Section 3

Benchmarks for 900 MHz and 1800 MHz

Summary

3.1 This section sets out the international auction benchmark evidence points which provide the basis for estimating the value of 900 MHz and 1800 MHz spectrum in the UK. This is step 2a in the analytical framework we set out in Section 1 (step 2c – our interpretation of these benchmark evidence points in order to derive lump-sum values for 900 MHz and 1800 MHz spectrum in the UK – is set out in Section 5). Supporting material for the issues discussed in this section is in Annexes 7, 8 and 9.

3.2 The derivation and interpretation of international auction benchmark evidence points is consistent with the approach in our August 2014 and February 2015 consultations, although it differs in some detailed respects, reflecting consultation responses and new evidence that has become available since February 2015 (specifically, the recent German auction which concluded in June 2015).

3.3 The rest of this section:

a) provides an overview of our February 2015 consultation proposals, stakeholder responses to those proposals, and our view of these responses; and

b) explains our approach to making a judgement on an appropriate lump-sum values of 900 MHz and 1800 MHz spectrum in the UK, drawing on the international benchmark evidence.

August 2014 and February 2015 consultations and stakeholder responses

August 2014 consultation

3.4 In our August 2014 consultation we derived proposed lump-sum values for 900 MHz and 1800 MHz licences based on a notional licence with a 20-year initial term, and then used these lump-sum values to derive proposed annual licence fees. In deriving lump-sum values we considered the following evidence:

a) Bids in the UK 4G auction: our analysis is set out in Section 2 of this document.

b) International auction prices: we considered evidence from 4G auctions in the EU from 2010 onwards, particularly as to the relative value of spectrum bands included in the UK 4G auction, and the spectrum bands for which we are setting annual licence fees.

c) Technical evidence: we noted the difficulties of using technical modelling to determine the value of spectrum to individual operators.

3.5 Our approach to estimating lump-sum values involved the following steps:

a) Calculate absolute values for each frequency band from European auctions in UK-equivalent terms.

b) Use these in combination with our estimates of the UK market value of the 800 MHz and 2.6 GHz to derive a set of relative value benchmarks for the value in the UK of 900 MHz (based on its value relative to 800 MHz) and 1800 MHz spectrum (based on the distance method, which we discuss below).

c) Use these benchmarks to derive an estimate of the lump-sum value for each of 900 MHz and 1800 MHz spectrum in the UK, by:

   i) Grouping the benchmarks into tiers according to the quality of evidence we consider they provide to serve as a basis for ALF, placing more weight on benchmarks in higher tiers.

   ii) Assessing the risk that benchmarks may understate or overstate UK market values.

   iii) Reaching a view of the lump-sum value of 900 MHz and 1800 MHz spectrum by considering these benchmarks in the round.

   iv) Applying cross-checks, such as absolute-value benchmarks.

3.6 This approach reflected a number of changes to our initial approach as set out in our October 2013 consultation, following the consideration of consultation responses and further analysis that we conducted between the October 2013 and August 2014 consultations. In particular, we focused on relative benchmarks as evidence for the market value for 900 MHz and 1800 MHz spectrum (as opposed to a combination of absolute and relative values), and we adopted the distance method as the main measure of relative value for 1800 MHz spectrum.

Stakeholder responses to our August 2014 consultation

3.7 Stakeholders commented in detail both on our approach to assessing lump-sum values, and also on the relevance and interpretation of specific benchmarks. In the following, we summarise their main points relating to our approach, data sources and choice of benchmarks, and tiering of benchmarks. In paragraphs 5.6 - 5.16 of Section 5, we summarise their main points relating to our derivation of lump-sum values for 900 MHz and 1800 MHz spectrum in the UK, sensitivity analysis, and their alternative estimates of lump-sum values for 900 MHz and 1800 MHz spectrum in the UK.

Our approach

3.8 Stakeholders generally agreed that the approach described above included the correct elements, including:

a) The use of recent European auction data.

b) Our focus on relative benchmarks and, in particular, the use of the relative value of 900 MHz to 800 MHz for estimating 900 MHz value and the use of the distance method for estimating 1800 MHz value. EE, H3G, Telefónica and Vodafone

supported our use of these relative values.[132] BT agreed that absolute values should not be used and said relative values were potentially relevant.

c) The use of tiering to differentiate country benchmarks based on their quality as evidence points.

3.9 However, some stakeholders argued that we should take account of non-benchmark evidence (technical and commercial evidence) as to the relative values of different bands.

a) Vodafone cited a technical model relating to the possible use of the 700 MHz band for mobile services,[133] and said this model showed that the present use and future value of 800 MHz spectrum must be considerably more than that of 900 MHz spectrum (based on the intensity of use of the two bands which the model assumed). In our August 2014 consultation we noted that this model was consistent with a wide range of possible values of 900 MHz spectrum. Vodafone argued that a purpose-built model for 900 MHz could generate a significantly narrower, and lower, range of values for 900 MHz.

b) In contrast to Vodafone's first point above, H3G[134] argued that a comparison of technical characteristics and commercial opportunities of 800 MHz and 900 MHz shows they are of almost identical value.

Data from European auctions and derivation of benchmarks

3.10 Stakeholders did not disagree with the general approach we had used to convert European auction prices into UK-equivalent values for licences of similar duration to those awarded in the UK 4G auction. However, Telefónica[135] questioned some specific aspects of the calculations, including the use of PPP factors to convert values into £ sterling, the mechanics of the adjustments to reflect different licence durations and different dates of spectrum availability, including the use of a standard discount rate, and the averaging of lot prices. Telefónica also questioned the way we had taken account of DTT co-existence and coverage obligation costs when deriving the UK-equivalent benchmarks for 900 MHz and 1800 MHz from the auction prices in the country concerned.

3.11 Analysys Mason and Aetha (AM&A),[136] on behalf of EE and H3G, argued that the use of a proxy for the value of 2.6 GHz spectrum in Sweden appeared inappropriate given the availability of an auction price in that country (from 2008). Telefónica[137]

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[132] The distance method was proposed by EE and H3G in their responses to our October 2013 consultation.

[133] This model was designed by Analysys Mason for Ofcom in the context of a separate project, on changing the use of the 700 MHz band to mobile broadband.

[134] H3G, response to our August 2014 consultation, page 3.

[135] Telefónica, response to our August 2014 consultation, pages 56 to 62.

[136] AM&A, Review of Ofcom's determination of UK lump-sum values for 1800MHz and 900MHz spectrum to set annual licence fees, Final Report for EE and Three, page 2.

[137] Telefónica, response to our August 2014 consultation, pages 62 to 65.

agreed with the use of a proxy, but suggested taking an average of several possible measures.

3.12 EE[138] argued that for some benchmarks where we had used a straight average of lots sold, the calculation should reflect differences in the size of the lot and the population covered by each lot.

Definition and choice of tiers for benchmarks

3.13 Stakeholders' comments on our estimation of lump-sum values focused on our framework for assigning benchmarks to particular tiers, and on how we had applied this framework to a number of specific country benchmarks.

3.14 AM&A[139] (on behalf of EE and H3G) suggested that our framework to determine the tier for each benchmark was effectively a subjective country-by-country assessment. It argued that we seemed to look for reasons to exclude benchmarks and that, since Tier 3 benchmarks effectively carried no weight, we relied on a very small number of benchmarks.

3.15 It presented an alternative framework for deciding the tier and weight to attach to each benchmark, and placed all of the benchmarks in only two tiers (instead of the three tiers in our August 2014 consultation). AM&A categorised all 900 MHz benchmarks in our sample as Tier 2 (except Denmark, which it excluded), while for 1800 MHz it categorised Italy and the 2010 Germany benchmark as Tier 1 and all others as Tier 2.

3.16 In contrast, Telefónica[140] said our approach of assessing each benchmark qualitatively had considerable merit. Telefónica presented econometric analysis from NERA[141] aimed at establishing whether some benchmarks were statistical outliers and should be moved to Tier 3 on those grounds.

3.17 All MNO responses presented their own analysis of the appropriate choice of tier for each country benchmark within their preferred framework (Table A7.11 and Table A7.12 in Annex 7). There was broad agreement on the choice of tier for a number of countries as well as differences in a number of others.

3.18 There is only one benchmark country, Austria, where all MNO responses argued for a change to the choice of tier from the August 2014 consultation; they argued that both the 900 MHz and 1800 MHz benchmarks should be in Tier 2 or Tier 3 (as opposed to Tier 1 as in the August 2014 consultation).[142] The other main differences to the choice of tier in the August 2014 consultation related to:

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[138] EE, response to our August 2014 consultation, page 38.

[139] AM&A, pages 1 and 20.

[140] Telefónica, response to August 2014 consultation, pages 49 to 51.

[141] NERA: Review of country benchmarks used for setting lump sum values for UK 900 MHz and 1800 MHz – A Response to Ofcom's Further Consultation, Prepared by NERA Economic Consulting for Telefónica UK, 16 September 2014.

[142] Responses to our August 2014 consultation: AM&A Final report for EE and H3G, page C-1. Vodafone, page 24, Telefónica, page 6.

a) Ireland, where AM&A[143] (for EE and H3G) argued that the benchmarks for both 900 MHz and 1800 MHz should be in a lower tier (as did NERA,[144] for Telefónica, in the case of the 1800 MHz benchmark, although both NERA and Frontier,[145] for Telefónica and Vodafone respectively, agreed that the Ireland 900 MHz benchmark should be Tier 1 as in the August 2014 consultation).

b) The Germany 1800 MHz benchmark derived from the Germany 2010 auction, where AM&A[146] argued that it should be Tier 1 (although NERA[147] for Telefónica agreed with the Tier 2 ranking in the August 2014 consultation) while Frontier,[148] for Vodafone, considered Germany "not relevant";

c) The Spain 900 MHz benchmark and the Sweden 1800 MHz benchmark which Frontier, [149] for Vodafone, argued should be in Tier 1 rather than Tier 2.

February 2015 consultation

3.19 Having reviewed our analysis in light of stakeholder responses, our approach in the February 2015 consultation remained substantially the same as in the August 2014 consultation. Stakeholders agreed that our primary focus should be on relative benchmarks rather than absolute benchmarks and that, for 1800 MHz, our focus should be on benchmarks derived from the distance method. As regards aspects of our approach with which some stakeholders disagreed, we remained of the view that:

a) The variation in quality of evidence between countries justifies the continued use of three tiers (as opposed to two).

b) We should exercise judgement in deciding the tier of each benchmark from the available evidence (based on the criteria which we specified in our February 2015 consultation).

3.20 As regards technical and commercial evidence, in summary:

a) While we remained of the view that the possibility of greater certainty of spectrum availability is a reason to be conservative in interpreting the evidence, we did not agree that the change in certainty of future spectrum availability since the time of the 4G auction was much stronger than we considered it to be in our August 2014 consultation.

b) In assessing benchmark evidence, we took account of arguments as to the technical characteristics and commercial possibilities of the 900 MHz band relative to the 800 MHz band.

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[143] AM&A, Final report for EE and H3G, page C-5.

[144] NERA, response to our August 2014 consultation, pages 5 and 16.

[145] Frontier, report for Vodafone, page 22.

[146] AM&A, Final report for EE and H3G, page C-4.

[147] NERA, response to our August 2014 consultation, page 18.

[148] Frontier, report for Vodafone, page 11.

[149] Frontier, report for Vodafone, page 17.

c) We remained of the view that there is a risk that 1800 MHz awards which took place before 2012 may be understating the more recent market value of 1800 MHz relative to 800 MHz and 2.6 GHz bands.

d) We remained of the view that any network cost modelling would be subject to significant uncertainty about the specification of the model and appropriate parameter assumptions.

e) We considered that it was not appropriate to use assumptions incorporated in Analysys Mason's 700 MHz model as a basis for informing our view of the relative value of 900 MHz and 800 MHz spectrum.

3.21 We considered Telefónica's points about the conversion of European auction data into UK equivalent values (see Annex 7, paragraphs A7.26 to A7.55 of the February 2015 consultation and Annex 7, paragraphs A7.33-A7.75 of the present document). We remained of the view that use of a proxy value for 2.6 GHz, when applying the distance method to Sweden, was the most appropriate approach (see Annex 7, paragraphs A7.93 to A7.118 of the February 2015 consultation and Annex 7, paragraphs A7.114-A7.140 of the present document).

3.22 We considered comments from AM&A, H3G and EE about our framework for tiering in Annex 7, paragraphs A7.161 to A7.191 of the February 2015 consultation (see also Annex 7, paragraphs A7.205-A7.249 of the present document).

3.23 We considered the arguments put to us about the choice of tier for specific country benchmarks in Annex 8 of the February 2015 consultation. On the basis of this assessment we remained of the view that the Austria benchmarks should be treated as Tier 1 for both 900 MHz and 1800 MHz bands, that Ireland should be treated as Tier 1 for both bands, and that Tier 2 was appropriate for Spain (900 MHz) and the 2010 Germany auction (1800 MHz).

Changes from our August 2014 consultation to our February 2015 consultation

3.24 The main changes (in our February 2015 consultation) to the analysis set out in our August 2014 consultation were as follows:

a) We revised some of our benchmark data, as set out in paragraph 3.41 of the February 2015 consultation;

b) We moved the Sweden 1800 MHz benchmark from Tier 2 to Tier 1, as set out in paragraph 3.65 of the February 2015 consultation;

c) We revised our view of the risk of understatement or overstatement attached to some benchmarks, as set out in paragraphs 3.54 and 3.65 of the February 2015 consultation.

3.25 The criteria that we used in our February 2015 consultation for deciding in which tier a benchmark should be placed were similar to the criteria we used in the August 2014 consultation, but included a specific criterion related to strategic bidding (see paragraph 3.53 below). We provided a more detailed explanation of the criteria in Annex 7 of the February 2015 consultation. Our assessment when applying these criteria to each country benchmark was set out in Annex 8 of the February 2015 consultation.

Stakeholder responses to our February 2015 consultation

International benchmarking

3.26 Telefónica said that we had made a number of errors in our calculations of benchmarks – see Annex 7, paragraph A7.53. Telefónica also argued that our use of country-specific discount rates for only Tier 1 and Tier 2 benchmarks was arbitrary. It also said that the discount rate we used for Austria was implausibly high.

3.27 Telefónica presented a further paper from NERA relating to its econometric analysis, in which NERA argued that its quantitative approach to identifying outliers should be considered alongside qualitative assessment of benchmarks.

Technical and commercial evidence

3.28 EE and Telefónica argued that greater certainty over the release of new spectrum bands for mobile was likely to have reduced the market value of 900 MHz and 1800 MHz spectrum. EE suggested that we should have made a quantitative estimate of this impact, and adjusted our estimates of ALF market value accordingly.

3.29 Vodafone and Telefónica argued that we have overstated the extent to which LTE900 prospects have developed over the last few years. Vodafone also argued that we have underestimated the extent to which LTE900 development was anticipated by auction participants before and in 2012.

Addressing stakeholder responses to our February 2015 consultation

International benchmarking

3.30 We have investigated Telefónica's allegations of errors in our dataset, and found no such errors, as detailed in Annex 7, paragraph A7.57. We consider that deriving country-specific discount rates only for Tier 1 and Tier 2 benchmarks remains a proportionate approach, as we place considerably less weight on Tier 3 benchmarks. For Austria, we base our country-specific discount rate on the WACC estimate of the national regulator, RTR, for the purpose of setting mobile termination rates, consistent with our approach for other country-specific rates. We remain of the view that this is appropriate because of the reasons set out in Annex 7 (paragraphs A7.67).[150]

3.31 NERA's arguments relating to its econometric identification of outliers is set out in Annex 7. Our view is that this does not provide us with sufficient reasons to alter our tiering decisions, for the reasons set out in paragraphs A7.232 to A7.238.

Technical and commercial evidence

3.32 We consider the issue of greater certainty over new spectrum availability in Annex 9, paragraphs A9.5-A9.35. As noted in Section 1, paragraph 1.38, we recognise that developments since the 4G auction could have increased confidence in the future

[150] For our new Germany 2015 benchmarks we use a country-specific WACC based on the rate used for determining mobile termination rates in Germany.

availability of some spectrum bands, and we take account of this possibility in setting ALFs.

3.33 We do not consider there is a robust approach to quantifying the impact of improved prospects of future spectrum release, and stakeholders have not presented any such approach. We note that, in principle, we could estimate the impact of 700 MHz and 1.4 GHz spectrum availability on ALF spectrum values by comparing ALF spectrum prices from the 2015 auction in Germany with prices from earlier auctions in the same country, or in other relevant countries. However, we do not consider that a reliable inference can be drawn from these comparisons for the reasons discussed in paragraphs A9.29-A9.30.

3.34 We consider changes over time in the relative values of 900 MHz and 800 MHz in Annex 9, paragraphs A9.36-A9.78. In summary our view is that:

a) It remains unclear from benchmark evidence whether the value of 900 MHz, relative to the value of 800 MHz, has risen over the period since late 2010;

b) The device ecosystem for LTE900 is sufficiently well established at this point to make this a realistic band for LTE deployment; and

c) While there is some evidence indicating that commercial opportunities for LTE900 have developed in line with expectations, we cannot rule out the possibility that this may have occurred more quickly than expected at the time of auctions of 900 MHz spectrum in 2011 and 2012.

3.35 Overall, therefore, we remain of the view that there is a risk of understatement of relevant 900 MHz benchmarks from an increase in the attractiveness of the LTE900 ecosystem (although we cannot be sure of the scale of any understatement).

3.36 We have also considered whether changes in expectations of 700 MHz availability for mobile may have changed the forward-looking value of spectrum in other bands for which 700 MHz may be a substitute. Our assessment of this issue is set out in Annex 7, paragraphs A7.171 to A7.181, and where this affects our assessment of specific country auction prices and benchmarks this is included in our assessment for the country concerned in Annex 8.

3.37 We note that the 700 MHz and 1.4 GHz bands were included in the German 2015 auction. We have included benchmarks for 900 MHz and 1800 MHz from the German 2015 auction in our updated analysis and these benchmarks will reflect the availability of 700 MHz and 1.4 GHz in Germany.

Stakeholder responses to our update on the German 2015 auction

3.38 Telefónica and Vodafone agreed that new benchmarks based on the German 2015 auction should be included in our international benchmarking analysis, and said that both benchmarks should be Tier 1 evidence points. Vodafone said that the particular circumstances of the German auction made it the most important Tier 1 data point in our dataset.

3.39 BT and EE argued that the benchmarks should be Tier 2 evidence points, and that these benchmarks did not provide a reason for changing our lump-sum value estimates. Their reasons for believing that relative prices were not reliable reflections of UK market value were: evidence of signalling and strategic demand reduction in the auction, the impact of the 900 MHz price cap, the time gap between the 2010 and

2015 auctions (on which our benchmarks are based), and the fact that 1800 MHz spectrum sold for more than 900 MHz in the auction.

Addressing stakeholder responses to our update on the German 2015 auction

3.40 We consider that Germany 2015 benchmarks for both 900 MHz and 1800 MHz should be included in our analysis of lump-sum values, along with our existing 1800 MHz benchmark from the 2010 auction, and we set out our detailed assessment of the German 2015 auction in Annex 8.

3.41 Having considered stakeholder arguments, our view is that both the 900 MHz and 1800 MHz benchmarks carry a risk of understating UK market value. We agree that 900 MHz and 1800 MHz prices may have been affected by signalling and strategic demand reduction. We also consider that there may have been a substantial change in expectations about the availability of the 700 MHz band for mobile between the 2010 and 2015 auctions. Both of these risks suggest that relative prices may understate UK market value. For 900 MHz, our view remains that the 900 MHz price cap creates a further risk that prices in the German auction understate market value.

3.42 As set out in paragraphs 3.61 and 3.73 below, we consider that changes in expectations about the availability of the 700 MHz band for mobile have implications for the risk of understatement or overstatement of some of our other benchmarks.

3.43 We have also considered the implications of BT and EE's arguments for our tiering assessment. We recognise that there are reasons which might suggest that the Germany 900 MHz and 1800 MHz benchmarks could be treated as Tier 1 or Tier 2 evidence points, and we set out our view on tiering of these benchmarks in paragraphs 3.65-3.67 and 3.75-3.76 below. In Section 5, we set out how we take these benchmarks into account in deriving lump-sum values.

Our approach following consideration of stakeholders' responses

3.44 Our approach to estimating the lump-sum value of 900 MHz and 1800 MHz spectrum in the UK remains as described at paragraph 3.5 above. We now summarise our position on the components of this approach set out in paragraph 3.5 (a), (b), (c)(i) and (c)(ii). The components in (c)(iii)) and (c)(iv) relating to deriving and cross-checking lump-sum values for 900 MHz and 1800 MHz spectrum in the UK are set out in Section 5.

Absolute value benchmarks

3.45 The data points used to develop the benchmarks are taken from auctions of 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz licences in Europe since the start of 2010. The auction prices we consider are set out in Table 3.1 in terms of their UK-equivalent absolute values. They include adjustments to reflect differences from the UK 4G auction licences such as annual spectrum fees, licence duration, delayed availability of spectrum, currency and population.

Table 3.1: Results of European auctions 2010-2014 (absolute values in UK-equivalent £m per MHz)[151]

	800 MHz	900 MHz	1800 MHz	2.6 GHz
Austria (2013; 2010)[152]	68.0	77.9	44.0	1.9
Czech Republic (2013)	45.5		6.0	3.0
Denmark (2012; 2010)[153]	16.4	2.9	1.3	10.3
Germany (2010)	53.1		1.9	1.6
Germany (2015)		16.1	20.7	
Greece (2014; 2011)[154]	38.5	32.6	14.4	3.5
Ireland (2012)[155]	58.9	35.6	23.1	
Italy (2011)	52.2		16.7	3.8
Portugal (2011)	42.1	29.7	8.1	7.5
Romania (2012)	44.8	48.2	19.4	10.8
Slovak Republic (2013)	39.3		7.2	4.7
Spain (2011)[156]	59.3	40.0		4.6
Sweden (2011)	21.2		9.3	
UK (2013)	33			5.5

Source: Ofcom

3.46 The absolute values presented in Table 3.1 now include values for 900 MHz and 1800 MHz from the auction in Germany which concluded in June 2015 (i.e. after our February 2015 consultation), and our UK market values for 800 MHz and 2.6 GHz for comparison.

Relative value benchmarks

3.47 For each country in Table 3.1 above, we calculate benchmarks based on the ratio between values in different spectrum bands. For 900 MHz benchmarks, we calculate

[151] We do not consider that reliable band-specific auction prices can be derived from available information about auctions in the Netherlands, Norway, Slovenia or Switzerland.

[152] 800/900/1800 MHz awarded in October 2013; 2.6 GHz in October 2010.

[153] 800 MHz awarded in June 2012; 900/1800 MHz in September 2010; 2.6 GHz in May 2010.

[154] 800 MHz and 2.6 GHz awarded in October 2014; 900 MHz and 1800 MHz in November 2011.

[155] Results based on information from Comreg.

[156] A multiband auction took place in in July 2011. One lot of unsold 900 MHz spectrum was re-auctioned in November 2011. The 900 MHz value shown is from November 2011.

the ratio between 900 MHz and 800 MHz values in the country concerned and apply this to the corresponding value of 800 MHz in the UK. For 1800 MHz benchmarks, we apply the distance method, which consists of: (a) calculating the Y/X ratio (calculated as the difference in value between 1800 MHz and 2.6 GHz ("Y"), divided by the difference in value between 800 MHz and 2.6 GHz ("X"), expressed as a percentage); and (b) relating this to the corresponding 800 MHz and 2.6 GHz values in the UK.[157] We set out details of these calculations in Annex 7 (paragraphs A7.76-A7.143), including our treatment of differences in expected DTT co-existence costs and coverage obligations between the UK and benchmark countries.

3.48 The resulting relative value benchmarks for the lump-sum values of 900 MHz and 1800 MHz in the UK that are derived from the European auctions are shown in Tables 3.2 and 3.3 below. Table 3.2 also shows the 900 MHz benchmarks when expressed in terms of the ratio of 900 MHz to 800 MHz value (i.e. the relative value benchmark in the table expressed as a ratio to the UK 800 MHz value of £33m per MHz which is gross of expected DTT co-existence costs and without coverage obligation). Similarly, Table 3.3 also shows the 1800 MHz benchmarks when expressed in terms of the Y/X ratio.

Table 3.2: Relative value benchmarks for 900 MHz in UK, and associated ratio of 900 MHz to 800 MHz

	Relative value benchmark £m per MHz	900 MHz / 800 MHz ratio
Austria	37.8	115%
Denmark	5.7	17%
Germany (2015)	9.4	29%
Greece	28.8	87%
Ireland	18.2	55%
Portugal	21.2	64%
Romania	30.6	93%
Spain	22.2	67%

Source: Ofcom

[157] For example, in Italy the Y/X ratio = 27%. We can identify a benchmark value for 1800 MHz in the UK, in this case £12.8m per MHz, which would lead to the same 27% ratio in the UK (taking our conclusions on the market values of 800 MHz and 2.6 GHz values from Section 2), so £12.8m is our Italy distance method benchmark for the value of 1800 MHz in the UK.

Table 3.3: Relative value benchmarks for 1800 MHz in UK, and associated Y/X ratio[158]

	Relative value benchmark £m per MHz	Y/X ratio
Austria	23.0	64%
Czech Republic	7.2	6%
Germany (2010)	5.6	0%
Germany (2015)	15.1	35%
Greece[159]	14.4	33%
Ireland	13.3*	28%
Italy	12.8	27%
Portugal	5.9	2%
Romania	11.3	21%
Slovak Republic	7.3	6%
Sweden	16.0*	38%

Source: Ofcom
* Relative value benchmark derived using our preferred 2.6 GHz proxy

3.49 Telefónica said in its response to the February 2015 consultation that these ratios are inconsistent with the tables presented in Annex 8. However the difference in ratios is not an inconsistency, and arises because the ratios in Tables 3.2 and 3.3 are based on the same UK 800 MHz value so as to be directly comparable between countries, whereas the ratios presented in Annex 8 are those used to actually generate the relative value benchmarks.[160]

[158] For Ireland and Sweden we use proxy estimates of the value of 2.6 GHz in deriving distance method benchmarks for 1800 MHz, as discussed in Annex 7, paragraphs A7.114-A7.140.

[159] We have corrected an error in the February 2015 consultation in the calculation of the Y/X ratio for the Greece 1800 MHz benchmark (the ratio was reported as 29% when it should have been 33%). For distance method benchmarks such as Greece, where bands sold in different years, we adjust the calculation to remove the effect on the Y/X ratio of PPP conversion factors being taken at different times. In the case of Greece this calculation was previously only applied to the "Y" component of the Y/X ratio, rather than both the "Y" and "X" components. This error was not present in any other benchmarks.

[160] As discussed in Annex 7, for some countries we derive the relative value using a country benchmark for 800 MHz that is net of expected DTT co-existence costs and/or with coverage obligation. For these countries we derive the UK-equivalent benchmark using a UK value of 800 MHz that is correspondingly also net of expected DTT co-existence costs and/or with coverage obligation. But, so that the ratios in Tables 3.2 and 3.3 are directly comparable between countries, all the ratios in the tables are expressed relative to the UK value of 800 MHz that is gross of expected DTT co-existence costs and without coverage obligation (£33m per MHz). This means that, for the countries

Framework for using benchmarks to assess UK market value

3.50 We develop our estimates for UK market value of 900 MHz and 1800 MHz spectrum based on this set of relative value benchmarks. To do so:

a) First, we group the benchmarks into tiers, according to our assessment of the quality of evidence as a basis for ALF. We place more weight on benchmarks in a higher tier as we regard them as being more informative of UK market values.

b) Second, we assess the risk that individual benchmarks may be understated or overstated estimates of market value in the UK and characterise the nature of that risk in terms of likelihood, scale and direction of any potential understatement or overstatement.

c) Third, we reach a view as to the lump-sum value of 900 MHz and 1800 MHz in the UK, in light of these benchmarks, taking account of the quality and nature of each benchmark evidence point (reflecting, respectively, the tier of the evidence point and its risk of understatement or overstatement referred to above).

d) Fourth, we apply cross-checks to our estimates of the lump-sum values for 900 MHz and 1800 MHz in the UK.

3.51 We describe the first two of these steps below. The third and fourth steps are described in Section 5, paragraphs 5.35-5.94.

Quality of benchmarks (tiers)

3.52 We categorise the available benchmarks into three tiers which reflect their relative quality to serve as a basis for ALF.

3.53 In particular we use criteria reflecting the following considerations:

a) Whether auction prices appear likely to have been primarily determined by a market-driven process of bidding in the auctions (e.g. not set by reserve prices);

b) Whether the evidence available to us suggests that the relative prices in the auction are at least as likely to reflect bidders' intrinsic valuations of spectrum as strategic bidding; and

c) Whether we have a clear, evidence-based reason for considering that the outcome is less informative of forward-looking relative spectrum values in the UK (having regard to country-specific circumstances and auction dates).

3.54 A more detailed discussion of the criteria is in Annex 7 and the choice of tier for each country benchmark is explained in Annex 8 (with the exception of the 900 MHz benchmarks for Austria and the 900 MHz and 1800 MHz benchmarks for Germany, which we discuss below).

3.55 When using benchmarks to inform our judgement on the lump-sum value of 900 MHz and 1800 MHz in the UK, we consider that we should place most weight on

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for which we use a different UK 800 MHz value, the ratio shown in Table 3.2 or 3.3 is different from the ratio used to generate the relative value benchmark (i.e. the ratio presented in Annex 8).

benchmarks which are in Tier 1, some weight on benchmarks in Tier 2, and that benchmarks that are in Tier 3 should be considered as having relatively little informative value for these purposes.

Assessment of risks of understatement or overstatement

3.56 In interpreting the benchmarks we consider whether there is a risk that benchmarks might understate or overstate the value of the corresponding band in the UK. Our approach to assessing the likelihood and scale of this risk is set out in Annex 7.[161] We apply this approach to each country benchmark, as assessed in detail in Annex 8. We take these risks into account in interpreting the evidence.

Relative value benchmarks for 900 MHz spectrum

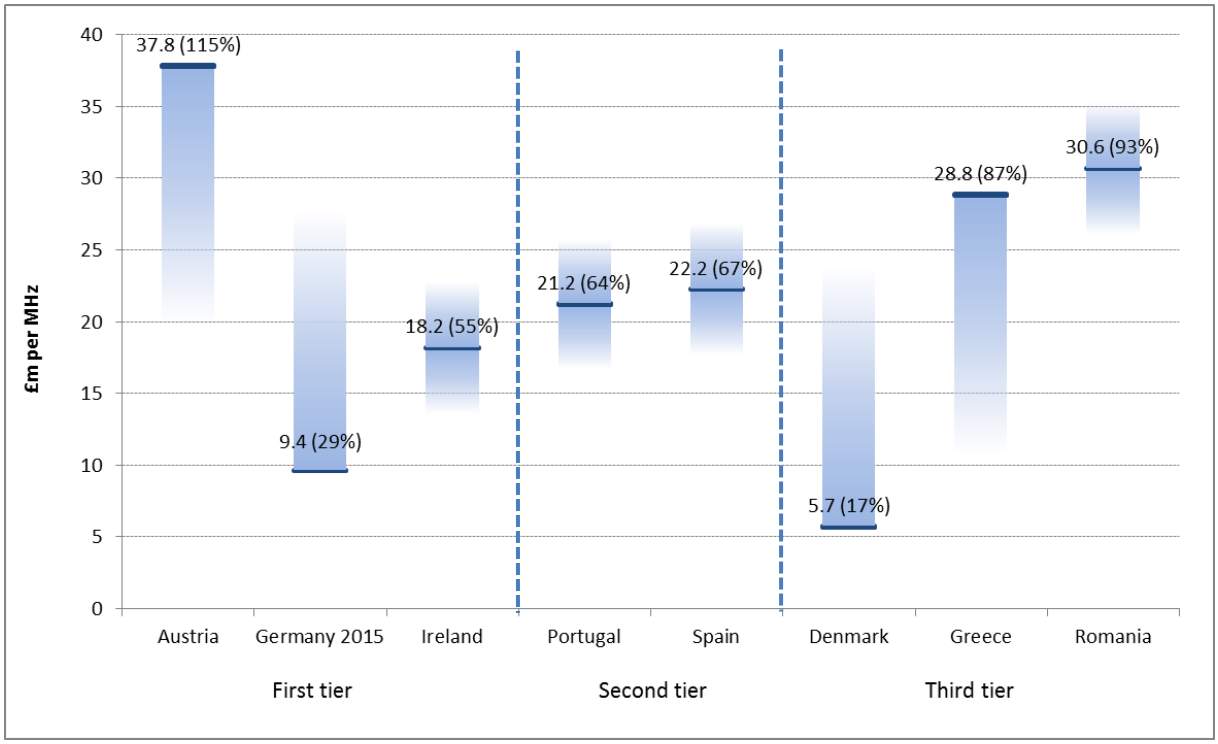
3.57 We have relative value benchmarks (based on 900 MHz to 800 MHz paired ratios) from eight countries where spectrum has been auctioned in both bands since 2010 as shown in Table 3.2 above – Austria, Denmark, Germany, Greece, Ireland, Portugal, Romania and Spain. Our assessment of the tier in which we categorise each benchmark, along with our assessment of the risk that the benchmark might either understate or overstate the market value of 900 MHz in the UK, is set out in Annex 8. Table A8.1 in Annex 8 summarises this assessment of tier and risks for each benchmark country.

