Three's response to Ofcom's Annual Licence Fees for 900MHz and 1800MHz spectrum further consultation.

Non-confidential

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Executive Summary.

Hutchison 3G UK Ltd (Three) welcomes the opportunity to respond to Ofcom's Annual licence fees (ALFs) for 900MHz and 1800MHz spectrum further consultation[1].

Ofcom's consultation sets out revised proposals for implementing the Government's Direction to Ofcom to set ALFs for 900MHz and 1800MHz spectrum to reflect full market value (having particular regard for the sums bid in the UK 4G auction), namely:

- for 900MHz, a new base ALF for 900MHz at £1.57m per MHz (rather than £1.99m per MHz in Ofcom's initial consultation[2]); and
- for 1800MHz, a new base ALF of £0.96m per MHz (rather than £1.19m per MHz).

Three strongly agrees with many aspects of Ofcom's revised ALF proposals, in particular that:

- Ofcom should set ALFs more conservatively than in its previous consultation, in order more appropriately to take account of the asymmetry of risk and availability of future spectrum bands;
- Ofcom's international benchmark evidence should focus primarily on the relative values of 900MHz and 1800MHz to the values of 800MHz and 2.6GHz in each benchmark country, rather than absolute values of 900MHz and 1800MHz spectrum;
- Ofcom should use the "distance-method" for determining the lump-sum value of 1800MHz spectrum;
- Ofcom should use a cost of debt for the discount rate to convert the lump-sum values of 900MHz and 1800MHz into ALFs, rather than weighted-average cost of capital (WACC);
- Ofcom is right that lump-sum spectrum should be treated as 100% debt financed, rather than equity financed;
- Ofcom should use the consumer price index (CPI) inflation measure for setting future ALFs, rather than the retail price index (RPI); and
- Ofcom should set the same common effective date (CED) for all licensees and should phase in the new ALF rates.

However, Three strongly disagrees with some other major aspects of Ofcom's revised proposals.

First, Three disagrees with Ofcom's estimated market value of 800MHz and 2.6GHz spectrum in the UK.

[1] Annual licence fees for 900MHz and 1800MHz spectrum: Further consultation, Ofcom, 1 August 2014.
[2] Annual licence fees for 900 MHz and 1800 MHz spectrum: Consultation, Ofcom, 10 October 2013.

Ofcom now proposes that the market value of 800MHz and 2.6GHz spectrum in the UK should be based on an analysis of bids by the marginal bidders in the auction, rather than the linear reference price (LRP) method, as in Ofcom's first consultation.

In principle, Ofcom could use either method for determining the UK 800MHz and 2.6GHz values – and they should lead to similar results.

However, Three considers that Ofcom has wrongly analysed the bids made by marginal bidders in the auction, having the effect of over-estimating the market value of 800MHz and 2.6GHz in the UK auction. In particular, Ofcom's approach is far from conservative.

In contrast, Three's application of the LRP method leads to an estimate of the market value of 800MHz of £25.0m per MHz (compared to Ofcom's value of £32.6m) and market value of 2.6GHz of £3.6m per MHz (compared to Ofcom's value of £5.5m).

These are the values recommended in our expert report by Power Auctions, appended at Annex A.

Second, Three disagrees with Ofcom's interpretation of international benchmark evidence for determining the relative values of 900MHz and 1800MHz to 800MHz and 2600MHz spectrum.

Specifically, Three considers that Ofcom has been conservative with its 900MHz lump-sum value but, in contrast, very aggressive with its 1800MHz estimate. This is due to what appears to be a highly subjective categorisation of very few data points.

For instance, Ofcom's 1800MHz lump-sum value is significantly higher, and its 900MHz value is significantly lower, than their respective simple averages. This asymmetry is surprising given that Ofcom's own analysis suggests that it is very uncertain about the quality of its benchmarks.

In particular, Three considers that Ofcom's proposed UK 1800MHz lump-sum value of £14m per MHz is too high (on the basis of Ofcom's proposed UK 800MHz and 2600MHz values), both in absolute terms and in relation to the 900MHz value (61%).

In contrast, Three's benchmarking approach leads to a UK 1800MHz lump-sum value of £7.7m per MHz for 1800MHz, and £21.3m per MHz for 900MHz spectrum (on the basis of Three's proposed UK 800MHz and 2600MHz values).

If a discount were also applied to reflect Ofcom's conservative approach, then the resulting values would £6.5m per MHz and £19.0m per MHz respectively. These are the values recommended in our expert report by Analysys Mason and Aetha report, appended at Annex B.

Third, Three disagrees with Ofcom's rejection of technical and economic evidence as to the relative value of 900MHz and 800MHz spectrum.

In its previous consultation, Ofcom proposed to take technical and commercial evidence into account as well, but has now decided against this.

We disagree with this, as a comparison of technical characteristics and commercial opportunities of 800MHz and 900MHz shows that they are of almost identical value.

Three therefore suggests that for 900MHz, international benchmarking evidence and technical/commercial evidence should be given equal weight, namely:

– international benchmarking evidence implies a lump-sum value of £21.3m per MHz; and
– technical/ commercial evidence implies a lump-sum value of £25.0m per MHz, i.e. the same as 800MHz.

Hence, we consider that £23.2m per MHz is the most appropriate lump-sum value of 900MHz spectrum.

Fourth, Three disagrees with Ofcom's cost of debt for converting lump-sum values to ALFs.

The cost of debt discount rate for converting lump-sum values to ALFs should reflect the relevant risks to the Government of the ALF payments, which Three considers the corporate cost of debt does not.

In Three's analysis, the relevant risks to the Government of the ALF payments are near risk-free. Three estimates that the relevant discount rate should be at a premium at most of 0.2% over the risk-free rate, implying a pre-tax real CPI discount rate of 2.7%.

This value is recommended in our expert report by Economic Insight, appended at Annex C.

Fifth, Three disagrees that Ofcom has made an adequate impact assessment of its proposals for revising ALFs.

Accordingly, overall, Three considers that Ofcom has not implemented the Government's Direction to Ofcom to set ALFs for 900MHz and 1800MHz spectrum to reflect full market value nor that Ofcom has been conservative in its approach.

The effect of this is that Ofcom's revised proposals continue to overstate the ALF for 1800MHz, which Three considers should be £0.49m per MHz per year. Three believes that Ofcom's proposals for the ALF for 900MHz are also overstated and should be £1.48m per MHz per year.

Table 1 below summarises Ofcom and Three's proposed ALFs, highlighting the underlying proposed UK 800MHz and 2600MHz values, 900MHz and 1800MHz lump-sum values, relevant discount rate and overall proposed ALFs.

Table 1: Ofcom and Three's proposed ALFs.

	900MHz calculation		**1800MHz calculation**	
	Ofcom	Three	Ofcom	Three
800MHz value (per MHz)	£32.6m	£25.0m	£32.6	£25.0m
2600MHz value (per MHz)	£5.5m	£3.6m	£5.5m	£3.6m
900/1800MHz value (per MHz)	£23.0m	£23.2m	£14.0m	£7.7m
Discount rate (pre-tax real CPI)	3.8%	2.7%	3.8%	2.7%
ALF (per MHz per year)	£1.57m	£1.48m	£0.96m	£0.49m

Source: Ofcom, Three.

The remainder of Three's response to Ofcom's consultation explains our position in further detail, including supporting reports by Power Auctions, Analysys Mason and Aetha Consulting, and Economic Insight.

Contents.

1. Three disagrees with Ofcom's market value of 800MHz and 2600MHz spectrum in the UK.

Ofcom's revised proposal is to set ALFs more conservatively than in its previous consultation, in order more appropriately to take account of the asymmetry of risk and availability of future spectrum bands. Three strongly agrees with this approach.

Ofcom also now proposes that the market value of 800MHz and 2.6GHz spectrum in the UK should be based on an analysis of bids by the marginal bidders in the auction, rather than the linear reference price (LRP) method, as in Ofcom's first consultation.

In principle, Ofcom could use either method for determining the UK 800MHz and 2.6GHz values – and they should lead to similar results.

However, Three considers that Ofcom has wrongly analysed the bids made by marginal bidders in the auction, having the effect of over-estimating the market value of 800MHz and 2.6GHz in the UK auction. In particular, Ofcom's approach is far from conservative.

In contrast, Three's application of the LRP method leads to an estimate of the market value of 800MHz of £25.0m per MHz (compared to Ofcom's value of £32.6m) and market value of 2.6GHz of £3.6m per MHz (compared to Ofcom's value of £5.5m).

Three has commissioned Power Auctions to review and evaluate Ofcom's marginal bidder analysis. Power Auctions' report is provided in Annex A to this submission. In the remainder of this section, we summarise its main points.

Three accepts that the marginal bidder approach could be used to estimate the market value of 800MHz and 2.6GHz in principle. However, Three strongly disagrees with the way Ofcom has implemented the marginal bidder approach. In particular:

– Ofcom's implementation of the marginal bidder approach violates the Revenue Equivalence Theorem; and
– without the spectrum reservation, UK auction revenue would have been lower, not higher, as claimed by Ofcom.

Furthermore, Three considers that Ofcom has wrongly analysed the bids made by EE in the auction, thereby has significantly over-estimated the market value of 800MHz and 2.6GHz in the UK auction. More specifically:

– EE's bid for 2x20MHz of 800 MHz should not be interpreted as an expression of EE's true value, but an attempt to increase opponents' costs and, therefore, should not be relied upon in the marginal bidder analysis;

– Ofcom's implementation of the marginal bidder approach included many arbitrary and subjective decisions. For example, Ofcom omitted EE's bids for (2xA1, 9xE) and (4xA1, 9xE) from its analysis. If these bids are also included, then the corrected full market value of 800 MHz spectrum becomes £23.68m/ MHz – significantly lower than £32.63m/ MHz estimated by Ofcom.

