Summary

This is a significant piece of work and we appreciate the effort that Ofcom has made to make its analysis and logic clear.

Ofcom's proposals however are based on four fundamental but unsubstantiated and incorrect assertions:

- that competition and consumers would be harmed if only three 'national wholesalers' were to provide higher quality data services in the future;
- that Vodafone currently has a near-term route to providing an LTE network (of unrivalled quality) by using its existing holding of sub-1GHz spectrum;
- that, knowing this, Vodafone could and would bid 'strategically' in the upcoming auction to exclude its rivals; and
- that EE, as an 1800MHz operator, must acquire sub-1GHz spectrum in order that it too can provide a competitive LTE network.

None of these assertions are borne out by the facts and therefore the case for the proposed spectrum floors is fatally undermined and should not be pursued further. Instead, we would invite Ofcom to examine again in some detail its assumptions before proceeding to draw up a framework for the auction.

We also believe that there are a number of material deficiencies in the proposed structure of the auction that require remedy before any final decision is adopted.

Material shortcomings in Ofcom's approach

The three largest national wholesalers currently compete vigorously to supply wholesale access to at least 16 retail operators. There is no evidence that this competition is waning and accordingly that unsuccessful bidders in the auction would be unable to conclude access arrangements in future. Ofcom has erred in failing to take this into account when undertaking the competition assessment that appears to be the foundation for its auction design.

Spectrum in the 900MHz band is not in reality available for the deployment of an LTE network. Quite simply, Vodafone cannot clear and use its 900MHz band for LTE in time to compete with either EE or [✂]. That Ofcom *does not even consider* the feasibility of using the existing 900MHz spectrum for LTE — and to date has not undertaken any meaningful investigation into this matter [✂]

[✂]

EE however is in a different position. It alone amongst UK operators already has sufficient usable spectrum (and infrastructure) to deploy an LTE network. This was recognised by the European Commission and indeed it was fundamental to the requirement that the merged parties divest some 1800MHz spectrum. Moreover, Ofcom's own technical analysis shows, even *before* correcting for its errors, that EE's 2x20MHz 1800 network would be of a superior quality to [✂]. The special treatment afforded to EE through Ofcom's specification of the spectrum floors cannot be justified and, more seriously, it risks re-creating the very competitive distortion that the Commission sought to prevent by agreeing the divestment undertakings.

Deficiencies in the auction design

The mechanical linking of the annual licence fees to the amounts paid in the auction will distort the bidding process, the outcome of that auction and future competition. [✂] We propose an alternative method which builds on Ofcom's established practice of setting annual spectrum fees; is consistent with the Direction from Government and will not interfere with the outcome of the auction. We also suggest that the proposed coverage obligation is considerably more expensive to meet than Ofcom believes [✂].

A way forward

If the auction is simply allowed to run without restrictions then there is a possibility that the smallest operator (and others) will fail to acquire any sub-1GHz spectrum; not because the other MNOs will bid strategically but because they simply put a higher value on the spectrum. This is what happens in a competitive market and it is what happened in the German auction. All the currently available evidence suggests that those unsuccessful operators would then successfully conclude a commercial wholesale arrangement with one of the successful bidders. Failing this, Ofcom could intervene *ex post* or even *ex ante* by attaching a wholesale access obligation to one or more of the 800MHz lots (as it contemplates in this consultation).

[✂]

Failing this, Ofcom should just let the auction run. The only restriction necessary is that no operator should be allowed to acquire more than 2x10MHz of 800MHz in order to prevent the bifurcation of the market that the Commission was keen to avoid.