3.58 These relative value benchmarks are shown in Figure 3.1, grouped by tier. The shaded areas in Figure 3.1 illustrate our assessment of the likelihood or scale of possible understatement or overstatement associated with each benchmark. The length of these shaded areas reflects a combination of the likelihood and scale of potential understatement or overstatement (with a larger risk of a larger understatement or overstatement being represented by a longer shaded area, although the resulting length of the shaded areas is not drawn to a specific scale and so is only illustrative).[162]

[161] Some specific types of auction circumstances and/or country-specific factors can be relevant to this assessment of risks as well as to the grouping of benchmarks into tiers, such as the date of the auction. We discuss this further in Annex 7, including an explanation of when the choice of tier is affected or when we instead only take account of this factor through the assessment of risks.

[162] The Denmark relative value benchmark depends on the 800 MHz auction price that is gross of expected DTT co-existence costs but with a coverage obligation (£16.4m per MHz). Another way to derive the benchmark would be to use the lower Denmark 800 MHz auction price that is net of expected DTT co-existence costs and without a coverage obligation (£7.1m per MHz). This would yield a relative value benchmark of £12.6m per MHz, which is much higher than £5.7m per MHz and still subject to similar risks of being understated.

Figure 3.1: 900 MHz paired ratio benchmarks in £m per MHz



Source: Ofcom

Note: Percentages in brackets represent the ratio of 900 MHz to 800 MHz

Developments in our analysis since our February 2015 consultation

3.59 Stakeholder responses included arguments that the Austria benchmark should be in a different tier from that which we set out in February 2015. We have considered these arguments in detail in Annex 8, and we set out our position on the choice of tier for Austria below. It is shown in Figure 3.1 in Tier 1.

3.60 Stakeholders also disagreed with our assessment of the risk of understatement or overstatement of the Austria and Ireland benchmarks. Having considered these arguments in detail, we have not changed our assessment of the risk of understatement or overstatement for Ireland. However, for Austria we now conclude that the 900 MHz benchmark is at larger risk of larger overstatement. For both Ireland and Austria our reasoning is set out in Annex 8.

3.61 As set out in Annex 7, paragraphs A7.171 to A7.181, we consider that the evidence of changes in expectations of 700 MHz availability for mobile following the February 2012 World Radio Conference (WRC-12) provides a reason for auction prices of 900 MHz or 800 MHz prior to this date to overstate the forward-looking value of these bands. We have reviewed our assessment of risks in light of this, as set out in Annex 8, and we now consider that the 900 MHz Greece benchmark is at larger risk of larger overstatement (compared to a risk of understatement or overstatement in our February 2015 consultation).

3.62 We have also added a new Germany 2015 benchmark, based on the 900 MHz price from the June 2015 auction (which was not available when we published our February 2015 consultation) and the 800 MHz price from the May 2010 auction. In our July 2015 update note, we provisionally considered this to be at risk of understatement and a Tier 1 benchmark. We now conclude that the Germany 2015

benchmark is at larger risk of larger understatement for the reasons set out in Annex 8. We consider further below the choice of tier for Germany.

3.63 Whilst Figure 3.1 shows the 900 MHz benchmarks for Austria and Germany in Tier 1, we recognise that there are possible reasons why they might not meet the criteria for inclusion in that tier (as discussed in greater detail in Annex 8).

3.64 For Austria, given the technical and commercial evidence about the expected relative values of 900 MHz and 800 MHz, we have not identified a specific explanation for the 900 MHz to exceed the 800 MHz price based on intrinsic value in Austria. This could indicate that either the second or third criterion for inclusion in Tier 1 set out in paragraph 3.53 above is not met.

3.65 For Germany, we identify two possible reasons why the second and third criteria for inclusion in Tier 2 might not be met.

a) First, there is evidence that the price of 900 MHz spectrum in the 2015 auction might have been affected by strategic bidding, although we cannot be sure of the scale of the effect. This could indicate that the second criterion for inclusion in Tier 1 is not met.

b) Second, there is evidence of a substantial change in expectations about the availability of the 700 MHz band for mobile between the 2010 auction of 800 MHz and the 2015 auction of 900 MHz.[163] This could indicate that the third criterion for inclusion in Tier 1 is not met.

3.66 On the other hand, the auction prices in Austria and Germany are market-based information determined by bidding in the auctions in question. In contrast, the (Tier 2) Portugal and Spain benchmarks do not reflect auction bids by operators but instead the reserve prices set by the regulator, which we would generally expect to be less informative about market value. We consider this is an important distinction between the Austria and Germany benchmarks and the benchmarks for Portugal and Spain, relating to our first criterion for inclusion in Tier 1.

3.67 Therefore, whilst we recognise the case for both the Austria and Germany benchmarks to be in Tier 2, on balance we have decided to include both the Austria and Germany benchmarks in Tier 1 (which reflects the distinction noted above between these benchmarks and those for Portugal and Spain). We take account of the points in paragraphs 3.644 and 3.65 through the risks of overstatement or understatement. We return to this issue when deriving lump-sum values in Section 5.

Distance method benchmarks for 1800 MHz spectrum

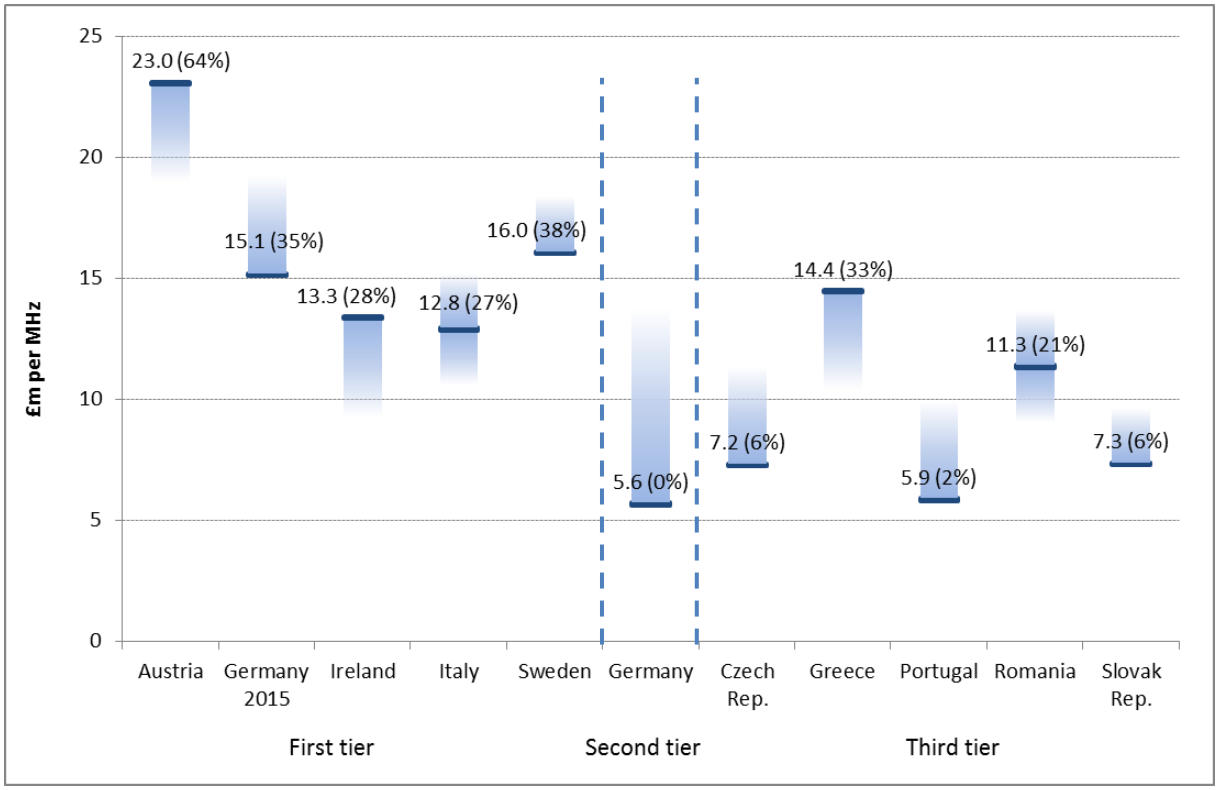
3.68 We derive eleven distance method benchmarks from countries where spectrum has been auctioned in relevant bands as shown in Table 3.3 above – Austria, Czech Republic, Germany (2010 and 2015), Greece, Ireland, Italy, Portugal, Romania, Slovak Republic, and Sweden.

[163] As set out in Annex 8 (paragraph A8.477), any change in expectations in the UK about the availability of the 700 MHz band for mobile between the 4G auction in 2013 and today is much less substantial than in Germany between the 2010 and 2015 auctions.

3.69 Interpreting these benchmarks requires an assessment of the interplay of different auction and country factors for the three bands involved in the distance method calculation: 800 MHz, 1800 MHz and 2.6 GHz. Our position on tiering and interpretation of these benchmarks is set out in Annex 8.

3.70 The benchmarks are shown in Figure 3.2. As with Figure 3.1, the shaded areas illustrate our assessment of the likelihood, scale and direction of potential understatement or overstatement associated with each benchmark.

Figure 3.2: 1800 MHz distance method benchmarks in £m per MHz



Source: Ofcom

Note: Percentages in brackets represent the Y/X ratio.

Developments in our analysis since our February 2015 consultation

3.71 Stakeholders argued that the benchmarks for Austria and Sweden should be in different tiers from those which we set out in February 2015. We have considered these arguments in detail; having done so, we have not changed the tier for these country benchmarks for the reasons set out in Annex 8.

3.72 Stakeholders also disagreed with our assessment of the risk of understatement or overstatement of the Austria benchmark. Having considered these arguments in detail, we now conclude that the Austria 1800 MHz benchmark is at larger risk of overstatement (but, as before, that we cannot be sure of the scale of any overstatement) for the reasons set out in Annex 8.

3.73 As set out in Annex 7, paragraphs A7.171 to A7.181, we consider that the evidence of changes in expectations of 700 MHz availability for mobile following WRC-12 provides a reason for auction prices of 1800 MHz or 800 MHz prior to this date to overstate the forward-looking value of these bands. We have reviewed our assessment of risks in light of this, as set out in Annex 8, and we now consider that:

a) Greece benchmark is at larger risk of overstatement;

b) Portugal benchmark is at larger risk of understatement; and

c) Sweden benchmark is at risk of understatement.[164]

3.74 We have also added a new Germany 2015 benchmark, based on the 1800 MHz price from the June 2015 auction (which was not available when we published our February 2015 consultation) and the 800 MHz and 2.6 GHz prices from the May 2010 auction. This means that we now have two 1800 MHz benchmarks from Germany. In our July 2015 update note, we provisionally considered the new 2015 benchmark to be at risk of either overstatement or understatement and to be a Tier 1 benchmark. Having considered stakeholder responses to our update note, our conclusion is that it is at larger risk of understatement. We explain our reasons for this in Annex 8.

3.75 Figure 3.2 shows the 1800 MHz benchmark for Germany in Tier 1. However, we recognise that there are possible reasons why it might not meet the criteria for inclusion in that tier (as discussed in greater detail in Annex 8):

a) First, there is evidence that the price of 1800 MHz spectrum in the 2015 auction might have been affected by strategic bidding, although we cannot be sure of the scale of the effect. This could indicate that the second criterion for inclusion in Tier 1 is not met.

b) Second, there is evidence of a substantial change in expectations about the availability of the 700 MHz for mobile between the 2010 auction of 800 MHz / 2.6 GHz and the 2015 auction of 1800 MHz. When we discussed the 900 MHz benchmark we said this could indicate that the third criterion for inclusion in Tier 1 is not met. This is also a possibility for the 1800 MHz benchmark, although in our view the argument for failing to meet the third criterion is weaker in the case of the 1800 MHz because 700 MHz might be a less close substitute for 1800 MHz than for other sub-1 GHz spectrum in the 900 MHz band.

3.76 As for the 900 MHz benchmark, whilst we recognise the case for the Germany 2015 benchmark for 1800 MHz to be in Tier 2, on balance we have decided to include it in Tier 1 and to take account of the points in paragraph 3.75 through the risk of understatement. We return to this issue when deriving lump-sum values in Section 5.

[164] In all three cases, this represents a change from a risk of understatement or overstatement in our February 2015 consultation.

Section 4

Impact of the geographic coverage obligation on market value of ALF bands

Introduction

4.1 The Government and the four MNOs (EE, H3G, Telefónica and Vodafone) agreed a series of voluntary commitments on 17 December 2014. These included a commitment by each MNO to implement 90% geographic voice coverage throughout the UK by no later than 31 December 2017 (at specified signal strength thresholds). This commitment has been given effect through a variation by consent of the MNOs' spectrum licences. In this document we refer to this commitment as the "geographic coverage obligation".[165]

4.2 The MNOs can meet the obligation using any frequencies or technologies available to them, including LTE at 800 MHz, GSM at 900 MHz, GSM at 1800 MHz, and UMTS at 2100 MHz. Voice services are provided over GSM and UMTS at present. Although the LTE networks in the UK do not currently provide voice services, we consider it is likely that voice over LTE (VoLTE) will become a viable option for providing voice services before the end of 2017 (i.e. within the timeframe relevant to meet the geographic coverage obligation).[166]

4.3 The question which we consider in this section is whether, and if so how, this geographic coverage obligation affects the market value of spectrum in the ALF spectrum bands at 900 MHz and 1800 MHz, taking account of the incremental costs incurred by the MNOs to meet the obligation. We have set this out as step 2b in the analytical framework we describe in Section 1.

4.4 In our February 2015 consultation, we set out our initial view of this question, which was that that the geographic coverage obligation is unlikely to have a material effect on the market value of either 900 MHz or 1800 MHz spectrum for the purpose of ALF. We invited stakeholders to comment on our analysis and this initial view and, if they disagreed with our approach, to set out their preferred alternative approach and their view of what any such alternative approach implied about the impact of the geographic coverage obligation on the market value of 900 MHz and 1800 MHz spectrum for the purpose of ALF.

4.5 We received responses from EE, H3G, Telefónica and Vodafone, all of whom disagreed with our view. We have considered the responses we received and have reviewed our analysis in light of them. For the reasons set out below our overall

[165] There is also a different coverage obligation in the 800 MHz spectrum licence acquired in the 4G auction by Telefónica, which we refer to as the "800 MHz coverage obligation". This obligation is specified in terms of data coverage rather than voice coverage.

[166] In their responses to our February 2015 consultation, Vodafone (page 23) and Telefónica (page 54) provided some support for this view. EE, Vodafone and H3G have announced plans to introduce VoLTE in 2015, see: http://www.lightreading.com/mobile/volte-rich-communications/ee-on-track-to-launch-volte-in-summer/d/d-id/716904?_mc=RSS_LR_EDT. H3G has now launched VoLTE in the UK in September 2015, see http://www.totaltele.com/view.aspx?ID=491111.

position remains as we set out in our February 2015 consultation. Accordingly, in this section:

a) We begin with an explanation of the approach which, in our view, is appropriate for assessing the impact of the geographic coverage obligation on the market value of the ALF bands. This is materially the same analysis as we presented in our February 2015 consultation.

b) We then present our initial view of the impact on market value of the 900 MHz and 1800 MHz bands as set out in the February 2015 consultation.

c) Next we set out the comments that EE, H3G, Telefónica and Vodafone have made on our initial view, and our responses to those comments.

d) Finally, we present our conclusions.

Approach to assessing the impact of the geographic coverage obligation on market value

4.6 The Government Direction requires us to revise ALF to reflect full market value. In Section 2 we define market value for the purpose of ALF as the market-clearing price in a well-functioning market, or the forward-looking marginal opportunity cost of the spectrum. As noted in Section 2, this means that, taking Vodafone's holdings of 900 MHz as an example, we are not therefore seeking to establish Vodafone's value of its 900 MHz licence. Instead it is the value that is denied to other operators by Vodafone continuing to hold this spectrum that is relevant to the marginal opportunity cost and market value. In particular, it is the value to the other operator that would gain the highest value if it were to acquire Vodafone's 900 MHz frequencies (or part of them). Below we refer to this highest-value alternative holder of the spectrum as the marginal operator or marginal bidder.

4.7 The market value of spectrum for the purpose of ALF therefore depends on the value to the marginal operator (i.e. the highest-value operator that does not hold that specific spectrum) since this determines the opportunity cost. For example, in analysing the market value of the 800 MHz band, we have identified EE as the marginal bidder for 800 MHz spectrum. This is because EE was the highest losing bidder in the 4G auction for additional 800 MHz spectrum (i.e. for more spectrum than it won in the auction).

4.8 We recognise that the MNOs may incur incremental costs to meet the geographic coverage obligation which could, therefore, reduce the overall value that they themselves attach to their current spectrum holdings. However, we do not consider that this is relevant to the impact on the market value of 900 MHz and 1800 MHz. We consider that the impact on market value depends on the value to the marginal operator of acquiring additional ALF spectrum.

4.9 As in Section 2, we use the term "additional spectrum" to refer to more spectrum in that band than the operator currently holds. For example, considering the four MNOs:

a) EE and H3G currently have no spectrum in the 900 MHz band. Therefore for these operators, "additional spectrum" would mean them acquiring some spectrum in the 900 MHz band.

b) All four operators currently have holdings in the 1800 MHz band: EE has the largest holdings of 2x45 MHz, H3G has 2x15 MHz (in both cases after completion

of the spectrum trade between EE and H3G), whilst Telefónica and Vodafone have smaller holdings of 2x5.8 MHz each. Therefore, additional 1800 MHz spectrum would mean these operators acquiring more 1800 MHz spectrum than they currently hold.

4.10 In general, the value of spectrum to an operator is the difference in its profit with and without the specific spectrum in question.

4.11 Putting together these two points (i.e. looking at this question from the perspective of the marginal operator and the difference in profit with and without the specific spectrum in question), we show in Table 7.1 our approach to considering the impact of the geographic coverage obligation on the market value of the ALF bands.

4.12 The marginal operator's profit without the additional ALF spectrum and without the geographic coverage obligation is shown in Table 7.1 as the value labelled "A". In Sections 3 to 6 in this document, in effect, we assess estimates of the market value of ALF spectrum shown in Table 7.1 as the marginal operator's difference in profit with and without additional ALF spectrum, i.e. C (= B-A). We do so using the available market information (in particular, bids in the 4G auction and international benchmarks). For example, the highest losing bidders' incremental bid values in the 4G auction for additional 800 MHz and 2.6 GHz spectrum provide market information which we consider when deriving the market value of those bands.

Table 4.1: Impact of geographic coverage obligation on market value of ALF spectrum through its effect on marginal operator's profit

	Profit without geographic coverage obligation	Profit with geographic coverage obligation	Incremental cost of geographic coverage obligation
Without additional ALF spectrum	A	D	G = A-D
With additional ALF spectrum	B	E	H = B-E
Market value of ALF spectrum	C = B-A	F = E-D	
Impact of geographic coverage obligation on market value of ALF spectrum[167]			F-C or G-H

Source: Ofcom

4.13 The geographic coverage obligation could affect the marginal operator's profit both with and without additional ALF spectrum. The market value becomes the difference in profit with and without additional ALF spectrum in the presence of the geographic coverage obligation, i.e. F (= E-D).

[167] The two expressions of F-C and H-G are equivalent:
F-C = (E-D)-(B-A)
G-H = (A-D)-(B-E), which can be rearranged as (E-D)-(B-A)

4.14 As far as we are aware there is no market information currently available that we can use to assess the market value in the presence of the geographic coverage obligation (F).[168] This is in contrast to the market value without that obligation (C), as explained above.

4.15 We now consider two aspects to the possible impact of the geographic coverage obligation on the market value of ALF spectrum:

a) First, the impact of additional ALF spectrum on the incremental cost to the marginal operator of meeting its own geographic voice coverage obligation; and

b) Second, the impact on the marginal operator's value of additional ALF spectrum of the existence of the geographic coverage obligation on other MNOs, against which it is competing.

Impact of additional ALF spectrum on the incremental cost to the marginal operator of meeting its own geographic voice coverage obligation

4.16 We can describe the impact of the geographic coverage obligation on the market value of the ALF bands by considering the incremental cost of the obligation to the marginal operator with and without additional ALF spectrum:

a) Incremental cost of the geographic coverage obligation to the marginal operator, which is the difference in its profit with and without the geographic coverage obligation with its existing spectrum holdings, i.e. G (= A-D).

b) Incremental cost of the geographic coverage obligation to the marginal operator with additional ALF spectrum, i.e. H (= B-E).

c) The impact on the market value of the ALF bands of the geographic coverage obligation is the difference between the two incremental costs set out above, i.e. G-H.

4.17 Therefore, we recognise that the marginal operator may incur incremental costs to meet the geographic coverage obligation. However, in our view it is not the incremental cost of the geographic coverage obligation on its own which leads to an

[168] In contrast, for the 800 MHz coverage obligation in the spectrum licence acquired in the 4G auction by Telefónica there is market information available that the impact was a reduction in market value of the 800 MHz spectrum with the obligation of £1.55m per MHz (or £31m for the 2x10 MHz block). This was the difference in bid value in the 4G auction of the marginal bidder for the spectrum with the 800 MHz coverage obligation (Vodafone) compared to the same amount of 800 MHz spectrum without the obligation - see paragraph 2.59 (a) in Section 2.
The 800 MHz coverage obligation does not fit neatly into the approach set out in Table 7.1. This is because the obligation was attached to a specific lot of 2x10 MHz of 800 MHz spectrum in the 4G auction, so that there was not a meaningful distinction between acquiring this additional spectrum and having the 800 MHz coverage obligation – they came as a package (whereas the geographic coverage obligation applies to each MNO regardless of whether or not it acquires additional ALF spectrum). Therefore, in terms of Table 7.1, we interpret £31m as the difference between the first two columns (without distinguishing the rows), i.e. as the impact of the 800 MHz coverage obligation on the market value of the 800 MHz spectrum to which that obligation applies. For the avoidance of doubt, for the purpose of ALF we focus in Section 2 on the market value of the 800 MHz band without the 800 MHz coverage obligation.

impact on market value. Instead it is the difference in the incremental costs of the marginal operator with and without additional ALF spectrum.[169]

4.18 One possibility is that the geographic coverage obligation has no impact on the marginal operator's value of additional ALF spectrum. This might be, for example, because the marginal operator's current spectrum holdings are the lowest cost way for it to meet the geographic coverage obligation, and acquiring additional ALF spectrum would not change this. In this case, the difference in profit with and without the geographic coverage obligation would be the same both with and without additional ALF spectrum, i.e. H would be the same as G (which also means that F would be the same as C). In other words, the geographic coverage obligation would not change the market value of the ALF spectrum.

4.19 Another possibility is that the impact of the geographic coverage obligation could be to decrease the market value of the ALF spectrum. However, for the incremental costs of meeting the geographic coverage obligation to have a direct impact in reducing ALF, a significantly different approach would need to be relevant, such as:

a) If market value for the purpose of assessing the impact of the geographic coverage obligation on ALF were to depend on the private value of the ALF spectrum to the licensee, instead of the opportunity cost (and if the operators' holdings of non-ALF spectrum did not provide similar voice coverage capabilities to their ALF spectrum). Therefore, such a different approach would require us to define "market value" as the private value instead of the opportunity cost, which we do not consider appropriate; and

b) If the geographic coverage obligation were causally related only to the operators' holdings of ALF spectrum.

4.20 For the sake of completeness, we have also considered the possibility that the marginal operator's cost of meeting the geographic coverage obligation would be reduced if it acquired additional ALF spectrum. If this were the case, the impact of the geographic coverage obligation could be to increase the market value of that ALF spectrum. It might seem counter-intuitive that there could be an increase in the market value of ALF spectrum as a consequence of the geographic coverage obligation, especially as the MNOs might incur an incremental cost in order to meet this obligation. The rationale for this implication is as follows:

a) The marginal operator for the ALF spectrum has the geographic coverage obligation regardless of whether or not it acquires any additional ALF spectrum. Therefore, it is not the cost of meeting the obligation in itself which is relevant to market value (see paragraphs 4.7 and 4.17 above).

b) So the value of the ALF spectrum to the marginal operator is greater with the geographic coverage obligation, if it could use additional ALF spectrum to reduce its cost of meeting the obligation. This is because:

[169] In our February 2015 consultation, we said that each MNO – and hence the marginal operator – has the geographic coverage obligation regardless of whether or not it acquires additional ALF spectrum. We also said (footnote 184) that if an operator other than an MNO were the marginal operator for additional ALF spectrum, the impact on market value was likely to be zero as that operator does not have to meet the geographic coverage obligation. We have modified our position on this latter point, as explained in paragraph 69 below. However, the modification does not change the analysis in a way that would cause us to change our overall view.

i) the marginal operator can derive the same value from the additional ALF spectrum as it could without the geographic coverage obligation;

ii) plus there is another source of value, given the geographic coverage obligation, namely reducing the marginal operator's cost of meeting that obligation.

Impact on the marginal operator's value of additional ALF spectrum of the existence of the geographic coverage obligation on other MNOs

4.21 There is a second type of effect which could have an impact on market value. In the discussion above we suggested that the marginal operator can derive the same value from the additional ALF spectrum with the geographic coverage obligation as it could without the obligation (see paragraph 4.20b)i) above). However, it is possible this is not the case, due to the effect of the geographic coverage obligation on other MNOs against which the marginal operator is competing.

4.22 The geographic coverage obligation must be met by each of the MNOs. This means that, from the perspective of the marginal operator, the other MNOs – against which it is competing – may have more extensive network coverage with the geographic coverage obligation than in the absence of that obligation. Depending on the exact nature of the sources of value that the marginal operator would derive from additional ALF spectrum, this increase in coverage by its competitors could affect the marginal operator's commercial value from additional ALF spectrum. For example, one possibility is that the geographic coverage obligation could reduce the marginal operator's commercial value, perhaps because:

a) Without the obligation, achieving superior coverage to its competitors could be part of the marginal operator's value of additional ALF spectrum.

b) However, if these competitors have more extensive coverage with the geographic coverage obligation, the likelihood that the marginal operator would achieve such superior coverage to its competitors through using additional ALF spectrum could be reduced.

4.23 Using the approach in Table 4.1, it would be possible in principle to distinguish in separate columns between:

a) Profit with geographic coverage obligation on other operators (but not the marginal operator); and

b) Profit with geographic coverage obligation on the marginal operator as well as other operators.

4.24 The former would reflect the second effect discussed in this sub-section, arising from the impact on the marginal operator's value of additional ALF spectrum of the existence of the geographic coverage obligation on other MNOs, against which it is competing. The latter would, in addition, take account of the first effect of additional ALF spectrum in reducing the marginal operator's cost of meeting its own obligation (discussed in the preceding sub-section).

4.25 We now consider our initial view for each of the ALF bands in turn, as set out in the February 2015 consultation.

Our initial view in the February 2015 consultation of the impact on market value of the 900 MHz band

4.26 We set out below the reasons presented in the February 2015 consultation for why we considered that the geographical coverage obligation is unlikely to affect the market value of the 900 MHz band for the purpose of ALF.

4.27 The available evidence from bids for sub-1 GHz spectrum (at 800 MHz) in the 4G auction suggests that the marginal operator for additional 900 MHz spectrum may be EE. However, similar points as discussed below would also be relevant if the marginal operator were H3G.

4.28 First, we consider the difference in the marginal operator's incremental cost of meeting its own geographic coverage obligation. EE's holdings include 2x5 MHz of 800 MHz spectrum plus large holdings in the 1800 MHz and other higher-frequency bands. Since EE has the geographic coverage obligation with and without additional ALF spectrum, the relevant question is whether EE's cost of meeting the coverage obligation would be lower with additional sub-1 GHz spectrum at 900 MHz, compared to with its existing spectrum holdings.

4.29 We do not consider it likely that EE's (or H3G's) cost of meeting the geographic coverage obligation would be materially lower with acquisition of 900 MHz spectrum. The obligation relates to voice coverage, which does not have the same bandwidth requirements as data services. EE and H3G each hold only 2x5 MHz of 800 MHz spectrum. But this limited bandwidth of sub-1 GHz spectrum may still be sufficient to deliver sufficiently wide coverage to assist in meeting the obligation for voice services, without the need for additional sub-1 GHz spectrum (and, as noted at paragraph 4.2 above, we consider it reasonable to assume that voice over LTE will become a viable option for providing voice services by the end of 2017).

4.30 Second, there is the potential for an effect on the market value of 900 MHz arising from the existence of the geographic coverage obligation on other MNOs, e.g. if there is a change in voice coverage competition arising from the geographic coverage obligation (see paragraph 4.22 above). Whether or not this is the case, and the scale of any effect, depends on the sources of value of additional 900 MHz spectrum to the marginal operator. For example, part of the value of additional 900 MHz spectrum to EE in the absence of the geographic coverage obligation could have been an extension of its voice coverage to gain a competitive advantage in voice coverage over its competitors.[170] If so, then this value could be reduced if the existence of the geographic coverage obligation required other operators to extend their own voice coverage beyond the levels that they would otherwise have reached.

4.31 However, it seems unlikely to us that the marginal operator's competitive position in voice coverage would be a significant factor in its value for additional 900 MHz spectrum for the same reasons as given above (i.e. it is unlikely that 900 MHz would confer a material relevant capability that it could not obtain using its existing 800 MHz spectrum holding).

[170] We do not directly observe EE's value of additional 900 MHz spectrum. Instead in Section 2 we assess the lump-sum market value of the 900 MHz band taking into account EE's bids for additional 800 MHz spectrum in the 4G auction and international benchmarking evidence on the relative value of 900 MHz and 800 MHz spectrum.

Our initial view in the February 2015 consultation on the impact on market value of the 1800 MHz band

4.32 We set out below the reasons presented in the February 2015 consultation for why we considered that the geographical coverage obligation is unlikely to affect the market value of the 1800 MHz band for the purpose of ALF.

4.33 As for the 900 MHz band, we consider the two types of effect described in our approach.

4.34 First, we consider that acquiring additional 1800 MHz spectrum is unlikely to affect the marginal operator's incremental cost of meeting its own geographic coverage obligation. As discussed below, the underlying reasons are:

a) operators without large holdings of sub-1 GHz spectrum already have material holdings in the 1800 MHz band; and

b) operators with sub-1 GHz spectrum are more likely to use that low-frequency spectrum for their lowest-cost way to meet the coverage obligation.

4.35 It is not clear which of the MNOs is the marginal operator for additional 1800 MHz spectrum, so we consider each in turn:

a) EE already holds 2x45 MHz of 1800 MHz spectrum as well as 2x5 MHz in the 800 MHz band, 2x20 MHz in the 2.1 GHz band and 2x35 MHz of 2.6 GHz spectrum. It could use one or more these bands to meet the coverage obligation. It seems likely that its cost of meeting the coverage obligation would not be materially affected by acquiring additional 1800 MHz spectrum on top of its large holdings in that band.

b) H3G already holds 2x15 MHz of 1800 MHz spectrum as well as 2x5 MHz in the 800 MHz band and 2x15 MHz in the 2.1 GHz band. It seems likely that its cost of meeting the coverage obligation would not be materially affected by acquiring additional 1800 MHz spectrum on top of its already significant holdings in that band.

c) Telefónica only holds 2x5.8 MHz of 1800 MHz spectrum, but it also has 2x10 MHz in the 800 MHz band, 2x17.4 MHz in the 900 MHz band and 2x10 MHz in the 2.1 GHz band. It could use one or more these bands to meet the coverage obligation, such as its sub-1 GHz spectrum. It seems likely that its cost of meeting the coverage obligation would not be materially affected by acquiring additional 1800 MHz spectrum on top of its significant sub-1 GHz holdings.

d) Vodafone similarly only holds 2x5.8 MHz of 1800 MHz spectrum, but it also has 2x10 MHz in the 800 MHz band, 2x17.4 MHz in the 900 MHz band, 2x15 MHz in the 2.1 GHz band, 2x20 MHz of paired spectrum and 25 MHz of unpaired spectrum respectively in the 2.6 GHz band. It seems likely that its cost of meeting the coverage obligation would not be materially affected by acquiring additional 1800 MHz spectrum on top of its significant sub-1 GHz holdings.

4.36 The second effect is the possible impact that the existence of the geographic coverage obligation on other MNOs could have on the marginal operator's value of additional 1800 MHz spectrum. It is not clear that any change in voice coverage competition would materially affect the market value of 1800 MHz spectrum. This is because extension of voice coverage is unlikely to be a source of value of additional

1800 MHz spectrum, given each MNO's existing spectrum holdings as discussed above.

Stakeholder responses to our February 2015 consultation and our view on issues raised in these responses

4.37 As noted above, EE, H3G, Telefónica and Vodafone all disagreed with the position we set out in the February 2015 consultation that the geographical coverage obligation is unlikely to affect the market value of the 900 MHz band or the 1800 MHz band for the purpose of ALF. While stakeholders took different approaches to addressing the issues, the arguments they made on this subject can broadly be categorised as follows:

a) Disagreements with the conceptual framework we have used (as set out in paragraphs 4.6 to 4.25 above).

b) Arguments that we have not properly considered the possibility of the marginal operator being an operator other than one of the four current MNOs.

c) Arguments that, for the purpose of ALF, the geographic coverage obligation is comparable to the 800 MHz coverage obligation.

d) Estimates of the costs to MNOs of the coverage obligation.

e) Other arguments for adjusting ALFs to reflect the geographic coverage obligation.

f) Proposals for how we should take account of the impact of the geographic coverage obligation in setting ALFs.

4.38 We set out stakeholder responses on each of these points in turn below, and our position in light of their responses, noting that there is some overlap between the issues.

4.39 We note that stakeholder arguments focused on the approach set out in paragraphs 4.6 to 4.25 above. No stakeholder commented directly on the reasons set out in paragraphs 4.26 to 4.36 above for why, when applying that approach, we considered that the geographic coverage obligation is unlikely to affect the market value of either 900 MHz or 1800 MHz spectrum.

Our conceptual framework

Stakeholder responses

4.40 [✂] EE (page 82) also said that "[G]iven this flawed framework for assessment that the "market" is limited to four bidders each of whom is already subject to the coverage obligation, Ofcom has made it impossible for itself to arrive at any other conclusion than that the coverage obligation makes no difference to "market" value."