Accordingly, Ofcom's approach is neither conservative nor has particular regard for the sums bid in the UK 4G auction, as required by the Government Direction.

Power Auctions develops an alternative approach to estimating the "full market value" of 800 MHz and 2.6GHz. We utilise Linear Reference Prices (LRPs) without a revenue constraint and adjust those to reflect lower revenue that would have been raised in an auction without the spectrum reservation (to reflect the full market value). Our estimated values are presented in Table 1 below (alongside Ofcom's estimates):

Table 2: Estimated values of 800MHz and 2.6GHz per MHz

Band	Ofcom's estimate (1st consultation)	Ofcom's estimate (2nd consultation)	Three's estimate
800MHz (without coverage obligation, net of DTT costs)	£26.85m	£32.63m	**£25.04m**
800MHz (with coverage obligation, net of DTT costs)	£25.30m	£31.08m	**£23.49m**
2.6 GHz	£4.95m	£5.50m	**£3.57m**

Source: Ofcom, Three.

Below, we discuss the above points in more detail.

Ofcom's implementation of the marginal bidder approach violates the Revenue Equivalence Theorem.

In its implementation of the marginal bidder approach, Ofcom effectively simulates a uniform-price auction, i.e. the competitive bidding process that yields values for 800MHz and 2.6GHz based on the highest losing bid. Ofcom takes the bids from the actual auction (with a Vickrey pricing rule) and substitutes them into the pricing rule of a uniform-price auction. The resulting values of 800MHz and 2.6GHz, when aggregated, produce higher revenue than was actually achieved in the UK 4G auction.

Ofcom's analysis runs contrary to the accepted principle that a change in the auction format causes bidding behaviour to change. In particular, Ofcom cannot expect to raise higher revenue by simply changing the pricing rule – bidders would respond to the change by reducing their bids. According to the Revenue Equivalence Theorem, bidding behaviour would change in a way that fully offsets the higher pricing rule of the uniform-price auction, rendering the change revenue-neutral (as long as both auction formats assign the same items to the same bidders).

It is not straightforward to generalise this result if the allocation of licences change with a change in the auction format. However, Ausubel et al. (2014)[3] demonstrate that in a class of environments, in which bidders have multi-unit demands and exhibit linear marginal values, the ex-post revenue of the Vickrey auction is greater than that of the uniform-price auction. There do not exist any results in the literature establishing the reverse ranking in any class of environments (see Section 2 of Annex A for more details).

Therefore, the estimates of 800 MHz and 2.6 GHz values should be bounded by actual 4G auction revenue (irrespective of whether Ofcom uses the marginal bidder or the LRP approach).

Without the spectrum reservation, UK auction revenue would have been lower, not higher as claimed by Ofcom.

In the Second ALF Consultation, Ofcom argues that the UK auction revenue potentially understates the spectrum's full market value because of the spectrum reservation:

[3] Ausubel, L. M., P. Cramton, M. Pycia, M. Rostek and M. Weretka (2014), "Demand Reduction and Inefficiency in Multi-Unit Auctions," *Review of Economic Studies*, forthcoming, at Section 5, http://restud.oxfordjournals.org/content/early/2014/07/27/restud.rdu023.full.pdf?keytype=ref&ijkey=jGg1ddzGeMl0NpK.

> *"… the auction revenue from the prices paid by H3G and EE for 800 MHz spectrum at the reserve price is below market value for the purpose of ALF, due respectively to spectrum reservation for H3G and EE being the only losing bidder for additional 800 MHz spectrum".*[4]

Ofcom simulates an alternative auction result by removing the spectrum reservation, but keeping all bids as in the actual auction.

We strongly disagree with Ofcom's assumptions underlying this approach. In particular, Three would certainly not have placed all the same bids if it had not been an opt-in bidder. In an equivalent auction without spectrum reservation, Three would have only bid for 800 MHz spectrum at the reserve price or would not have bid for 800 MHz spectrum at all (knowing we had no chance of winning it). This would have had significant implications for the auction revenue reducing it by 12-15% (Scenarios 2 and 3 in Section 3.2 of Annex A).

This is entirely consistent with the general principles of auction theory: subsidising designated bidders (i.e. reserving spectrum for small operators) is likely to create extra competition and induce the unsubsidised incumbents to bid more aggressively, potentially improving auction revenue.

Our analysis of the UK auction without spectrum reservation is supported by evidence from the Canadian 700 MHz auction[5]. In the Canadian auction, as in the UK auction, a removal of the spectrum reservation would have reduced revenue significantly – by 19%-34% (Section 3.3 of Annex A).

Our analysis is further corroborated by a comparison of auction prices in Europe. Auctions in countries with effective spectrum reservations (Ireland, the Netherlands, Romania) raised higher revenue per MHz/pop than auctions without spectrum reservations (Spain, Portugal, Germany). (Section 3.4 of Annex A).

Overall, without the spectrum reservation, the UK auction revenue would have been lower, not higher as claimed by Ofcom. In order to replicate a "competitive" market outcome without the spectrum reservation, Ofcom should reduce the UK auction revenue by 12-15% and use this figure as the revenue constraint when estimating the value of 800 MHz spectrum.

[4] Second ALF Consultation, [2.18]
[5] The Canadian 700 MHz auction was chosen because of its similar auction format and publicly available bid data.

EE's bid for 2x20MHz of 800 MHz was not an expression of its value, but an attempt to increase opponents' costs and, therefore, should not be relied upon.

Ofcom's marginal bidder analysis relies to a large extent on a difference between two bids: EE's bids for package of (2xA1, 4xC) and (4xA1; 4xC). We can easily demonstrate that EE's bid for (4xA1; 4xC) had virtually no chance of winning and that therefore there is no reason to think that this bid is reflective of EE's true value.

It is also worth noting that EE submitted a supplementary bid for (2xA1,5xC), which was very competitive, fit with the other bidders' final clock bids and therefore formed a feasible allocation for the winner determination problem. The (4xA1; 4xC) bid, on the other hand, did not fit with the opponents' bids and was less competitive. The value gap between these two bids permitted EE to overstate its true valuation of (4xA1, 4xC) in order to attempt to increase its opponents' costs. Indeed, while the (4xA1, 4xC) bid had no chance of winning, it was very close to setting price for Vodafone and Telefonica (see Section 4 of Annex A for more details).

Three would therefore caution Ofcom against using EE's bid for (4xA1, 4xC) to assess its intrinsic incremental value of 2x10 MHz of 800 MHz spectrum. Instead, it should be treated as a price setting bid, which was submitted with no intention of winning. This bid should not be relied upon in Ofcom's marginal bidder analysis.

Ofcom's implementation of the marginal bidder approach included many arbitrary and subjective decisions.

It appears that in its implementation of the marginal bidder approach, Ofcom has omitted some of EE's bids. More specifically, the bid for (9xE), which was EE's final clock bid, as well as bids for (2xA1, 9xE) and (4xA1, 9xE) were omitted from the marginal bidder analysis. We add the Incremental Bid Values based on those bids to Ofcom's table 2.5 (see Table 3 below).

Table 3: Ofcom omitted some EE bids in its marginal bidder analysis (Ofcom's expanded Table 2.5)

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	
1x45 MHz of 2.6 GHz (9xE)	**£25.49m**	**£61.0m**	**£23.68m**	
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, Three.

Using the difference between EE's bids for (4xA1, 9xE) and (2xA1, 9xE), while otherwise adopting exactly Ofcom's methodology, produces a "full market value" of £23.68m/ MHz for 800 MHz spectrum. The fact that the identical methodology applied to an equally plausible row of Table 2.5 produces such a different result highlights the arbitrary and subjective nature of Ofcom's implementation of the marginal bidder approach.

Three's estimate of 800 MHz value is based on LRPs with revenue adjusted to reflect no spectrum reservation.

Given Ofcom's implementation of the marginal bidder approach is not satisfactory, we develop our alternative estimates of the "full market value" of 800 MHz and 2.6 GHz licences. We utilise LRP without a

revenue constraint and adjust Three's bids in the absence of a spectrum reservation (based on Scenario 3 of Section 3, Annex A).

We then prorate the prices to a simulated revenue target of £2002m (the auction revenues in the absence of a spectrum reservation), maintaining proportional mark-ups from the reserve prices and maintaining the value relationship between A1 and A2 blocks. Our recommended value estimates are:

– 800 MHz band (no coverage obligation, no DTT costs): £25.04m/ MHz; and
– 2.6 GHz band: £3.57m/ MHz

The details of our calculations are presented in Section 6, Annex A.

Note that, while the 800 MHz value estimate is substantially lower than Ofcom's estimated value of £32.63m/ MHz, it is actually slightly higher than the value obtained from utilising EE's omitted bids while otherwise adopting exactly Ofcom's methodology (£23.68m/ MHz). Therefore, we have substantial confidence that this reduction is justified.

2. Three disagrees with Ofcom's interpretation of international benchmark evidence.

Ofcom's revised proposal is that international benchmark evidence should focus primarily on the relative values of 900MHz and 1800MHz to the values of 800MHz and 2.6GHz in each benchmark country – rather than absolute values of 900MHz and 1800MHz spectrum – and that Ofcom should use the "distance-method" for determining the lump-sum value of 1800MHz spectrum. Three strongly agrees with this.

However, Three disagrees with Ofcom's interpretation of international benchmark evidence.

Specifically, Three considers that Ofcom has been conservative with its 900MHz lump-sum value but, in contrast, very aggressive with its 1800MHz estimate. This is due to what appears to be a highly subjective categorisation of very few data points.

For instance, Ofcom's 1800MHz lump-sum value is significantly higher, and its 900MHz value is significantly lower, than their respective simple averages. This asymmetry is surprising given that Ofcom's own analysis suggests that it is very uncertain about the quality of its benchmarks.

In particular, Three considers that Ofcom's proposed UK 1800MHz lump-sum value of £14m per MHz is too high (on the basis of Ofcom's proposed UK 800MHz and 2600MHz values), both in absolute terms and in relation to the 900MHz value (61%).