Vodafone Limited
June 2011

Introduction

There are a number of steps in the argumentation which underpin Ofcom's analysis and the consequent specification of spectrum floors:

- A separate market for higher quality data services is likely to develop;
- A four player market of national wholesalers is required for sufficient retail and wholesale competition within this future market;
- A mix of sub-1GHz and higher frequencies is required to be able to compete in the future (using LTE) in this market because a national wholesaler without any sub-1GHz spectrum may 'struggle to match' the quality of services offered by an operator with 2x20MHz of contiguous sub-1GHz spectrum;
- Spectrum must be held rather than 'rented' through network access agreements because those without holdings of the critical sub-1GHz would be in a weak bargaining position to secure such arrangements;
- Ofcom can define a number of 'spectrum floors' which specify the minimum amount of spectrum that is required to be able to compete in the new data world;
- Vodafone and O2 each has enough sub 1-GHz spectrum to qualify for a place on the spectrum floor already and therefore neither needs to acquire sub-1GHz spectrum in the auction. Neither of these statements applies to either 3 or EE.
- If the auction were allowed to operate without restrictions then both Vodafone and O2 would bid strategically to exclude either EE or 3 (or both) from competing in the putative higher quality data services market in order to preserve their unmatchable competitive advantage;
- Ofcom needs to set high reserve prices in order to ensure that purchasers of the 'reserved' spectrum have the wherewithal to be able to compete;
- Ofcom can set an in-building coverage obligation to 95% of the population on one lot of the 800MHz band such that the costs of compliance will be relatively low;
- Ofcom can set the AIP for both 900MHz and 1800MHz spectrum based on the price per MHz achieved in the auction without distorting its outcome.

Unfortunately we find that much of Ofcom's analysis is either insufficiently substantiated or plainly wrong.

There are two relatively recent decisions which are relevant to our response and to which we refer throughout this document: the decision of the European Commission to allow the merger between Orange and T-Mobile subject to conditions[1] (including the OFT's request for a reference back to the UK)[2] and the decision by Ofcom to allow Vodafone and O2 to use their 900MHz spectrum for UMTS.[3] We believe that the salient points, for the purposes of this response, from these decisions are as follows:

Re-farming decision

- Ofcom concluded that there was little likelihood of a competitive distortion as a consequence of allowing Vodafone (and O2) to use its 900MHz spectrum for 3G. It recognised that, because of the merger, EE, and to a lesser extent 3 through its network sharing arrangement with EE, is in the strongest position in terms of network capability for providing UMTS services. It has the largest amount of 2100MHz spectrum and access to the largest number of base station sites. Both operators would be able to improve their coverage (if required) and consequently reduce any competitive advantage that O2 or Vodafone might realise from using 900MHz spectrum for the provision of 3G services.

- Ofcom also concluded that a UMTS 900MHz network deployed by O2 or Vodafone could still provide improved quality of coverage to some indoor locations when compared to what Everything Everywhere (EE) or 3 could provide with 2100MHz. However, the extent of the improved quality of coverage is relatively small. The degree of this advantage will be dependent on the construction of buildings and the location of the user within the building. Little or no advantage would exist in many easier to serve indoor locations. In addition, other ways of dealing with poor indoor coverage, such as in-building repeaters and femtocells have become a more plausible strategy for EE/3 to address residual areas of coverage disadvantage.

Merger decision

- The Commission found that through the combination of their existing spectrum holdings T-Mobile UK and Orange UK would be the *only*

[1] Case no/COMP/M.5650 *T-Mobile/Orange*
[2] Office of Fair Trading Request for referral pursuant to Article 9(2) of Council Regulation (EU) 139/2004
[3] Ofcom, *Advice to Government on the consumer and competition issues relating to liberalisation of 900MHz and 1800MHz spectrum for UMTS*, 25 October 2010

mobile operator with the ability to access a 2x20MHz carrier in the short to medium term and therefore be in a position to deploy a 4G network *without recourse to any spectrum to be awarded by Ofcom in the future*. In the 1800MHz spectrum band, the merged entity would have had a total 2x60MHz holding, which would have left it with sufficient spectrum to launch such a network.