4.41 Vodafone (page 19) made a similar comment that given our "selected very narrow methodology", our conclusion that the geographic coverage obligation is unlikely to have a material effect on the market value of ALF spectrum is "virtually unavoidable".

4.42 Vodafone (page 19) noted that our estimates of the market value of ALF spectrum were arrived at through a multi-step analysis, where the first and second steps had

reference to valuations of other spectrum bands which were derived in the absence of the geographic coverage obligation, and suggested that we had ignored this fact.

4.43 Vodafone (page 21) commented that our approach of comparing the incremental cost of meeting the geographic coverage obligation with and without additional spectrum was 'misplaced', because it is not additional spectrum that an operator needs to increase its coverage, but increasing investment in network infrastructure. It said (pages 23-24) that the geographic coverage obligation would have had a negative impact on spectrum values in general, and in particular "on the lowest frequency bands since these are the ones where the coverage obligation can be satisfied at the lowest cost to the operator, with the lowest investment choices foregone". However Vodafone also said (page 25) that "the effect of the coverage obligation is to suppress the valuation of all spectrum, on a fairly symmetric basis".

4.44 Vodafone argued (page 25) that improved coverage compared to other operators is a factor in the value of marginal spectrum to operators, and that since all operators in the UK will have very high coverage because of the geographic coverage obligation, this factor disappears.

4.45 Vodafone (page 25) also argued that "there will have been changes to the private values of operators given the enhanced coverage obligation" and that "such changes need to be taken into account either directly or indirectly in the calculation of ALF, given the statement by the Secretary of State that the costs of meeting the new obligation should be taken into account in the consideration of ALF levels".

4.46 Telefónica argued that we should look at each operator's holdings as a whole, rather than focusing on marginal increments of spectrum, commenting that "one may reasonably suppose that the coverage obligation would transfer with the licence if the licence was sold as a whole" (page 56, paragraph 174). It also argued that our treatment of the geographic coverage obligation is inconsistent with our treatment of DTT co-existence costs in the 4G auction (page 56, paragraph 175).

4.47 H3G argued (pages 3–15) that we have not correctly assessed the impact of the geographic coverage obligation on the market value of 1800 MHz spectrum for the purpose of ALF. H3G distinguished between:

a) The market value of an 1800 MHz licence before the geographic coverage obligation was given effect;

b) The current market value of an 1800 MHz licence which is "unencumbered" by the geographic coverage obligation; and

c) The current market value of an 1800 MHz licence which is encumbered by the geographic coverage obligation.

4.48 H3G argued that we appear to have compared (a) and (c), i.e. the market value of ALF spectrum before the agreement vs the value of encumbered ALF spectrum today, but that we should instead have compared the value of (b) and (c), i.e. unencumbered vs encumbered ALF spectrum today, which H3G described as a "forward-looking analysis".

Our view

4.49 As noted in paragraph 4.6 above, we define market value for the purpose of ALF as the market-clearing price in a well-functioning market, or the forward-looking marginal

opportunity cost of the spectrum. The market value of spectrum for the purpose of ALF therefore depends on the value to the marginal operator, the highest-value operator that does not hold that specific spectrum, since this determines the opportunity cost (paragraph 4.7). It does not depend on the private value of the ALF spectrum to the licensee (paragraph 4.19).

4.50 Each of the four MNOs has agreed to be subject to the geographic coverage obligation regardless of whether or not it acquires additional spectrum in the 900 MHz or 1800 MHz bands. So if the marginal operator for a spectrum licence is one of the four existing MNOs, it is already subject to the geographic coverage obligation whether or not it acquires the additional spectrum in question. This was the basis of our initial view that the geographic coverage obligation is unlikely to affect the market value of 900 MHz or 1800 MHz spectrum for the purpose of ALF. We consider in the next subsection the case where the marginal operator is not an MNO, and explain why this does not change our view.

4.51 Our assessment is based on a standard economic characterisation of market value, as stakeholders appear to recognise,[171] and we apply a standard economic framework to meet the terms of the Government direction. The comments above from EE (paragraph 4.40) and Vodafone (paragraph 4.41) suggest that we have reached the only reasonable conclusion from applying this framework.

4.52 Since our definition of market value concerns the value of additional spectrum, we disagree with Vodafone's argument that comparing the incremental cost of meeting the geographic coverage obligation with and without additional ALF spectrum is misplaced.

4.53 In our view, EE's discussion of its "common sense proposition" does not adequately distinguish between the private value of spectrum to the current holder and the market value of the spectrum to the marginal operator. A conclusion of no change in market value to the marginal operator is entirely consistent with a "common sense proposition" that the private value of spectrum to the current holder has been affected by the geographic coverage obligation.

4.54 For similar reasons we do not agree with EE or Vodafone that changes to spectrum values in general or the private values of operators need to be taken into account in ALF, unless such changes also affect the market value of ALF spectrum.

4.55 As regards Vodafone's argument that improved coverage relative to other operators is a factor in the value of marginal spectrum which disappears as a result of the geographic coverage obligation, we set out in the February 2015 consultation our view (reiterated in paragraphs 4.31 and 4.36 above) that the marginal operator's

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[171] In particular, Vodafone (response to our October 2013 consultation, page 4) noted that "Ofcom correctly defines the concept from the Direction of 'full market value' as the market clearing price when supply equals demand…[T]he price at which supply equals demand is that which the highest losing bidder or 'marginal excluded user' is prepared to pay for a given increment of spectrum. This is lower and not the same as the price a winning bidder is prepared to pay". Vodafone argued that the Direction clearly gave us the responsibility of determining who the marginal excluded bidder was in the UK 4G auction in order to derive full market value from the auction data. Telefónica, in response to our February 2015 consultation, submitted a paper by Professor Martin Janssen which notes (page 9) that "[E]conomists widely agree that the market value of spectrum is based on its opportunity cost. The opportunity cost in an auction is the highest marginal value of any bidder for a spectrum block she did not acquire."

competitive position in voice coverage is unlikely to be a significant factor in its value for additional 900 MHz spectrum or 1800 MHz spectrum. Vodafone has not presented any new evidence or arguments that would undermine that view.

4.56 We do not consider that Telefónica has set out reasoning as to why we should "look at each operator's holdings as a whole" – again, in our view the relevant question for the market value of spectrum is the value of a marginal increment of spectrum to a marginal operator, not the private value to MNOs of their own spectrum holdings.

4.57 Vodafone suggested that we ignored the fact that the first and second steps in our multi-step analysis derived spectrum values in the absence of the geographic coverage obligation. We include the effect of the geographic coverage obligation at step 2(b) in our framework set out in Section 1. In any event, given our analysis and conclusion on the impact of the geographic coverage obligation, it is not necessary to take account of it at a different step or at multiple steps of our analysis.

4.58 We do not agree with Telefónica that our assessment is inconsistent with our treatment of DTT coexistence costs in the 4G auction. In that case, liability for DTT co-existence costs was dependent on the amount of 800 MHz spectrum acquired, at a rate of £30m for each 2x5 MHz. Therefore, these costs would have been incurred by the marginal bidder if it had acquired additional 800 MHz spectrum and we analyse the impact of these costs on the marginal bidder's valuation of spectrum in Annex 6. In contrast, each MNO has the geographic coverage obligation regardless of whether or not it acquires additional ALF spectrum (and we address in the next subsection the implications if the marginal operator is a new entrant).

4.59 H3G distinguished between the market value of ALF spectrum before the geographic coverage obligation was agreed, and the market value of ALF spectrum which is unencumbered by the geographic coverage obligation. H3G commented (page 7) that the market value of unencumbered spectrum may or may not have changed. It presented a graphical illustration in which the market value of unencumbered spectrum is assumed to be lower than the market value of ALF spectrum before the geographic coverage obligation was agreed. However, H3G has not put forward any reason why the market value of unencumbered ALF spectrum might differ from that of ALF spectrum before the agreement.

4.60 Assuming that an 'unencumbered' licence could be created, since the licence itself would not be different from an ALF licence before the agreement, the only possible difference would be in the identity of the marginal operator. As H3G suggested, such an operator might not be one of the four current MNOs who have agreed to be bound by the geographic coverage obligation. We discuss this possibility in the following subsection. In our view H3G has not explained any other meaningful distinction between the framework it proposed and the one we have used. Having estimated the market value of 900 MHz and 1800 MHz licences for the purpose of ALF in the absence of the geographic coverage obligation, we consider it reasonable for us to use these market values, rather than the market value of hypothetical unencumbered licences, as a basis for assessing whether the obligation should impact future ALFs.

The possibility that the marginal operator is not one of the four current MNOs who have agreed to be bound by the geographic coverage obligation

Stakeholder responses

4.61 EE, H3G and Telefónica argued that we have not properly considered the possibility of the marginal operator being an operator other than one of the four current MNOs.

4.62 EE (page 82) said that there is a "real prospect of market developments that should lead Ofcom to consider that the coverage obligation *does* impact the market value of additional spectrum". It noted, in particular, the possibility of new entry, [✂], and of an entrant being the marginal operator in respect of ALF spectrum. It disagreed with the view we set out in our February 2015 consultation that an entrant would not be subject to the geographic coverage obligation if it acquired ALF spectrum. EE commented that: "In the case where a new entrant is the marginal operator for 1800/900 MHz spectrum then, due to the costs it would incur to meet the coverage obligation, the value of the 1800/900 MHz spectrum would fall".

4.63 EE argued (page 83) that, for the market value of ALF spectrum to be lower because of the geographic coverage obligation, it is not necessary that market entry should be the most likely scenario, but "only that there is a non-negligible risk of such a change", and that the value an operator attaches to a spectrum holding today will take into account "its value in a range of future circumstances (such as sale to an entrant)". EE then argued that "there is a clear and obvious cost to the current licensees to meet the new coverage obligation, and it is likely that these costs would similarly lower the value attributed to this spectrum by any new entrant operator to whom the licence may be transferred".

4.64 H3G also argued that the geographic coverage obligation could affect market values if the marginal operator were not one of the four current MNOs.

4.65 H3G gave an example of its concept of an "unencumbered" 1800 MHz licence by suggesting that "an MNO may partition its ALF licence into several frequency blocks, retaining some blocks together with the geographic coverage obligation itself and selling other blocks, unencumbered by the geographic coverage obligation, to a second operator – which could be an MNO, a new entrant or a fixed operator wanting to run a mobile business. Alternatively, the MNO could sell all of its assets and obligations, including the encumbered ALF licence, to another operator." H3G referred to the proposed H3G/Telefónica and BT/EE mergers as examples of this.[172]

4.66 In H3G's view, "there should be no presumption that the marginal bidder is already subject to the coverage obligation" and "if the marginal operator is not an MNO the impact of the 90% coverage obligation is unlikely to be zero, because the operator is not bound by the 90% coverage obligation and is unlikely to value encumbered and unencumbered ALF spectrum the same".

4.67 Telefónica (page 56, paragraph 174) also argued that the marginal operator might not be one of the four MNOs. By way of example, Telefónica said that it supposed that BT would take on EE's geographic coverage obligation and would consider both

[172] H3G further suggested that an operator may transfer a licence "on a concurrent basis so that both transferor and transferee must meet the obligation", or split a licence geographically so that both operators are dependent on each other to meet their respective obligations in the whole of the UK.

the costs of EE's geographic coverage obligation and the expected level of ALF for 1800 MHz when negotiating the price for its proposed purchase of EE.

Our view

4.68 For convenience and for consistency of terminology with stakeholder responses, in this section we refer to an operator other than one of the four current MNOs as a "new entrant" (even though such an operator could already be present in the market on a small scale).

4.69 We agree with EE that, if a marginal operator other than an MNO had traded to it all or part of an ALF licence, it would normally be subject to the geographic coverage obligation unless the licence were varied[173]. For this reason, we recognise that the comment in footnote 184 of our February 2015 consultation was incorrect.

4.70 We have considered whether this correction – and more generally the possibility that the marginal operator might be someone other than the four current MNOs – is a reason for changing our initial view that the geographic coverage obligation is unlikely to affect the market value of the 900 MHz or 1800 MHz bands for the purpose of ALF. For the reasons set out below, we consider that our initial view remains appropriate.

4.71 First, the geographic coverage obligation was designed to be met by the four current MNOs who agreed to be bound by it, and who already have a national network. It is not clear that an operator other than one of those four MNOs, which did not have access to a national network, could reasonably be required to meet the obligation as currently drafted. In the event that a new entrant sought to have traded to it all or part of an existing 900 MHz or 1800 MHz licence, we consider that we would have discretion to vary its licence to remove the geographic coverage obligation as appropriate in the circumstances.

4.72 Second, operators other than the current four MNOs have tended to play only a limited role in the evidence we use to determine the market value of ALF spectrum, and accordingly their valuation of spectrum has had a limited influence on our assessment of the UK market value of 900 MHz and 1800 MHz spectrum for the purpose of ALF:

a) New entrants have played little role in influencing our estimate of the UK market value of 800 MHz and 2.6 GHz spectrum in step 1. Our estimate of the UK market value of 800 MHz is based on bids by the four current MNOs in the 4G auction. Niche (a new entrant) won rights to 2x15 MHz of 2.6 GHz spectrum in the auction, and our estimate of the market value of this band (£5.5m per MHz) is informed by Niche's winning bids. However, it is not clear that our estimate of the

[173] This is on the basis that the Wireless Telegraphy (Mobile Spectrum Trading) Regulations 2011 (SI 2011/1507) (as amended), which apply in respect of trades of the 900 and 1800 MHz ALF spectrum, provide, in summary, for the transfer of all of the obligations in a licence to the transferee (where the trade is in respect of all of the licence), or of the 'corresponding part of each of the obligations under the licence', where the trade is in respect of part of the frequencies or geographic scope thereunder. Given that the geographic coverage obligation is related to the holding of a licence for the use of any of the ALF bands and can be met by 'using any frequencies and technologies available to the licensee', the transferee of a partial transfer would normally be subject to the geographic coverage obligation unless the licence were varied.

value of 2.6 GHz spectrum would differ materially if we only took account of the valuations of the four current MNOs.[174]

b) Similarly, the international benchmark evidence which informs our assessment of relative spectrum values is largely driven by incumbent national MNOs. For example, in auction outcomes from which we derived Tier 1 evidence points, all the bidders were incumbent national MNOs. This was also true of Tier 2 evidence points, with the exception that some regional operators acquired 2.6 GHz spectrum in Spain.

4.73 To the extent that our estimates of the market values of 900 MHz and 1800 MHz spectrum for the purpose of ALF are based on the valuations of existing MNOs, then these values are unlikely to be affected by the geographic coverage obligation, as explained above.

4.74 Third, if we consider the case of a new entrant which might wish to have traded to it all or part of a 900 MHz or 1800 MHz licence[175], and if we assume (notwithstanding the first point above) that doing so would require it to meet the geographic coverage obligation, then there are three possible cases, illustrated in Figure 4.1. These cases differ from each other, depending on whether the value of the spectrum to the new entrant is above or below the value of the spectrum to that current MNO who would be the marginal operator in the absence of the new entrant.

4.75 In Case 1, even absent the geographic coverage obligation the new entrant has a lower valuation of the licence than the MNO who is the marginal operator (before considering the implications of the new entrant). Since the new entrant has a lower value, it would not displace this MNO as the marginal operator (i.e. as the operator which is the highest-value alternative holder of the spectrum). In this case the geographic coverage obligation reduces the value of the spectrum to the new entrant, but it has **no effect** on the market value of the spectrum for the purpose of ALF, which is the value to an existing MNO.

4.76 In Case 2, there is a difference in the true marginal operator with and without the geographic coverage obligation:

a) Absent the geographic coverage obligation the new entrant has a higher valuation of the licence than the MNO that would otherwise be the marginal operator. The new entrant therefore displaces the MNO as the true marginal operator. Taking an MNO as the marginal operator would therefore lead to an underestimate of market value in these circumstances.

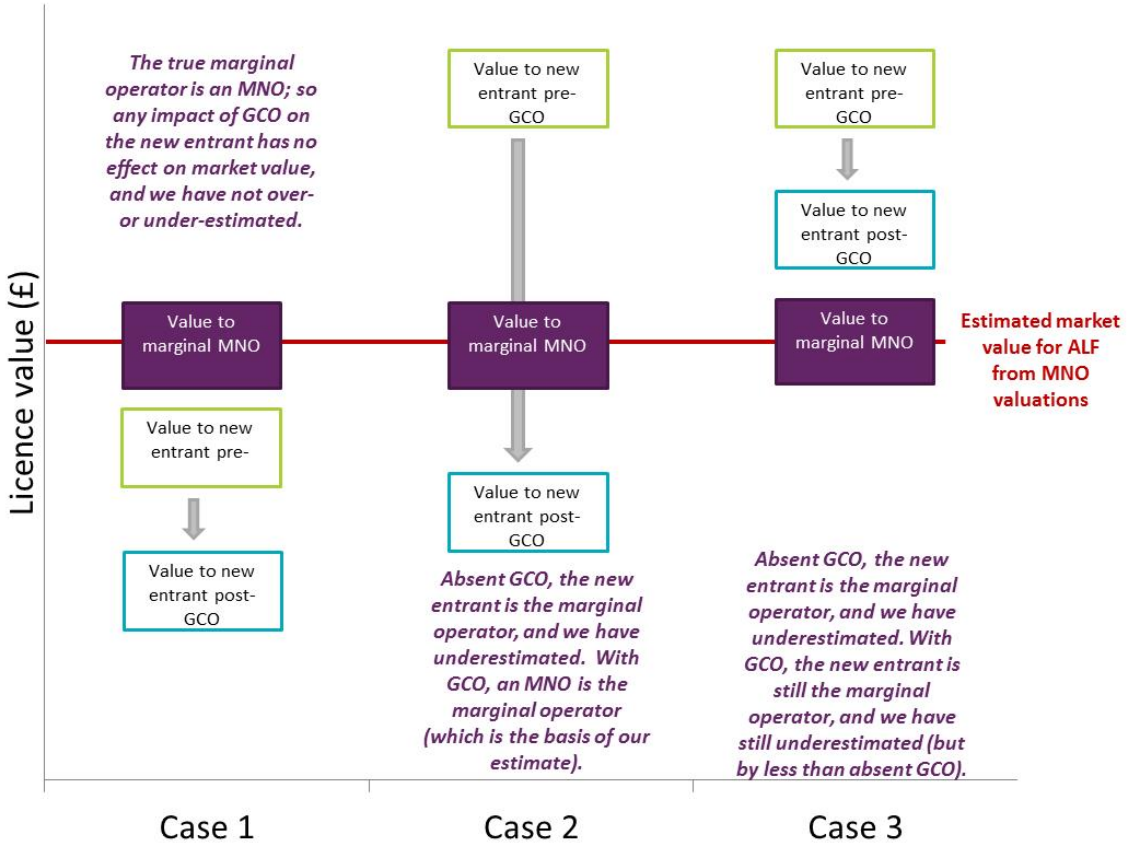
b) With the geographic coverage obligation the value of the licence to the new entrant is reduced to a level that is below the value to the marginal MNO (i.e. to that MNO which is the highest-value alternative holder of the spectrum amongst

[174] To take a necessarily hypothetical example, if Niche had not bid in the auction, and assuming other bids were unchanged, then Telefónica would have acquired 2x10 MHz and Vodafone an additional 2x5 MHz (2x25 MHz in total) of the 2.6 GHz spectrum which Niche in fact won. In this case, Vodafone would have been the marginal bidder for additional 2.6 GHz spectrum, with a marginal valuation of £5.37m per MHz for a further 2x5 MHz or 2x10 MHz. Changing our estimate of the UK market value of 2.6 GHz from £5.5m per MHz to £5.37m per MHz would not materially change our ALF benchmarks, and would not change our ALFs – see paragraph A7.204 in Annex 7.

[175] In the discussion below, when we refer to the value of a licence we mean a licence for a marginal increment of spectrum.

the MNOs). Accordingly, the effect of the geographic coverage obligation would be that an existing MNO is now the true marginal operator. Taking account of the new entrant makes **no difference** to the market value of the spectrum for the purpose of ALF.

Figure 4.1: Effect of geographic coverage implication (GCO) on a new entrant does not change our ALF estimates



4.77 In Case 3, the new entrant is the marginal operator both with and without the obligation:

a) Absent the geographic coverage obligation the new entrant again has a higher valuation of the licence than the highest-value existing MNO that would otherwise be the marginal operator (as in Case 2). The new entrant therefore becomes the true marginal operator.

b) However, with the geographic coverage obligation, in Case 3, whilst the geographic coverage obligation reduces the value of the licence to the new entrant, the new entrant continues to be the true marginal operator (unlike Case 2). Moreover, the market value of the licence is actually increased by comparison with Case 1 or 2 where the MNO was the marginal operator (as the market value in Case 3 is now set by the new entrant). By not taking into account the valuation of the new entrant, we would be **underestimating** market value, both with and without the geographic coverage obligation (although the underestimate is smaller with the obligation).

4.78 Therefore, given that the evidence we use reflects the value to an MNO (with the minor possible exceptions noted in paragraph 4.72 above), taking account of the possibility that a new entrant might be the true marginal operator either makes no difference to our analysis (in Cases 1 and 2) or suggests that we might have underestimated market value (in Case 3).

4.79 The points set out above are consistent with our initial view in the February 2015 consultation, that the geographic coverage obligation is unlikely to affect the market value of the 900 MHz or 1800 MHz bands for the purpose of ALF.

4.80 H3G's arguments on the implications of a new entrant relate to its view of the analytical framework (see paragraphs 4.47-4.48 and 4.59-4.60 above). However, the implication it drew from its analytical framework depended on a specific argument relating to the identity of the marginal operator. As noted, H3G's argument was that if the marginal operator is not one of the four current MNOs then, in H3G's view, the impact of the geographic coverage obligation is unlikely to be zero because the operator is unlikely to have the same value for encumbered and unencumbered spectrum. This is essentially the point we have considered in paragraphs 4.68 to 4.78 above. Again, we consider that our analysis holds whether the comparison is between "encumbered" spectrum and either "unencumbered" spectrum or spectrum prior to the geographic coverage obligation.

4.81 H3G set out a number of ways in which it thinks ALF licences could be sold. An implication of our revised view, set out in paragraph 4.69 above, is that if an ALF licence were to be partitioned in the ways H3G suggested, then the acquirer would be subject to the general coverage obligation unless we varied the licence. H3G also commented that an MNO could sell all its assets and obligations, giving the examples of proposed mergers. However, the market value of spectrum for the purpose of ALF depends on the value of a spectrum licence for a marginal increment of spectrum to a marginal operator. We do not consider that there is merit in H3G's arguments about the implications of the possibility that the marginal operator[176] may not be one of the four current MNOs.

4.82 Our analysis above also addresses Telefónica's comments about the possibility that the marginal operator is not one of the four current MNOs. While the costs of meeting the geographic coverage obligation could in principle affect BT's valuation of acquiring EE, our estimate of the market value of 1800 MHz spectrum is not informed by BT's valuation of EE.

Comparisons with the 800 MHz coverage obligation

Stakeholder responses

4.83 EE (page 76) argued that onerous coverage obligations generally reduce spectrum value, and that we have recognised this in our assessment of UK and international auction evidence, particularly in assessing the UK auction price for the lot of 800 MHz spectrum which included a coverage obligation. EE further argued that it is not the case that spectrum value is affected only where the coverage obligation applies to some but not all licences in a band. It cited the examples of Denmark and Romania, in which coverage obligations were attached to all 800 MHz licences, and

[176] Or, in the event that an MNO sold all its assets and obligations, the acquirer of those assets and obligations.

commented that the 800 MHz price in Denmark was unusually low while some 800 MHz spectrum was unsold in Romania.

4.84 According to Telefónica (page 55, paragraph 170), "the 2013 4G auction [which included a lot of 800 MHz with a coverage obligation] firmly establishes the principle that the costs associated with a coverage obligation should be reflected in the market price of the spectrum with which the spectrum is associated". It noted that we have used bid data "to derive the value of the coverage obligation as an input into the setting of ALF payments for both 900 MHz and 1800 MHz". Telefónica (page 55, paragraph 169) argued that, similarly to the 800 MHz coverage obligation, "the incremental cost of meeting the new voice obligations are specifically associated with the licences for 900 MHz and 1800 MHz" because "the legal obligation is solely associated with these bands". By way of example, Telefónica said that "if Vodafone was to surrender both its 900 MHz and 1800 MHz licences, it would no longer be obliged to meet the voice coverage obligation." Telefónica (page 55, paragraph 173) argued that our view that the geographic coverage obligation is unlikely to affect the market value of the ALF bands for the purpose of ALF is "inconsistent with Ofcom's argument that Telefónica's 800 MHz licence has a lower market value owing to a coverage obligation".

4.85 Vodafone (page 25–26) noted that we set a lower reserve price for the 800 MHz spectrum in the 4G auction which had a coverage obligation, and argued that: "One might therefore reasonably expect that the new 90% coverage commitment will have had a similar downward impact on the value of UK mobile spectrum generally". According to Vodafone (page 26), the geographic coverage obligation is "atypically comprehensive in any international comparison" because "most countries that require a coverage obligation express this in population terms, rather than in area coverage".

Our view

4.86 In our view, the 800 MHz lot in the UK 4G auction (Lot A2) which included a coverage obligation is not a relevant comparator for any effect of the geographic coverage obligation on the market value of 900 MHz or 1800 MHz spectrum for the purpose of ALF. The reason for this is that only the successful bidder for Lot A2 was subject to the 800 MHz coverage obligation which was included in the licence – and the successful bidder only became subject to the 800 MHz coverage obligation as a result of acquiring Lot A2. In contrast, as noted above, each of the four MNOs is subject to the geographic coverage obligation regardless of whether or not it acquires additional spectrum in the 900 MHz or 1800 MHz bands. A bidder for Lot A2 would rationally factor into its bids any cost it faced of meeting the associated 800 MHz coverage obligation, whereas an MNO which was the marginal operator for ALF spectrum would not factor the cost of having to meet the geographic coverage obligation into its valuation (since it has to meet this obligation whether or not it acquires additional ALF spectrum).[177]

4.87 With regard to EE's comments on Denmark and Romania, we note that our reasoning above depends on the circumstances of the marginal bidder with and without the spectrum in question. If (hypothetically) the 800 MHz coverage obligation had applied to all 800 MHz spectrum in the UK auction, an MNO could still have avoided the obligation by not acquiring any 800 MHz spectrum, in which case the

[177] We have considered the case of a new entrant as the marginal operator in the previous subsection.

auction bids and market value of 800 MHz spectrum might have been lower than they were. The relevant distinction between the 800 MHz coverage obligation and the geographic coverage obligation is that the former was causally related (for all bidders, including the marginal bidder) to bids for acquiring the 800 MHz lot with that obligation (Lot A2 in the 4G auction), whereas each of the four MNOs is subject to the geographic coverage obligation regardless of whether or not it acquires additional ALF spectrum.

4.88 As regards Telefónica's comments, in assessing any effect of the geographic coverage obligation on the market value of ALF licences, we consider that the relevant question is whether the obligation affects the value of a marginal increment of spectrum to a marginal operator (because this determines market value), whether or not a current licence holder could in practice avoid the obligation by relinquishing all of its holdings[178]. Whether costs of meeting a coverage obligation are reflected in the market value of associated spectrum depends on the specific circumstances as we have described above.

4.89 Turning to Vodafone's comments, the lower reserve price for Lot A2 than for A1 lots in the 4G auction reflects the fact that any costs to an MNO of meeting the 800 MHz coverage obligation would only be incurred if it acquired Lot A2. Again, this is the key distinction between the 800 MHz coverage obligation and the geographic coverage obligation which applies to all MNOs – the fact that one is based on population coverage and the other on geographic coverage is in our view less relevant to the question we are addressing.

Costs of the geographic coverage obligation

Stakeholder responses

4.90 Both EE and H3G argued that they would incur additional network investment and operating costs in meeting the geographic coverage obligation. Both Vodafone and Telefónica implied that, whilst they would not incur additional direct costs themselves, they would be exposed to an indirect cost associated with the loss of the competitive advantage associated with greater coverage (that they would otherwise have had over other MNOs in the absence of the obligation).

4.91 EE commented that the geographic coverage obligation imposes substantial additional costs on EE because, like H3G, it did not have access to low frequency spectrum when building its network. EE estimated its additional costs at [✂]. EE said that it cross-checked its estimate using Ofcom's MCT cost model.

4.92 EE argued that Telefónica and Vodafone enjoy a significant cost advantage because they have been able to build their networks with access to low-frequency spectrum. It said that this cost advantage is greater than the difference in ALF payments between 900 MHz and 1800 MHz spectrum under our proposals.

4.93 [✂]

[178] As set out in paragraphs 4.1 and 4.2 above, the MNOs agreed to implement 90% voice coverage throughout the UK by the end of 2017, before this was given effect through variations in their spectrum licences, and the MNOs can meet the obligation using any frequencies or technologies available to them.

4.94 Vodafone (pages 26–28) claimed that all operators would lose value as a result of the geographic coverage obligation (a "universal loss of value") because "operators presently with higher coverage levels will have lost their coverage advantage and the ability to reduce network expenditure in the future, whilst operators with lower coverage levels will have incurred additional network investment as the price for eliminating coverage differentiation".

4.95 Telefónica argued that [✂], and said that one effect of the geographic coverage obligation was to "nullify any competitive advantage" which Telefónica could have had from meeting the 800 MHz coverage obligation.

4.96 Telefónica (page 53) commented that "by Ofcom's own admission, the [geographic] coverage obligation will impose substantial costs on holders of 900 MHz and 1800 MHz spectrum, and this does affect the overall market value of this spectrum". [179] It argued that if this were not the case operators would have made this investment without Government intervention.

4.97 Telefónica said that by achieving 98% population coverage (as required by its 800 MHz coverage obligation) it will achieve at least 90% geographic coverage, and suggested that all operators are likely to achieve both 90% geographic coverage and 98% population coverage by the end of 2017. It therefore suggested that the cost of meeting the (98% population) 800 MHz coverage obligation could provide an indication of the costs of meeting the (90%) geographic coverage obligation.

4.98 In this context, Telefónica said that the £31m difference in value to Vodafone of otherwise-identical packages of 800 MHz spectrum with and without the 800 MHz coverage obligation is the correct value for the purposes of assessing the impact of the 800 MHz coverage obligation on the value of 800 MHz spectrum according to our methodology. However Telefónica noted that H3G and EE's bid differentials between 800 MHz spectrum with and without the 800 MHz coverage obligation were between £85m and £400m, with the lowest bid differential for a 2x10 MHz lot being £96m, suggesting a much higher willingness to pay to avoid the 800 MHz coverage obligation in their cases. Telefónica suggested £96m as a conservative estimate of H3G and EE's value in avoiding a coverage obligation (on the basis of its view that 98% population coverage and 90% geographic coverage are broadly equivalent), and concluded that "the voice obligation will extract up to £96m per operator out of the industry, with the bulk of this being spent over the next 30 months" (page 55, § 171).[180]

4.99 H3G, in estimating the costs of meeting the geographic coverage obligation, offset the direct costs by an assessment of the benefits to each MNO of the delay in implementation of revised ALF rates (on account of the additional time taken to consult on the implications of the geographic coverage obligation for ALF). H3G

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[179] This appears to refer to our comment that "MNOs may incur incremental costs to meet the geographic coverage obligation which could, therefore, reduce the overall value they attach to their spectrum holdings" (see paragraph 6.7 of the February 2015 consultation). The term "overall value" refers to private value, not market value. We also said that, under our proposed approach, these incremental costs would not in themselves necessarily lead to an impact on market value (see paragraphs 1.13 and 6.7 of the February 2015 consultation).

[180] Telefónica also argued that in the 4G auction it anticipated some competitive upside from having network roll-out that other operators may not replicate, and that this was a further reason why the lowest observed bid difference for the 800 MHz coverage obligation in the auction might be a conservative estimate the cost of the geographic coverage obligation.

commented that "due to their much larger spectrum portfolio, EE, Vodafone and O2 will enjoy much greater savings than Three from the 4-7 month delay in the introduction of the new ALFs" (page 16). It estimated the savings as having an NPV of around £22m for Vodafone and Telefónica, and £26m for EE as against £8m for H3G itself.[181]

Our view

4.100 We recognise that the MNOs could incur incremental costs in meeting the geographic coverage obligation that they agreed with Government, and that this could impact the private value of their spectrum holdings.[182] However, we consider that the relevant question is whether the geographic coverage obligation impacts on the market value of the ALF spectrum, not on the private value of the spectrum, and we do not consider that it does for the reasons set out in this Section. Accordingly, we do not consider that stakeholders' estimates of the costs to them of meeting the geographic coverage obligation that they agreed to, and their related arguments above, affect our analysis of the effect of the geographic coverage obligation on the market value of the ALF spectrum.

Other arguments for adjusting ALFs to reflect the geographic coverage obligation

Stakeholder responses

4.101 Some respondents presented arguments that we should adjust ALFs to reflect the effects of the geographic coverage obligation which did not directly relate to the market value of ALF spectrum.

4.102 EE argued[183] that "it had a legitimate expectation that Ofcom would not only consider whether the incremental costs of the geographic coverage obligation would affect the market clearing price for 900 and 1800 MHz spectrum, but would properly consider whether to make an adjustment to ALFs (or the way in which they are implemented) to take account of the incremental costs of the geographic coverage obligation" (page 89). In this context, EE said that it relied on Ofcom's letter of 27 January 2015.

4.103 Vodafone (page 25) stated that "changes in the private values of operators given the enhanced coverage obligation … need to be taken into account either directly or indirectly in the calculation of ALF, given the statement by the Secretary of State that the costs of meeting the new obligation should be taken into account in the consideration of ALF levels".