In contrast, Three's benchmarking approach leads to a UK 1800MHz lump-sum value of £7.7m per MHz for 1800MHz, and £21.3m per MHz for 900MHz spectrum (on the basis of Three's proposed UK 800MHz and 2600MHz values).

If a discount were also applied to reflect Ofcom's conservative approach, then the resulting values would £6.5m per MHz and £19.0m per MHz respectively. These are the values recommended in our expert report by Analysys Mason and Aetha report, appended at Annex B.

Three has identified what we consider are significant problems with Ofcom's assessment, namely:

- Ofcom's 900MHz and 1800MHz values are highly sensitive to the Tiers and weights used;
- Ofcom ignores its Tier 3 benchmarks and relies on too few data points;
- Ofcom omits key criteria in the classification of its benchmarks;
- Ofcom uses ad hoc criteria instead of applying objective principles to categorise all benchmark values; and

– Ofcom is much more conservative in its determination of the 900MHz lump-sum value than in respect of 1800MHz spectrum.

Three considers that a better approach would be to incorporate as much evidence as possible in the analysis and apply clear and consistent principles to classify all benchmarks. Three has applied this approach to estimating the UK lump-sum values of 1800MHz and 900MHz spectrum, which we discuss further below and in the Analysys Mason and Aetha report.

Three has serious reservations about Ofcom's proposed 900MHz and 1800MHz lump-sum values.

Ofcom has addressed many of our concerns with its previous lump-sum values. In particular, Ofcom no longer uses absolute measures (other than as a cross-check) to arrive at its lump-sum estimates. Instead, it has adopted our proposed distance method for 1800MHz. Ofcom also presents a clearer explanation of the framework used to classify benchmarks and of its determination of lump-sum values.

Nevertheless, Three continues to have serious reservations about Ofcom's revised values. Table 4shows Ofcom's estimates of full market value for 900MHz and 1800MHz spectrum in the UK, together with its 800MHz and 2.6GHz prices based on the marginal bidder method.

Table 4: Ofcom's lump-sum estimates of UK spectrum value

Band	800MHz	900MHz	1800MHz	2.6GHz
£m per MHz	£35.6m[6]	£23.0m	£14.0m	£5.5m
Value relative to 900MHz	155%	100%	61%	24%

Source: Ofcom.

In Three's view, Ofcom's proposed 1800MHz value is too high, both in absolute terms (£14m per MHz) and in relation to the 900MHz value (61%). We consider that this is due to a highly subjective categorisation of a very small number of benchmarks: Ofcom's 900MHz value is conservative while its 1800MHz figure is very aggressive. This is

[6] This is Ofcom's estimate for an 800MHz licence without coverage obligation and gross of coexistence costs.

supported by our expert report from Analysys Mason and Aetha appended at Annex B.

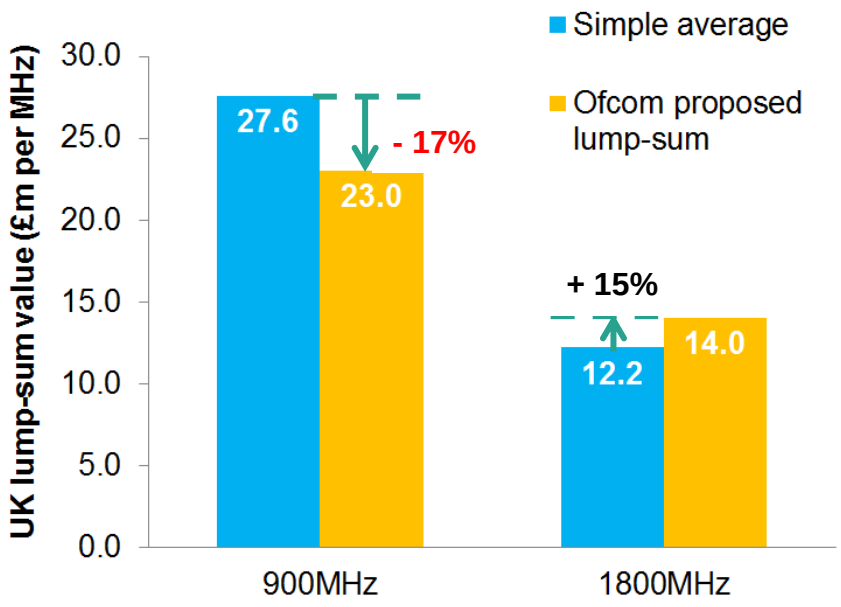
Ofcom's 1800 lump-sum value is significantly higher, while the 900MHz value is significantly lower, than their simple averages.

There are inherent limitations to any benchmarking approach for estimating the value of 900MHz and 1800MHz spectrum in the UK. The sample of recent EU auctions provides relatively few data points, and it is not possible to control for every factor that could possibly influence relative values between countries.

In light of those limitations, it is very important that the benchmarking approach is inclusive and tries to use as many data points as possible. The starting point should therefore be to attach the same weight to all observations and set a simple average value for 900MHz and 1800MHz, unless evidence clearly suggests that significant differences in the quality of benchmarks will not even out in the aggregate.

However, Ofcom's proposed 1800MHz lump-sum value is 15% higher than the 1800MHz simple average, while its 900MHz value is 17% lower than the 900MHz average value.

Figure 1: Ofcom's 1800MHz UK lump-sum value is at the top end of all possible values.[7]



Source: Ofcom, Three.

This asymmetry is surprising given that Ofcom is not confident that its 900MHz and 1800MHz benchmarks reflect market value in the UK (see section 3.3 of the Analysys Mason/Aetha report).

Ofcom's proposed lump-sum values are highly sensitive to the Tiers and weights used.

Ofcom classifies its benchmark values in three Tiers, or excludes them entirely, based on the extent to which they are informative of UK value. This is a change from its previous 2-Tier classification of more important/less important (and excluded) that has not been adequately justified.

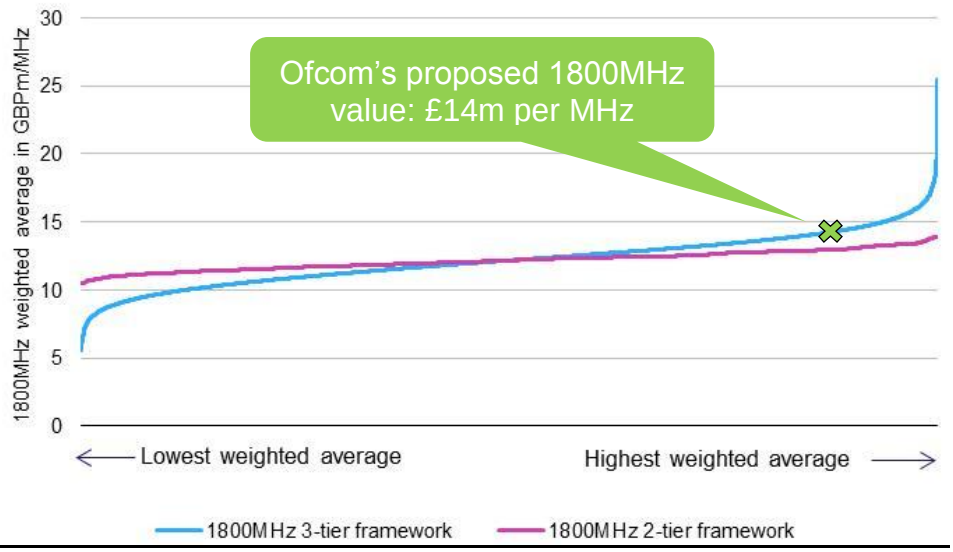
Three agrees with Ofcom that it is necessary to group benchmarks into Tiers and attach greater weight to the more important Tiers, to reflect key differences in the quality of the evidence where they exist. But by increasing the number of Tiers Ofcom has greatly widened the range of

[7] The 900MHz simple average excludes the Denmark value, which in our view is not at all informative given that the three main incumbents were not allowed to participate in the award. The 900MHz average is £24m per MHz if Denmark is included.

possible values. This makes the lump-sum determination highly sensitive to the Tiers and weights used.

For instance, Figure 2 shows (in blue) the weighted-average 1800MHz values associated with each possible combination of Ofcom's nine 1800MHz benchmarks and three Tiers, assuming weights of 2, 1 and 0 used in Ofcom's cross check. The pink curve shows the corresponding 1800MHz average if only two Tiers are used (assuming weights of 2 and 1).

Figure 2: Ofcom's 1800MHz UK lump-sum value is at the top end of all possible values.



Source: Three.

Ofcom's three-Tier framework produces a much wider range of possible 1800MHz lump-sum values (£5.6m to £25.5m per MHz) than its previous two-Tier framework (£10.5m to £13.9m per MHz).

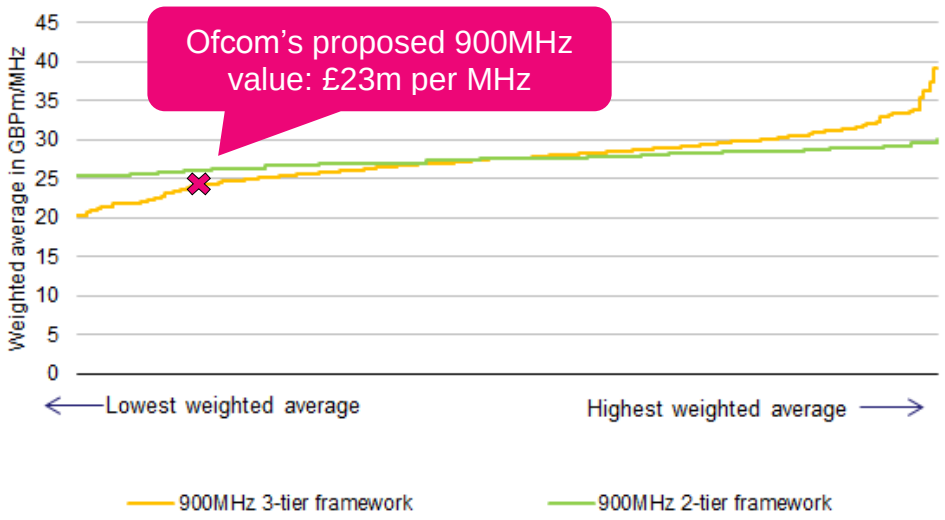
Moreover, Ofcom's proposed 1800MHz value is towards the top end of all possible results, given that very few tiering combinations would lead to a weighted average value of £15m per MHz:

– a two-Tier framework could not produce an 1800MHz value as high as £14m per MHz (if weights of 1 or 2 are assumed); and
– a three-Tier framework can only arrive at £14m per MHz by ignoring or giving minimal weight to low price 1800MHz benchmarks, and

assigning most weight to high price auctions (given weights of 2, and 0). This is precisely what Ofcom has done.