- The merged entity had a sufficient holding of spectrum and an established site grid that would enable it to offer 4G services at the maximum 100 megabits per second speed in *"the near future*".[4] The preliminary view of the OFT was that the merged entity would be able to launch a 4G network within two or three years.[5]

- No other mobile operator holds such a surfeit of spectrum that it would be in a similar position to that of the merged entity in terms of its ability to deploy a 4G network. Accordingly, the merged entity would face no credible competitive constraint in the provision of 4G services. This is an outcome that clearly would not operate to the benefit of mobile consumers. Both the Commission and the OFT were provided with illustrative evidence from Vodafone in relation to Australia. In that market, the market leader Telstra was able to act independently of its competitors (most obviously in its pricing) largely because no other network was able to match Telstra's network capability in terms of network coverage and capacity.[6]

- Although the Commission considered that it might be possible for competitors of the merged entity to deploy rival 4G networks in the future using spectrum in the 800MHz and 2.6GHz bands subsequently acquired in auctions, it concluded that the merged entity would: *"have a significant technological and marketing advantage over competitors…be able to offer superior network quality in terms of maximum download speeds, and potentially also in terms of consistency of provision of lower download speeds**…[it] would also have a significant time advantage due to the uncertain timing of the auction and the time needed to clear the sub 1GHz spectrum**."*[7] *(our emphasis)*

- The Commission concurred in the concern expressed by the OFT that the transaction could lead to the creation of a two-tier or "bifurcated" retail market, in which the market would tip in favour of a strong 4G infrastructure operator with a first-mover advantage. Whilst other existing mobile operators might ultimately be able to deploy a 4G network, their service offerings would be likely to be inferior to that of

[4] Commission Decision, paragraph 120
[5] OFT, Article 9(2) request, paragraph 105
[6] OFT, Article 9(2) request, paragraph 109
[7] Commission Decision, paragraph 128

the merged entity, a shortcoming that might not be easily remedied given the time advantage enjoyed by the merged entity.[8] This concern would, as the Commission recognised, apply equally to the wholesale access and origination market.[9]

- The commitments offered by France Telecom and Deutsche Telekom were designed to address the Commission's preliminary conclusion that the merger of their UK operating companies would raise competition concerns arising out of the concentration of spectrum. The Commission accepted that the divestment of 2x15MHz spectrum should prevent competition from being distorted in future by enabling either of O2, Vodafone or 3 to build a competing 4G network.

To summarise:

- the decision to allow Vodafone and O2 to re-farm confers no distortive advantage on these operators. The service provided by either operator can be replicated by EE and 3 using their access to a greater number of sites and alternative technologies. There is therefore no sense in which either EE or 3 needs to be advantaged in the acquisition of sub-1GHz spectrum in order to correct for a current distortion caused by the re-farming decision. Such restorative rough justice, by Ofcom's own analysis, has no basis in evidence. What we establish in this response is that there is no *future* market advantage that Vodafone will enjoy as a consequence of its existing holdings of sub-1GHz spectrum that requires addressing through the proposed spectrum floors.

- the Commission recognised the risk that, without a remedy, the market for high speed broadband services could bifurcate because other operators would be unable to match the service offered by EE using their existing spectrum. If Ofcom were to proceed to adopt the approach proposed in the consultation, there is a clear risk that a two-tier market will emerge that will not operate in the interests of mobile consumers. The fact that technically there may be four infrastructure providers will ultimately be irrelevant if the market structure has been radically altered.

The remainder of our response is structured to cover broadly the flow of the logic in the consultation that we outlined above.

Section 1 – considers Ofcom's competition analysis and the basis for its conviction that four national wholesalers are required for a competitive wholesale and retail market.

[8] OFT, Article 9(2) request, paragraph 110
[9] Commission Decision, paragraph 80

Section 2 – critiques Ofcom's technical analysis including the implicit assumption that Vodafone can use its 900MHz spectrum for LTE in the near future and the relative benefits of sub-1GHz versus higher frequency spectrum.

Section 3 – covers the design of the auction; in particular the possibility of strategic bidding and the linkage of the annual licence fee to the outcome of the auction.

Section 4 – ties our concerns with Ofcom's approach in this consultation to its legal duties

Section 5 – details our conclusions and suggests a way forward

Section 6 – provides responses to the individual questions

Section 1 – Market analysis

Summary

1. As Ofcom rightly recognises in section 5 and Annex 6 of its consultation document, an assessment of existing and future competition in wholesale and retail mobile markets must be a central consideration to be taken into account when drawing up a framework for the auction of spectrum in the 800MHz and 2.6GHz bands.