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[181] See Table 3 of H3G's submission (£3.5m in 2015 and £4.5m in 2016).

[182] We note Vodafone's argument that there would be a relative loss of competitive advantage to operators who would have higher coverage in the absence of the geographic coverage obligation. If so, then there would be a corresponding relative gain to those operators who would have lower coverage in the absence of the geographic coverage obligation. For these latter operators, the gain associated with the reduction in competitive disadvantage in coverage would offset (to some degree) their direct costs of meeting the geographic coverage obligation. We also note that, if the proposed acquisition of O2 (Telefónica) by Hutchison Whampoa (parent company of mobile operator H3G) were to take place, then H3G may not need to incur incremental costs in meeting the geographic coverage obligation (noting Telefónica's point in paragraph 4.97 above that it will achieve at least 90% geographic coverage by achieving the 98% population coverage required under its 800 MHz licence condition).

[183] EE response pp 76-78 and 89.

4.104 Telefónica (page 57, paragraph 178) argued that "effectively penalising mobile operators in the way Ofcom has proposed would completely remove any incentive on future co-operation with the Government". It said that private companies may no longer agree to undertake "socially beneficial initiatives which adversely affect their enterprise value, if they are not to be reasonably compensated".

Our view

4.105 In relation to EE's claim that it had a legitimate expectation that we would properly consider whether to make an adjustment to ALFs to take account of the incremental costs of the geographic coverage obligation, we are confident that through our February 2015 consultation and our consideration of the responses to it, we have properly considered whether the geographic coverage obligation should impact future ALFs, taking account of the associated incremental costs incurred by the MNOs. This is in accordance with what we said we would do in our letter to the Secretary of State of 17 December 2014[184] (in response to the letter of the Secretary of State of the same date[185]) and our letter to EE of 27 January 2015.

4.106 As regards Vodafone's comment, to the extent that Vodafone is suggesting that the letter of the Secretary of State of 17 December 2014 meant that the Government Direction should be interpreted differently in light of the agreement reached between the Government and the MNOs in respect of the geographic coverage obligation and/or that the Secretary of State was instructing us to adjust ALF level in light of the geographic coverage obligation, we do not agree with Vodafone. The Secretary of State in his letter of 17 December 2014 set out his view that interested parties should be given a reasonable opportunity to comment on whether they consider the geographic coverage commitment, taking account of the associated incremental costs incurred by the MNOs, should impact on future ALFs. We agreed that all interested parties should be given that opportunity, and we gave them that opportunity as set out above. We do not consider that the Secretary of State's letter bears any further or alternative interpretation in this regard.

4.107 Finally, we note Telefónica's claim that we are penalising mobile operators. As we said above, we have properly considered whether the geographic coverage obligation should impact future ALF, in accordance with our letter to the Secretary of State of 17 December 2014. We do not accept that we are penalising the mobile operators in any way. We make no comment as to operators' potential future incentives.

Specific proposals for taking account of the geographic coverage obligation

Stakeholder responses

4.108 Stakeholders proposed different ways for taking account of the geographic coverage obligation. In summary, EE proposed that we should choose a lower ALF value from the range of possible market values for 1800 MHz spectrum or allow a more gradual phase-in of increases in ALFs. H3G proposed that we consult again in light of its comments and we phase in the ALFs payable by H3G over a period longer than one year. Telefónica proposed that each operator's total lump-sum value of ALF should

[184] http://media.ofcom.org.uk/content/posts/news/2015/Letter_to_Secretary_of_State.pdf
[185] http://media.ofcom.org.uk/content/posts/news/2015/Ed_Richards_Mobile_Coverage_Agreement.pdf

be discounted by £96m (i.e. its estimate of the incremental costs of the geographic coverage obligation) and that we introduce only half of the increase until the end of 2017. Vodafone suggested two methods for adjusting ALFs to compensate operators for costs associated with the geographic coverage obligation, both of which would give a lower 800 MHz value and lead to a roughly 10% deduction in all ALFs.

Our view

4.109 For the reasons set out in this Section, we disagree with the MNOs' arguments that we should revise ALFs in light of the geographic coverage obligation. As such, we do not consider it necessary to address their proposals for how such revisions should be implemented. Section 7 discusses the issue of phase-in separately.

Decision

4.110 Having considered the various points raised by stakeholders above, we conclude that the approach to assessing the impact of the geographic coverage obligation on market value set out in paragraphs 4.6 to 4.25 and our views from the application of that approach to the ALF spectrum bands in paragraphs 4.26 to 4.36 remain appropriate. In summary, we consider that:

a) The market value of spectrum for the purpose of ALF depends on the value to the marginal operator, not on the private value of the ALF spectrum to the licensee.

b) Each of the four current MNOs is already subject to the geographic coverage obligation, and we have not identified any reason why the obligation would affect their marginal valuations of additional ALF spectrum.

c) If the marginal operator were a new entrant, given that the evidence we use relates to current MNOs, we expect that the geographic coverage obligation would either have no implications for our estimate of the market value of 900 MHz or 1800 MHz spectrum for the purpose of ALF, or could potentially imply that we have underestimated market value.

4.111 In light of this, our view is that that the geographic coverage obligation is unlikely to affect the market value of the 900 MHz band or the 1800 MHz band for the purpose of ALF. We have therefore decided not to reduce the future level of ALFs in light of the geographic coverage obligation.

Section 5

Assessment of lump-sum values

Introduction

5.1 This section sets out the estimates of the lump-sum values of 900 MHz and 1800 MHz which we use as a basis for setting annual licence fees. This is step 2c in the analytical framework we set out in Section 1.

5.2 The approach that we have adopted to assess the lump-sum values of 900 MHz and 1800 MHz is consistent with the approach in our August 2014 and February 2015 consultations. However, for the reasons set out in this section, our final estimate of the lump-sum value of 900 MHz (£18m per MHz) is a reduction from the value proposed in our February 2015 consultation (£23m). Our final estimate of the lump-sum value of 1800 MHz (£13m per MHz) is the same as in that consultation.

5.3 This section:

a) sets out our approach to deriving lump-sum values in our August 2014 and February 2015 consultations, stakeholder's comments on the approach set out in those consultations, and our view of those stakeholder comments;

b) presents our assessment of the UK lump-sum value of 900 MHz spectrum;

c) presents our assessment of the UK lump-sum value of 1800 MHz spectrum;

d) sets out our cross-checks; and

e) summarises our decisions.

Our approach to deriving lump-sum values

August 2014 consultation

5.4 As described in paragraph 3.5, our estimation of lump-sum values involved a number of steps. The initial steps – calculation of international relative value benchmarks, grouping these benchmarks into tiers, and assessing the risk that benchmarks may understate or overstate UK market values – are discussed in Section 3 above. In the present section we consider the remaining steps, which we identified in our August 2014 consultation as:

a) Reaching a view of the lump-sum value of 900 MHz and 1800 MHz spectrum by considering these benchmarks in the round.

b) Applying cross-checks, such as absolute-value benchmarks.

5.5 The first of these steps involves using our judgement as to how most appropriately to assess the available benchmarks, rather than relying on summary statistics such as weighted averages. In using our judgement, we adopt a conservative approach to interpreting the evidence as set out in Section 1, paragraphs 1.38 to 1.43.

Stakeholder responses to the August 2014 consultation

5.6 In response to our August 2014 consultation, stakeholders made the following comments in relation to these two steps.

Derivation of lump-sum values and sensitivity analysis

5.7 Stakeholders did not agree with how we had exercised our judgement when using the relative value benchmarks to arrive at our proposed lump-sum values for 900 MHz and 1800 MHz. MNOs proposed using a form of weighted averaging (assigning different weights to different tiers) in order to derive their own proposed lump-sum values.

5.8 AM&A and H3G suggested that taking a conservative approach could mean applying a discount to estimates of market value.[186] In addition, EE, H3G and AM&A argued that our estimated lump-sum value of 1800 MHz was high relative to that of 900 MHz.[187]

Alternative estimates of lump-sum values put forward by stakeholders in response to the August 2014 consultation

5.9 Respondents to the August 2014 consultation suggested different lump-sum values for 900 MHz and 1800 MHz spectrum from those we had proposed. This was for two reasons:

a) They disagreed with our proposed UK market values for 800 MHz and 2.6 GHz (as already discussed in Section 2).

b) They disagreed with our view (based on benchmark evidence) of the value of ALF spectrum relative to these UK market values for 800 MHz and 2.6 GHz (as reflected in the 900:800 MHz ratio in the case of 900 MHz and the distance method in the case of 1800 MHz).

5.10 A summary of proposals put forward by stakeholders is shown in Table 5.1, and compared to our estimates in August 2014. These are expressed both in terms of the lump-sum values themselves (in £m per MHz) and in terms of their relativity to 800 MHz and 2.6 GHz spectrum values (the 900:800 ratio in the case of 900 MHz spectrum and the distance method Y/X ratio[188] in the case of 1800 MHz spectrum). The numbers in bold in the first four rows of Table 5.1 were those cited by the stakeholders themselves. We derived the relativity ratios corresponding to the lump-sum value proposals of EE, H3G and Telefónica (Vodafone expressed its proposals in terms of ratios only).

5.11 Differences between these relativities and the relativities implied by our proposed lump-sum values in the August 2014 consultation (shown in the bottom row of table 5.1) were driven mainly by different allocations of individual country benchmarks to different tiers (summarised in Annex 7). In addition, AM&A used a much lower value for the Sweden 1800 MHz benchmark than Ofcom, Frontier and NERA.

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[186] AM&A, page 34, and H3G, page 29.
[187] Responses to our August 2014 consultation: EE pages 5-6, H3G page 2, AM&A, page 39
[188] This ratio is derived as the difference in value between 1800 MHz and 2.6 GHz ("Y"), divided by the difference in value between 800 MHz and 2.6 GHz ("X"), expressed as a percentage.

Table 5.1: Summary of MNO estimates of lump-sum values for 900 MHz and 1800 MHz (based on values of 4G auction bands preferred by stakeholder), compared to our estimates in August 2014

	900 MHz value per MHz	900 MHz to 800 MHz ratio	1800 MHz value per MHz	Equivalent Y/X ratio
EE (based on AM&A)[189]	**£21m**	70%	**£8m**	12%
H3G (based on AM&A)[190]	**£23.2m**	93%	**£7.7m**	19%
Telefónica[191]	**£15.5m**	62%	**£10m**	25%
Vodafone (based on Frontier)[192]	not given	**57%-65%**	not given	**28%**
Our August 2014 consultation[193]	£23m	65%	£14m	28%

Source: Ofcom from stakeholder responses

5.12 In the case of 900 MHz, Telefónica argued that we had overstated the 900:800 MHz relativity (its estimate of the 900 MHz lump-sum value implying a 900:800 MHz ratio of 62%, as against the August 2014 consultation measure of 65%). The ratio implied by our estimates in August 2014 was consistent with the top of the range presented by Vodafone, but Vodafone said that the appropriate value is likely to be close to the bottom of this range (i.e. 57%). In contrast EE and H3G argued that we had understated the 900:800 MHz ratio, by a significant amount in H3G's view.

5.13 Conversely, EE and H3G argued that we had overstated the relativity for 1800 MHz significantly. They proposed values of 1800 MHz which implied Y/X ratios of 12% and 19% respectively, well below the 28% implied in the August 2014 consultation.

[189] EE response to the August 2014 consultation, page 42. We derived the ratios using EE's proposed values of £29.89m per MHz for 800 MHz and £4.99m per MHz for 2.6 GHz, reported on page 28 of AM&A's response.
[190] H3G response to the August 2014 consultation, page 4. We derived the ratios using H3G's proposed values of £25.04m per MHz for 800 MHz and £3.57m per MHz for 2.6 GHz on page 12 of its response. We note that AM&A (p. 29) presents H3G's 800 MHz estimate, gross of DTT coexistence costs, as £28.04m, but this value does not appear in H3G's submission and H3G said that technical / commercial evidence implies an 800 MHz value of £25m per MHz (which is used in deriving its £23.2m per MHz figure).
[191] Telefónica response to the August 2014 consultation, page 74. We derived the ratios using Telefónica's proposed values of £25m per MHz for 800 MHz and £4.95m per MHz for 2.6 GHz.
[192] Vodafone response to the August 2014 consultation, Annex 2, pages 2-3 and Annexe 4. Frontier (on behalf of Vodafone) said that 31% (net of coexistence costs) is an appropriate relative value, which corresponds to 28% on a gross basis.
[193] Based on UK values of £35.63m per MHz for 800 MHz and £5.5m per MHz for 2.6 GHz.

5.14 In contrast, Telefónica suggested a more modest adjustment to our Ofcom's August 2014 consultation position. Vodafone said that our Y/X ratio was consistent with the appropriate relative value of 1800 MHz.

5.15 In summary, and focusing on relative values:

a) For 900 MHz, Vodafone and Telefónica's estimates were lower than our August 2014 estimate, while EE and H3G's estimates were broadly consistent with ours.

b) For 1800 MHz, Vodafone and Telefónica's estimates were broadly consistent with our August 2014 estimates, while EE and H3G's were lower.

c) EE and H3G also argued that the ratio (of 61%) between the 1800 MHz and 900 MHz lump-sum values implied by the August 2014 consultation (£14m per MHz to £23m per MHz) was unjustifiably high.

5.16 Respondents argued that there was a need for sensitivity analysis and commented on the extent to which they considered we had met this need, as described in Annex 7, paragraphs A7.187-A7.189.

February 2015 consultation

5.17 Our approach in the February 2015 consultation remained the same as in the August 2014 consultation. In particular, we remained of the view that:

a) In deriving lump-sum value estimates, we should consider the benchmarks in the round, rather than relying on summary statistics such as weighted averages;

b) We should consider a range of cross-checks, broadly similar to those in our August 2014 consultation (with the exception of the weighted average of benchmarks, which we no longer used as a cross-check in light of the subjective nature of the selection of weights).

5.18 Our lump-sum value estimates took into account the following:

c) Quality of evidence as reflected in the different tiers, placing most weight on benchmarks in Tier 1, some weight on benchmarks in Tier 2, and treating Tier 3 benchmarks as having relatively little informative value.

d) Risks of understatement or overstatement in the benchmarks.

e) Conservative approach to interpreting the evidence.

5.19 For both 900 MHz and 1800 MHz, we began by considering **Tier 1 benchmarks**.

5.20 In the case of 900 MHz, we considered that a figure which was halfway between the average value of the two Tier 1 benchmarks (Austria and Ireland) and the lowest of these benchmarks (Ireland) could be appropriate, looking solely at first-tier benchmarks. This took account both the risk of overstatement in the higher benchmark (Austria) and our conservative approach to interpreting the evidence.

5.21 In the case of 1800 MHz, we considered that a figure lower than halfway between the average value of the Tier 1 benchmarks (Austria, Ireland, Italy and Sweden) and the lowest of these benchmarks (Italy) might be appropriate, looking solely at first-tier benchmarks. This was because, in addition to the risk of overstatement in the highest

benchmark (Austria) and our conservative approach to interpreting the evidence, we also took into account the characteristics of the Ireland benchmark. This benchmark was at a larger risk of overstatement, and it was close to the bottom of the range of Tier 1 benchmarks, leading to a risk that the true lowest benchmark in Tier 1 might be lower than we had taken it to be.

5.22 We next considered **Tier 2 benchmarks**, on which we placed less weight than Tier 1 benchmarks.

5.23 For 900 MHz, the two Tier 2 benchmarks (Portugal and Spain) were around 5% lower than our estimate from Tier 1 benchmarks. We did not consider there was a strong basis to modify our estimate in light of this.

5.24 In the case of 1800 MHz, the single Tier 2 benchmark (Germany 2010) was much lower than our estimate from Tier 1 benchmarks, but it was at larger risk of being a larger understatement, and again we did not consider there was a strong basis to modify our estimate from Tier 1 benchmarks in light of this.

5.25 Finally, we considered **Tier 3 benchmarks**. For 900 MHz, two of the three Tier 3 benchmarks were higher than our estimate from Tier 1 benchmarks, while the third was much lower but was a larger risk of larger understatement. For 1800 MHz, one of the five Tier 3 benchmarks was similar to our estimate from Tier 1 benchmarks, one was materially lower, and the remaining three were much lower. We placed considerably less weight on these benchmarks and we did not consider they provided a basis to modify our estimates from the Tier 1 benchmarks in relation to both 900 MHz and 1800 MHz.

5.26 We further considered stakeholders' alternative estimates of spectrum values (see Annex 7, paragraphs A7.250 to A7.260 in this document). As part of this discussion in Annex 7, we considered arguments that our 900 MHz and 1800 MHz estimates were inconsistent.

5.27 We noted that, as described above (paragraph 5.8), AM&A and H3G appeared to have interpreted our August 2014 consultation as suggesting that taking a conservative approach could mean applying a discount to estimates of market value. We clarified our view that we would not consider that such an approach would be appropriate. We noted that we had addressed the comments that we received in response to the August 2014 consultation on our conservative approach to interpreting the evidence (see Section 1 above, paragraphs 1.41 to 1.43).

Stakeholder responses to our February 2015 consultation and July 2015 update

<u>Derivation of lump-sum values and sensitivity analysis</u>

5.28 In response to our February 2015 consultation, EE said that there was a lack of transparency in how we had arrived at our lump-sum value for 1800 MHz. It also referred to its previous comment that "Ofcom should recognise the uncertainty over the appropriate tiers and weightings by carrying out a sensitivity analysis of the impact of varying Ofcom's assumptions" and said, in particular, that in paragraph

A7.158 of the February 2015 consultation "Ofcom has not even stated the weightings used"[194].

5.29 Frontier (on behalf of Vodafone) noted that, due to our revision of the UK value of 800 MHz, our 900 MHz and 1800 MHz benchmarks were lower in February 2015 than in our August 2014 consultation. However, Frontier noted that we had reduced our estimate of the lump-sum value of 1800 MHz spectrum but not our estimate of 900 MHz spectrum, and argued that this was inconsistent.

Alternative estimates of lump-sum values put forward by stakeholders

5.30 EE presented an alternative estimate of the lump-sum value of 1800 MHz in its response to the February 2015 consultation (based on network cost modelling, as discussed in greater detail in Annex 9). Telefónica and Vodafone presented alternative estimates of lump-sum values in their responses to our July 2015 update. These estimates are summarised in Table 5.2 below.[195]

Table 5.2: Summary of estimates of lump-sum values from EE, Telefónica and Vodafone (based on values of 4G auction bands preferred by stakeholder), compared to our estimates in February 2015

	900 MHz value per MHz	900 MHz to 800 MHz ratio	1800 MHz value per MHz	Equivalent Y/X ratio
EE[196]	Not given	Not given	**£5.2m – £5.5m**	-1% - 0%
Telefónica[197]	**£10.9m – £18.4m**	45% - 55%	**£9.8m – £13.1m**	25% - 27%
Vodafone (based on Frontier)[198]	Not given	**29% - 54%**	Not given	**27% - 32%**
Our February 2015 consultation[199]	£23m	70%	£13m	27%

Source: Ofcom from stakeholder responses

Addressing stakeholder responses to our February 2015 consultation

5.31 We explained how we derived lump-sum values for 900 MHz and 1800 MHz respectively in paragraphs 3.55 to 3.59 and 3.67 to 3.72 of the February 2015

[194] EE's response to the February 2015 consultation, p. 46.
[195] Telefónica suggested further reductions from its estimates to account for the geographic coverage obligation. Similarly, Vodafone argued that we should reduce our estimates of the UK value of 800 MHz spectrum in light of the geographic coverage obligation, and since its estimates below are relative valuations based on the UK value of 800 MHz and 2.6 MHz, such a reduction would also imply lower lump-sum values for ALF spectrum.
[196] EE response to the February 2015 consultation, page 11.
[197] Telefónica's response to the July 2015 update, page 28.
[198] Vodafone's response to the July 2015 update, page 11 – 13.
[199] Based on UK values of £33m per MHz for 800 MHz and £5.5m per MHz for 2.6 GHz.

consultation (which are also summarised above). Our corresponding final assessment is set out below in paragraphs 5.35 to 5.52 and 5.53 to 5.68.

5.32 To be clear, in both cases we do not use explicit weightings by tier to derive these estimates of lump-sum value. This is because we remain of the view that, in deriving lump-sum value estimates, we should consider the benchmarks in the round, rather than relying on summary statistics such as weighted averages. However, for illustration, in Annex 7 we have compared our lump-sum values for 900 MHz and 1800 MHz with the results of a weighted average based on the weights proposed by AM&A and Frontier. We have also carried out a sensitivity analysis of our choice of tier for various benchmarks, and we present this in Section 5 (paragraphs 5.48 to 5.51 and 5.66-5.67) and in paragraphs A7.197 to A7.204 of Annex 7.

5.33 Changes in our estimates of 900 MHz and 1800 MHz between August 2014 and February 2015 cannot be directly compared with one another as Frontier implies, for example because we have changed our interpretation of some of the specific benchmarks – see paragraph A7.268 for details.

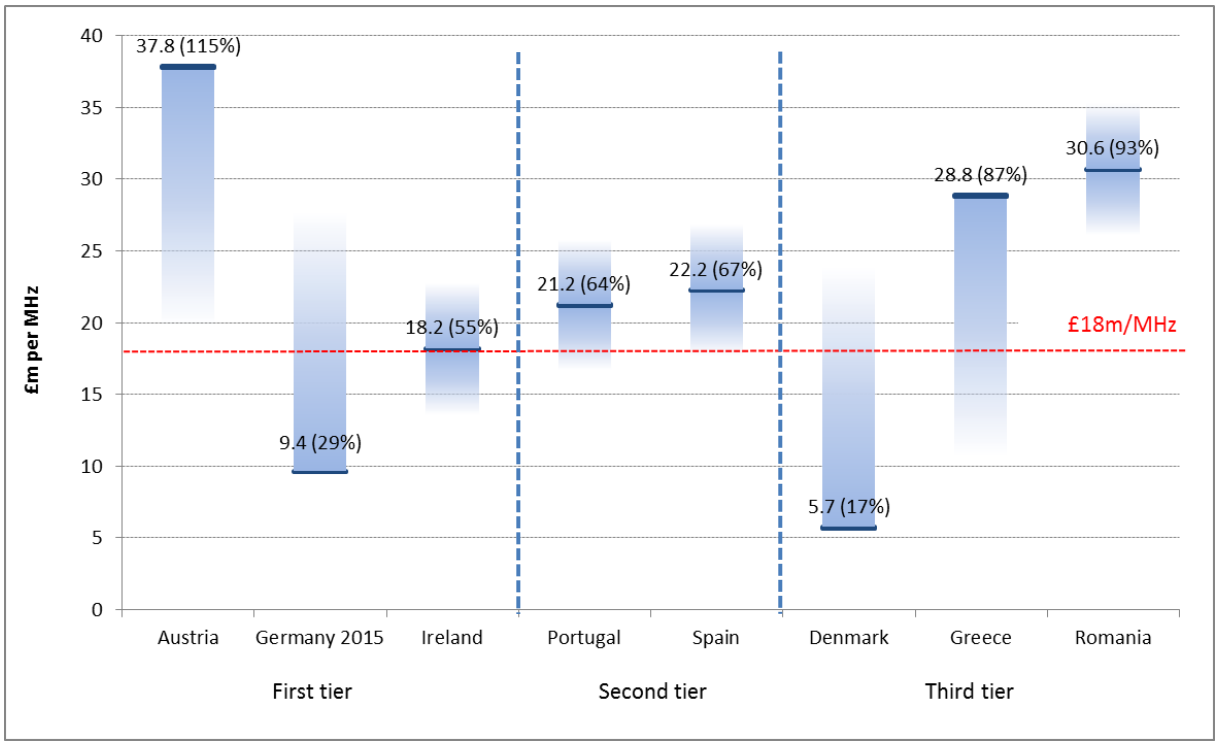
5.34 Our approach to assessing the lump-sum values of 900 MHz and 1800 MHz, including adopting the cross-checks that we consider appropriate, remains as in the February 2015 consultation.

Our conclusions on the lump-sum value of 900 MHz spectrum in the UK

Relative value benchmarks

5.35 Our relative value benchmarks for 900 MHz are shown in Figure 5.1 below.

Figure 5.1: 900 MHz paired ratio benchmarks in £m per MHz



Source: Ofcom

Note: Percentages in brackets represent the ratio of 900 MHz to 800 MHz

Estimate of market value of 900 MHz spectrum in the UK

5.36 As described above, we start by considering Tier 1 benchmarks. We have three benchmarks in Tier 1 (Austria, Germany 2015 and Ireland), of which the highest (Austria) is almost four times that of the lowest (Germany). The Austria and Germany benchmarks are at a larger risk of, respectively, a larger overstatement and a larger understatement. The average of Tier 1 benchmarks is £21.8m per MHz.

5.37 As in our February 2015 consultation, in light of our view that we should take a conservative approach to interpreting the evidence and the risk of overstatement in our highest benchmark, we consider that in looking at the benchmarks in Tier 1 alone an appropriate estimate of UK market value would be between the average (£21.8m per MHz) and the lowest benchmark (£9.4m per MHz).

5.38 In our February 2015 consultation, we considered that an appropriate estimate from Tier 1 benchmarks could be the halfway point (or midpoint) between the average value and the lowest benchmark. On the basis of our updated dataset, this midpoint is £15.6m per MHz.

5.39 The changes in our Tier 1 benchmarks in the updated dataset compared to our February 2015 consultation are as follows:

a) Austria is at larger risk of larger overstatement (in our February 2015 consultation we considered this was a risk of overstatement, without being sure of the likelihood or scale of overstatement).

b) Germany is an additional benchmark which is now the lowest Tier 1 benchmark, and it is at larger risk of larger understatement.

5.40 These risks of overstatement or understatement for Austria and Germany have implications for estimating UK market value, and tend to offset one another. We note that the approach of taking the midpoint between the average and the lowest benchmark places extra weight on the lowest benchmark compared to the other Tier 1 benchmarks. With our updated dataset this is now a concern because the lowest Tier 1 benchmark, Germany, is at larger risk of larger understatement. In light of this we consider that the midpoint value of £15.6m is too far below the average of Tier 1 benchmarks (£21.8m) to be an appropriate estimate.[200]

5.41 Therefore, in our view, an appropriate estimate from Tier 1 benchmarks is above the midpoint between the average and the lowest benchmark, i.e. above £15.6m per MHz. Taking this into account and looking at the Tier 1 benchmarks in the round, our judgement is that £17m or £18m per MHz could be an appropriate estimate of lump-sum value from the Tier 1 benchmarks. A reason to prefer the higher of these figures, £18m, is that it is similar to the Ireland benchmark.

5.42 We next consider Tier 2 benchmarks (Portugal and Spain). These two benchmarks are at a similar level to each other and the average is £21.7m (which, by coincidence, is similar to the average of Tier 1 benchmarks). Comparing this to the figures discussed above for Tier 1 benchmarks of £17m and £18m, it is 28% and 21% higher respectively.

5.43 While we place less weight on second-tier than first-tier benchmarks, we consider that these two similar Tier 2 benchmarks provide further basis for preferring a lump-sum value estimate of £18m over one of £17m. However, given our conservative approach and the fact that we place less weight on Tier 2 benchmarks, we do not consider it is a basis for a higher estimate than £18m.

5.44 Next we consider Tier 3 benchmarks. We place considerably less weight on Tier 3 benchmarks, because they have relatively little informative value. They would only cause us to change our view in unusual circumstances (e.g. if they were within a narrow range and significantly different from our Tier 1 and Tier 2 estimates, having regard to risks of understatement or overstatement where relevant). One of the three Tier 3 benchmarks (Denmark) is well below all Tier 1 and Tier 2 benchmarks (and is at a larger risk of larger understatement). The two other Tier 3 benchmarks are closer to the Austria benchmark than to the Ireland or Germany benchmarks (Romania and Greece, which is at larger risk of larger overstatement). The average of Tier 3 benchmarks alone is £21.7m per MHz (again, by coincidence, this is similar to the average of Tier 1 and Tier 2 benchmarks).[201] We do not consider our Tier 3

[200] With the dataset in our February 2015 consultation (i.e. without the Germany 2015 benchmark), the average of Tier 1 benchmarks was £28.0m and the midpoint between the average and the lowest benchmark (Ireland at £18.2m) was £23.1m.

[201] The average of Tiers 1, 2 and 3 benchmarks is also £21.7m per MHz. These averages do not take account of the risks of understatement or overstatement in the benchmarks.

benchmarks provide a sufficient basis for making an adjustment to the lump-sum estimate derived from Tier 1 and Tier 2 benchmarks.

5.45 On balance, subject to the sensitivity and cross-checks discussed later in this section, we consider that **£18m per MHz** is an appropriate estimate of the market value of 900 MHz spectrum in UK for the purpose of setting ALF, adopting a conservative approach to interpreting the benchmark evidence. In particular, we consider this estimate is conservative because (a) it is below the average of Tier 1 benchmarks, (b) it is below both Tier 2 benchmarks, and (c) it is below all but one of the Tier 1 and Tier 2 benchmarks.

5.46 Another way of describing this market value is by expressing it as the ratio to the value of 800 MHz spectrum. It implies a value of 900 MHz which is 55% of our estimated UK market value for 800 MHz (of £33m per MHz, gross of expected DTT co-existence costs and without coverage obligation).

5.47 We note that £18m per MHz is materially (22%) lower than the estimated lump-sum value for 900 MHz in our February 2015 consultation. This takes account of:

a) the fact that we have a new Tier 1 benchmark in our dataset (Germany 2015), which is much lower than the other Tier 1 and Tier 2 benchmarks, albeit that it is at larger risk of larger understatement; and

b) a change in our assessment of the risk of overstatement in the Austria benchmark to a larger risk of larger overstatement (from a risk of overstatement).

5.48 In Section 3 we discussed possible reasons for both the Austria and Germany benchmarks to be in Tier 2 instead of Tier 1. We explained that on balance we decided to include them both in Tier 1, and above we derived the lump-sum value estimate of £18m on this basis. Now, as a sensitivity, we consider the implications if instead we included both the Austria and Germany benchmarks in Tier 2:

a) There would only be one Tier 1 benchmark (Ireland) at £18.2m with a risk of either overstatement or understatement. This benchmark would therefore be our best estimate of lump-sum value based on Tier 1 evidence.

b) The average of Tier 2 benchmarks, which would now include Austria and Germany, would be £22.7m (although with much wider dispersion of benchmarks since the highest would be Austria at £37.8m and the lowest would be Germany at £9.4m). There could be a case for an upward adjustment to the Tier 1 benchmark to take account of Tier 2 evidence. However, adopting a conservative interpretation of the evidence might suggest no such upward adjustment, thereby leaving the lump-sum value estimate at £18.2m.

c) There would be no change to the Tier 3 benchmarks or to the reasons for our conclusion above of no modification to the estimate derived from the Tier 1 and Tier 2 evidence.

5.49 Therefore, in our view, the sensitivity of including both Austria and Germany benchmarks in Tier 2 would imply a similar lump-sum value estimate to £18m per MHz.

5.50 As summarised in Section 3 at paragraphs 3.64 and 3.65, there are two distinct possible reasons for considering that the Germany benchmark does not meet the Tier 1 criteria (evidence of strategic bidding and substantial change in expectations

about availability of the 700 MHz band). For the Austria benchmark there is one such possible reason (technical / commercial evidence). In our view the possible reasons to include Germany in Tier 2 are at least as strong as for Austria. Therefore, in our view, it is not appropriate to place weight on a sensitivity with Germany retained in Tier 1 and Austria moved to Tier 2.

5.51 There is a case to consider a sensitivity with Germany moved to Tier 2 and Austria retained in Tier 1. Since this would involve moving the lowest Tier 1 benchmark to Tier 2, it would imply a materially higher estimate of lump-sum value.[202] However, because we adopt a conservative interpretation of the evidence, we do not consider this sensitivity provides sufficient basis for us to increase our lump-sum value estimate above £18m per MHz.

5.52 Overall, therefore, subject to the cross-checks discussed later in this section, we conclude that an appropriate lump-sum value of 900 MHz spectrum, based on a conservative interpretation of the evidence, is **£18m** per MHz.