In the case of 900MHz, the opposite is true. Ofcom's three Tiers also widen the range of possible values, from £25.4m-£30.1m per MHz to £20.3m-39.2m per MHz. But in this case, Ofcom's £23m per MHz value is towards the bottom end of all possible 900MHz weighted average values. In fact, Ofcom could not have set such a low 900MHz value based on a mechanistic application of its previous two-Tier framework.

Figure 3: Ofcom's 900MHz UK lump-sum value is towards the bottom of all possible values.



Source: Three.

This shows that Ofcom has been conservative with the (implicit) weights given to the 900MHz benchmarks, but very aggressive with its 1800MHz weights. The sensitivity of both values to the Tiers and weights used highlights the importance of using objective criteria to classify benchmarks and then giving appropriate weight to them.

We have three main concerns with Ofcom's benchmark classification: the weight given to the Tier 3 values, the omission of key principles and the inclusion of ad hoc criteria.

Our main concerns with Ofcom's benchmark classification are:

– Ofcom ignores the Tier 3 benchmarks and relies on too few data points;
– Ofcom omits key criteria in the classification of its benchmarks;
– Ofcom uses ad hoc criteria instead of applying clear and consistent principles across all benchmarks.

We propose three sets of changes to address each of those concerns in Table **5**. These are colour-coded in red, yellow and blue respectively, and discussed in the following three sections.

Table 5: Three's proposed changes to Ofcom's classification.[8]

	1800MHz			900MHz		
Country	**Tier 1**	**Tier 2**	**Tier 3**	**Tier 1**	**Tier 2**	**Tier 3**
Austria	25.5			39.2		
Ireland	14.3			20.3		
Italy	13.5					
Germany		5.6				
Sweden		~~17.5~~ 5.5				
Czech Rep			7.5			
Portugal			6.1		21.8	
Romania			12.0			33.5
Slovakia			7.5			
Spain					23.2	
Denmark						~~6.1~~

Source: Three.

Ofcom ignores its Tier 3 benchmarks and relies on too few data points.

Our first concern relates to the newly created Tier 3 category and the weight Ofcom attaches to it. This is discussed in Section 3.4.1 of the AM&A report.

[8] As discussed below, we propose a different 1800MHz value from Sweden and consider that Ofcom should remove the Danish 900MHz value from its data set, as incumbents were not allowed to participate in that award.

In effect, Ofcom gives the same weight to the Tier 3 values and the excluded benchmarks – zero. Ofcom does not consider those values in its non-mechanistic approach, and it attaches zero weight to them in its mechanistic cross-check. As a result, Ofcom relies on very few data points to arrive at its lump-sum values.

Ofcom should not adopt two separate categories and then give them equal (ie zero) weight. By differentiating between Excluded and Tier 3 benchmarks, Ofcom recognises that Tier 3 values are more informative of UK market value. There are two ways to assign proper weight to the Tier 3 benchmarks:

– by reverting to Ofcom's previous 2-Tier framework of more important and less important values (together with the excluded category) – for instance, by moving the Tier 3 900MHz and 1800MHz benchmarks to Tier 2; or
– by retaining the 3-Tiers (plus excluded) but assigning a positive weight to Tier 3.

We prefer the first option, as it reflects a more inclusive approach. That option reduces the range of possible values, minimising the scope for subjectivity to unduly influence values while still recognising key differences in the quality of individual benchmarks. This is reflected in the changes proposed in Table **5** (in red). Our proposed treatment of Denmark is discussed in the next section.

Ofcom omits two key criteria in the classification of benchmarks

Our second concern relates to the omission of certain criteria in Ofcom's framework. Sections 3.1 and 3.4.4 of the Analysys Mason and Aetha report explain this. Table 6 compares Three's and Ofcom's criteria for classifying benchmark values from other countries.

Table 6: Ofcom vs Three's classification of evidence points.

Price represents market value in country	Ofcom	Three
No lots sold at reserve	●	●
No unsold spectrum	●	●
No bidder precluded from bidding	●	Exclude
Band-specific prices can be directly inferred	●	●
All relevant bands have been auctioned (ie no need to use proxy values for 2.6GHz)	●	●
No obvious contenders for spectrum due to packaging/non-contiguous lots	●	●
Auction took place after late 2011 (post emergence of LTE1800 ecosystem)	●	●
Same number of bidders in each band	●	●
Price is relevant to UK value	**Ofcom**	**Three**
EU award from 2010 onwards	●	●
All prices from single multi-band auction (ie no large time gap between awards)	●	●
All band available for sale	●	●
Other (e.g. 2G is as important as in the UK, etc)	●	●

Source: Three, Ofcom.

Our framework includes two key criteria that Ofcom omits in assessing whether a benchmark represents market value in a country:

– **Whether band-specific prices can be directly inferred** – Ofcom defines market value as the market-clearing price in a well-functioning market.[9] For all CCA awards except Austria, Ofcom lacks the bid data needed to determine whether its estimates adequately explain auction outcomes or reflect market value. In the case of Austria, strictly speaking Ofcom's linear prices do not reflect market value, because bands would not have cleared and winners would not have

[9] Paragraph 2.9 of the Consultation.

chosen the same packages at those prices.[10] In practice, different methods to disaggregate package prices can generate very different estimates. Due to informational limitations, Ofcom applies Austrian prices based on its LRP method and Irish values reflecting final clock prices to UK values that are based on a marginal bidder approach. For these reasons, benchmarks from CCA awards should be Tier 2 at best;

– **Whether all relevant bands have been auctioned (ie. no need to use proxy values)** – 1800MHz distance estimates require benchmark countries to have auctioned 800MHz, 1800MHz and 2.6GHz. If some bands have not been auctioned (e.g. Ireland's 2.6GHz) the resulting 1800MHz UK estimates will rely on a mix of actual and proxy values. Different assumptions about the proxy value can then generate very different estimates. For these reasons, benchmarks that rely on proxy values should at best be Tier 2.

Ireland's CCA auction illustrates why the first criterion is needed. Ofcom relies on the ratio of final clock prices to estimate band prices for 800MHz and 1800MHz. In its report for Ofcom, Dotecon uses a simple linear fit instead.[11] We add Ofcom's proxy value for 2.6GHz, which has not yet been auctioned in Ireland, in both cases.[12] This yields two very different 1800MHz distance parameters from Ireland: 32% (Ofcom's) and 13% (Dotecon's).

Table 7: Different methods to estimate band prices in CCA auctions can produce very different values.

	800MHz	1800MHz	2.6GHz	D
Ofcom final clock prices (£m per MHz)	63.5	25.2	6.8	**32%**
Dotecon simple linear fit (€m per MHz)	60.0	13.1	6.4	**13%**

Source: Ofcom, Dotecon.

[10] Ofcom uses use the Austrian LRP (calculated without revenue constraint) for the Austrian A2, B2 and C1 lot categories as inputs. Ofcom's Update on European auctions shows that this method generates maximum excursions of €65.7m across bidders. This is the maximum amount that Austrian bidders would have to be compensated with in order to choose their winning packages at the linear reference prices proposed.

[11] Section 4 of Dotecon's 800MHz and 2.6GHz linear reference prices and additional spectrum methodology. Report prepared for Ofcom, September 2013

[12] Ofcom's 2.6GHZ proxy is based on the 2.6/800 ratio of 10.7%,the average (geometric mean) of the ratio in ten EU countries where the 800MHz value is net of co-existence costs.

Ofcom's treatment of Sweden provides a good example of why the second criterion is required. Sweden auctioned 2.6GHz spectrum in 2008, two years before Ofcom's 2010 cut-off date. Instead of using an actual price, Ofcom prefers a 2.6GHz proxy based on the average 800/2.6 ratio in other EU countries. This has a large upward impact on the UK 1800MHz estimate from Sweden, as shown in Table 8.[13]

Table 8: Ofcom uses an inflated 1800MHz distance estimate from Sweden

£m/MHz UK equivalent	800	1800	2.6	D	UK 1800
Ofcom	21.2	9.7	2.0	**40%**	**17.5**
Three	21.2	9.7	9.7	**0%**	**5.5**

Source: Ofcom, Three.

For these reasons, we invite Ofcom to adopt our proposed criteria and classify prices from CCA awards and benchmarks that rely on proxies as Tier 2 at best. This would downgrade the 900MHz and 1800MHz Austrian and Irish benchmarks to Tier 2. We have reflected these changes in Table **5** (in yellow).

In our view, Ofcom should also use our proposed 1800MHz UK value from Sweden and exclude the Danish 900MHz benchmark from its data set. That auction precluded incumbents from participating, so the resulting price provides no useful information about market value in that country.

Ofcom uses ad hoc criteria instead of applying clear and consistent principles across all benchmarks.