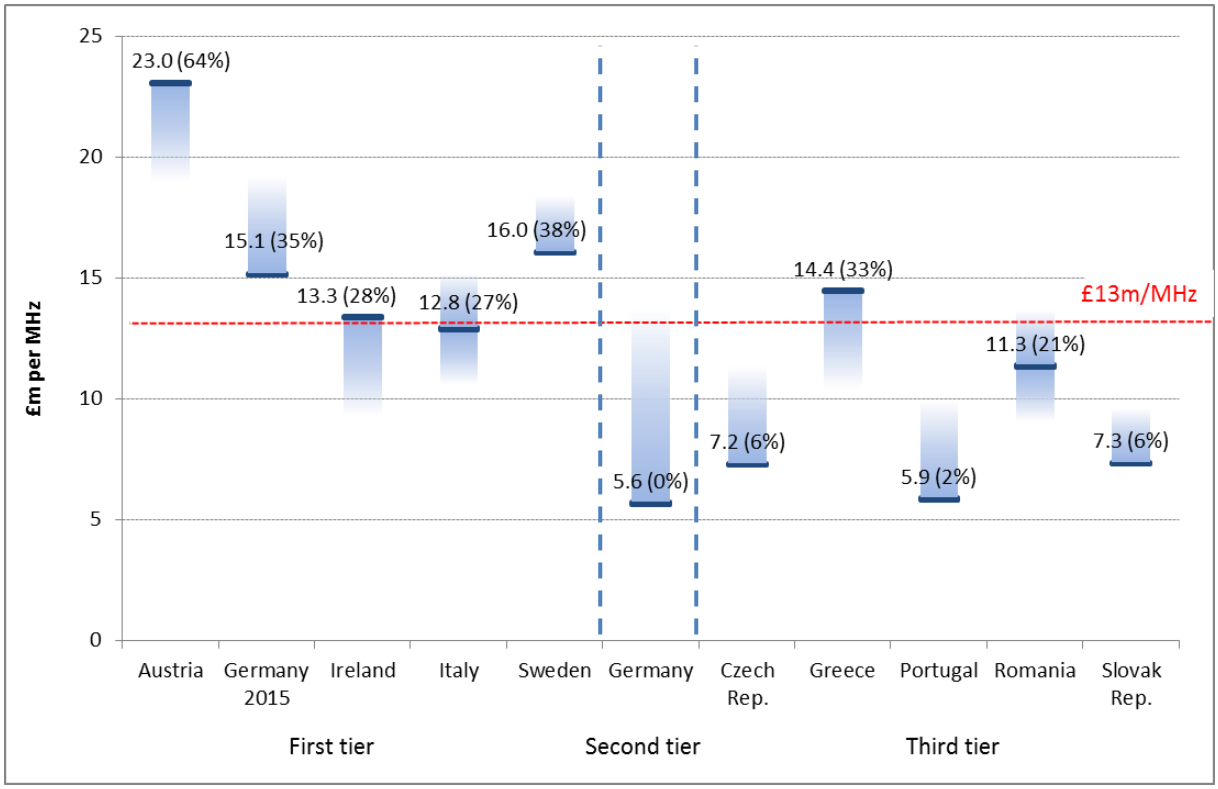
[202] For Tier 1 benchmarks, this sensitivity would be similar to our analysis of Tier 1 benchmarks in the February 2015 consultation, from which we identified a lump-sum value estimate of £23m (although we now consider that the highest Austria Tier 1 benchmark is at larger risk of larger overstatement). Germany would be a third Tier 2 benchmark which would be much lower than the other two, albeit at larger risk of larger understatement. The average of Tier 2 benchmarks would be £17.6m. Taking into account the larger weight we place on first-tier than second-tier benchmarks, this suggests that, for this sensitivity, a lump-sum value estimate between £20m and £23m might be appropriate.

Our conclusions on the lump-sum value of 1800 MHz spectrum in the UK

Distance method benchmarks

5.53 Our distance method benchmarks for 1800 MHz are shown in Figure 5.2 below.

Figure 5.2: 1800 MHz distance method benchmarks in £m per MHz



Source: Ofcom

Note: Percentages in brackets represent the Y/X ratio.

Estimates of market value of 1800 MHz spectrum in the UK

5.54 We start by considering Tier 1 benchmarks. We have five benchmarks in Tier 1: Austria, Germany 2015, Ireland, Italy and Sweden. The highest, Austria, is around 80% higher than the lowest, Italy, while Germany, Ireland and Sweden are somewhat closer to Italy than Austria. There is a larger risk that the Austria and Ireland benchmarks overstate the UK market value, although in both cases we cannot be sure of the scale of potential overstatement. There is a risk that the Sweden benchmark understates UK market value, and a larger risk that the Germany 2015 benchmark understates it, although, again, we cannot be sure of the scale in either case. The average of the five benchmarks is £16m per MHz.

5.55 As in the February 2015 consultation, in light of our view that we should take a conservative approach to interpreting the evidence and the risk of overstatement in two of the benchmarks, we consider that in looking at the Tier 1 benchmarks alone an appropriate estimate of UK market value would be between the average (£16m per MHz) and the lowest of these five benchmarks (i.e. Italy at £12.8m per MHz).

5.56 In our February 2015 consultation, we considered that an estimate from Tier 1 benchmarks below the midpoint between the average value and the lowest benchmark would be more appropriate than the midpoint (on the basis of our updated dataset, this midpoint is £14.4m per MHz, compared to £14.6m in February 2015). Our reasons for this view in the February 2015 consultation remain valid:

a) Ireland is at larger risk of overstatement, albeit that we cannot be sure of the scale of any overstatement; and

b) Ireland is only 4% higher than the Italy benchmark, which is the lowest benchmark in Tier 1, so if Ireland is overstated by more than 4% the true lowest benchmark in Tier 1 may be lower than we have taken it to be.

5.57 There are changes in our Tier 1 benchmarks in the dataset compared to our February 2015 consultation, which are as follows:

a) Austria is at larger risk of overstatement although we cannot be sure of the scale (in our February 2015 consultation we considered this was a risk of overstatement without being sure of either the likelihood or scale).

b) Sweden is at risk of understatement although we cannot be sure of the likelihood or scale (in our February 2015 consultation we considered this was a risk of understatement or overstatement).

c) Germany is an additional benchmark which, at £15.1m, lies above the lowest Tier 1 benchmark and below the average, and is at larger risk of understatement, although we cannot be sure of the scale of understatement.

5.58 The changes to the risks have offsetting implications, with the change to Sweden tending to imply a higher estimate and the change to Austria tending to imply a lower estimate. The addition of the Germany 2015 benchmark could imply a higher estimate on the basis that it is above our February 2015 lump-sum value estimate of £13m per MHz, or a similar or lower estimate because adding it to our dataset means that the average of Tier 1 benchmarks is slightly lower than in February 2015 (since it is below the average of Tier 1 benchmarks in the February 2015 consultation of £16.3m).

5.59 Looking at the Tier 1 benchmarks in the round, and adopting a conservative interpretation of the evidence, we consider that our approach in the February 2015 consultation remains appropriate, namely to take an estimate from Tier 1 benchmarks below the midpoint of £14.4m.

5.60 Therefore, we consider that £13m per MHz could be an appropriate estimate from the Tier 1 benchmarks. We note this figure is similar to two of the benchmarks (Ireland and Italy), and lower than the other three Tier 1 benchmarks.

5.61 We next consider the single benchmark in Tier 2, which is Germany 2010. The average of Tier 2 benchmarks alone would be £5.6m (i.e. the value of the Germany 2010 benchmark). However, the Germany 2010 benchmark is at larger risk of being a larger understatement. We said in our February 2015 consultation that the extent to which this second-tier benchmark is consistent with the implications we draw from the first-tier benchmarks depends on the scale of understatement, which is unknown. Given this, and the lesser weight we place on second-tier than first-tier benchmarks, we did not consider there is a strong basis to modify the view we derive from the first-tier benchmarks.

5.62 In addition, we now have the Germany 2015 benchmark which, in our view, provides better quality information than the Germany 2010 benchmark.[203] This strengthens the case for making no downward adjustment to £13m on the basis of the Tier 2 evidence.

5.63 Of the five benchmarks in Tier 3, Greece is above our estimate of £13m, although it is at larger risk of overstatement and Romania is lower at £11.3m. The three others are lower at around £6m to £7m, although all three of these benchmarks are at risk of understatement. As discussed above, we consider that Tier 3 benchmarks have relatively little informative value and we place considerably less weight on them. In addition, in view of the fact that we have five Tier 1 benchmarks with a value close to or above our estimate of £13m, we do not consider our Tier 3 benchmarks provide a sufficient basis for making an adjustment to the lump-sum estimate derived from Tier 1 benchmarks.[204]

5.64 On balance, subject to the sensitivity and cross-checks discussed later in this section, we consider that **£13m per MHz** is an appropriate estimate of the market value of 1800 MHz spectrum in UK for the purpose of setting ALF, adopting a conservative approach to interpreting the benchmark evidence. In particular, we consider this estimate is conservative because (a) it is below the average of Tier 1 benchmarks, and (b) it is below all but one of the Tier 1 benchmarks.

5.65 Another way of describing this market value is by expressing it as the distance method Y/X ratio. It implies a Y/X ratio of 27%.

5.66 In Section 3 we discussed possible reasons for the Germany 2015 benchmark to be in Tier 2 instead of Tier 1. We explained that on balance we decided to include it in Tier 1, and above we derived the lump-sum value estimate of £13m on this basis. Now, as a sensitivity, we consider the implications if instead we included the Germany 2015 benchmark in Tier 2:

a) There would be four Tier 1 benchmarks (Austria, Ireland, Italy and Sweden) at an average of £16.3m (as in the February 2015 consultation), with two of the benchmarks (Austria and Ireland) at larger risk of overstatement and one (Sweden) at risk of understatement. The midpoint between the lowest Tier 1 benchmark and this average would be £14.6m. There would be the same reasons as set out above to derive an estimate from Tier 1 benchmarks below this midpoint and a similar figure of £13m would seem an appropriate estimate.

b) The average of Tier 2 benchmarks, which would now include Germany 2015 as well as Germany 2010, would be £10.3m with Germany 2010 at larger risk of larger understatement. In our view, there would not be a strong basis for a downward adjustment to the estimate from Tier 1 benchmarks based on this average and an even weaker case taking into account that the higher Germany

[203] As discussed in Section 3, on balance we have decided to classify it as a Tier 1 benchmark, whereas the Germany 2010 benchmark is in Tier 2. In addition, the Germany 2015 benchmark constitutes more up-to-date evidence. We also note that the Germany 2015 benchmark is at risk larger risk of understatement. If £15.1m (Germany 2015) is an understatement, this suggests that £5.6m (Germany 2010) could understate the market value by a substantial amount.

[204] The average of Tier 3 benchmarks alone is £9.2m per MHz. The average of Tiers 1, 2 and 3 benchmarks is £12.0m per MHz. These averages do not take account of the risks of understatement or overstatement in the benchmarks.

2015 benchmark provides more up-to-date information than the Germany 2010 benchmark.[205]

c) There would be no change to the Tier 3 benchmarks or to the essential reasons for our conclusion above of no modification to the estimate derived from the Tier 1 and Tier 2 evidence.

5.67 Therefore, in our view, the sensitivity of including the Germany 2015 benchmark in Tier 2 would not imply a different lump-sum value estimate.

5.68 Overall, therefore, subject to the cross-checks discussed later in this section, we conclude that an appropriate lump-sum value of 900 MHz spectrum, based on a conservative interpretation of the evidence, is **£13m** per MHz.

Cross-checks

5.69 We consider the following cross-checks of the estimates set out above:

a) First, we compare our estimates of the value of 900 MHz and 1800 MHz in the UK to the value of these bands in benchmark countries, in terms of the absolute UK-equivalent value, rather than the relative value measures which we used to derive our estimates above. We begin by considering each band individually, and then we compare results between the two bands.

b) Second, we compare the ratio of our estimates of 1800 MHz to 900 MHz lump-sum values in the UK to the corresponding ratio within benchmark countries where both bands were awarded.

c) Third, we compare our estimates to the average of Tier 1 countries, and the average of Tier 1 and Tier 2 countries, within each band.[206]

5.70 For each cross-check, we consider whether it would be appropriate in light of our analysis of the cross-check to revise either of our estimates.

Absolute values

5.71 We consider in turn absolute benchmarks for 900 MHz and 1800 MHz, and then consistency between our values for the two bands. We consider the absolute values of 900 MHz and 1800 MHz in the countries concerned as a cross-check on our estimates of £18m and £13m per MHz respectively. These absolute values are an input into the relative value benchmarks we have used above, and so they should not be seen as an independent source of evidence. However, we see it as a useful sense check to ask whether our estimated values seem reasonable when compared with absolute values of that band in other countries.

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[205] If the Germany 2010 benchmark were ignored, it would leave Germany 2015 as the single Tier 2 benchmark at a level above £13m. In effect, compared to our analysis above, in this sensitivity we would be moving one benchmark (Germany 2015) from Tier 1 to Tier 2. This move would suggest that there should be less weight on the Germany 2015 benchmark in the sensitivity than in our analysis above. As such, in our view, there would not be a sound basis for an upward adjustment to the estimate from Tier 1 benchmarks.

[206] In our August 2014 consultation, we used weighted averages as an additional cross check. We consider these in Annex 7.

5.72 To be clear, we consider that our assessment of the evidence above using relative value benchmarks provides a better approach, because relative values are likely to be more reliable than absolute values which are more sensitive to a range of country-specific factors, as discussed in the August 2014 consultation.[207]

5.73 For example, there is much greater potential for absolute benchmarks to be affected by factors such as urbanisation, which vary widely between countries and may affect the value of spectrum (in particular, sub-1 GHz spectrum may be higher-value, other things equal, in less urbanised countries, as discussed in Annex 7). Austria, Ireland, Greece, Romania and Portugal are, to varying degrees, less urbanised than the UK. This may have increased the absolute value of 900 MHz in those countries, although not necessarily the relative value of 900 MHz to 800 MHz.

5.74 We would only modify the lump-sum value estimates derived from the (more reliable) relative values based on the evidence of the (less reliable) absolute values in exceptional circumstances (e.g. if the absolute values were tightly grouped and substantially different to our lump-sum value estimate for that band, having regard to the risk of understatement or overstatement of estimates). For the reasons set out below, we do not consider that such circumstances are present either for the 900 MHz or the 1800 MHz band.

Absolute values of 900 MHz

5.75 The absolute values of 900 MHz spectrum in our benchmark countries are included in Table 3.1. We repeat them in Table 5.3 in ascending order and they are also shown in Figure 5.3.

Table 5.3: Absolute values for 900 MHz spectrum (UK-equivalent £m per MHz)

Country	Absolute value	Tier[208]	Known risk of under / overstatement
Denmark	£2.9m	3	Larger risk of larger under-statement
Germany (2015)	£16.1m	1	Larger risk of under-statement
Portugal	£29.7m	2	Larger risk of larger over-statement
Greece	£32.6m	3	Larger risk of larger over-statement
Ireland	£35.6m	1	Risk of under- or over-statement
Spain	£40.0m	2	Larger risk of larger over-statement
Romania	£48.2m	3	Risk of over-statement
Austria	£77.9m	1	Larger risk of larger over-statement

Source: Ofcom

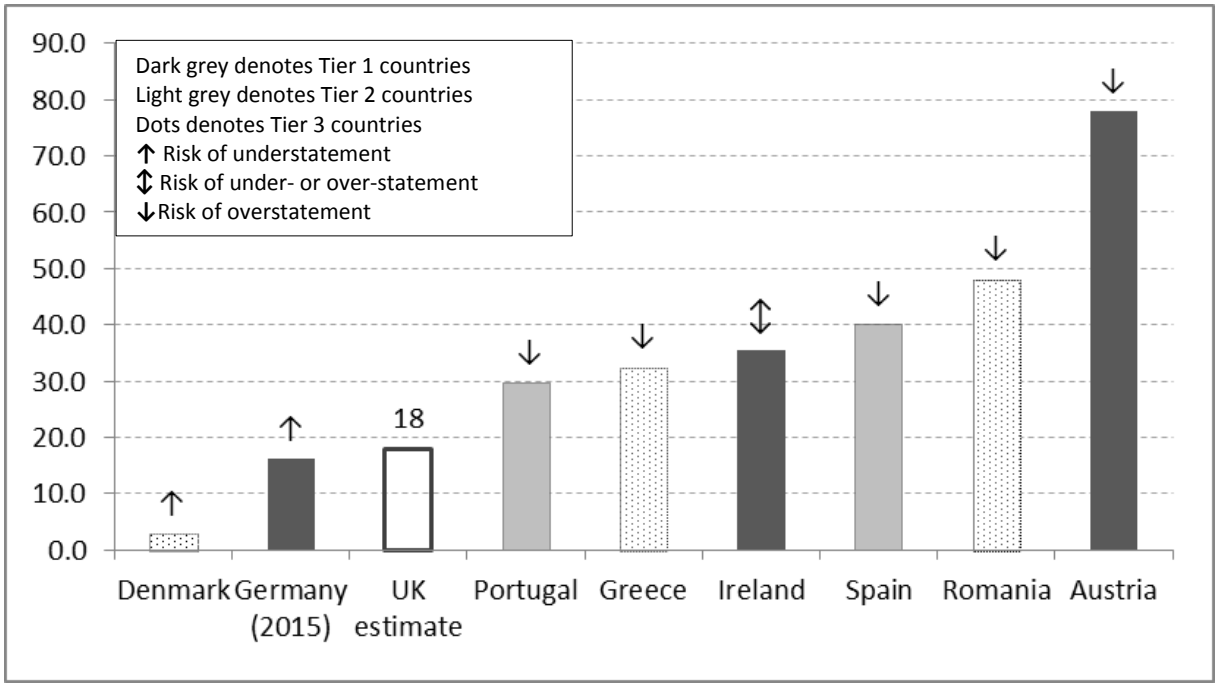
5.76 Eight countries in our sample have auctioned 900 MHz spectrum since 2010. The average of Tier 1 benchmark countries is £43.2m per MHz, and it is £39.9m per MHz

[207] August 2014 consultation, paragraphs 3.19-3.21.
[208] The tiers shown in Table 5.3 and Figure 5.3 and discussed below relate to the tiers for the associated relative value benchmark in that country.

across Tier 1 and Tier 2 countries. The average absolute value in all countries is £35.4m per MHz. Each of these averages is substantially higher than our estimate of £18m per MHz for the UK (around 140%, 120% and 95% higher respectively).

5.77 The absolute values of 900 MHz are more widely dispersed than the relative values, with a range of £75m between the highest and lowest absolute value in Table 5.3, or around £62m excluding Denmark, compared to a range of around £30m for the relative values.

Figure 5.3: Absolute values for 900 MHz spectrum (UK-equivalent £m per MHz)



Source: Ofcom

5.78 We note the following about our lump-sum value estimate for 900 MHz of £18m per MHz:

a) Both of the values below £18m are at risk of understatement (Denmark and Germany), whereas the values above £13m are either a two-way risk (Ireland) or at risk of overstatement (Portugal, Greece, Spain, Romania and Austria).

b) Considering absolute values used in Tier 1 benchmarks, £18m lies between Germany (risk of understatement) and Ireland, although much closer to the lower of these absolute values (Germany). The remaining absolute value from a Tier 1 benchmark, Austria, is substantially higher at around £78m (albeit that this figure has a larger risk of larger overstatement).

c) Our estimate is also well below values in the two Tier 2 countries (Portugal and Spain).

5.79 This analysis shows that our estimate is below most of the absolute values from other countries in our benchmark set. We note that this would be true of any estimate below £29.7m (i.e. the next-lowest absolute value) – i.e. only a very large upward revision of our estimate would change its ranking.

Absolute values of 1800 MHz

5.80 The absolute values of 1800 MHz spectrum in our benchmark countries are included in Table 3.1. We repeat them in Table 5.4 in ascending order and they are also shown in Figure 5.4.

Table 5.4: Absolute values for 1800 MHz spectrum (UK-equivalent £m per MHz)

Country	Absolute value	Tier[209]	Known risk of under / overstatement
Denmark	£1.3m	Excluded	Larger risk of larger under-statement
Germany (2010)	£1.9m	2	Larger risk of under-statement
Czech Republic	£6.0m	3	Larger risk of under-statement
Slovak Republic	£7.2m	3	Larger risk of larger under-statement
Portugal	£8.1m	3	Risk of under- or over-statement
Sweden	£9.3m	1	Risk of over-statement
Greece	£14.4m	3	Larger risk of over-statement
Italy	£16.7m	1	Larger risk of over-statement
Romania	£19.4m	3	Larger risk of over-statement
Germany (2015)	£20.7m	1	Larger risk of under-statement
Ireland	£23.1m	1	Larger risk of over-statement
Austria	£44.0m	1	Larger risk of over-statement

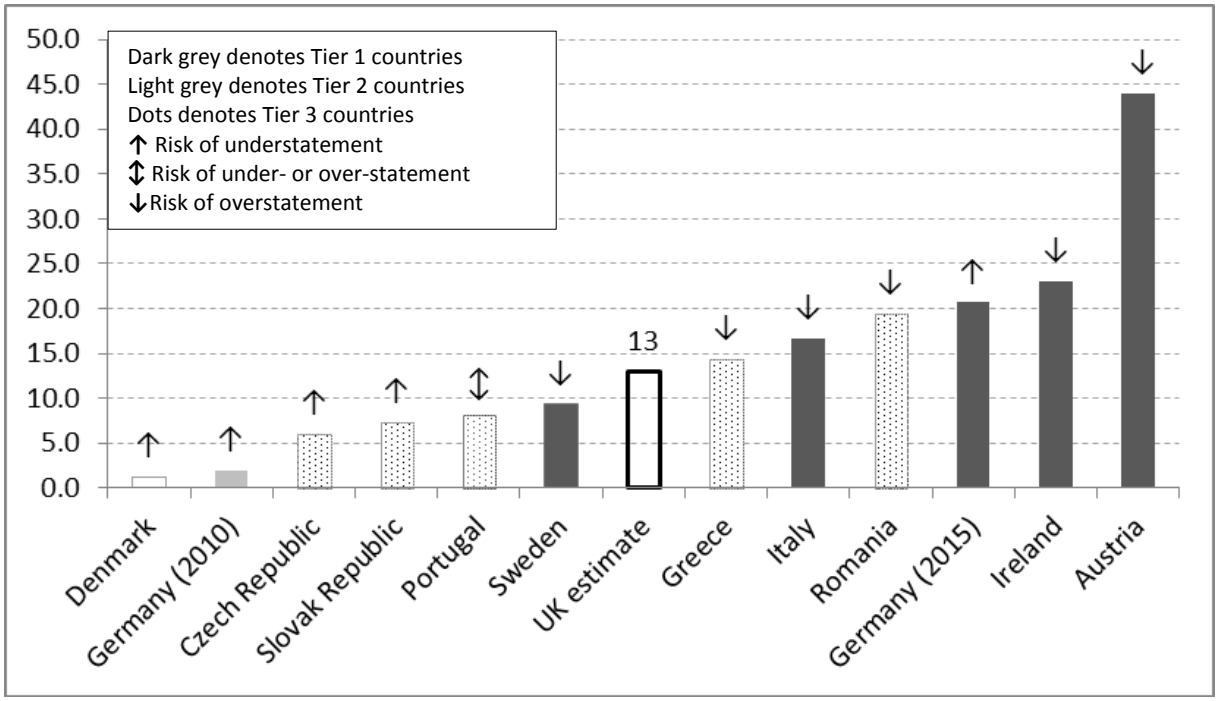
Source: Ofcom

5.81 The average absolute value in Tier 1 benchmark countries is close to £23m. We have one Tier 2 benchmark for 1800 MHz, Germany 2010, of £1.9m, which is at larger risk of larger understatement. The average across all countries is £14.3m per MHz. The Tier 1 average is 77% higher than our estimate of £13m per MHz for the UK, and the average across all countries is 10% higher.

5.82 Again, the absolute values for 1800 MHz are more widely dispersed than the corresponding set of relative values. All the distance method benchmarks we consider are above the UK value of 2.6 GHz of £5.5m[210] and they range up to £23m. In contrast, absolute values range from around £1m to £44m. Two of these absolute values (Denmark and Germany 2010) are substantially lower than the UK value of 2.6 GHz.

[209] The tiers shown in Table 5.4 and Figure 5.4 and discussed below relate to the tiers for the associated relative value benchmark in that country.
[210] This is a result of how the distance method benchmark is calculated, as set out in Annex 7, paragraphs A7.78-A7.84.

Figure 5.4: Absolute values for 1800 MHz spectrum (UK-equivalent £m per MHz)



Source: Ofcom

5.83 We note the following about our lump-sum value estimate for 1800 MHz of £13m per MHz:

a) Most of the values below £13m are at risk of understatement (other than Portugal, which is at risk of either understatement or overstatement, and Sweden, which is at risk of overstatement). Of the values above £13m, five are at risk of overstatement (Greece, Italy, Romania, Ireland and Austria). One absolute value above our lump-sum value estimate is at larger risk of understatement (Germany 2015).

b) Considering absolute values used in Tier 1 benchmarks, £13m lies between Sweden and Italy. The absolute values of Germany 2015 and Ireland are between around £20m and £23m. The remaining absolute value from a Tier 1 benchmark, Austria, is substantially higher at around £78m (albeit that this absolute value has a larger risk of overstatement).

c) Our estimate is substantially above the absolute value from the single two Tier 2 benchmark (Germany 2010), although this absolute value is at larger risk of larger understatement.

Our conclusion on cross-checks against absolute values

5.84 As noted above (at paragraph 5.74), we would only modify the lump-sum value estimates derived from our (relative value) benchmarks based on the cross-check against absolute values in exceptional circumstances.

5.85 Our estimates for both 900 MHz and 1800 MHz are below most of the absolute values from our Tier 1 benchmarks (and for 1800 MHz this includes the new absolute value since February 2015 which is at larger risk of understatement, Germany 2015). However, we note that the absolute values from Tier 1 benchmarks are more widely dispersed than the benchmarks themselves.

5.86 Comparing the rankings for our 900 MHz and 1800 MHz lump-sum value estimates against all absolute values, our estimate for 1800 MHz lies in the middle of the rankings of absolute values, whereas for 900 MHz it is near the bottom of the rankings. However, as noted above, most of the 1800 MHz absolute values that are lower than our lump-sum value estimate of £13m per MHz are at risk of understatement and most are from Tier 3 benchmarks. In addition, we reiterate that these values are sensitive to country-specific factors, and this is reflected in the wide dispersion of the results.

5.87 In the circumstances, and taking into account our conservative interpretation of the evidence, we do not consider that a revision to either of our lump-sum value estimates is appropriate in light of this analysis.

Within-country ratios of the value of 1800 MHz to 900 MHz

5.88 We now compare the ratio of 1800 MHz to 900 MHz implied by our lump-sum value estimates against the ratios in our benchmark sample where both 900 MHz and 1800 MHz have been auctioned (as shown in Table 5.5).

Table 5.5: Ratio of value of 1800 MHz to value of 900 MHz

Country	1800 MHz / 900 MHz ratio	Tier (900 MHz)	Tier (1800 MHz)
Austria	56%	1	1
Ireland	65%	1	1
Germany (2015)	129%	1	1
Portugal	27%	2	3
Romania	40%	3	3
Denmark	43%	3	Excluded
Greece	44%	3	3

Source: Ofcom

5.89 AM&A said that this this cross-check is of limited value as the manner in which we conduct it provides no new information at all. We recognise that it does not involve independent evidence from that used to develop our lump-sum value estimates. However, we still consider this cross-check is useful, as it indicates that our estimates imply a relative value of 1800 MHz to 900 MHz in the UK which is consistent with the relative values of these bands within benchmark countries.[211]

5.90 Our analysis suggests a value for 1800 MHz that is around 72% of the value of 900 MHz spectrum (£13m per MHz compared to £18m per MHz). This is within the

[211] As described above, our 900 MHz estimate is based on its value relative to 800 MHz within benchmark countries, while our 1800 MHz estimate is based on its value relative to 800 MHz and 2.6 GHz within countries. In this sense, the value of 1800 MHz in a country did not inform our 900 MHz benchmark from that country, and the value of 900 MHz in a country did not inform our 1800 MHz benchmark from that country.

wide range of ratios of 56% to 129% from the three countries that provide a Tier 1 benchmark for each band (Austria, Germany and Ireland). It is below the average (geometric mean of 78% and arithmetic mean of 83%) for the 1800 MHz / 900 MHz ratios in these three Tier 1 countries. However, in both Ireland and Germany we have identified a risk that the 1800 MHz / 900 MHz ratio is overstated, whilst we have identified a risk of understatement of the ratio in Austria. The other ratios presented above are all somewhat lower than 72%, but come from countries where either our 900 MHz or 1800 MHz benchmarks, or both, are Tier 3 which means that we place considerably less weight on them. These ratios typically represent the ratio of the reserve prices set by regulators.

5.91 We do not consider that a revision to either of our estimates is appropriate in light of this cross-check.

Comparison of estimates to average benchmark values

5.92 When deriving our lump-sum value estimates for each of 900 MHz and 1800 MHz, we considered the respective average of Tier 1 relative value benchmarks. For each band we considered that we should choose a value falling below this average. We now compare the relativity of our lump-sum value estimates to the average of Tier 1 benchmarks as between the two ALF bands, as shown in Table 5.6.

Table 5.6: Average benchmark values, £m per MHz

	900 MHz	1800 MHz
UK lump-sum value estimate	£18m	£13m
Average of Tier 1 benchmarks	£21.8m	£16.0m
UK value as % of average	83%	81%
Average of Tier 1 and Tier 2 benchmarks	£21.8m[212]	£14.3m
UK value as % of average	83%	91%

Source: Ofcom

5.93 Our estimates of UK market value for 900 MHz and 1800 MHz are, respectively, 83% and 81% of the average of Tier 1 benchmarks. We consider that these percentages are broadly consistent between the two spectrum bands.[213]

5.94 We do not consider that a revision to either of our estimates is appropriate in light of this cross-check.

[212] Coincidentally, Tier 1 benchmarks have a similar average value to Tier 2 benchmarks.
[213] We also note the slightly different balance of risks between the two bands. In the case of 900 MHz, Austria is at larger risk of larger overstatement whilst Germany 2015 is at larger risk of larger understatement. For 1800 MHz, Austria and Ireland are both at larger risk of overstatement, whilst Germany 2015 is at larger risk of understatement and Sweden is at risk of understatement.

Summary of our decisions on lump-sum values of 900 MHz and 1800 MHz spectrum

5.95 Our decisions on lump-sum value estimates are summarised in Table 5.7.

Table 5.7: Lump-sum values for 900 MHz and 1800 MHz

900 MHz	1800 MHz
£18m per MHz	£13m per MHz

Section 6

Annualisation

Introduction

6.1 This section sets out the approach that we have decided to adopt to convert our estimate of the lump-sum value of the spectrum into annual fees and corresponds to step 3 in the analytical framework we set out in Section 1. Supporting material for this section is set out in Annex 10.

6.2 The rest of this section discusses in turn the following issues:

a) Spreading the lump-sum value using a constant real profile;

b) Inflation index;

c) Discount rate for annualisation:

i) Upper polar case;

ii) Lower polar case;

iii) Risk sharing; and

d) Tax adjustment.

6.3 In setting out our decisions, and the reasons for them, we have followed the structure of our February 2015 consultation, which included addressing stakeholders' comments to our August 2014 consultation. At the relevant points throughout our analysis, we have specified how we have taken account of any new points raised by stakeholders in response to our February 2015 consultation.

6.4 We address the issues of an appropriate discount rate used in the derivation of benchmarks in Annex 7 (paragraph A7.45 *et seq*.) and terminal value in Annex 10 (paragraph A10.87 *et seq*.), including our response to stakeholders' comments.

6.5 In summary, in the light of stakeholders' responses we have decided to adopt the following approach to calculating the discount rate, as discussed below and in Annex 10:

a) Use observed market debt rates on 10-year bonds in deriving our estimate for the cost of debt;

b) Adjust the cost of debt for an inflation risk premium; and

c) Incorporate an adjustment for risk sharing.

Spreading the lump-sum value using a constant real profile

6.6 In our October 2013, August 2014 and February 2015 consultations, we proposed to spread the lump-sum value of spectrum over 20 years, using an ALF profile that is flat in real terms, that is a 20-year annuity.

6.7 Stakeholders broadly agreed with this proposal in response to our October 2013 consultation and we received no further comments on this specific issue in response to the August 2014 and February 2015 consultations (with the exception of a point raised on terminal value, which we discuss in Annex 10 (paragraph A10.87 *et seq*).

6.8 Having considered stakeholders' responses, we conclude that a reasonable approach is to spread the lump-sum value over 20 years using a constant real profile. In summary, we have decided to adopt this approach because we consider that:

a) a 20-year period is consistent with the initial term of the spectrum licences awarded in the UK 4G auction;

b) a flat profile is the most pragmatic approach, as in reality the many factors underlying changes in the future value of the spectrum are difficult to forecast for Ofcom, which risks making any more sophisticated approach spuriously precise;

c) a constant real price profile (meaning that the ALF moves each year in line with a specified inflation index set out in the fees regulations) is more appropriate than ALFs that would be constant in nominal terms but decreasing over time in real terms (assuming positive inflation) because:

i) it avoids a higher initial value which reduces over time in real terms and we are not aware of clear evidence that suggests there is likely to be systematic downward trend in value; and

ii) it is at less risk of being out of line with underlying spectrum value.

Inflation index

Our proposed approach

6.9 In our October 2013 consultation we proposed to use RPI as a measure of inflation. In response to this consultation stakeholders argued that we should use CPI instead of RPI. They reiterated their preference for indexation using CPI in response to our April 2014 consultation on the specific issue of the methodology that we proposed to adopt if we were to derive an appropriate discount rate for annualising the lump sum values into annual fees on the basis of CPI (instead of RPI)[214].

6.10 In our August 2014 consultation, recognising stakeholder's responses, we proposed to use CPI as the measure of inflation in calculating ALFs, both for the purposes of (i) the discount rate that we adopt at various stages of our ALF methodology (in estimating the lump-sum value of spectrum and also in annualising such lump sums into ALF), and (ii) the way we derive the change in ALF each year in line with this measure of inflation.

6.11 In our August 2014 consultation, we prosed to estimate the discount rate using a risk-free rate plus debt premium approach. Using this methodology we required both[215] a

[214] Annual licence fees for 900 MHz and 1800 MHz: methodology to derive a discount rate consistent with CPI inflation, Consultation, 17 April 2014: http://stakeholders.ofcom.org.uk/consultations/900-1800-mhz-fees-cpi/

[215] Index-linked gilt use the retail prices index and the yields from these gilts are typically used as a source of evidence on the risk-free rate.

CPI inflation assumption (we proposed 2% per annum) and a RPI inflation assumption (we proposed 3.3% per annum, which was consistent with our CPI inflation assumption).

6.12 In February 2015, we changed our approach to estimating the discount rate (we proposed to use debt yields) and as a consequence we no longer required an RPI inflation assumption. In respect of CPI inflation, in February 2015 we proposed the same approach to inflation index and value (i.e. CPI and an inflation rate of 2%) as in August 2014.

Stakeholders' responses

6.13 As noted above, stakeholders were generally in favour of using CPI as the measure of inflation throughout the consultation process.