Finally, our third concern relates to the inclusion of certain criteria in Ofcom's framework. As shown in Table 8 above, we do not agree with several of Ofcom's criteria. Instead of adopting clear principles and applying them consistently to all benchmarks, Ofcom appears to use some ad hoc reasons to rationalise certain values and fit Ofcom's pre-

[13] See sections 5.1-5.2 of the Analysys Mason and Aetha report. To assist comparability the table uses Ofcom's 1800MHz estimate of £9.7m per MHz, instead of the value of £9.3m per MHz proposed in the report.

conceived view of their reliability. This is discussed in Sections 3.4.2 and 3.4.3 of the Analysys Mason and Aetha report.

To illustrate this point, Table 9 compares the reasons provided by Ofcom to categorise certain 900MHz and 1800MHz benchmarks.

Table 9: **Ofcom's benchmark classification is highly subjective.**

	1800MHz			900MHz		
Ofcom Tier	**1**	**1**	**2**	**2**	**2**	**3**
Price reflects market value in country	**AU**	**IE**	**DE**	**PT**	**ES**	**RO**
No lots sold at reserve	✓	✓	✓	✗	✗	✗
No unsold spectrum	✓	✓	✓	✗	✓	✗
No excluded bidder	✓	✓	✓	✓	✓	✓
Auction post 2011	✓	✓	✗	n/a		
No obvious contenders	✓	✓	✗	✗	✗	✓
Band prices can be directly inferred	✗	✗	✓	✓	✓	✗
All relevant bands auctioned (no proxy)	✓	✗	✓	n/a		
Price is relevant to UK value						
EU award from 2010 onwards	✓	✓	✓	✓	✓	✓
All prices from single auction (no large gap)	✗	✓	✓	✓	✗	✓
All band available for sale	✓	✓	✗	✗	✗	✓
Other (e.g. 2G is as important as in the UK)	✓	✓	✓	✗	✓	✗

Source: Ofcom, Three

Like Austria and Ireland, Germany's 1800MHz price meets Ofcom's main criterion for Tier 1 status. The price was determined by bidding. All lots sold above reserve, with no excluded bidders and no unsold lots. Ofcom

even cites an academic article concluding that bidding was competitive and revenue was close to expectations.[14]

Nevertheless, Ofcom assigns the German 1800MHz value to Tier 2 on the basis that i) there were 'obvious contenders' due to existing allocations; ii) the auction took place before development of the LTE 1800 ecosystem; iii) only 2x25MHz of spectrum was available. As discussed in the Analysys Mason and Aetha report, these reasons are not particularly convincing.

In any event, Three does not understand why Ofcom should be more concerned about these factors than about the following problems with its Austrian and Irish 1800MHz benchmarks:

– Austria: many possible band values depending on the method used to disaggregate CCA package prices, and a 3-year gap between the 800MHz/900MHz/1800MHz auction and the 2.6GHz award;

– Ireland: many possible band prices depending on the method used to disaggregate package prices and the 2.6GHz proxy value used, and the fact that 1800MHz is more valuable in Ireland than in the UK because 2.6GHz spectrum has not yet been auctioned.

Similarly, Ofcom classifies Romania's 900MHz benchmark as Tier 3 – less informative than the 900MHz Tier 2 values from Spain and Portugal. This is on the basis that the Romanian values reflect reserve prices set by the regulator. But this is also true of Spain and Portugal, where 900MHz sold at reserve and prices were not determined by bidding.[15]

The other reason provided for Romania's Tier is that 2G is much more important in that country than in the UK. It is unclear why this relegates Romania to Tier 3 while the following do not impact Portugal or Spain's status as Tier 2 benchmarks:

– 2G is also much more important in Portugal than in the UK - Ofcom has not presented any statistics (e.g. the proportion of 2G traffic across countries) to justify its decision, so there is no way to tell whether Romania is indeed an outlier;
– Ofcom ignores the existence of 'obvious contenders' for 900MHz in both Portugal and Spain;[16] and

[14] Paragraph A8.115 cite P. Cramton & A. Ockenfels, The German 4G Spectrum Auction: Design and Behaviour (June 2014), p. 4. Available at http://www.cramton.umd.edu/papers2010-2014/cramton-ockenfels-german-4g-auction.pdf
[15] In Portugal, 800MHz and 900MHz sold at reserve (and one sub-1GHz lot went unsold). In Spain, the lowest 800MHz block and all 900MHz spectrum sold at reserve.
[16] In Portugal, due to pre-existing allocations and the sub-1GHz cap, only Vodafone could buy a 900MHz lot that was contiguous with its existing frequencies, which it won. The lack of bids from Optimus and TMN for the other (unsold) lot indicates that their valuation for non-contiguous spectrum was below reserve. The Spanish Nov 2011 auction made available

– the amount of spectrum available – two 900MHz blocks in Portugal and one in Spain vs the entire band in Romania – and the fact that the 800MHz and 900MHz Spain prices used by Ofcom are from different auctions.

In our view, Ofcom is not in a position to draw these distinctions because the impact of these factors on market value is essentially unknown. Ofcom is also very uncertain about the extent to which its benchmarks reflect market value (as show in Tables A8.1 and A8.2 of the consultation).

We continue to believe that Germany 1800MHz should be in Tier 1. In our view, Romania 900MHz does not deserve that status (as spectrum sold at reserve, there was unsold spectrum and package prices need to be disaggregated), but it should certainly be accorded the same status as Portugal and Spain and more weight than Denmark and the excluded benchmarks. Table **5** reflects these changes (in blue).

Ofcom is more conservative in its determination of 900MHz value than the 1800MHz value.

Our final concern is that Ofcom has not been equally conservative in its determination of the 900MHz and 1800MHz lump-sum values. In the case of 900MHz Ofcom is conservative in two respects:

– Ofcom sets an initial value of £25m per MHz, towards the lower end of the Tier 1 benchmarks – which in its view would be appropriate if only those values were considered; and
– It then reduces the value further to £23m per MHz, to take account of the Tier 2 benchmarks (Portugal's £21.8m per MHz and Spain's 23.2m per MHz).

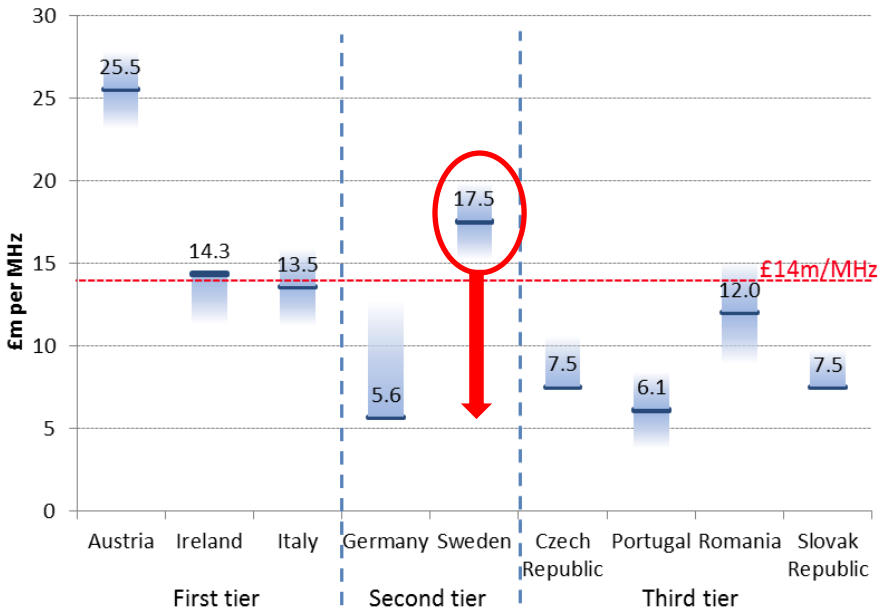
In the case of 1800MHz, Ofcom also sets an initial lump-sum (£14m per MHz) in the bottom half of its Tier 1 values But the figure is not then reduced to take account of the Tier 2 benchmarks on the basis that those values (Germany's £5.6m per MHz and Sweden's £17.5m per MHz) are less consistent – one is above and one below the initial value of £14m per MHz.

However, as shown in Table 8 above the reason for the very different 1800MHz Tier 2 benchmarks is that Ofcom uses of a proxy value instead of the actual value from Sweden's 2008 2.6GHz auction. If the correct

a single 900MHz lot released by Telefonica (who eventually won it), which was adjacent to Telefonica's and Vodafone's 900MHz existing holdings.

value from Sweden is used, the resulting UK 1800MHz estimate from Sweden would be £5.5m per MHz, almost the same as Germany's £5.6m per MHz.

Figure 4: Ofcom should have been more conservative with its 1800MHz UK value.



Source: Figure 3.3 of the Consultation

Following the same logic applied to 900MHz, Ofcom should then have reduced its initial 1800MHz lump-sum value of £14m per MHz to take account of its Tier 2 benchmarks. This would have ensured a consistent application of its conservative approach.

A more inclusive benchmarking approach produces an 1800MHz UK lump-sum value of £7.6m per MHz, and a 900MHz lump-sum value of £21.4m per MHz.

A key difficulty with the benchmarking exercise is that there are not many recent EU awards. We have adopted the following principles to address this problem:

– the overall approach should be inclusive and make use of as many data points as possible;
– the classification of benchmarks into Tiers should be based on clear and objective criteria; and
– a two-Tier framework reduces the range of possible values, minimising the scope for subjectivity while still recognising key differences in the quality of individual benchmarks.

Table 10 summarizes our classification of individual benchmarks based on these principles. This is discussed in further detail in Section 4 of the Analysys Mason and Aetha report.

Table 10: Three's proposed classification of evidence points.

1800MHz						
Country	**Price can't be inferred**	**Use of proxy**	**Unsold spectrum**	**Large gap between auctions**	**Spectrum sold at reserve**	**Tier**
Austria	✓			✓		2
Czech Rep			✓		✓	2
Germany						1
Ireland	✓	✓				2
Italy						1
Portugal			✓		✓	2
Romania	✓		✓		✓	2
Slovakia	✓				✓	2
Sweden				✓		2
900MHz						
Austria	✓					2
Ireland	✓					2
Portugal			✓		✓	2
Romania	✓		✓		✓	2
Spain					✓	2

Source: Section 4.1 of the Analysys Mason/Aetha Report.

Our framework recognises Tier 1 status to recent benchmarks from multi-band SMRA auctions in the EU where all relevant bands sold above reserve. Only the German 2010 and Italian 2011 1800MHz benchmarks meet that test. All other 900MHz and 1800MHz benchmarks are Tier 2. This reflects the fact that there is significant uncertainty about them, and no sound basis for drawing distinctions about the extent to which they are informative of UK value.

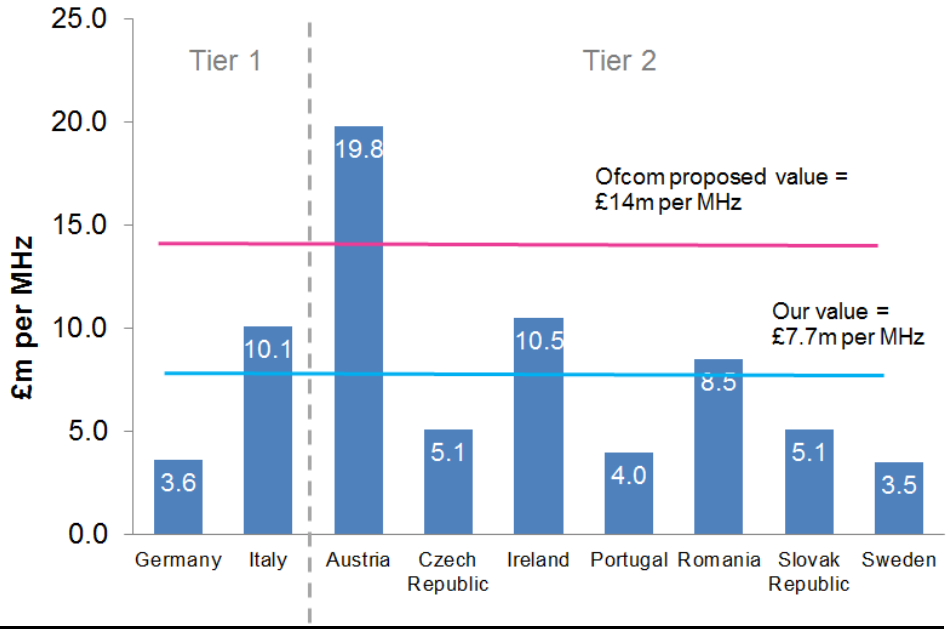
Our previous response invited Ofcom to assign explicit weights to its evidence and use a weighted average as its proposed lump-sum value. Ofcom continues to prefer a 'non-mechanistic' approach, with weighted average values used as cross-checks. We have no particular objection to this. Both approaches should produce similar values if consistently applied.

Annex D presents the data inputs we have used to calculate our proposed lump-sum values, namely:

– Our UK 800MHz values (with and without coverage obligation, gross and net of co-existence costs) and 2.6GHz values, set out in Table 2;
– Three's corrected input values from recent EU auctions, and the resulting UK 900MHz and 1800MHz estimates; and
– Our proposed two Tiers and weights (2 for Tier 1 and 1 for Tier 2) and the classification set out in Table 10.

As shown in Figure 5, our proposed 1800MHz lump-sum value is £7.7m per MHz. Our value is very close to the simple average value of all 1800MHz data points (£7.8m per MHz), reflecting an inclusive approach to the benchmarking exercise. Our proposed value should be an upper bound because it is based on the weighted average value of our 1800MHz distance estimates, and includes no discount to reflect Ofcom's conservative approach. If a small discount is applied (as is proposed in the Analysys Mason and Aetha report), then the resulting lump-sum value for 1800MHz is £6.5m per MHz.

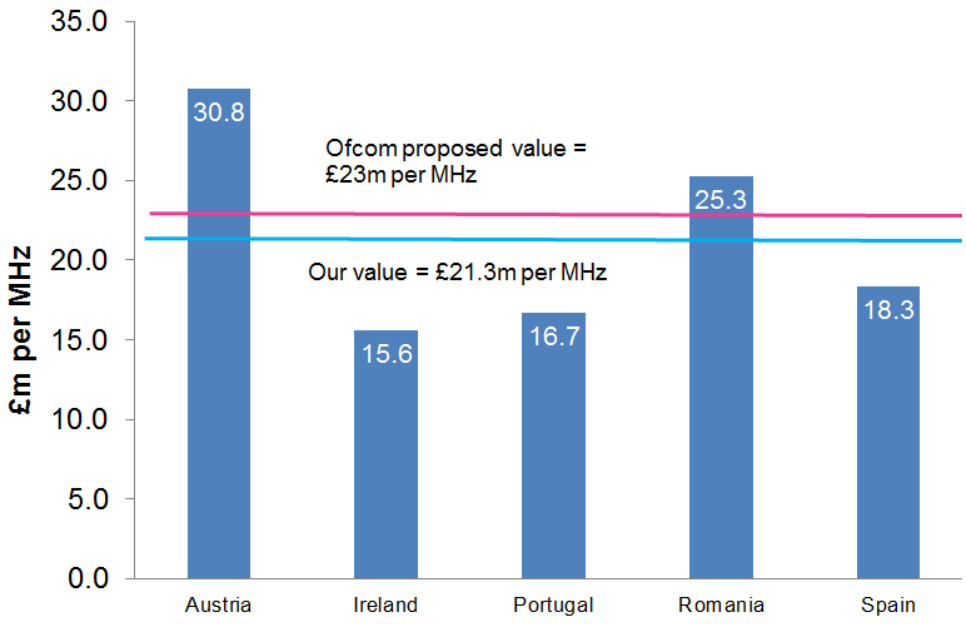
Figure 5: Three's proposed 1800MHz UK lump-sum value.



Source: Three.

Our proposed 900MHz lump-sum value is £21.3m per MHz. Given that all of our 900MHz benchmarks carry the same weight, the lump-sum value is the same as the simple average 900MHz value, and slightly lower than Ofcom's proposed £23m per MHz. If a small discount is applied to reflect a conservative approach (as is proposed in the Analysys Mason and Aetha report), then the resulting lump-sum value for 900MHz would be £19m per MHz

Figure 6: Three's proposed 900MHz UK lump-sum value



Source: Three.

Section 7 of the Analysys Mason and Aetha report criticise Ofcom's 1800/900 cross-check, which is solely based on Austria and Ireland. The ratio of our proposed lump-sum values (36%) is much closer to the geometric mean of the benchmark ratios, suggesting that our proposed lump-sum values are much more robust than Ofcom's.

Table 11: Our proposed 1800/900 ratio is much lower than Ofcom's

	900MHz	1800MHz	1800/900 ratio
Ireland	39.6	25.2	64%
Ofcom UK	23.0	14.0	61%
Austria	79.4	48.6	61%
Greece	32.8	14.5	44%
Denmark	2.9	1.2	43%
Romania	47.3	19	40%
Three UK	21.3	7.7	36%
Portugal	24.9	3.2	13%
Geometric mean			**40%**

Source: Section 7, Analysys Mason and Aetha report.

3. Three disagrees with Ofcom's rejection of technical evidence as to the value of 900MHz spectrum.

Ofcom's updated approach to estimating the value of 900MHz spectrum in the UK relies on:

– estimating the value of 800MHz spectrum in the UK; and
– adjusting it for a 900MHz/ 800MHz price ratio, based on the evidence from international benchmarking evidence.

In its previous consultation, Ofcom proposed to take technical and commercial evidence into account as well, but has now decided against this.

We disagree with this, as a comparison of technical characteristics and commercial opportunities of 800MHz and 900MHz shows that they are of almost identical value.

Three therefore suggests that for 900MHz, international benchmarking evidence and technical/commercial evidence should be given equal weight, namely:

– international benchmarking evidence implies a lump-sum value of £21.3m per MHz; and
– technical/ commercial evidence implies a lump-sum value of £25.0m per MHz, i.e. the same as 800MHz.

Hence, we consider that £23.2m per MHz is the most appropriate lump-sum value of 900MHz spectrum.

In contrast, we agree with Ofcom that technical or commercial evidence is unsuitable for estimating the value of 1800MHz spectrum, owing to its lack of technical proximity to either to 800MHz or 2600MHz spectrum.

Ofcom states that the model it used to value 700MHz spectrum is not fit to estimate the relative values of 800MHz and 900MHz:

> *"The model as currently designed and specified does not distinguish between 800 MHz and 900 MHz spectrum. In principle it would be possible to introduce additional assumptions to attempt to capture the difference in device ecosystems and other factors.*
>
> *However, there is considerable uncertainty about the relevant assumptions to make and the results would be highly sensitive to the input assumptions. In addition, the model's focus on network cost savings may not fully capture the difference in commercial value between the two bands."*[17].

[17] Ofcom's Consultation, [A9.23-[A9.24]], page 6

The 900 MHz band is currently widely used to serve the 3G customers (the largest part of the customer base) and the remaining 2G customer. It is also liberalised for 4G in the UK (i.e. MNOs are able to refarm it for 4G when they chose to do so) and being rapidly deployed now for 4G across the in other European and global markets[18].

In the UK, 900MHz also enjoys a higher transmission power limit than the 800MHz band, further increasing its value (owing to incrementally better coverage and capacity). All these factors suggest that the technical and commercial value of 900MHz spectrum is no less than the value of 800MHz spectrum (and possibly higher)[19].

Turning to the evidence from the European auction, we identify two factors that could cause prices of 900MHz and 800MHz to diverge in the short run. These are:

1 **Relative abundance of 900MHz spectrum**: there was 2x35 MHz of 900 MHz available vs. 2x30 MHz of 800 MHz.
2 **Differences in auction design:** differences in spectrum caps help to explain why 900MHz spectrum was relatively cheap in some countries (compared with 800MHz spectrum).