6.14 In response to our August 2014 consultation, we received the following comments:

a) Vodafone[216] suggested that our approach to calculating the cost of debt in the August 2014 consultation using a real RPI-adjusted rate and then converting that to a CPI adjustment is unnecessarily cumbersome and compounds the risk of forecast error. Oxera on behalf of Vodafone also alluded to arguments made in relation to CPI in its previous reports[217]. We understand this to be a reference to its previous argument that licensees are exposed to inflation risk from assuming 2% inflation in deriving the real discount rate, but linking ALFs to actual outturn inflation[218].

b) Telefónica[219] also suggested that the discount rate should be adjusted to reflect the lack of inflation risk premium needed in ALF (this argument is discussed further in Annex 10, paragraph A10.42 *et seq*).

6.15 We received no further comments on this specific issue in response to our February 2015 consultation.

Our conclusion

6.16 We have decided to use CPI as the measure of inflation in calculating ALFs as proposed in our August 2014 and February 2015 consultations because we agree with stakeholders that CPI provides a preferable measure of inflation compared to RPI. We note CPI's official status[220] and its use in the WACC calculated for the 2015 MCT market review and Bank of England's Inflation Target, which is defined in terms of CPI.

6.17 We consider that Vodafone's comment set out in paragraph 6.14 a no longer applies given our revised approach to estimating the discount rate uses observed market debt rates.

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[216] Vodafone's response to the August 2014 consultation, p.42.
[217] See, for example, Vodafone's response to the August 2014 consultation, Annex 4, p.12.
[218] Oxera report for Vodafone May 2014, p.10; Vodafone response to the May 2014 consultation, p.10-11.
[219] Telefónica's response to the August 2014 consultation, p.79 and Annex II, p.16-18.
[220] RPI is no longer an 'official statistic' as it does not meet international standards. See http://www.ons.gov.uk/ons/rel/mro/news-release/rpirecommendations/rpinewsrelease.html

6.18 We have considered the issue of inflation risk, and the related issue of an appropriate inflation forecast in light of Telefónica's response, in Annex 10 (paragraph A10.42 *et seq)*. In summary, we reduce lower polar case by 10bps to remove the inflation risk premium.

6.19 Based on the analysis set out in that annex and in the August 2014 and February 2015 consultations, we conclude that we should apply a long-term CPI inflation assumption of 2% per annum. This is consistent with the Bank of England CPI inflation target.

Discount rate for annualisation

6.20 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 the lump-sum value paid today. An appropriate discount rate depends on, among other things, the uncertainty associated with this future ALF payment stream. An important factor in this uncertainty relates to changes in the market value of the spectrum over time. The discount rate which will leave MNOs indifferent between paying ALF and paying a lump-sum amount depends on the extent to which they (rather than the Government) are exposed to the effect of such changes in market value over time and, therefore, it is an important consideration in determining an appropriate discount rate.[221] For ease of exposition, we refer (throughout this section and in Annex 10) to the "**degree of exposure to changes in market value of spectrum over time**" as the "**degree of risk**" or just as "**risk**".[222]

Our proposed approach

6.21 In the August 2014 consultation, we proposed that the discount rate used to annualise the lump-sum value should reflect the risk of the cash flows coming from licensees to the Government through the ALF[223]. We pointed out that exactly what the nature of this risk is depends on the nature of the ALF obligation. We considered two (hypothetical) polar cases to illustrate this. In the first polar case, the licensees face none of the risk of the cash flows and the Government faces all of the risk, whereas in the second polar case, the licensees face all of the risk and the Government none of the risk:

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[221] This analysis is not dependent on the fact that it is the Government that is the recipient of the ALF payments. Our task is to assess "market value" in a context where payments for spectrum take the form of a stream of annual payments as opposed to a one-off lump-sum payment. This concept of market value needs to apply equally in a situation where one company decides to trade (or lease) its spectrum usage rights to another company in return for annual payments, with the opportunity for these payments to be adjusted in light of changes in market value over time (rather than being traded outright for a one-off payment).

[222] The key consideration in this context is the extent to which the licensee is exposed to changes in the market value of spectrum over time (which we refer to as the extent of the licensee's risk exposure). However, it is sometimes more convenient for drafting purposes to phrase this in terms of the extent to which the exposure to changes in the market value of spectrum over time is, in effect, being transferred away from the licensee to Government (which, for convenience, we refer to as the extent of Government's risk exposure). However, where we do refer to the extent of Government's risk exposure this is intended as a reference to the extent to which the licensee's exposure to changes in the market value of spectrum over time is reduced (e.g. by the effect of reviews of ALF).

[223] The approach to discount rate that we proposed in our August 2014 consultation represented a change from our October 2013 consultation, in which we proposed to use the WACC.

a) *Upper polar case* - If, hypothetically, the ALF payments were set up in such a way that they varied in line with the future after-tax cash flows of the licensee (e.g. through some form of (hypothetical) net revenue sharing arrangement between the licensees and the Government), the correct discount rate to use would be the rate that the licensee would use to convert the expected cash flows from using the spectrum into a lump-sum. This may be approximated by the MNOs' WACC as calculated for the MCT market review 2015-18.[224] From the licensee perspective, in this hypothetical scenario its risk would be reduced because the ALF payments would be correlated with its profitability (when the value derived from using the spectrum went down, the impact on net cash flow would be moderated by the reduction in ALF payments etc). Therefore, a variable ALF reduces MNO risk because a variable ALF is likely to move in line with MNOs' revenues (derived from the use of the spectrum). Conversely, the Government would bear the risk of variation in its cash flows through variation in the ALFs. The higher discount rate would lead to higher (starting) ALFs in this first polar case.

b) *Lower polar case* – If, hypothetically, the ALF payments were set up so that they were completely fixed regardless of circumstances, the ALF would effectively be akin to a form of secured debt (or finance lease) and the correct discount rate would be the corresponding interest rate for such a debt instrument. This lower discount rate would lead to lower ALFs, reflecting the position in this second polar case that the licensees would bear the risk associated with the variation in their net cash flows (and the Government would bear no risk other than the default risk[225]) because the level of ALF payments would be fixed (e.g. the ALF payments would not adjust to offset changes in the profitability of exploiting the spectrum which, for these purposes, is taken to vary with the market value of the spectrum).

6.22 We recognised that neither of these cases fit the situation we are addressing here. We therefore sought to identify what we considered to be the best available proxy rate to use for the purposes of setting ALFs, taking a conservative approach to interpreting the available evidence.

6.23 We noted a number of features of ALF which made it closer to the 'debt rate' case than the 'WACC' case. However, we also recognised that ALF is not exactly aligned with the debt rate case, as (i) a licensee could avoid paying the ALF by handing back the spectrum with limited effect on the rest of its financial operations (in contrast to most debt where 'default' can have significant negative implications), and (ii) ALFs could be revised either up or down (although we noted that these two factors were likely to be closely linked).

6.24 We suggested that the ability for ALF to be revised up or down alters the balance of risk between the Government and licensees compared to a situation where ALFs are set 'once and forever'. At the extreme, if ALFs were revised so frequently that changes in market value were reflected in the fee levels in real time, the ALF would essentially reflect the underlying expected cash flows from the spectrum. This would transfer all of the risk of these cash flows to the Government. Any reduction (increase) in expected cash flows would be reflected in a decrease (increase) in market value of the spectrum, which would immediately feed through to lower (higher) ALFs. As such, the ALF obligation would be much closer to the 'WACC' case

[224] Mobile call termination market review 2015-18, Final Statement, 17 March 2015, http://stakeholders.ofcom.org.uk/consultations/mobile-call-termination-14/statement/

[225] The cost of debt includes default premium and default risk premium.

described above where the market value of the spectrum tracks the licensee's after tax profit.

6.25 We said that in practice, our approach to fee reviews is somewhere between these two extremes. This suggests that the MNOs could in practice be sharing the underlying risks of the business for which the spectrum is employed. This further suggests that using the debt rate could understate the discount rate it would be appropriate to use if the review regime were significantly to transfer risk away from the licensees. However, we noted that there is considerable difficulty in estimating the extent of such a transfer of risk. In line with our conservative approach when interpreting the evidence to derive ALFs, we therefore in August 2014 proposed to use the cost of debt rate for the purposes of deriving ALFs.

6.26 In our February 2015 consultation, we proposed the same approach to the discount rate as in August 2014 except that we proposed to apply a 25% risk sharing adjustment because we recognised that, despite the difficulties of estimating the extent of the risk transfer, we should exercise our regulatory judgement on the risk sharing adjustment. In brief, we proposed to calculate the discount rate as the cost of debt (lower polar case) plus 25% of the difference between the cost of debt (lower polar case) and the WACC (upper polar case).

Stakeholder responses and our analysis in light of these responses

6.27 Stakeholders commented on these issues in their responses to both the August 2014 and February 2015 consultations. In the following sub-sections, we summarise these stakeholder comments before presenting our analysis and conclusions, in light of stakeholders' comments. We do this for each of the following issues in turn:

a) The relevant upper polar case;

b) The relevant lower polar case; and

c) Risk sharing.

Upper polar case – the WACC

Stakeholders' responses to the August 2014 consultation

6.28 In response to our August 2014 consultation, we received the following comments from H3G and BT:

a) H3G[226] argued that the WACC is not a relevant upper bound as, in its view, the risk of the ALF will never reflect the underlying business risk. Specifically, H3G[227] suggested that MNOs' WACC reflects many additional business risks unrelated to and on top of the value of spectrum, including risks relating to consumer demand and the intensity of competition. By contrast, it suggested the business risks associated with spectrum are much narrower, as the market value of spectrum

[226] H3G's response to the August 2014 consultation, p.39.
[227] H3G's response to the August 2014 consultation, p.39.

(especially higher frequency spectrum) at the margin is determined by the costs of technological substitutes for increasing network capacity.[228]

b) H3G[229] also argued that, even if ALFs were revised annually to reflect full market value, they would still not reflect the same risk as the relevant spectrum cash flows. This is because market value reflects the present value of expected long-term forward-looking cash flows, i.e. a weighted-average of expected future cash flows, hence, should always be less variable than year-on-year annual cash flows.

c) By contrast, BT[230] suggested that the WACC is a relevant polar case, and there are arguments to use it as the discount rate. It suggested that, while it may be difficult to determine exactly where between the two poles the ALF case sits:

> "Many regulatory settings require judgements about the future to be made and Ofcom cannot simply avoid doing this in this context by stating it is hard to do; that would be an abrogation of their duties. Ofcom should be able to exercise its regulatory judgement on the appropriate range in which such risk sharing could reasonably fall rather than deliberately set it at the bottom extreme of the range which is guaranteed to be below the right value with complete certainty."[231]

d) BT[232] also argued that the annuity should be derived on an equivalent basis to how the purchaser established its own lump-sum value of the spectrum (e.g. in deciding its maximum bid in an auction) with annual charges set on an equivalent basis in terms of applicable discount rate. This relates to the risk faced by the licensee in raising the relevant funds up front (i.e. the MNOs' WACC) rather than the risk associated either with the flow of payments to the Government or the risks around the licensees' revenues from using the spectrum.

Stakeholders' responses to the February 2015 consultation

6.29 In response to our February 2015 consultation, EE and NERA on behalf of Telefónica submitted a number of comments on the specific issue of the upper polar case.

6.30 EE considered that the MCT WACC should not form part of Ofcom's range and set out several reasons for its view.[233] First, it said that the principle of equal treatment means that Ofcom should treat different situations differently and that several considerations for setting charge controls are not relevant for setting ALFs. EE noted examples such as providing a reasonable rate of return and creating incentives for new investment and efficiency in financing. EE also noted that ALF lump sum would require a one-off financing while charge controls needed to reflect the longer term

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[228] With regard to the cost of debt, EE also argued that the risks associated with ALF payments to Government are not affected by the firm-specific factors that are reflected in the yield to maturity (YTM) on MNO parent company bonds. It suggested that basing the discount rate on a YTM that reflects the average risk of a MNO is therefore likely to lead to ALFs being set too high (EE's response to the August 2014 consultation, p.53). In Annex 10 we consider various specific adjustments which have been suggested to reflect the differences between ALF and corporate debt, including the more secure nature of the ALF obligation relative to unsecured debt.
[229] H3G's response to the August 2014 consultation, p.39.
[230] BT's response to the August 2014 consultation, p.3-5.
[231] BT's response to the August 2014 consultation, p.5.
[232] BT's response to the August 2014 consultation, p.4.
[233] EE's response to the February 2015 consultation. p. 58-59.

nature of raising finance to fund investments over time. EE considered that in our February 2015 consultation we had rightly acknowledged these arguments.

6.31 EE considered that 'when used in this context [as the upper polar case] the unadjusted MCT WACC is an inappropriately distortive parameter'[234] because:

a) It ignores the fact that spectrum demand is based on long-term network planning and long-term forecasts and therefore is much less affected by macroeconomic cycles than consumer demand for mobile services.

b) EE noted DotEcon's report[235] for Ofcom's October 2013 consultation, that there is no obvious link between the auction prices and general share prices.

c) EE argued that, while it may be difficult to disaggregate a pure play spectrum holder from an MNO, that did not justify simply adopting the unamended MCT WACC as the upper polar case. EE considered that Ofcom could choose and use a beta of half that of a mobile operator (i.e. 0.3) representing just below the bottom end of the range of potential mobile operator asset betas recommended by Brattle. Alternatively, EE thought that we could reduce the uplift to the cost of debt to below the proposed 25% level. However, EE considered that each of the adjustments would still involve the upper polar case inappropriately reflecting a pure hypothetical case which does not reflect reality.[236]

6.32 EE considered that the cost of debt should form the upper point of Ofcom's range. EE submitted that the best view of the available evidence is that the risks are similar to those associated with debt, but that in several aspects ALFs are likely to prove less risky than debt. On this basis, according to EE, the discount rate should be no higher than the cost of debt, which EE estimated to be 0.4% (real).

6.33 NERA[237] on behalf of Telefónica considered that it was inconsistent for us to recognise the one-off nature of the 'ALF transaction' while using the long-run WACC for the upper polar case. NERA estimated the short-run risk-free rate and calculated the short-term WACC on two bases: i) assuming the same total market return as we did in our MCT WACC and ii) assuming the same equity risk premium as we did in our MCT WACC. It estimated that the short term WACC (post tax, real, CPI deflated) was between 44 and 98 bps lower than the MCT WACC and this in turn would reduce the risk sharing (and the discount rate) by between 11 and 25 bps.

Our analysis of stakeholders' responses to the August 2014 consultation

6.34 H3G's argument is essentially that the exposure to systematic risk is different for a firm holding spectrum alone compared to the entirety of a mobile business. In relation to this, we note that in the context of disaggregating BT's WACC, we have set out that certain conditions strengthen the case for assessing risk on a project-specific basis:

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[234] EE's response to the February 2015 consultation, p. 60

[235] http://stakeholders.ofcom.org.uk/binaries/consultations/900-1800-mhz-fees/annexes/benchmarking.pdf

[236] EE's response to the February 2015 consultation, p. 62.

[237] NERA, Deriving ALFs from Lump-Sum Valuations – A Response to Ofcom's Second Consultation, http://stakeholders.ofcom.org.uk/binaries/consultations/annual-licence-fees-900-MHz-1800-MHz/responses/Telefonica_Annex_-_Deriving_ALFs_from_Lump_Sum_Valuations.pdf

a) there are strong a priori reasons for thinking that the systematic risk faced by the project is significantly different from that faced by the overall company (e.g. different income elasticities of demand and/or stability of cash flows);

b) there is evidence which can be used to assess variations in risk, e.g.:

   i) it is possible to identify benchmark firms that are close to "pure play" comparators in terms of having similar risk characteristics to individual projects within the firm;

   ii) it is possible to use other quantitative analysis (such as quantified risk assessments);

   iii) data on the firm are available at a disaggregated level (e.g. via separated accounts); and

c) correctly identifying variations in risk, and reflecting this in an adjusted rate of return, is likely to bring about significant gains for consumers.[238]

6.35 We consider that these conditions are not met within the context of ALF for the following reasons:

a) We do not agree with H3G that there is a strong a priori reason to consider that the systematic risk faced by holding spectrum is significantly different from that of mobile operators as a whole. For example, we do not consider that the network cost savings associated with having additional marginal spectrum are unaffected by the factors H3G suggested as "additional business risks".[239] We remain of the view, as we set out in the October 2013 consultation, that we consider the WACC applicable to an average UK mobile-only operator (as derived in the MCT market review 2015-18 for the MCT charge control) is likely to capture the systematic risks which would apply to the ALF licences.

b) Further, there is a lack of evidence that can be used to assess the suggested variations in risk. For example, there is clearly no 'pure play' spectrum holder or disaggregated MNO accounts which could be used as a basis for such an assessment, and no other quantified analysis has been conducted in this area.[240]

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[238] See paragraph 5.24 in Ofcom's approach to risk in the assessment of the cost of capital: Final statement, 18 August 2005, http://stakeholders.ofcom.org.uk/binaries/consultations/cost_capital2/statement/final.pdf.

[239] In particular, network cost savings do vary with the level of consumer demand, as set out, for example, in our cost benefit analysis for changing the use of 700 MHz spectrum (see Decision to make the 700 MHz band available for mobile data: Statement, 19 November 2014, http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/statement/700-mhz-statement.pdf and Analysys Mason, *Assessment of the benefits of a change of use of the 700 MHz band to mobile*, 27 October 2014, http://stakeholders.ofcom.org.uk/binaries/consultations/700MHz/annexes/benefits_700MHz.pdf.

[240] We note that the recent MCT market review 2015-18 includes some illustrative analysis of disaggregating betas for mobile from the wider parent companies, but even this presents significant challenges as noted in that document (see paragraphs A10.142-A10.147 in Mobile call termination market review: Final statement, 17 March 2015, http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-call-termination-

6.36 We therefore consider that the MCT WACC is an appropriate upper bound for the discount rate in the hypothetical upper polar case where ALF changes frequently enough to reflect real-time changes in value, or is directly linked to MNOs' net revenues.

6.37 As we stated in the February 2015 consultation[241], we agree with BT's comment set out in paragraph 6.28c and therefore we consider that the appropriate discount rate lies between our lower and upper polar cases, and despite the difficulties of estimating the extent of the transfer of risk from licensee to Government, we should exercise our regulatory judgement on the appropriate value of the risk-sharing adjustment. We address this in more detail in paragraph 6.61 *et seq*. below.

6.38 BT's view described at paragraph 6.28d above is similar to our proposed approach in the October 2013 consultation. However, we set out in the August 2014 consultation that the nature of our annualisation exercise is not to reproduce the original cash flows on which the lump-sum value is based. Rather, we are seeking to spread the lump-sum value over a notional 20-year period to calculate a constant real annual payment from the licensees to the Government. In principle, an average efficient MNO (on which our estimation of the discount rate is based)[242] and the Government should be indifferent between payment for the spectrum in the form of a lump-sum payment or ALF. This means that the discount rate used to annualise the lump-sum value should reflect the risk of the cash flows coming from licensees to the Government through the ALF, rather than the risk to the licensee of the cash flows associated with using the spectrum. Therefore, we consider that the WACC is relevant as the upper polar rate.

Our analysis of stakeholders' responses to the February 2015 consultation

6.39 EE considered that the appropriate upper end of a range should be the cost of debt. As noted in paragraphs 6.23, we consider that the cost of debt approach does not sufficiently capture the risks of a change in the market value of spectrum in light of the possibility of a review in future. The cost of debt might be the appropriate rate if there were no possibility of a review. This is the lower polar case and is discussed in paragraph 6.47 *et seq*.

6.40 EE suggested that because, in its view, the MCT WACC clearly overstated the risk in the upper polar case, even if it is difficult to calculate the downward adjustment, any adjustment would be better than no adjustment. It suggested simply halving the MCT beta. The MCT asset beta is the weighted average beta for the portfolio of assets employed by an MNO. If an asset, such as spectrum, makes up a significant proportion of the assets employed by the MNO and has a significant lower asset beta than other assets in that portfolio, then by definition those other assets must have a significantly higher beta. We are not persuaded that betas associated with individual

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14/statement/Annexes_7-13_final.pdf). Disaggregating part of the mobile business from the rest of the mobile business would likely be equally, if not more, challenging.

[241] Annual licence fees for 900 MHz and 1800 MHz spectrum: Provisional decision and further consultation, 19 February 2015, Paragraph 4.54

[242] We have considered the relevance of the average efficient operator in Annex 10, paragraph A10.16 *et seq*.

assets in an MNO's portfolio of assets would vary significantly, considering that they are all used in the provision of mobile phone services.[243]

6.41 Spectrum is a fundamental asset in the provision of mobile phone services (EE itself noted that it was more likely to default on debt than on ALF), and the value of spectrum is derived from its use in providing services such as mobile phone services. Therefore, it appears to us reasonable to base our calculations on the assumption that the beta of the spectrum is similar in value to that of the MNO as a whole.

6.42 As stated in paragraph 6.31a, EE considered that spectrum demand is based on long-term network planning and long-term forecasts and therefore is much less affected by macroeconomic cycles than consumer demand for mobile services. We note that an MNO's share price reflects investors' expectations of the long-term profitability, cash flows and risk. We therefore believe that variations in the share price reflect the long-run risk of spectrum.

6.43 NERA (on behalf of Telefónica) considered that it was inconsistent for us to recognise the one-off nature of the 'ALF transaction' (and use the current yield to maturity on debt) while using the long-run WACC for the upper polar case. We consider that it is appropriate to combine the current cost of debt with the longer-run WACC, because in the upper polar case spectrum is similar to other assets used in the provision of mobile services. In that polar case, payments for spectrum are not fixed, so cannot be "bought out" at today's prevailing cost of debt.

Ofcom's conclusions on the upper polar case

6.44 We conclude that the WACC is an appropriate estimate for the upper polar case where that upper polar case is the hypothetical scenario in which the ALF payments were set up in such a way that they varied in line with the future after-tax cash flows of the licensee (e.g. through some form of (hypothetical) net revenue sharing arrangement between the licensees and the Government).

6.45 We conclude that the WACC calculated for the MCT charge control for the MCT market review 2015-18[244], which we published on 17 March 2015, is a reasonable proxy for the WACC applicable to the upper polar case.

6.46 Specifically, in our 2015 MCT Statement we used a pre-tax nominal WACC of 9.1%. This equates to a post-tax[245] nominal WACC of 7.3% and, when incorporating our

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[243] This differs to the situation where a firm provides a range of businesses, products or services which are clearly different and we would have an a priori reason to consider that each faced different systematic risk (and therefore a different beta).

[244] Mobile call termination market review 2015-18, Final Statement, 17 March 2015, http://stakeholders.ofcom.org.uk/consultations/mobile-call-termination-14/statement/

[245] From 1 April 2015, the corporate tax rate was 20% (see HMRC, *Rates and allowances: Corporation tax,* https://www.gov.uk/government/publications/rates-and-allowances-corporation-tax). However, as set out in the 2015 Summer Budget (https://www.gov.uk/government/publications/summer-budget-2015), the Government intends to reduce the rate to 19% from April 2017 and 18% from April 2020). As set out in paragraph 6.129 we use a corporate tax rate of 18.3% (20% in February 2015 and August 2014 consultation) since this represents the best estimate of what the average tax rate will be over the next 20 years. Our post-tax calculations therefore include an adjustment for a corporate tax rate of 18.3%. However, changing from 20% to 18.3% does to change the post-tax, real MCT WACC (5.2%) when rounded to 1 decimal place.

CPI estimate of 2%, it equates to a post-tax real WACC of 5.2%, which we consider an appropriate value for our upper polar case.

Lower polar case – the cost of debt

6.47 In August 2014 we proposed to calculate the cost of debt as the sum of the risk-free rate and a debt premium.

6.48 Our provisional view in the February 2015 consultation maintained our position that the appropriate discount rate for the lower polar case should be a measure of the cost of debt. However, in light of responses to the August 2014 consultation, in February 2015 we changed our position on which measure of the cost of debt to use and we based our estimate of the cost of debt on observed yields-to-maturity on 10-year MNO debt (rather than on the measure for the cost of debt used in the MCT). We did this using an average of yields-to-maturity over the preceding 12 months.

Stakeholders' responses to August 2014 and February 2015 consultations

6.49 In response to our August 2014 consultation, we received the following comments:

a) Vodafone[246], EE[247] and Telefónica[248] all argued that we should calculate the cost of debt based on current yields to maturity, rather than using our traditional approach (used in MCT).

b) EE[249] and Vodafone[250] said that the cost of debt is not the lower bound but the correct rate. In their view, using the cost of debt is therefore not conservative in itself and we should therefore be conservative in our approach to estimating it.

c) According to H3G,[251] the correct rate could be somewhat below the traditional cost of debt. It argued that ALF payments are for all relevant purposes risk free and the risk-free rate should therefore be the relevant discount rate. It suggested that at most we should include only a very small debt premium on top of the risk-free rate to reflect the low likelihood of default and the limited fallow period if default were to occur. Telefónica, Vodafone and EE also suggested a number of adjustments to the cost of debt observed from market data to better reflect the specific features of ALF.

6.50 In response to our February 2015 consultation, all licensees welcomed our change to using the observed yields-to maturity on 10-year MNO debt as the basis for our debt rate. However:

a) NERA (on behalf of Vodafone) thought that a 12 month average as a measure of current cost lies significantly above truly short-run estimates of 1 month or 3 months averages which are better proxies for the current cost of debt.

b) EE considered that we should update the yield-to-maturity estimate using the latest market data prior to setting the ALFs.

[246] Vodafone's response to the August 2014 consultation, p.40-41 and Annex 4.
[247] EE's response to the August 2014 consultation, p.49-53.
[248] Telefónica's response to the August 2014 consultation, p.76-77 and Annex II, p.4-10.
[249] EE's response to the August 2014 consultation, p.45 and 49.
[250] Vodafone's response to the August 2014 consultation, p.40.
[251] H3G's response to the August 2014 consultation, p.40-42 and Annex C.

6.51 In calculating the cost of debt, EE considered that Ofcom needed to adopt a more conservative point estimate. EE noted that Ofcom had selected the mid-point in its cost of debt range and thought a lower point estimate for the cost of debt would be appropriate.

6.52 EE referred to previously submitted evidence that Ofcom had included in its analysis a Deutsche Telecom bond that contained a clause which initiated a change in the coupon rate following a downgrade in the credit rating on the issuer. EE also noted that bond holders are subject to market risk when the bond is traded and will incur capital losses on disposal should the bond price go down.

Our analysis of stakeholders' responses to August 2014 and February 2015 consultations

6.53 As noted above, in February 2015 we stated that we agreed with stakeholders that the cost of debt should be calculated from the yields to maturity. We indicated that we intended to do so using an average yield to maturity calculated over 12 months. Vodafone suggested that we should use a shorter period such as 1 month or 3 months.

6.54 We recognise that in calculating the current cost of debt there is a choice to be made about the appropriate averaging period. A balance needs to be struck between a short window (which is more recent but might potentially capture atypical market conditions) and a longer average (which would average out atypical market conditions). We are seeking a rate which is reflective of current market conditions, rather than a long-term rate. However, there is a risk in using rates derived from a very small time window, in that atypical movements could distort the rate calculated in this way. In our view, a 12 month averaging period is an appropriate balance between the desire to capture current, rather the long term, market conditions and the risk of calculating a rate dominated by atypical short- term movements.

6.55 We agree with EE's suggestion that we should update our estimate of the yield to maturity using the latest available data. Our conclusion on the choice of debt rate therefore uses up-to-date data (27 August 2015) to define the lower polar case and this reduces the lower polar case from 0.9%, used in our February consultation, to 0.6% used in this decision (see paragraph A10.61 in Annex 10).

6.56 Turning to the other points raised, we do not agree with EE's and Vodafone's argument that the cost of debt is the correct rate rather than the lower bound – and that, because of this, we should be conservative in our approach to estimating the cost of debt. As discussed further below, we consider that the possibility of a review of ALF in the event of a material misalignment means that the cost of debt is the lower bound, rather than the correct rate.

6.57 EE[252] highlighted that corporate debt payments are not always fixed or non-performance related, noting that the Deutsche Telekom bond used as one of the comparators in determining the cost of debt contains a clause which allows for an adjustment to coupon payments following a change in the credit rating of the bond issuer. However, such an adjustment does not seem likely to be as fundamental as an ALF review. Were a future review of ALF to use a similar methodology to that used in this document, it could affect not just the discount rate at which a lump-sum value is converted into an annual payment equivalent, but also the size of the lump-

[252] EE's response to the August 2014 consultation, p.49.

sum value itself. In contrast, to extend the analogy of the bond, a clause such as that noted by EE may affect the coupon payment, but it would not change the principal which is due for repayment at maturity.

6.58 Furthermore, we consider that bond investors would likely see the coupon adjustment mechanism as a credit enhancement because it provides them with protection from downside risks. Therefore, one would expect, all other things being equal, that such a bond would have a lower coupon than a bond without such protection. Including this Deutsche Telecom bond in our calculation, if anything, therefore depresses our yield-to-maturity calculation.

Our conclusions on the lower polar case

6.59 We conclude that the cost of debt is an appropriate estimate for the lower polar case where that lower polar case is the hypothetical scenario in which the 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.

6.60 We have set out in Annex 10 the factors we consider and the calculation of an appropriate cost of debt for ALF.[253] On the basis of the analysis set out in Annex 10, we consider an appropriate lower polar rate, converted to a post-tax real figure using our 2% CPI inflation assumption, is a cost of debt of 0.6%[254] (post-tax, real). This reflects the current yield to maturity (YTM) on 10-year MNO debt, using latest available data, and an adjustment for inflation risk premium.

Risk sharing

6.61 In the August 2014 consultation we recognised that it was possible that the appropriate discount rate lies above the cost of debt.[255] However, we also recognised the difficulty in estimating the transfer of risk from licensees to Government, and we said that because of our view that we should take a conservative approach when interpreting the evidence, we did not make an allowance for such risk sharing.

6.62 In our February 2015 consultation we reconsidered this point in light of BT's representation that taking a conservative approach is not the same as deliberately setting ALFs below our view of an appropriate level. In February 2015 we set out our revised view that, despite the difficulties of estimating the extent of such a transfer of risk, we should exercise our regulatory judgement on the risk-sharing allowance. Accordingly, we undertook an exercise to explore the nature of risk sharing (i.e. exposure to changes in the market value of spectrum over time).

6.63 We used a highly stylised and simplified scenario in which there was a single review around halfway through the period, i.e. after around ten years, at which point the ALF

[253] In Annex 10 we set out in detail our approach to calculating the lower polar case, in particular our view on: using observed market debt rates (yields-to-maturity); and the further adjustments we consider are warranted to account for: use of an average efficient operator rather than most efficient operator; duration; security; inflation risk; and liquidity risk.

[254] In our February 2015 consultation this value was 0.9%.

[255] The approach to discount rate that we proposed in our August 2014 consultation represented a change from our October 2013 consultation, in which we proposed to use the WACC.

would be reset on the basis of the information available at that time. The simple calculation of risk transfer under this scenario is set out in Annex 10, paragraph A10.63. Under this assumption, the Government would bear slightly more than 40% of the risk in the stylised example. Taking our illustrative example to be informative as a starting point, we considered that an adjustment somewhat lower than 40% may be justified, and in line with adopting a conservative approach when interpreting the evidence. Incorporation of the effect of the threshold for review in the illustrative example, not taking account of the potential for there to be more than a single review, and a high level sense check led us to the view that a risk sharing adjustment of 25% would be a sensible and conservative reflection of the exposure to changes in market value that the Government is likely to bear. Accordingly, in February 2015 we applied a 25% risk sharing adjustment in estimating an appropriate discount rate.

6.64 The lower polar case (cost of debt) included the risk of default of ALF. The risk sharing estimate captures the additional risk, which arises from the possibility of a fee review. For this reason we applied the risk sharing percentage to the difference between the cost of debt (lower polar case) and the WACC (upper polar case).

Stakeholders' responses to the August 2014 consultation

6.65 In response to our August 2014 consultation, the MNOs argued that the Government does not share the risk of the underlying spectrum cash flows:

a) EE,[256] H3G[257] and Vodafone[258] argued there is little risk of licensees returning spectrum (unless market value falls below the ALF) due to its importance to their business and the ability to trade spectrum rights to a competitor;

b) H3G[259] and Vodafone[260] also noted that we retain significant discretion over the circumstances under which we would open a review and argued it is more likely to be revised up than down. Vodafone suggested there will always be a lag between changes in value and evidence of these changes becoming available, during which time licensees will bear any change in value. H3G noted that "Ofcom has now committed to there not being a review of the ALF for a period of at least five years" (emphasis in the original) and noted that our suggested approach of reviewing ALF only if there is reason to believe there is a material misalignment between ALF and spectrum value means that "Government's risk is effectively 'capped' and could perhaps be characterised more in terms of low probability / high impact events that could cause spectrum value to diverge materially from that currently estimated by Ofcom".[261] H3G therefore suggested that it is not clear Government is really sharing risk to any significant extent. EE[262] argued that, even with a review process, the ALF payments will be much less volatile than the profitability of a business. Further, it suggested that the Government would not be exposed to individual business risks but only to significant changes in overall market value;

[256] EE's response to the August 2014 consultation, p.46 and 48.
[257] H3G's response to the August 2014 consultation, p.41 and Annex C, p.10-11.
[258] Vodafone's response to the August 2014 consultation, p.39-40.
[259] H3G's response to the August 2014 consultation, Annex C, p.6-7.
[260] Vodafone's response to the August 2014 consultation, p.39-40.
[261] H3G's response to the August 2014 consultation, Annex C, p.6.
[262] EE's response to the August 2014 consultation, p.49.

c) EE[263] and H3G[264]said that, if there was a default, there would likely be a high degree of recoupment (even compared to other secured debt) due to (i) the Government's priority claim in the event of insolvency and (ii) the highly saleable nature of the spectrum. Telefónica made a similar point in response to the October 2013 consultation [265]; and

d) EE [266]argued we mischaracterised debt, such that ALF is actually closer to other forms of debt than we had set out.

6.66 As noted above (see paragraphs 6.28 c and 6.28 d), in contrast, BT argued in response to our August 2014 consultation that risk is shared with the Government and so it was wrong to set the discount rate at the cost of debt, which effectively assumed zero risk sharing. Instead, BT said that we should exercise regulatory judgement on the appropriate range of risk sharing.

Stakeholders' responses to the February 2015 consultation

6.67 In response to our February 2015 consultation, stakeholders raised issues in two main areas:

a) Vodafone and EE argued that there was a low probability of a review taking place in future (and that we should make little or no allowance for risk sharing on this account); and

b) Telefónica (referring to a paper it had commissioned from NERA) argued that we should use an option pricing framework to assess risk sharing (and that this might lead us to conclude that there should be no adjustment for risk sharing).

6.68 Vodafone submitted a paper it commissioned from Oxera,[267] which concluded that 'Ofcom's approach is a reasonable specification of what will happen if there is a single review in 10 years. However, its assessment of 40% risk share can only overstate the true level of risk share, since the reality is that the value will only be recalculated following a material and low probability event'.[268] Oxera considered that the risk weighting would be well below 25% because:

a) only a material change would result in a further review;

b) Ofcom's approach assumed that the ALF would perfectly reflect changes in value of investments in mobile phone companies;

c) given the maturity of mobile industry it was unlikely that there would be another material change in industry circumstances which would trigger a review; and

d) it was not obvious that there has ever been an event in the mobile industry which would have resulted in a review.

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[263] EE's response to the August 2014 consultation, p.46-48.
[264] H3G's response to the August 2014 consultation, p.41 and Annex C.
[265] Telefónica's response to the October 2013 consultation, paragraph 314.
[266] EE's response to the August 2014 consultation, p.47-49.
[267] Oxera's note prepared for Vodafone entitled 'Is Ofcom's ALF adjustment justified?', of 15 April 2015.
[268] Oxera's note prepared for Vodafone entitled 'Is Ofcom's ALF adjustment justified?', of 15 April 2015 p5

6.69 Vodafone considered that 25% risk sharing was way above any reasonable ceiling of an appropriate 'blend'. Vodafone set out several grounds for believing that a properly and conservatively set ALF will not need to be revised:

a) present spectrum fee charges per channel were derived from a review carried out in 1996 to 1998 and are currently approximately 20 years old;

b) future spectrum release and/or auctions will be carried out with the intent to avoid any 'capacity crunch'; and

c) it is not impossible that the number of active or potentially active mobile operators will reduce and this may, as a minimum, potentially limit any extent to which the value of spectrum may rise in the future.

6.70 Vodafone therefore considered that it was by no means axiomatic that any review within the next 20 year period would conclude that an ALF change is appropriate or necessary.

6.71 Vodafone considered that there was circularity in Ofcom's logic. In its view, the risk sharing adjustment increased the ALF which, in turn, made reviews more likely.

6.72 EE examined the 'risk of dramatic misalignment between ALFs and market value'.[269] EE considered that Ofcom's suggestion that future reviews of 700 MHz and 2.1 GHz could provide evidence of material misalignment on ALF reveals a material error in our current approach to ALFs, in particular our failure to factor in the quantitative impact on present value of ALFs of future spectrum releases. Further, EE thought that if Ofcom sets ALFs appropriately conservatively, there should not be any present reason for Ofcom to consider a material misalignment between ALFs and market review to be likely. EE considered that once this was done, the risk of misalignment 'moves from being a probability to a mere theoretical possibility'[270] and that Ofcom would then have no basis upon which it could legitimately draw the conclusion that the Government would face over double the risk from ALF than from debt.

6.73 EE disagreed that licensees would be more likely to default on their ALF payments than on their debt payments. EE considered that spectrum is the single most important asset that enables it to generate revenue to meet its financial commitments. Also, EE noted that if the sunk investment costs makes it unlikely to default, it could trade the licence.

6.74 EE stated that it was not obvious that there was likely to be any material negative impact on the Government even if a licensee did default on its ALFs. EE noted that ALFs were highly secured against an asset and that that asset was non-depleting and re-sellable.

6.75 In response to the February 2015 consultation, Telefónica submitted a paper by NERA which argued that our approach to deriving a risk sharing adjustment lacks methodological foundations. It suggested that an option pricing framework could be used to estimate the discount rate and that, under some plausible scenarios, the risk premium for risk sharing is offset by other factors.

[269] EE response to the February 2015 consultation, p. 67.
[270] EE response to the February 2015 consultation, p. 69.

6.76 We understand NERA's argument to be as follows: in NERA's view, the MNOs' ability to hand back spectrum and the possibility for ALF to be revised up or down, which we noted in our consultation, are 'real option' characteristics. In particular, NERA said that "the event of the MNO renegotiating[271] the ALF in an adverse market environment is akin to the Government granting a put option to the MNO to hand back the licence"[272] and that widely established option pricing theory exists to price such options. NERA thought that our proposed risk-sharing formula failed to incorporate the specific payoff and valuation features associated with options.

6.77 Similarly, NERA argued that the Government's right to 'renegotiate' the ALF in favourable market conditions constituted a call option that has economic value (to the Government) and there should be a deduction from the discount rate to allow for this value. Crucially, NERA considered that the two effects offset each other to an extent and that the net value of the two options may even be positive to the Government (in a case where revenues and profits are expected to increase over time).

6.78 NERA provided an overview of the theory of option pricing and how it might apply in the context of ALF setting. In particular NERA used a three period stylised example to illustrate the value of the put option.

6.79 NERA noted that it had made a number of limiting assumptions in the stylised example, and considered that its approach was likely to overestimate the value of risk sharing for the following reasons:

a) Its approach assumed that the put option was valued "at the money", while we stated that we would apply a materiality threshold. NERA considered that this would reduce the value of any real put option valued "at the money".

b) Its approach assumed that the put option can be exercised from year 1 onwards. However, NERA thought that it was highly unlikely that the MNO would start 'renegotiations' in the first few years and that this, therefore, reduced further the option value.

c) Its approach did not value the existence of the option for Ofcom to increase ALFs in case spectrum increases in value in favourable market conditions. According to NERA, "the right of Ofcom to renegotiate the ALF payments is a "call option" and its value would need to be subtracted from any option value associated with the right of the MNO to renegotiate or revoke the licence in unfavourable market conditions ("put option")"[273]. NERA also said that "given the symmetry of potential renegotiations, the net value of the two options is likely to be close to zero and cannot justify a risk sharing premium as high as 1.1% as proposed by Ofcom"[274].

6.80 In response to our February 2015 consultation, EE, Telefónica and Vodafone stakeholders estimated the discount rate which they considered appropriate:

[271] NERA used the term 'renegotiate' to characterise an ALF review in the case, where the licensee is seeking a fee reduction because the market value of spectrum has fallen. We note that an ALF review is not a negotiation.
[272] NERA's paper submitted by Telefónica in response to our February 2015 consultation, p. 11.
[273] NERA's paper submitted by Telefónica in response to our February 2015 consultation, p. 27.
[274] NERA's paper submitted by Telefónica in response to our February 2015 consultation, p. 27.

a) Vodafone considered that there is a very strong case for the use of the cost of debt (0.9%) or as a maximum a lower level of risk sharing (for example 10%, rather than Ofcom's proposal of 25%, which would imply a discount rate of 1.0%.)

b) EE concluded that, taking into account the points it raised, the appropriate discount rate was in the range -0.7% to 0.4% and that a truly conservative approach would set the discount rate somewhat closer to -0.7%.

c) Telefónica (based on the paper it commissioned from NERA), concluded that, taking into account the points it raised, the appropriate discount rate was 0.9%.

Our analysis – why there is risk sharing

6.81 As set out in the discussion of the upper and lower polar cases above, we do not consider that our approach to fee reviews is at either of the hypothetical polar cases. As proposed in our previous consultations, our approach is to set the ALF as a fixed annual fee in real terms and it will remain at this level unless and until it is changed following a future ALF review. As a consequence, ALF will not vary each year with the revenues earned from the spectrum (or be linked to drivers of spectrum value in real terms in any other way).

6.82 As the upper polar case represents a situation in which the Government bears all of the systematic risk associated with changes in spectrum market value from year to year, it is not an appropriate representation of our approach to fee reviews.

6.83 On the other hand, we do not consider that the lower polar case is appropriate either. Our methodology for deriving the annual fee rates is to convert the lump-sum values (for 900 MHz and for 1800 MHz in Section 5) into their equivalent 20-year annuities. This is because the lump-sum values themselves are derived using information on the value of auctioned licences which have an initial period of 20 years during which ALF is not charged. However, this does not mean that ALF will necessarily be fixed for 20 years (or, indeed, that it will definitely be reviewed at 20 years).

6.84 We currently are not minded to review ALF within the next five years, and thereafter we would be likely to review ALF only if there were grounds to believe that a material misalignment had arisen between the level of these fees and the value of the spectrum, in keeping with our general policy on fee reviews. However, given the scope for spectrum value to change over time, we consider that it is reasonable to assume that these fee rates are likely to be reviewed at some stage during a 20-year period, although we cannot predict with any certainty at what point any such review (or reviews) might occur.

6.85 We do not agree with the suggestion that in future reviews we would be more likely to revise ALF upwards than downwards. It is reasonable to expect we would initiate a review where a material misalignment had arisen between the level of these fees and the value of the spectrum in either direction (i.e. the value of the spectrum had changed such that it was either materially above or materially below the level of ALF). We also note that there are external influences which could induce us to open a review. For example, there could be particular points at which evidence of changes in underlying market value becomes available.

6.86 In addition, although licensees are more likely to request a fee review in the first instance if they consider the ALF is too high, they also have the ability to hand the spectrum back (and doing so may not have the same negative implications for their other debt as 'normal' default on debt, as set out in paragraphs 6.89 - 6.91 below).

We note that the risk of hand back of the licence is in addition to default on the ALF (which is akin to the risk of default on corporate debt). Therefore, our lower polar case (the cost of debt) includes the risk premium for default on ALF and the additional risk of hand back (derived from changes in the market value of spectrum) is relevant to our assessment of risk sharing. The upper polar case includes the equity type risk of the value of spectrum and therefore, the risk sharing also incorporates some of this equity type risk (including the possibility of hand back) arising from the possibility of review.

6.87 Hand back would be most likely to occur when the licensee is unable to trade the spectrum rights under the licence with the current level of ALF liabilities, i.e. the ALF is higher than the value of the licence to the marginal excluded user. The potential for the licensee to hand back the licence could provide a 'hard stop' on the licensee's exposure to the risk of ALF not being changed in the face of large falls in market value (in that the licensees can always decide to hand spectrum back and so are not dependent on our discretion as to whether or not to open a review of ALF in these circumstances). While the importance of spectrum to the MNOs' business would probably make this a 'last resort', it remains an option open to them were they to consider that the value of the spectrum was materially lower than the cost involved in continuing to use it. EE noted that because the licensees had sunk investment their private values of the spectrum were likely to be greater than the market value. EE considered that, in light of this, the market value of the ALF would have to fall greatly before they would consider handing back the spectrum. We agree that the gap between private value and market value affects the point at which the 'hard stop' would come into effect. However, if a fall in market value were sufficiently material this would still be a relevant consideration.

6.88 As to EE's point that the Government is likely to achieve a high degree of recoupment in the case of default, we have considered this in relation to the 'security' of ALF payments compared to other forms of debt in Annex 10 paragraph A10.28 *et seq*.

6.89 Turning to EE's view that we mischaracterised debt, we consider that this arises from an overly narrow reading of our arguments. For example, in the August 2014 consultation, we noted that the ability to hand back spectrum provides the option of 'defaulting' on this debt with limited effect on the rest of a licensee's financial operations. This is in contrast to most debt, where default can have significant negative implications (e.g. cross default clauses).

6.90 Failing to repay a debt can have significant repercussions for a firm beyond the contractual provisions for such an eventuality set out in relation to that debt. The effect on the market's perception of the firm's creditworthiness and financial security, and the knock-on effect this can have on its ability to raise new financing, are significant implications from failing to meet a debt obligation. These are less likely to arise from a firm handing back a spectrum licence. Cross-default clauses are therefore only one example of the way in which default on debt can have negative consequences for a firm. EE's argument was that "a significant proportion of corporate debt instruments do not contain this clause, and this is only one characteristic which affects yields on bonds, [and so] Ofcom simply cannot justify any

discount rate in excess of the cost of debt on this basis".[275] However, this does not address the wider point.

6.91 Having considered the arguments raised by EE, our view remains that ALF has certain features which make it more risky (from the Government's point of view as 'lender') than 'normal' secured debt.

6.92 For these reasons, we agree with BT that it is not appropriate to assume that the Government bears zero risk and the licensees all of the risk. We therefore conclude that we should exercise our regulatory judgement about the extent of risk sharing to be reflected in the discount rate.

Our analysis – the degree of risk sharing

6.93 As set out in paragraphs 6.81 – 6.92, we consider that neither polar position (WACC or cost of debt) would be correct. However, the judgement on an appropriate balance to strike between these polar cases is influenced by the way the review regime operates.

6.94 Accordingly, as set out in our February 2015 consultation, we undertook an exercise to explore the nature of risk sharing (i.e. exposure to changes in the market value of spectrum over time). We do not consider that the points raised in responses present reasons for us to change our view. We therefore summarise our analysis (as in the February 2015 consultation) before addressing the points raised in responses.

6.95 A future review is likely to be conducted only if there is evidence that a material misalignment between ALF and the market value of spectrum has developed. However, in our view, it is reasonable to assume that these fee rates are likely to be reviewed at some stage during a 20-year period, although we cannot predict with any certainty at what point any such review (or reviews) might occur (see paragraph 8.56). We do not think it sensible to try to assign specific probabilities to when a review (or reviews) might take place. Accordingly, we cannot calculate the exact degree of risk sharing associated with the potential for review. However, we can gain insights into this question by considering the potential scale of risk transfer under various circumstances.

6.96 A highly stylised and simplified scenario would be one where there was a single review around halfway through the period, i.e. after around ten years, at which point the ALF would be reset on the basis of the information available at that time. The simple calculation of risk transfer under this scenario is set out in Annex 10, paragraph A10.63. Under this assumption, the Government would bear slightly more than 40% of the risk in the stylised example. This represents a significant proportion of the risk which would, correspondingly, imply a discount rate significantly above the cost of debt. We consider this scenario provides a relevant insight that there could be a significant transfer of risk (noting that the stylised scenario needs to be interpreted carefully taking into account its limitations). The potential quantum of the effect reinforces our view that it is not appropriate to ignore risk sharing in estimating an appropriate discount rate.

6.97 However, as noted above, this calculation is on the basis of a stylised scenario and in practice the position is likely to be much more complicated than this. Some of the

[275] EE's response to the August 2014 consultation, p.47.

differences between the simplifying assumptions in our stylised scenario described above and the approach to reviews in practice would imply the Government takes on a greater share of risk. However, other differences would imply the Government's share of risk is reduced relative to the stylised scenario. We consider alternative scenarios further in Annex 10, paragraph A10.71.

6.98 Although it is possible to create many scenarios of how the review regime might operate, these are essentially hypothetical since there is no certainty as to whether and when any reviews will be undertaken. This means that there is no clear way of quantifying the effect of the possibility of review taking place on the Government's share of risk and the consequent effect on an appropriate discount rate. Therefore, while we consider that the illustrative examples discussed in Annex 10 provide a point of reference which could suggest that the Government may bear a significant share of the risk, the assessment of the share of risk that should be incorporated in the discount rate is inevitably a matter of judgement rather than of fact.

6.99 However, we consider that one key difference between the stylised scenario considered above and the position in practice is that a review of ALF would not be undertaken at a fixed point in time. Neither would a review necessarily be undertaken as soon as there appeared to be some difference between the ALF and the true value. While a review could be undertaken where there was evidence of material misalignment between ALF and market value, there would be no requirement for reviews to be undertaken automatically.

6.100 The consequence of this is that any review would be subject to a "threshold for review" effect, in that there would need to be evidence of a material misalignment between underlying market value and ALF before a review was instigated. While it is not possible to be definitive about the scale of this effect given the nature of the review regime, it is clear that it reduces the extent of risk transfer relative to the stylised scenario (i.e. single review at a fixed point in time) set out above. This would suggest that taking a figure for risk transfer of less than 40% (in the case of a review about half-way through the 20-year period) could be reasonable for a single review.

6.101 Taking a higher level view is also helpful in our analysis here. We know that the level of risk borne by Government is between the two extremes of 0% and 100%, but will not be at either of these extremes. The nature of the review regime means there is likely to be some variance in underlying market value which does not trigger a review, which suggests the top end of this range is less likely. Since we are taking a conservative approach in interpreting the evidence, we consider it appropriate to discount the entire top half of the range and only consider a share of risk for the Government from the bottom half of the range between 0% and 100%. We have not identified clear reasons to prefer any particular figure within this narrower range of 0% to 50%, given the complexity and uncertainty relevant to the analysis. Choosing the mid-point of a range reflects the equal probability of the value being above and below that mid-point. The mid-point within this narrower range is 25%.

6.102 Taking our illustrative example to be informative as a starting point, the above considerations suggest an adjustment somewhat lower than 40% may be justified, as a conservative interpretation of the evidence. Incorporation of the effect of the threshold for review in the illustrative example, not taking account of the potential for there to be more than a single review, and a high level sense check lead us to the view that a risk sharing adjustment of 25% would be a sensible and conservative reflection of the risk that the Government is likely to bear. Accordingly, we apply a 25% risk sharing adjustment in estimating an appropriate discount rate as set out in paragraphs 6.118 – 6.120.

Our analysis of stakeholder comments

6.103 Turning to the points raised in responses we note that Oxera (on behalf of Vodafone) agreed that our framework was reasonable, although it disagreed with the judgement that we reached.

6.104 Vodafone considered there was circularity in the relationship between the discount rate and the likelihood of review. In its view the higher the discount rate, the higher the ALF, and the higher the probability of review (because the ALF is higher than market value) which in turn implies a higher discount rate. However, there is no circularity in our analysis, because our judgement on the implications of future review of ALF (as explained above) is not dependent on any specific discount rate. In addition, Vodafone's circularity argument implies that in future an event would lead us to realise that our risk sharing assumption was 'wrong' and that we would reset the ALF once we realised this. We consider that our choice of the degree of risk sharing (i.e. 25%) is appropriately conservative and we have no reason at the time of setting the discount rate to believe that any review would be more likely to adjust the rate down then it would be to adjust the rate up.

6.105 EE considered that a review was a mere theoretical possibility. Our view on whether and how often fees will reviewed in the next 20 years is a matter of judgement. We cannot be sure that a review will take place: but a review is more than just a theoretical possibility. Given this, we believe that for the purpose of our illustrative example, it is not unreasonable to assume one review at 10 years.

6.106 Vodafone stated that current spectrum fees had not changed in the last 20 years. In this respect, we note that significant fee increases were introduced in 1999, 2000 and 2001, when the ALF rates reached their current level. These rates (along with AIP for other bands) were considered for review in 2004/5. We took a policy decision in February 2005 to maintain the fees payable for the ALF bands for a period of three years.[276,277] One reason why Ofcom decided not to review 900 MHz and 1800 MHz AIP in 2005 was because of the prospect of significant changes to these licences in the next few years, for example the prospect of liberalisation for 3G. In the event, the process of liberalisation was dependent on changes in EU legislation and was slower than had been expected, so that in January 2009 this issue was subsumed into the Government's proposed 'Wireless Radio Spectrum Modernisation Programme' which

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[276] See Ofcom document entitled 'Spectrum Pricing. A consultation on proposals for setting wireless telegraphy act licence fees' of 29 September 2004, which is available here: http://stakeholders.ofcom.org.uk/binaries/consultations/spec_pricing/summary/spec_pricing.pdf In paragraph 4.2.9 of that consultation document we said that "Ofcom proposes to maintain the current fees for 2G spectrum for a period of three years, and to revisit the situation in 2007/08, by when a number of key uncertainties should have been resolved." A key issue in this context was the prospect of liberalising the 2G spectrum for 3G use (possibly in conjunction with some 2G spectrum release and re-award). The first mobile liberalisation consultation document (Application of spectrum liberalisation and trading to the mobile sector Including implementation of the Radio Spectrum Committee Decision on 900 MHz and 1800MHz Consultation, 20 September 2007) included AIP revision as part of the option specification). http://stakeholders.ofcom.org.uk/binaries/consultations/liberalisation/summary/liberalisation.pdf.

[277] See paragraph 3.22 of Ofcom's 'Spectrum Pricing' statement of 23 February 2005 which mentioned the possibility of an earlier review "in connection with long term decisions on the long term future of the 2G spectrum.": http://stakeholders.ofcom.org.uk/binaries/consultations/spec_pricing/statement/statement.pdf

included an initial proposal to make the licences for 900 MHz and 1800 MHz subject to a spectrum fee reflecting the 'spectrum's full economic value'[278]. This initial proposal was given effect in December 2010, when the Government directed Ofcom to revise the level of ALFs for the 900 MHz and 1800 MHz licences so that they reflect 'full market value'.

6.107 Oxera questioned whether there has ever been an event in the mobile industry which would have resulted in a review. In our view, taking into account the discussion in the previous paragraph, there have been events within the last 20 years to justify a review and changes to fees. Similarly, we do not consider it unreasonable to take into account the potential for a future review of ALF.

6.108 EE argued that, by suggesting that future reviews of 700 MHz and 2.1 GHz could provide evidence of material misalignment, we revealed a failure to take account of future spectrum releases. However, our comments about the possible timing of a review related to the new evidence that would become available in the future at the time of an award of the 700 MHz band or review of fees for 2.1 GHz licences – for example, the auction bids and prices for 700 MHz. That new evidence could provide grounds for a review, although we also noted that this would still depend on there being evidence of a material misalignment between ALF and market value around these times. We have taken account of the impact on ALF of future spectrum releases, as set out in Annex 9.

6.109 As noted above, NERA (on behalf of Telefónica) argued that an option pricing approach could be used for assessing the implications of possible reviews of ALF in future. We have therefore considered whether this approach can add insight into the nature of risk sharing and whether it could be practical to apply when estimating an appropriate discount rate for the purposes of ALF.

6.110 An option pricing approach would characterise the potential for ALF reviews in terms of a series of call and put options as NERA set out. A key point to make is that the effect of ALF reviews is to alter the way in which the exposure to the effects of changes in spectrum market value over time is shared between licensee and Government. However, we note that:

a) There is an unavoidable uncertainty about future spectrum market value: the exposure to the effects of this uncertainty ("risk") has to be allocated between the two parties (Government and licensee); and

b) The way in which this exposure is allocated is determined by the nature of the ALF review regime.

6.111 NERA claimed that the difficulty in accurately estimating the value of the call option and the put option may not be an issue because, according to NERA's paper, the value of the two options should be the same and therefore they should offset each other to an extent. We disagree with this argument. Representing the ALF review regime in terms of a series of call and put options characterises the allocation of risk but it cannot make this underlying risk "go away" (i.e. it does not change the existence of uncertainty about future spectrum market value). The option pricing approach simply represents risk sharing in a different way. In our framework, which

[278] See Action 6(c) of the Interim Digital Britain report: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/238653/7548.pdf

reflects the approach usually taken in calculating discount rates, investors are risk averse and there is a price for bearing risk. Options are a means of transferring particular types of risk from one party to another but they do not create a costless opportunity to transfer risk onto other parties.

6.112 In this context, the creation of the combined options (to represent the effect of ALF reviews) moves the effects of a change in the market value of spectrum from the MNO to the Government. The combined options are likely to reduce the expected volatility of the MNOs profits. The value of the spectrum is derived from its use. If the spectrum generates more income than expected (and therefore MNO's profits increase) then some of this benefit would be hypothetically passed on in higher ALFs through the 'call option'. Similarly, if the spectrum generates less income and profits than expected, the MNO would hypothetically benefit from reduced ALFs (through the 'put option').

6.113 Option pricing is therefore not dissimilar to how we set up the issue: how we best estimate the discount rate commensurate with the risk sharing conferred by the possibility of future review. We consider that option theory is consistent with our conceptual approach.

6.114 The issue, therefore, is whether the option pricing approach is a better way of guiding us in exercising our regulatory judgement on an appropriate degree of risk sharing (and ultimately an appropriate risk sharing percentage) than the approach that we set out in the February 2015 consultation (and repeated above).

6.115 NERA adopted a number of simplifications: a) it used a stylised example rather than an actual estimate of the option values, b) it used a 3-period model rather than a 20-year model[279] and c) on this basis, NERA calculated only the put option value and not the call option value. However, if we were to use option pricing, we would need to calculate the value of both the put option and the call option for a 20-year period. This would require us to adopt a complex model and the results would be dependent on and sensitive to several key assumptions, such as the volatility of the value of the underlying asset (i.e. spectrum) and defining the values of spectrum which would trigger a review. An option pricing approach may also obscure the critical assumptions on which the discount rate is dependent.

6.116 Based on the evidence presented to us and our analysis, while option theory might be an alternative framework to consider the risk sharing issue, calculating the option prices is complex and is sensitive to the underlying assumptions. Therefore, we conclude that, in practice, option pricing does not provide a better way of guiding us in estimating an appropriate risk sharing adjustment.

Our conclusions on the adjustment for risk sharing

6.117 For the reasons set out above, we conclude that is appropriate to take into account a degree of risk sharing, and that an appropriate estimate of that risk sharing is **25%**. We use this risk sharing percentage to uplift the lower polar case as explained below.

[279] We are using the discount rate to annualise the lump-sum values over 20 years, and would need to understand how NERA's model could be applied to this time period.

Derivation of discount rate

6.118 In line with our analysis above and in Annex 10, we consider that an appropriate starting point for the discount rate is the cost of debt based on observed YTM data on comparator bonds, which gives a rate of 0.6% (real, post-tax) based on market data up to 27 August 2015.[280]

6.119 As set out in paragraphs 6.117 and Annex 10, paragraph A10.81, we uplift this by 25% of the difference between the lower polar case (the cost of debt) and the upper polar case (the WACC) to reflect the additional risk the Government bears over and above that of a 'normal' creditor. This gives an uplift of 25 %*(5.2%-0.6%) or 1.2%.

6.120 For the purposes of annualising the lump-sum value, we therefore consider we should apply a discount rate of 1.8%.[281]

Tax adjustment

Our position in the August 2014 consultation

6.121 In the August 2014 consultation, we proposed to make a tax adjustment to ensure we levy an appropriate pre-tax ALF, taking into account any difference in the tax treatment of a lump-sum payment and an ALF payment. We noted that the tax treatment of annual fees would be more favourable than that of a lump-sum payment due to the ALF incorporating an allowance for the time value of money and adjusting for inflation. We said that as the ALF is close to being a form of debt instrument (although it may not exactly reflect the same risk as debt, as discussed above), this implies that the ALF payments displace 100% debt capacity. We noted that the tax deduction on interest payments for an equivalent lump-sum payment would therefore also assume that the lump-sum payment displaced 100% debt capacity. However, we considered that the tax deduction for interest payments is reflected in the after-tax debt rate, so it is not necessary to make an additional adjustment to the tax adjustment factor (TAF) to allow for this as stakeholders had suggested.

Stakeholders' responses

6.122 Telefónica suggested that "the conceptually correct approach" is to take into account interest deductibility of debt financing of the lump sum, and to use a pre-tax cost of debt to calculate the annuity. The riskiness of the ALF cash-flows is akin to debt and therefore the tax benefit of the ALF and lump sum are identical (as debt financing costs are fully tax deductible). Consequently, there is no need for a TAF adjustment term when the correct discount rate (i.e. pre-tax cost of debt) is used".[282]

6.123 Similarly, H3G[283] argued that interest payments on debt are normally tax deductible (unlike profits to equity holders), in which case the "pre-tax" and "post-tax" cost of debt should be identical. Accordingly, it argued that the relevant discount rate should simply be the "pre-tax" cost of debt and no further tax adjustment should be

[280] In our February 2015 consultation we estimated the rate was 0.9% based on market data up to 14 January 2015.
[281] In our February 2015 consultation the discount rate was 2.0%.
[282] Telefónica response to the August 2014 consultation, Annex II, p.20.
[283] H3G's response to the August 2014 consultation, p.42.

necessary. It suggested this would be a much simpler and more transparent approach than Ofcom's current method.

6.124 H3G[284] further suggested that a tax adjustment approach is based on an erroneous assumption that licensees would not revalue their licences to reflect market value, even on a periodic basis. It claimed financial reporting rules nevertheless require companies to conduct revaluation reviews of all assets on a periodic basis and to restate them accordingly.

6.125 No further comments were received in response to our February 2015 consultation.

Our analysis

6.126 We set out in the October 2013 consultation that the implications for the level of ALF are broadly similar whether using a post-tax approach (with its adjustment for the differential tax treatment) or using a real pre-tax approach. We set out that, as using a pre-tax calculation ultimately depended on a calculation using the real post-tax rate, we considered that it would be more transparent to do the calculation on a post-tax basis, and to make explicit our assumptions on the more favourable tax treatment of annual licence fees compared to a lump-sum payment. This is why we continue to adopt a post-tax approach with an explicit adjustment for tax effects.

6.127 In response to our August 2014 consultation, H3G suggested we are using a "non-standard concept of an 'after-tax' debt rate",[285] and by implication a non-standard approach to such calculations. However, this is not the case. A standard textbook on corporate finance sets out "…two ways to value a lease: … 2. Easy way: Discount the lease cash flows at the after-tax interest rate…" (original emphasis).[286] The lease cash flows being described in this quotation are after-tax flows that include the effects of capital allowances. We therefore consider, in contrast to H3G and Telefónica, that our approach is conceptually reasonable.

6.128 With regard to H3G's suggestion that that all assets will be marked to market, it is not clear to us that this would affect the tax benefit gained from that asset. First, while a revaluation may occur in future, the expected value of that revaluation (assuming the current value is the best unbiased estimate of the asset's true value) would be zero i.e. it could go up or down with equal probability. Second, even if an asset were revalued upwards for accounting purposes, this would not feed through into the tax deduction achievable, as the total tax benefit a company can achieve on an asset cannot exceed the amount it paid for it. Any such revaluation would therefore not affect the amortisation tax benefit on the spectrum asset purchased via a lump-sum payment as H3G seeks to suggest.

6.129 We therefore continue to apply a tax adjustment factor in our derivation of ALF. In the August 2014 and February 2015 consultations, we used a flat 20% corporate tax rate. In the Government's 2015 Summer Budget, it announced that the corporate tax rate would be reduced to 19% from April 2017 and 18% from April 2020. We calculated the tax adjustment of 1.064 (compared to 1.074 in the February 2015 consultation) based on the time varying corporate tax rates as set out in the 2015

[284] H3G's response to the August 2014 consultation, p.43.
[285] H3G's response to the August 2014 consultation, p.42.
[286] Brealey, Myers and Allen (2014), *Principles of Corporate Finance*, p.650.

Summer Budget, taking into account the time value of money.[287] This TAF equates to an average tax rate of 18.3% over the 20 year period.

6.130 We assume a CPI inflation rate of 2% (as discussed above) and (as before) amortise the lump-sum payment over 20 years. The tax adjustment is calculated from the difference in tax benefits from ALF payments compared to the amortisation tax deductions available through a lump-sum payment, converted to present values using the after-tax discount rate of 1.8% (as discussed above). The TAF is thus calculated as:

$$TAF = 1 + \left[\frac{(PV\ of\ tax\ benefits\ of\ ALF - PV\ of\ tax\ benefits\ of\ the\ amortisation\ of\ LSV)}{LSV}\right]$$

6.131 This latter version is computationally simpler (in that it is no longer necessary to derive the tax benefit of ALF through iteration), but produces the same result. The implication of increasing the discount rate above the debt rate is that we consider that ALF displaces less than 100% of debt. The equivalent lump sum would therefore also displace less than 100% of debt. We calculate that the impact of the tax adjustment is equivalent to an increase of 6.4% in the lump-sum value (slightly lower than 7.4% used in the February 2015 consultation). The full derivation of our ALF figures incorporates a TAF of this amount.

Summary of decision on deriving annual licence fees from lump-sum values

6.132 In summary, in deriving an annual fee from the lump-sum value we have decided to:

a) spread the lump-sum value of spectrum over 20 years, using an ALF profile that is flat in real terms, that is a 20-year annuity;

b) apply a post-tax discount rate of 1.8%;

c) take into account the differential tax benefits of the lump-sum value and the ALF; and

d) use the CPI index to adjust base year ALF level each year when the licence fee comes due for payment.

6.133 We use the following formula for calculating the base level of ALF from the lump-sum value of spectrum and updating it for inflation. This formula assumes an annuity payment with the payments made at the beginning of the year (as in our previous consultations).

[287] We used the same calculation method as we did in the October 2013 consultation, with the tax rates announced in the 2015 Summer Budget. http://stakeholders.ofcom.org.uk/consultations/annual-licence-fees-further-consultation/statement/

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

6.134 Where:

- ALF_t is the value of ALF in year t;
- LSV is the lump-sum value of spectrum;
- TAF is an adjustment factor that reflects the tax advantages of ALF over lump-sum payments (equal to 1.064 in this case);
- r is the real post-tax discount rate, i.e. 1.8%;
- t* is the length of period over which we spread the LSV for the purposes of calculating ALF, which is equal to the initial term of the licences obtained in the 4G auction, i.e. 20 years;
- CPI_{t0} is the level of the CPI (all items) index in March 2013 (125.6) 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”, which is 6.27%.