We consider that these factors have caused the prices of 900MHz spectrum to deviate from the prices of 800MHz spectrum in the short run. This, however, does not mean that 900MHz spectrum is less valuable than 800MHz spectrum in the long run. Three made previous submissions and continues to maintain that 900MHz and 800MHz spectrum are equally valuable. Ofcom should take technical evidence into account and set the ALF for 900MHz spectrum based on both the benchmarking evidence and technical evidence.

Based on the benchmarking evidence (presented in Section 2), the lump-sum value of 900MHz is £21.3m per MHz. However, based on the technical evidence, 900MHz should be valued at £25.04m per MHz (i.e. equal to the 800MHz value). We propose to take the average between these two values and use £23.17m as the most appropriate lump-sum value of 900MHz spectrum.

Below, we explain each factor in turn, highlighting how it affected the relative prices of 900 vs. 800 in the short run.

[18] "For example, LTE in 900MHz spectrum (3GPP band 8) – market status", GSA, August 2014, highlights that 4G is currently deployed in the 900MHz band in five networks globally (compared to 55 in the 800MHz band) and available in 335 devices (compared to 467 in the 800MHz band). This excludes the recent launch of 4G 900MHz by T-Mobile in the Netherlands.
[19] For the avoidance of doubt, we are not advocating using technical modelling to gauge market value of 1800MHz spectrum because 1800MHz spectrum does not have a good comparator spectrum band that has recently been auctioned.

Relative abundance of 900MHz spectrum contributed to its lower price.

One factor that affected the relative price of 900MHz spectrum is its relative abundance – 2x35MHz vs 2x30MHz of 800MHz spectrum. Competition for 800MHz spectrum was particularly fierce in countries with four operators present (e.g. Italy, Ireland, Germany). Incumbent operators felt they needed to obtain 2x10MHz of 800MHz spectrum each in order to provide good coverage and to have enough capacity to serve their customer base. In most of these countries, the price of 800MHz spectrum was bid up high and the challenger operator was left with no 800MHz spectrum.

Auction dynamics tended to be different in bidding for 900 MHz spectrum (in countries where it was auctioned). Like 800MHz spectrum, 2x10MHz of 900MHz spectrum was considered sufficient by incumbents to serve their existing 2G/3G customer base. This left 2x5MHz spectrum for the fourth ("challenger") operators. While this amount (2x5MHz) may have been considered insufficient by a large operator, for a small operator, it was preferable to get some low frequency spectrum than none. Indeed, small operators were clearly not in a position to outbid incumbents and to win 2x10MHz of 900MHz spectrum as their valuation of spectrum was lower due to much smaller customer base, as recognised in Ofcom's competition assessment for the UK 800MHz and 2600MHz auction.

Therefore, less intense competition for 900MHz spectrum in some countries (e.g. Ireland) partly reflects differences in the amount of spectrum available (2x35MHz vs. 2x30MHz of 800MHz). This, however, does not mean that 900MHz spectrum is less valuable in the long run.

Specific features of auction design could affect relative prices of 800MHz and 900MHz.

It appears that differences in relative prices, at least to some extent, can be attributed to differences in auction design, specifically to spectrum caps. Very few spectrum auctions had no spectrum caps in place (the 2008 US 700MHz auction is one example where almost no restrictions were put in place). These auctions typically produced very concentrated spectrum holdings. For example, in the US, only two operators out of four national operators won significant 700MHz spectrum. In order to avoid such an extreme concentration of spectrum, regulators around the world tend to impose spectrum caps to restrict maximum amount of spectrum any one operator could hold.

If spectrum caps are not too high and genuinely constrain operators' behaviour, they tend to be binding, i.e. some operators win the amount of spectrum up to the cap. For example, in the UK, both Vodafone and Telefonica won 2x10MHz of 800MHz spectrum (equal to their sub-1 GHz cap), while EE won 2x105MHz in total – equal to its total spectrum cap.

Spectrum caps therefore clearly affect auction outcomes. In Ireland, for example, each operator could win no more than 2x20MHz of sub-1GHz spectrum (across both 800MHz and 900MHz spectrum bands). There was also a cap on 900MHz spectrum in time period 1 (up until July 2015) – 2x10MHz. These two caps effectively created a focal point for the bidders: each incumbent operator protected its 900MHz spectrum holdings, but did not try to expand them, as it would have reduced their ability to bid for 800MHz. As a result, Meteor, Telefonica and Vodafone won 2x10MHz of 900MHz and 2x10MHz of 800MHz spectrum each, while Three won the remaining 2x5MHz of 900MHz spectrum (a block which was not in use before the auction). A combination of the spectrum caps and relative scarcity of 800MHz spectrum (compared with 900MHz) contributed to higher relative prices of the 800MHz band in Ireland.

In Austria, there were three caps: the sub-1GHz spectrum cap was set at 2x35MHz; the 800MHz cap – at 2x20MHz and the 900MHz cap – at 2x30 MHz. Given that the band-specific caps exceeded the sub-1GHz cap, it was less straightforward for the bidders to converge to any pre-determined outcome (e.g. the incumbent protects its legacy spectrum holdings and bids up to the sub-1GHz cap on 800MHz). As a result of the caps' being high and non-additive, all operators gained or lost some of the legacy spectrum (900MHz or1800 MHz). Overall, the result in Austria – higher relative price of 900MHz – was arguably driven by the auction design (high non-additive spectrum caps).

These two examples demonstrate that auction design matters: the outcomes can be very different in countries with broadly similar characteristics, but different auction design (e.g. different spectrum caps).

The two factors discussed above caused the relative price of 900MHz and 800MHz spectrum to diverge in the short run. This, however, does not mean that 900MHz spectrum is less valuable than 800MHz spectrum in the long run. It has very similar propagation characteristics and it is expected to be a very close substitute to 800MHz in near future. Three made previous submissions and continues to maintain that 900MHz and 800MHz spectrum are equally valuable. Ofcom should take technical evidence into account and set the ALF for 900MHz spectrum based on both the benchmarking evidence and technical evidence.

Based on the benchmarking evidence (presented in Section 2), the lump-sum value of 900MHz is £21.3m per MHz. However, based on the technical evidence, 900MHz should be valued at £25.04m per MHz (i.e. equal to the 800MHz value). We propose to take the average between these two values and use £23.17m as the most appropriate lump-sum value of 900MHz spectrum.

4. Three disagrees with Ofcom's cost of debt for converting lump-sum values to ALFs.

Ofcom's revised proposals determine the appropriate discount rate for converting lump-sum values to ALFs Ofcom concludes by:

- using a cost of debt, rather than WACC, for the discount rate to convert the lump-sum values of 900MHz and 1800MHz into ALFs;
- treating lump-sum spectrum as 100% debt financed, rather than equity financed; and
- using the CPI inflation measure, rather than the RPI.

Three strongly agrees with this approach.

The cost of debt discount rate for converting lump-sum values to ALFs should reflect the relevant risks to the Government of the ALF payments, which Three considers the corporate cost of debt does not.

In Three's analysis, the relevant risks to the Government of the ALF payments are near risk-free. Three estimates that the relevant discount rate should be at a premium at most of 0.2% over the risk-free rate, implying a pre-tax real CPI discount rate of 2.7%.

This value is recommended in our expert report by Economic Insight, appended at Annex C.

Three disagrees that MNOs' WACC is a polar case for the relevant discount rate.

In determining the relevant discount rate for converting the lump-sum values of spectrum into ALFs, Ofcom suggests considering two polar cases, namely:

- if the ALF payment were the same as the risk of the future after-tax cash flows associated with the spectrum, then the discount rate may be approximated by the MNOs' WACC, of 5.1%;
- if the ALF payment were completely fixed, regardless of circumstances, then the ALF would be akin to some form of highly secured debt and the correct discount rate would correspond to the interest rate on such an instrument, which Ofcom suggests as 2.6% (4.13-4.15)

Ofcom then suggests that the ALF obligation appears to have a number of features which means that it is close to its suggested debt rate case rather than the WACC case, and that in taking a conservative approach, Ofcom therefore proposes to use the debt rate case discount rate, of 2.6% (real, after-tax) (4.17, 4.25).

Three nevertheless considers that neither of Ofcom's suggested "polar cases" can correctly be described as polar cases for setting the relevant discount rate.

First, Three disagrees that if the ALF payment were the same as the risk of the future after-tax cash flows associated with the spectrum, then the discount rate may be approximated by the MNOs' WACC. This is because MNOs' WACC reflects many additional business risks unrelated to and on top of the value of spectrum.

In particular, the business risks associated with spectrum, especially incremental higher frequency spectrum such as 1800MHz, are much narrower than MNOs' overall business risks reflected in the WACC. This is because the market value of 1800MHz, at the margin, is determined by the costs of technological substitutes for increasing network capacity, such as adding additional cell sites or cell-splitting.

In comparison, overall business risks, as reflected in MNOs' WACC, include a much wider range of external factors, chiefly consumer demand and the intensity of competition.

Second, 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.

Third, Three's (and we believe the industry's) reasonable expectation of Ofcom revising the current proposed ALFs within 20 years of them coming into force is nevertheless low, as:

– Ofcom has not committed to in what circumstances it will review future ALFs, except not for at least five years and only then if there were grounds to believe that a material misalignment had arisen between the level of these fees and the value of the spectrum (6.28);
– there is unlikely to be any significant new international European benchmark information on 900MHz or 1800MHz spectrum values within the next 20 years, given the recent auctions of these bands across Europe and associated licence terms of around 20 years or indefinite terms; and
– based on the experience of the current fees for 900MHz and 1800MHz (Administered Incentive Pricing, AIP), Ofcom has not

revised these since they were first introduced in 1998 (even for inflation).