Section 7

Our decision on the base level of ALFs

7.1 The previous sections set out our assessment on each of the first three steps of our analytical approach. In this section we explain step 4, setting out our decision on the base levels of ALF (i.e. levels of ALF in March 2013 prices). We discuss in Section 8 how the ALFs will be implemented (including indexation for inflation since March 2013).

Base level of ALFs

7.2 Section 5 explains that our decision on the lump-sum values for 900 MHz and 1800 MHz is £18m per MHz and £13m per MHz respectively. Section 6 explains that our decision on the appropriate discount rate and tax adjustment factor (TAF) for converting these lump-sum values into an annual equivalent fee is 1.8% and 1.064 respectively. Using these values in the formula set out in paragraph 6.132 yields the annualisation rate of 6.27% which we apply to the lump-sum values to derive the base level of ALF. This means that our decision is that the base levels of ALF (expressed in March 2013 prices) are as follows:

a) 900 MHz: **£1.128m** per MHz; and

b) 1800 MHz: **£0.815m** per MHz.

7.3 As shown above, we derive the base levels of ALF rounded to three decimal places in £m per MHz. In previous consultations we derived these figures rounded to two decimal places, but we consider that, given the nature of the annualisation calculation, rounding to three decimal places is a reasonable approach without introducing an undue risk of spurious precision. For example, we note that a base level of ALF accurate to three decimal places (in £m per MHz per annum) would be derived from a lump-sum value accurate to zero decimal places (in £m per MHz) and an annualisation rate accurate to three decimal places (which corresponds to one decimal place, when expressed as a percentage).

Comparison to proposals in the February 2015 consultation

7.4 Table 7.1 provides a comparison of this decision with the position set out in the February 2015 consultation for each of steps 1-4. The percentage change in the ALFs at step 4 reflects the combined effect of changes at step 2 and step 3:

a) For 900 MHz, the reduction in ALF of -24% reflects the impact of the reduction in lump-sum value for 900 MHz at step 2 (see paragraph 5.47) together with the small change in annualisation rate at step 3 on account of the change in both the discount rate and the TAF.

b) For 1800 MHz, the change of -3% reflects the change in annualisation rate at step 3.

7.5 The derivation of lump-sum values for 900 MHz and 1800 MHz at step 2 uses the UK market values for 800 MHz and 2.6 GHz derived at step 1 as an input. Our position on UK market values remains the same as set out in the February 2015 consultation. We have also decided, having considered the responses to the February 2015

consultation and reviewed our analysis, that the geographic coverage obligation is unlikely to affect the market value of the 900 MHz band or the 1800 MHz band, and that it would not be appropriate for us to reduce the level of ALFs at step 2b in light of it. The reduction in base level ALF for 900 MHz therefore reflects (only) the change in our view of lump-sum value of 900 MHz in light of our updated analysis of the international benchmark evidence and the annualisation rate.

Table 7.1: Comparison between February 2015 consultation and our decision

	Step 1 (£m per MHz)		Step 2 (£m per MHz)		Step 3 (%)	Step 4 (£m per MHz pa)	
	800 MHz[288]	2.6 GHz	900 MHz	1800 MHz		900 MHz	1800 MHz
February 2015 consultation	**£33.0m**	**£5.5m**	**£23m**	**£13m**	**6.4%**[289]	**£1.48m**	**£0.84m**
Decision	**£33.0m**	**£5.5m**	**£18m**	**£13m**	**6.3%**	**£1.128m**	**£0.815m**
Effect on ALFs compared to February 2015 consultation	*input to step 2*		-22%	0%	-3%	-24%	-3%

Source: Ofcom

7.6 In Table 7.2 we show the effects of our decision on the level of payments by licensee.[290] We also include, for comparison, the current level of payments and the level of payments implied in the February 2015 consultation.

Table 7.2: Base level of ALF payments for 900 MHz and 1800 MHz by licensee (in £m per annum, March 2013 prices)

	Vodafone	Telefónica	EE	H3G	Total
Current fee levels	£15.6m	£15.6m	£24.9m	£8.3m	£64.4m
Based on proposals in February 2015 consultation	£61.2m	£61.2m	£75.6m	£25.2m	£223.3m
Based on our decision	**£48.7m**	**£48.7m**	**£73.4m**	**£24.5m**	**£195.2m**
Ratio to Current	3.1	3.1	2.9	2.9	3.0
% change vs February 2015 consultation	-20%	-20%	-3%	-3%	-13%

Source: Ofcom

[288] The value in this table for 800 MHz is expressed gross of expected DTT co-existence costs (of £3m per MHz). The corresponding value of 800 MHz net of the expected costs of DTT co-existence (i.e. as reflected in the observed bids for 800 MHz lots in the auction) is £30m per MHz.
[289] Table 5.1 in the February 2015 consultation showed the discount rate of 2.0%. In Table 7.1 we show the annualisation rate corresponding to this discount rate (given the TAF of 1.074 in the February 2015 consultation).
[290] The numbers in this table are based on H3G paying ALF for 2x15 MHz of 1800 MHz spectrum and EE paying ALF for 2x45 MHz, corresponding to the position after the transfer of 2x5 MHz from EE to H3G on 1 October 2015.

Section 8

Implementation

Introduction

8.1 This section sets out how we have decided to implement the revised fees, including:

a) having a common date for introduction of revised ALF;

b) the choice of common effective date and phasing-in of revised ALF;

c) calculating the first year's payment of revised ALF following the common effective date; and

d) implementation of inflation indexation.

8.2 We also set out our current position on future reviews of the level of ALF.

8.3 In setting out our decisions, and the reasons for them, we have followed the structure of our February 2015 consultation, which included addressing stakeholders' comments to our August 2014 consultation (and also to our October 2013 consultation, where relevant). In our February 2015 consultation we said that, if parties wished to provide further evidence on the length of the phase-in period we would consider it carefully. All the current licensees provided further comments on phase-in and we consider these in the relevant sub-section below.

Having a common date for introduction of revised ALF

Ofcom's proposed approach in consultations

8.4 The licences currently have different fee payment dates, reflecting the difference in the dates on which the licences were initially granted (28 February for EE, 31 July for Vodafone and Telefónica and 31 October for H3G).

8.5 In the October 2013, August 2014 and February 2015 consultations, we proposed for reasons of fairness as between the licensees that the revised ALF should be introduced on a date that was common to all of the licensees, rather than an introduction that produced a 'staggered' effect because of the different fee payment dates.

8.6 As to the way to achieve a common implementation across the licensees, in the August 2014 consultation we considered that it would be better to move licensees to a **common actual payment date**. We noted that a common actual payment date would simplify the regulations and their implementation by comparison with the alternative of having to specify and implement different inflation adjustments across the year (to reflect different licensee payment dates). However, recognising that changing the fee payment date may cause some disruption to licensees, we proposed to do this after the first payment of the revised ALF.

8.7 For the first payment of the revised ALF, we proposed to achieve a common implementation across the licensees by using a **common effective date** and by

adjusting the payment in the first year following the common effective date so that each licensee's first payment following such date would be made up of two sums:

a) the revised ALF applied to the licensee's spectrum holdings; plus

b) a sum equal to the difference between the revised ALF and current ALF, pro-rated in relation to the number of months between the common effective date for the introduction of the revised ALF and the licensee's next payment date.

8.8 Overall, we therefore proposed to achieve a common implementation across the licensees by:

a) for the first year of implementation – setting a common effective date for the introduction of revised ALF with each licensee's payment date remaining as it currently stands for payment of the first ALF following this common effective date; and

b) from the second year onwards – setting a common actual payment date for any subsequent ALF payment after the first one (i.e. by changing each licensee's payment date so that they are all on the same date). We proposed that the common actual payment date would be the first anniversary of the common effective date.

Stakeholder responses

8.9 In response to our August 2014 consultation, H3G said that it agreed with setting the same common effective date for all licensees and Vodafone said that it agreed with adopting a common actual payment date. EE and Telefónica did not comment specifically on these issues.

8.10 Stakeholders did not comment on this specific point in response to the February 2015 consultation.

Ofcom's decision

8.11 In light of stakeholders' responses, we conclude that it is fair to introduce the revised ALF so that all the licensees will pay a rate that reflects the market value of the corresponding spectrum from the same point in time. In line with our revised proposals as set out in the August 2014 and February 2015 consultations, we consider that a simple and pragmatic approach to achieve fairness through a common implementation across the licensees is by:

a) setting a common effective date that we use to determine the fees payable by each individual licensee on its first payment date following the common effective date (as if each licensee had to start paying the relevant fees at the revised rate from the common effective date);

b) adjusting the first payment of revised ALF which will be due on each licensee's respective current payment date, as explained in paragraph 8.7 above; and

c) setting a common actual payment date falling on the anniversary of the common effective date, so that from this point onwards the licensees will have the same payment date.

The choice of Common Effective Date ("CED") and phasing-in the revised ALF

Ofcom's proposed approach in consultations

8.12 We said in the October 2013 consultation that we proposed to set the common effective date to be the first day of the month following the new fees regulations coming into force, and that we did not propose to phase-in the revised ALFs. A number of respondents (including the MNOs and Prospect) argued in their responses to that consultation that there was a case to phase in the new fee rates over time and that we should consider the impact of different lengths of phase-in on investment, notably on the deployment of 4G networks. Some of the responses drew attention to other cases where increased fees have been phased in over time.

8.13 We considered these arguments carefully, and in the August 2014 consultation we set out revised proposals, including a proposal for phasing-in the revised ALFs. We proposed to set a common effective date as soon as practicable after the new fees regulations come into force, with a two-stage phase-in of revised ALF consisting of the following[291]:

a) one half of the increase (from the current ALF rate to the proposed new ALF rate) coming into effect on the CED; and

b) the second half of the increase becoming effective one year later (which, as set out above, would be the common actual payment date). We specified that from this date ALF rates would be at the proposed revised level.

8.14 In our February 2015 consultation, we proposed the same approach to phase-in as in our August 2014 consultation.

Stakeholder responses

Responses to the August 2014 consultation

8.15 In response to the August 2014 consultation, BT and three of the current licensees (Vodafone, EE and H3G) provided comments on our proposal to adopt a two-stage phase-in.

8.16 BT argued that we should introduce revised ALF in full, without phasing it in. BT contended that phasing-in the revised fees was not compatible with the Government Direction because the Government Direction requires the 900/1800 MHz spectrum to be charged at full market value and "not at some fraction of full market value". BT also said that the delay in charging for the 900/1800 MHz spectrum at full market value puts BT at an unfair disadvantage to its mobile competitors (because BT paid full market value for its spectrum at the time of the 4G auction), potentially distorting competition. BT also argued that under the Government Direction we should seek to "recoup" some of the "missed charges" in future payments[292].

[291] For simplicity, we have set out separately how we will take account of inflation (see paragraphs 8.46-8.54).
[292] BT's response to the August 2014 consultation, p. 5.

8.17 On the other hand, EE, H3G and Vodafone agreed that the revised ALFs should be phased-in. H3G did not comment specifically on the length of the phasing-in period. EE and Vodafone argued for a longer phase-in period (EE suggested three or more years, and Vodafone suggested five years). They argued that we had not properly considered the impact of the increase in fees on operators, in particular the effect on operators' investment plans, operating costs and consumer prices, and that we should carry out a cost benefit analysis of different options for phasing-in.

8.18 Both EE and Vodafone said that our proposals in the August 2014 consultation for a phasing-in period were not conservative and were not consistent with the approach we had previously taken in other sectors. In particular, they both pointed to the 5-year phasing-in proposed for consultation in the context of the broadcasting sector. In addition, EE referred to the 3-year phasing-in we applied to the introduction of revised licence fees for the maritime sector and Vodafone referred to our adoption of "glidepaths" when imposing wholesale charge controls following our analysis of specific markets for communications services. We understand Vodafone's argument to be that instances where, it said, we have adopted glidepaths for introducing price changes within the context of market reviews are analogous to the current decision on whether to phase-in ALFs. We note that the arguments put forward by the MNOs who responded on this point were broadly the same arguments made in response to the October 2013 consultation[293].

Responses to the February 2015 consultation

8.19 All the current licensees provided comments in relation to phase-in in response to our February 2015 consultation. Specifically, they argued for a longer phase-in period due to the impact of the geographic coverage obligation (which they had agreed since the time of the August 2014 consultation):

a) EE argued that both EE and H3G should be allowed a longer phase-in period to avoid a 'significant and discriminatory' financial impact on EE and H3G because they have to bear higher costs than the 900MHz operators in order to meet the geographic coverage obligation. In particular, EE proposed that, in relation to the 1800 MHz band only, we should introduce [✂] of the increase in the first year, [✂] in the second year, [✂] in the third year and the full increase from the fourth year[294];

b) H3G also claimed that we should treat it differently from the other licensees, by phasing-in its fees over a period "longer than 1 year", because the geographic coverage obligation results in a greater financial burden on H3G than the other licensees[295];

[293] EE's comments on phasing-in are set out in EE's response to the August 2014 consultation, p. 67-74 (section 7). EE made similar comments on phasing-in in its response to the October 2013 consultation, p. 37-40 (section 7.2). Vodafone's comments on phasing-in are set out in Vodafone's response to the August 2014 consultation, p. 36-38 (section 3.6) and Annex 3.1, p. 34-39 (section 6). Vodafone made similar comments in response to the October 2013 consultation. See, in particular, p. 50 (section 6.3.1) of that response and Annex 1, p. 54-59.

[294] EE's response to the February 2015 consultation, p. 84-87.

[295] H3G's response to the February 2015 consultation, p. 18-20. This is H3G's phrase; we referred to our proposals as a "two step" or "two stage" phase in (paragraph 6.14 of our August 2014 consultation).

c) Telefónica proposed that we delay the introduction of the second half of the increase until the end of 2017, arguing that this would coincide with the additional financial burden that the licensees face in meeting the new geographic coverage obligation[296].

8.20 Vodafone repeated its view that we should allow for a longer phase-in period, pointing again to the 4-5 year glidepath proposed for consultation in the context of the broadcasting sector (DTT) and the glidepaths in fixed telecoms regulation[297]. In particular, Vodafone disagreed with our comment in paragraph 7.20 of the February 2015 consultation and said that a glide path creates a cost-reduction incentive only in the case of charge controls that involve an extensive fixed and common cost recovery if it can be assumed that the starting point of any charge control is, in terms of the total sums recovered, the one Ofcom intended[298].

8.21 Vodafone also referred to our March 2015 decision to set the charge control for mobile termination rates at the new LRIC rate at the start of the second year of the charge control (i.e. from 1 April 2016), with a partial adjustment towards the new LRIC rate in the first year of the charge control (i.e. in 2015/16). Vodafone suggested that there might be an emerging bifurcation between the mobile sector on the one hand and the fixed telecoms and DTT sectors on the other hand as regards the speed of implementation decisions, and that this would be troubling and potentially discriminatory.

8.22 EE similarly referred to the partial adjustment in the first year of the charge control for mobile call termination rates (i.e. 2015-2016) and suggested that we should allow a longer phase-in period for ALFs because the ALF payments at the revised rates would be around three times the financial impact of the regulation of mobile termination rates[299]. EE said that a three year phase-in (i.e. a four-step phase-in) would enable time for operators to adjust consumer prices and make any adjustment in spectrum holdings, moderate the 'profit shock' for operators and help to offset the overall costs of the coverage obligation on EE and H3G[300].

Ofcom's decision

8.23 We consider that BT has incorrectly taken a narrow interpretation of the Government Direction when arguing that phasing-in revised fees that reflect full market value would not be compatible with the Government Direction. We do not agree with BT that implementing the revised fees through phasing-in would not be compatible with the Government Direction. The Government Direction makes no express provision in this regard and in our view leaves it to Ofcom to decide whether and if so how any fees should be phased-in. We also disagree with BT's argument that the Government Direction requires Ofcom to "recoup" what BT describes as "missing charges" in future payments.

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[296] Telefónica's response to the February 2015 consultation, p. 57-58 (§ 181-182).
[297] Vodafone's response to the February 2015 consultation, p. 58-59.
[298] Vodafone added the following comment: "In the absence of any P0 adjustment to eliminate volume forecast error the present glidepath approach allows retention of rather more than simply some of the benefits of any achieved cost reduction" (Vodafone's response to the February 2015 consultation, p.59).
[299] EE's response to the February 2015 consultation, p. 86.
[300] EE's response to the February 2015 consultation, p. 85-86.

8.24 In addition, we do not agree with BT's argument that adopting phasing-in would put BT at an unfair disadvantage to its mobile competitors. The spectrum holding awarded to BT at the 4G auction concerned a different frequency band (i.e. 2.6 GHz) and all the other winning bidders in the 4G auction paid on the same basis as BT for their spectrum holdings in the same band. Furthermore, the two-stage phase-in of revised ALF would result in the MNOs paying fees reflecting our estimate of market value in full from the common actual payment date (i.e. on the anniversary of the common effective date) and any effect of ALF levels on BT's competitive position ahead of this date is unlikely to be material.

8.25 We consider it appropriate to introduce revised ALFs as soon as practically possible, in the interests of good administration and recognising that we are revising ALFs having been directed to do so by Government. Specifically, we consider it appropriate to adopt a common effective date as soon as practicable after the new fees regulations come into force.

8.26 On the subject of phasing-in, we have considered EE's and Vodafone's comments on consistency with the approach that we have taken in other sectors. In our view, we should take an approach that considers in the round what an appropriate phase-in period would be for the revised ALFs, rather than focusing on previous decisions that we have taken in other sectors on phasing-in. Nonetheless, we do not consider that a two-stage phase-in would be inconsistent with the examples of our previous decisions that EE and Vodafone have cited as relevant precedents, which concern the fees set for the maritime, aeronautical and satellite sectors. In particular[301]:

a) the increases in the AIP-based fees for the maritime sector were introduced through a mix of a two-step phase-in and a three-step phase-in for larger increases of up to 300%;

b) the increases in the AIP-based fees for the aeronautical sector were introduced over a 5-step phase-in but these fees are increasing by a factor of up to 100 (i.e. 10,000%) from a low starting level[302];

c) the increase in the AIP-based fees for satellite earth stations (of up to approximately 200%) were introduced over a two-step phase-in[303].

8.27 Vodafone and EE both referred also to the consultation on broadcasting AIP which put forward a working hypothesis that AIP would be phased-in over a 5 year period. However, in our subsequent statement we said that we would consider, and consult on, the issue nearer the time (i.e. we have made no decision in this regard).

8.28 We do not agree that the use of glide paths when setting price controls is necessarily analogous to consideration of phase-in in the context of revising ALFs, as suggested by Vodafone and EE. In the February 2015 consultation (paragraph 7.20) we said that in the context of price controls, a glide path is often used to reinforce the incentive for the regulated company to make cost savings which can then be passed

[301] Aside from the relative magnitude of the fee increase, we note that these cases differ also in other respects. For example, the increases in the AIP-based fees for the maritime and aeronautical sectors affected a wide range of different types of licensees (including private individuals).
[302] EE referred to the increases in the AIP-based fees for the aeronautical sector in its response to the October 2013 consultation (p.39, section 7.2).
[303] EE referred to the increase in the AIP-based fees for satellite earth stations in its response to the October 2013 consultation (p.39, section 7.2).

on to consumers in time. If the regulated company cannot retain at least some of the benefits of cost reduction for a period then it will have a reduced incentive to make them. We explained that this cost-reduction incentive does not arise in a similar way with ALFs.

8.29 Vodafone seems to argue that the glide path only provides incentives for cost reduction in price controls if the starting charge is at cost (including a full P0 or one-off adjustment to achieve that). However, in our view, those are the circumstances when there is no glide path because the price control would track forecast cost from the start. A glide path can enhance incentives for cost reduction if it does not include a full P0 adjustment which allows the firm to gain continued profits for a period from cost reductions which it achieved in the previous price control period.

8.30 Both Vodafone and EE referred to the partial adjustment in the first year of the charge control for mobile call termination rates (i.e. 2015-2016). For the avoidance of doubt, we note that the cost-reduction incentive that we discussed in paragraph 7.20 of the February 2015 consultation is less relevant in that context because many of the assets used to provide mobile call termination are also used to provide other competitive services[304].

8.31 We disagree with EE's argument that we should allow a three-year phase-in period (i.e. a four-step phase-in) for ALFs since the ALF payments at the revised rates would be around three times the financial impact of the regulation of mobile termination rates. We do not consider it appropriate to focus on previous decisions on phasing-in that we have taken for different purposes, such as implementing a charge control for the termination of mobile calls. We also note that the factual circumstances relating to the implementation of the 2015-2018 charge control for the termination of mobile calls differ in many respects from those relating to the introduction of increased ALFs. For instance, the MNOs have been on notice of a likely increase in ALFs for a longer time than the corresponding period in the 2015 MCT review.

8.32 We do not agree with Vodafone's suggestion that there might be an emerging bifurcation between the mobile sector and the fixed or DTT sectors. In assessing how to give effect to any regulatory measure, we take account of all the factors that we consider relevant to its implementation. We do not agree there is any discrimination here because we are looking at different circumstances from those that we consider when imposing a charge control in the telecoms sector or regulating the broadcasting sector. For the avoidance of doubt, we also do not agree with Vodafone's comment that "in mobile Ofcom is generally proposing a more rapid implementation for regulatory charges than it is in fixed telecoms and for DTT"[305]. For instance, in relation to the regulation of termination rates, we decided not to adopt a glide path in the 2013 Fixed Narrowband Services Market Review.

8.33 In relation to stakeholders' additional arguments for a longer phase-in period, including any impact-related argument, we believe that a two-step phase-in is a fair and reasonable approach. In taking this view, we are balancing:

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[304] See, in particular, paragraph 8.65 of our MCT Statement of 17 March 2015: http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-call-termination-14/statement/MCT_final_statement.pdf

[305] Vodafone's response to to the February 2015 consultation, p. 59.

a) On one hand the fact that a significant period of time has passed since the Government Direction was made in December 2010, and since the conclusion of the 4G auction in March 2013. Licensees have, accordingly, had a significant period of notice that their fees would be significantly increased after the 4G auction. The conclusion of the 4G auction in March 2013 and the evidence considered in our overall consultation process will have provided further information to licensees on the possible level of the increase, although we agree with the point made by licensees that they did not know the precise level of the revised ALFs at this point.

b) On the other hand, recognising that the revised ALFs are significantly higher than the current level of fees.

8.34 We note that a two-step phase-in means that the licensees will all have more than one year's notice of the specific amount payable from the second year of implementation of revised ALFs, which is when their fees will start reflecting our estimate of market value in full.

8.35 We also note that an effect of the February 2015 consultation (and the following update on the German 2015 auction) has been to postpone the date on which the revised fees will be introduced by a further period of time.

8.36 We have considered the new arguments received from EE, H3G and Telefónica on the need to allow for a longer phase-in period because of the financial impact of the geographic coverage obligation, noting EE's and H3G's claims for a differential treatment on the grounds of the higher costs faced by the 1800 MHz licensees to meet that obligation (along with Vodafone's argument, as summarised in Section 4, against such differential treatment)[306]. Having concluded that the geographic coverage obligation is unlikely to have a material effect on the market value of either 900 MHz or 1800 MHz spectrum for the purpose of ALF (see Section 4 of this document), and noting that the licensees agreed with Government the inclusion of the geographic coverage obligation in their licences, we do not consider it appropriate to modify our approach of adopting a two-stage phase-in in light of any incremental costs associated with the geographic coverage obligation incurred by each individual licensee.

8.37 In summary, we have decided to adopt the approach to implementation that we proposed in our February 2015 consultation, which also reflected our August 2014 proposals. As noted above, an effect of the February 2015 consultation (and the following update on the German 2015 auction) has been to postpone the date on which the revised fees will be introduced.

8.38 Accordingly, we have decided to implement the revised ALF by:

a) setting a common effective date as soon as practicable after the new fees regulations come into force, which is **31 October 2015**;

b) introducing one half of the increase (from the current ALF rate to the proposed new ALF rate) with effect from the CED; and

[306] See, in particular, paragraphs 4.43, 4.44, 4.94 and 4.108.

c) introducing the second half of the increase with effect from the common actual payment date, which will be one year later.

8.39 We have implemented these decisions by making the new fees regulations, which will come into force on 15 October 2015. We have determined the revised fees for the first payment following the entry into force of these regulations on the basis of a common effective date of **31 October 2015**. The new fees regulations prescribe a common actual payment date of **31 October 2016**. From that date onwards, ALF will be payable on each following anniversary.

Calculating the first year's payment of ALF following the CED

Ofcom's proposed approach

8.40 In the August 2014 consultation, we set out how we proposed to calculate the first year's payment of ALF following the CED, using for illustration 31 January 2015 as the CED and 31 January 2016 as the common actual payment date. We do not deal in this sub-section with adjusting for inflation; this is covered in the next sub-section.

8.41 We proposed that each licensee's first year's payment of ALF following the CED would be made up of the following components:

a) a sum equal to 50% of the increase in ALF (i.e. half of the difference between the revised ALF and the current ALF) applied to the licensee's spectrum holdings; plus

b) a sum equal to the current ALF, pro-rated in relation to the number of months between the licensee's payment date and the common actual payment date.

8.42 This is the approach that we adopted in the draft fees regulations in the Notice published alongside the August 2014 consultation.

8.43 In our February 2015 consultation, we proposed the same approach to calculating the first year's payment of ALF following the CED as in our August 2014 consultation.

Stakeholder responses

8.44 Stakeholders did not comment on this specific point in response to the August 2014 consultation or to the Notice with the draft regulations. We received no comments also in response to the February 2015 consultation.

Ofcom's decision

8.45 We conclude that it is appropriate for us to calculate the first year's payment of ALF following the CED as described above. This is therefore how we have determined the fees payable for the first year of implementation of the revised ALF as prescribed in the new fees regulations, using the 31 October 2015 as the common effective date and the 31 October 2016 as the common actual payment date.

Implementation of inflation indexation

Ofcom's proposed approach

8.46 In the August 2014 consultation, we set out how we proposed to take account of inflation in setting ALF and how we proposed to implement the inflation indexation.

8.47 Specifically, we proposed a formula for calculating each year's ALF (ALF_t) that would incorporate an annual increase in ALF in line with inflation, as measured by the CPI index. In particular, we proposed that the nominal value of ALF would be inflated by the ratio:

$$\left[\frac{CPI_t}{CPI_{t0}}\right]$$

where:

a) CPI_{t0} is the level of the CPI (all items) index in March 2013 (which is when the UK 4G auction was completed); and

b) CPI_t is the latest available figure for the same index published in the Consumers Price Inflation Reference Tables by the Office for National Statistics ("ONS").

8.48 We specified that, in practice, the latest available CPI index figure at any time is likely to be two months old because inflation data related to each month is usually published by the ONS between the 15th and the 20th of the following month.

8.49 The draft fees regulations in the Notice published alongside the August 2014 consultation set out the formula that we proposed to use to derive inflation-adjusted ALF rates for the fees due on the CED and subsequently for the fees due on the common actual payment date.

8.50 In our February 2015 consultation, we proposed the same approach to taking account of inflation in setting ALF as in our August 2014 consultation.

Stakeholder responses

8.51 Stakeholders did not comment on the above indexation mechanism in response to the August 2014 consultation and our Notice with the draft regulations. We also received no comments on this matter in response to the February 2015 consultation.

Ofcom's decision

8.52 We conclude that it is appropriate for us take account of inflation in setting ALF and to implement the inflation indexation as described above.

8.53 Therefore, this is the approach that we have followed in making the new fees regulations. In particular, given that we made the new regulations on 23 September 2015, the latest available CPI index that we could use at the time we made the regulations was the index for August 2015, which was published by the ONS in

September 2015[307]. We have therefore used the August 2015 CPI index to adjust the base level of ALF (before deducting the current ALF rate and calculating the size of the 50% increase at the CED) in order to derive the amounts specified in the new fee regulations for the first payment obligation of each licensee following the CED.

8.54 Similarly, the ALF rates for the payment date of 31 October 2016 is defined in the regulations by a formula which adjusts from March 2013 prices using the CPI index for August 2016 (with each subsequent 31st of October payment date being inflated by the CPI index from the previous August).

Future Review of ALF

Ofcom's provisional view

8.55 In the October 2013 consultation, we proposed that the revised fees should be introduced for an indefinite period and should not be time limited. In the August 2014 consultation, in light of stakeholders' comments, we said that we were currently not minded to review ALF within the next five years, and thereafter we would be likely to review ALF only if there were grounds to believe that a material misalignment had arisen between the level of these fees and the value of the spectrum, in keeping with our general policy on fee reviews as set out in the Strategic Review of Spectrum Pricing[308].

8.56 In our February 2015 consultation, we said that our view on future reviews of ALF had not changed from the position set out in our August 2014 consultation[309]. We also noted that, since the August 2014 consultation, we had considered what assumptions it would be reasonable to make about the possibility of a review (or reviews) being carried out within the next 20 years, which is relevant to the choice of discount rate. We said that in our view it is reasonable to assume that these fee rates are likely to be reviewed at some stage during a 20-year period, although we cannot predict with any certainty at what point any such review (or reviews) might occur. For example, we recognised that it is possible there could be grounds for a review following an award of the 700 MHz spectrum and/or the review that we will need to undertake of the fees for the 2.1 GHz licences, though this would still depend on there being evidence of a material misalignment between ALF and market value around these times.

Stakeholder responses

8.57 We received no further comments from stakeholders on this issue in response to our August 2014 consultation.

8.58 In response to the February 2015 consultation, EE, Vodafone and Telefónica all argued that there was a low probability of review and much lower than Ofcom's stylised example of one review in 20 years. In Section 5 we set out stakeholders' comments in more detail.

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[307] The CPI for August 2015 is 128.4. See http://www.ons.gov.uk/ons/dcp171778_416118.pdf
[308] August 2014 consultation, paragraph 6.28.
[309] February 2015 consultation, paragraph 7.40.

Our view

8.59 The licence fees payable by the holders of the 900 MHz and 1800 MHz licences are prescribed by Ofcom through regulations. Accordingly, now that we have implemented the revised ALFs by making new regulations, these fees will remain applicable until we amend or revoke such regulations. This means that, in effect, ALFs are set for an indefinite period and are not time limited.

8.60 Our view on future reviews of ALF has not changed from the position set out in the August 2014 and February 2015 consultations. While we note that we cannot bind ourselves in advance as to the decisions we may take in the future on the exercise of our powers to revise spectrum fees, we consider that there would be a benefit in some period of certainty for licensees. We currently are not minded to review ALF within the next five years, and thereafter we would be likely to review ALF only if there were grounds to believe that a material misalignment had arisen between the level of these fees and the value of the spectrum, in keeping with our general policy on fee reviews as set out in the Strategic Review of Spectrum Pricing.

8.61 In Section 6, we set out how we have taken account of stakeholders' comments on the probability of a future fee review in concluding on the appropriate discount rate for converting our estimate of the lump-sum value of the spectrum into annual fees.

The new Regulations

8.62 On 1 August 2014, we published a notice explaining how we would give effect to Ofcom's revised proposals to implement the Government's direction[310]. The Notice was given in accordance with section 122(4) and (5) of the Wireless Telegraphy Act 2006 and contained a draft of the statutory instrument that we proposed to make in order to revise the fees which are currently payable under the Wireless Telegraphy (Licence Charges) Regulations 2011.

8.63 The draft statutory instrument set out how we proposed to give effect to our final decisions on the level of the ALFs and implementation, including in particular the adoption of a common effective date, phasing-in, the annual adjustment to inflation and the introduction of a common actual payment date. The figures in the draft statutory instrument reflected the proposals in the August 2014 consultation on the level of ALF (adjusted for inflation up to the date of that consultation) and used, for illustration, a CED of 31 January 2015.

8.64 We did not receive any comment on the specific provisions of the draft statutory instrument attached to our Notice[311].

8.65 We have now made the statutory instrument prescribing the revised fees.

8.66 The Wireless Telegraphy (Licence Charges for the 900 MHz frequency band and the 1800 MHz frequency band) (Amendment and Further Provisions) Regulations 2015 give effect to our final decisions, including those on the implementation of the revised rates, as explained above. These decisions concern, in particular, the adoption of a

[310] See http://stakeholders.ofcom.org.uk/consultations/notice-proposal-fees/
[311] EE said that, where applicable, their comments on the August 2014 consultation also apply to the parallel consultation on Ofcom's Notice.

common effective date, the phasing-in, the annual adjustment to inflation and the introduction of a common actual payment date.

8.67 In terms of drafting, the Wireless Telegraphy (Licence Charges for the 900 MHz frequency band and the 1800 MHz frequency band) (Amendment and Further Provisions) Regulations 2015 follow the same approach as was set out in the draft attached to the Notice (the level of fees has changed to give effect to the decisions in this statement). In particular, and as explained in the Notice, we have retained the pricing unit of a **2 x 200 kHz** national channel. Therefore, the fees set out in the Wireless Telegraphy (Licence Charges for the 900 MHz frequency band and the 1800 MHz frequency band) (Amendment and Further Provisions) Regulations 2015 are based on a 'base level' for the annual licence fees (expressed in March 2013 prices) of:

- **£451,200** per each 2 x 200 kHz national channel in the 900 MHz band, which is equal to **£1.128 million** for 1 MHz within the same band; and

- **£326,000** per each 2 x 200 kHz national channel in the 1800 MHz band, which is equal to **£0.815 million** for 1 MHz within the same band.

8.68 For the avoidance of doubt, the fees prescribed in the regulations in respect of the first payment following the regulations coming into force have been calculated in line with the formula explained in our Notice[312].

[312] In order to adjust for inflation, we have multiplied the 'base level' of fees for each paired channel of 200 kHz by 128.4/125.6 (the latest monthly CPI available before making the regulations divided by the CPI in March 2013). The result of this calculation is £461,258.60 for the 900 MHz band and £333,267.52 for the 1800 MHz band.