It is also a legitimate fear among licensees that Ofcom is more likely to revise ALFs if there is evidence that ALFs are too low than too high, given Ofcom's discretion as to when it might consider to review ALFs and Government's interest in higher rather than lower fees. This creates an asymmetric risk in favour of the Government and against licensees, through the underlying regulatory option to revise fees upwards but not downwards.

Indeed, Three considers that the most likely situation in which ALFs would be revised downwards is in the event of a licensee handing back spectrum to the Government – owing to the ALF being above its value to the licensee (or to any other licensee who might be interested to acquire it).

Moreover, if the future revision of ALFs represented a sharing of risk between MNOs and the Government, then this should have the effect of lowering MNOs' WACC. There is nevertheless no analysis of this in Ofcom's recent reviews of MNOs' WACC[20] nor apparent expectation of this among independent industry analysts or commentators.

Hence, Three considers that the probability that the Government shares any meaningful risk of the overall licensee's cash flows is remote. Therefore is it both inaccurate and misleading for Ofcom to define the MNOs' WACC as (the upper-bound) polar case for the relevant discount rate.

Three disagrees that the corporate cost of debt is also a polar case for the relevant discount rate.

Ofcom proposes that a debt rate of 2.6% (pre-tax real CPI), reflecting MNOs' unsecured corporate bond rates, is a lower bound polar case for the relevant discount rate. Three disagrees with this.

First, Ofcom notes that, if the ALF payment were completely fixed, regardless of circumstances, and MNOs had no option but to pay this level of fee, the ALF would effectively be akin to a form of highly secured debt and the correct discount rate would be the corresponding interest rate for such a debt instrument. (4.13)

[20] Such as in Ofcom's current Mobile call termination market review.

This itself implies that the lower bound polar case should reflect the risk associated with the ALF payments, which in the situation where the MNOs had no option but to pay this level of fee, would by definition be risk-free to the Government. This suggests that the lower bound polar case should be the risk-free rate – and/or should reflect the extent that relevant risks to the Government of the ALF payments are not risk-free.

Second, Three considers that the risk to the Government of the ALF payments is effectively risk-free, as:

1 the underlying asset (the spectrum licence) is not merely highly secured, but remains in the Government's ultimate ownership in all circumstances and its use can be revoked by Ofcom for non-payment, for other non-performance of other licence conditions or for "spectrum management" reasons at any time at Ofcom or Government's decision;

2 spectrum is a non-depletable asset, meaning that Government will always be able to recover 100% of its market value in the event of being revoked or handed back;

3 provided that ALF is set at (conservative) market value, as required by the Government Direction, or less, then the underlying licences should always have a positive market value (net of future ALF payments) to at least one MNO in the market – hence if one licensee is unable or unwilling to continue making the ALF payments, then sale to another MNO should always be available rather than handing back the licence to Ofcom, meaning that there should be no loss of ALF to the Government of a "fallow period", even for a short period[21];

4 the only likelihood that a licence is handed back to Government is if the ALF is significantly above market value (implying a net negative value to the licence, net of ALF payments) – but in this situation, Government will already have been over-compensated and ALFs will be overdue for revising downwards; and

5 in the event that a licensee becomes bankrupt then Government should easily be able to recover any unpaid ALF from the licensee's assets, being the highest ranking creditor (along with any other unpaid taxes), and the licensee's liquidators should easily be able to sell the licence (as above) to raise further funds, again leading to no loss to the Government.

Hence, from the Government's perspective, ALF payments are for all relevant purposes risk free and the risk-free rate should therefore be the relevant discount rate for converting lump-sum values into the ALF rates.

[21] Ofcom's suggestion that the probability of default is likely to be higher than other forms of debt (4.18) is appears spurious. Indeed, Ofcom's first consultation recognised that handing back spectrum would have significant negative implications for MNOs, namely, of ceasing business or dramatically limiting the number of customers that it can serve. As above, an MNO would only rationally hand back spectrum if the ALF were above market value that it or any other MNO were willing to continue paying.

Three therefore considers that the relevant discount rate should be 2.5% in pre-tax real CPI terms. This also reflects Three's view that Ofcom has slightly over-estimated the underlying risk-free rate, as evidenced in Annex C below.

At most Ofcom should allow a small premium on top of the risk-free rate to allow for any small perceived risk of a fallow period and associated loss of ALF income during this period. We estimate at most this should be around 0.2%, based on a:

– maximum expected probability of default per year of [2.5%] (weighted across all the 900MHz and 1800MHz licences);
– an average expected fallow period of 18 months; and
– an expected recovery rate of the value of the spectrum licences of 93%.

We consider that these all extremely conservative assumptions and represent the correct upper bound on the relevant cost of debt for setting the discount rate. This would imply a pre-tax real CPI discount rate of 2.7% and corresponding post-tax real CPI rate of 1.7%.

Please refer to Economic Insight's expert report commissioned by Three on Ofcom's proposed discount rate for setting ALFs, appended at Annex C, for further evidence and analysis in support of Three's position.

Ofcom should not now need to make any tax adjustment for setting ALFs.

Ofcom concludes that, as the ALF is close to being of form of debt instrument, this implies that the ALF payments displace 100% debt capacity and therefore that Ofcom needs to capture the tax deduction of interest payments for such a lump sum payment (4.32). Three agrees with this.

Ofcom then states that the tax deduction for interest rates is embedded 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" (4.32).

Three is puzzled as to this approach and to Ofcom's non-standard concept of an "after-tax" debt rate. This is because 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, the relevant discount rate should simply be the cost of debt (namely, Ofcom's "pre-tax" cost of debt) and no further tax adjustment should be necessary. This would be a much simpler and more transparent approach than Ofcom's current method.

Indeed, Ofcom's apparent motivation for continuing with a tax adjustment approach is an erroneous assumption that licensees would not revalue their licences to reflect market value, even on a periodic basis. Financial reporting rules nevertheless require companies to conduct revaluation reviews of all assets on a periodic basis and to restate them accordingly.

Hence, Three considers that Ofcom should just use the standard (pre-tax) cost of debt, as proposed above, as the relevant discount rate for converting lump-sum spectrum values to ALFs.

5. Three disagrees that Ofcom has made an adequate impact assessment of its proposals.

At paragraph 1.42 of the Consultation, Ofcom notes that in response to Ofcom's October 2013 consultation a number of stakeholders have called for Ofcom to carry out a full impact assessment in relation to its proposals for revising ALFs. In particular, stakeholders complained that when revising ALFs, Ofcom needed to demonstrate that its approach to setting ALFs (and the specific levels of ALFs 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."*

At paragraphs 1.43 and 1.44, Ofcom disagrees with this view and makes reference to how it has implemented the Government Direction to date, including by way of carrying out certain impact assessment work (aspects of which have been updated in the current Consultation).

Three nevertheless remains of the view that Ofcom has not conducted an adequate impact assessment of its ALF proposals, as required by its statutory duties. In particular, Ofcom has not adequately considered the impact of ALFs on the wider mobile communications market, especially in terms of competition, future investment and consumer retail prices.

Ofcom has obligations to both act in accordance with the Government Directions and discharge their statutory duties when proposing new ALF fees. In Three's view, Ofcom needs to further show how such requirements have been met.

Annex A Power Auctions report.

Annex B Analysys Mason and Aetha Consulting report.

Annex C Economic Insight report.

Annex D Data inputs used for our lump-sum estimates.

This Annex presents the data inputs we have used to calculate our proposed lump-sum values, namely:

– Our UK 800MHz (with and without coverage obligation, gross and net of co-existence costs) and 2.6GHz values;
– Three's corrected input values from recent EU auctions, and the resulting UK 900MHz and 1800MHz estimates; and
– Our proposed two Tiers and weights (2 for Tier 1 and 1 for Tier 2), and the classification set out in Table u.

Our proposed UK 800MHz and 2.6GHz values from Section 1 are as follows:

Table 12: Three's proposed 800MHz and 2.6GHz UK values

£m per MHz	Without coverage obligation	With coverage obligation
800MHz, net of DTT costs	£25.04m	£23.49m
800MHz, gross of DTT costs	£28.04m	£26.49m
2.6GHz	£3.57m	-

Source: Three

The individual data points, resulting 900MHz and 1800MHz UK values and our Tiers are shown in Table 13. This is identical to Table 3.1 of the Consultation, except for minor corrections highlighted in yellow. These are explained in Section 5 of the Analysys Mason and Aetha report.

Table 13: Results of European Auctions

£m per MHz, UK equivalent	800MHz	900MHz	1800MHz	2.6GHz
Austria	72.2	79.4	48.6	1.9
Czech Republic	44.1		6.0	3.0
Germany	52.9		1.9	1.6
Ireland	63.5	39.6	25.2	6.8
Italy	52.1		16.7	3.8
Portugal	37.3	24.9	3.3	2.5
Romania	43.9	47.3	19.0	10.6
Slovakia	38.5		7.1	4.6
Spain	40.4	26.4		1.9
Sweden	21.2		9.3	9.3
Simple average	**46.6**	**43.5**	**15.2**	**4.6**

Source: Three, based on Figure 3.1 of the Consultation

The resulting UK values based on the 900MHz/800MHz ratio for 900MHz and the distance method for 1800MHz are as follows.

Table 14: Our proposed 900MHz and 1800MHz values

	900MHz			1800MHz		
£m per MHz, UK equivalent	900/ 800	900	Weight	D	1800	Weight
Austria	110%	30.8	1	66%	19.8	1
Czech Republic				7%	5.1	1
Germany				1%	3.6	2
Ireland	62%	15.6	1	32%	10.5	1
Italy				27%	10.1	2
Portugal	67%	16.7	1	2%	4.0	1
Romania	108%	25.3	1	25%	8.5	1
Slovakia				7%	5.1	1
Spain	65%	18.3	1			
Sweden				0%	3.5	1
Weighted average			**21.3**			**7.7**

Source: Three.