2. Whilst Ofcom has clearly attempted to undertake such an assessment, Vodafone has material concerns about Ofcom's current analysis of a number of significant issues that inform Ofcom's approach. These are:

   (i) The unsubstantiated assertion that an outcome from the auction resulting in a mobile market with three infrastructure providers is inherently damaging to competition and by implication consumers;

   (ii) Ofcom's failure to take into account relevant evidence from the existing wholesale access market when undertaking its analysis;

   (iii) The weight that Ofcom erroneously appears to attach to the role played by 3 in the market when constructing its framework for the auction;

   (iv) Ofcom's decision to dismiss alternative, more proportionate ways of achieving its objectives;

   (v) Ofcom's error in suggesting that 900MHz is a credible substitute for 800MHz spectrum with respect to early LTE deployment (thus supposedly conferring a significant benefit upon 900MHz spectrum for the purposes of deploying an LTE network);

   (vi) Ofcom's failure to appreciate that its current approach may re-open the competitive distortion that the Commission's remedy in the *T-Mobile/Orange* merger was designed to address and lead to the creation of a two-tier retail mobile market;

   (vii) The absence of a rigorous analysis based on well-established competition law and economic principles when attempting to define relevant product and geographic markets.

3. Regrettably, these current deficiencies, whether considered individually or collectively, cast serious doubts upon the soundness of the approach and framework for the auction of the 800MHz and 2.6GHz frequency bands that are currently proposed in the consultation document. As such, Ofcom cannot safely rely upon the competition assessment it has undertaken to date when deciding upon its approach to the auction.

4. Ofcom's approach to the design of the proposed auction is predicated on the erroneous assumption that it is critical for the maintenance of effective competition to ensure that four national infrastructure operators (described as wholesalers in this consultation document) should operate and compete in the UK mobile market. This results in Ofcom proposing to adopt an auction design that will guarantee – through the use of spectrum floors – an outcome in at least four national wholesalers hold or acquire sufficient spectrum so as to deploy competing LTE networks.

5. Vodafone does not dispute the basic notion that the presence of a number of LTE infrastructure operators may be relevant to the intensity of competition in wholesale and retail mobile access and origination markets. However, we would dispute Ofcom's assertion that a market with three infrastructure operators creates a risk that wholesale and retail mobile markets will not be effectively competitive on a prospective basis.

6. This assertion is advanced with reference to minimal evidence, other than an attempt to draw inferences from outcomes in other *national* mobile markets outside of the UK. Unfortunately, the prospective analysis that Ofcom has undertaken does not satisfy the standard that would be expected of an NRA or competition authority undertaking such a review. Specifically, for reasons that we discuss below, seeking to rely upon international comparisons when undertaking such an analysis is ultimately of limited value and fraught with risk. Equally significantly, Ofcom has elected to ignore evidence as to how the wholesale access market operates in the UK when carrying out its assessment.

7. What is more relevant is the need for Ofcom to establish whether there is any risk that future competition in these wholesale and retail markets could be adversely affected, for example because they are tipped in favour of one operator. As we explain in our submission, there is a clear risk that Ofcom's current course of action may result in such an outcome.

8. In Annex 5 of its consultation document, Ofcom identifies a number of putative relevant product and geographic markets that may emerge following the launch of LTE services. These markets have not been identified in accordance with well established principles of market definition (reflected in decades of decisional practice by numerous competition and regulatory authorities) and economic analysis. Until such time as this analysis has been undertaken with reference to clear economic evidence, it would be seem more prudent for Ofcom to undertake its competition assessment with reference to the established market definitions (i.e., the mobile wholesale and retail access and call origination markets encompassing **both** voice and data services to customers).

9. Based on the above, we would therefore invite Ofcom to reconsider its proposed course of action and the justification upon which it is buttressed before it elects to proceed any further.

Four LTE infrastructure providers

10. Ofcom repeatedly emphasises that there is a correlation between the number of infrastructure providers and the nature of competition in wholesale and retail mobile access markets. Whilst this may be a relatively uncontentious claim in itself, what is considerably more questionable is the speculative claim that a market in which three competing infrastructure providers are present creates a risk that competition will be inhibited. Ofcom's assertion is based on its view that:

    (i) in such a market, the incentives for these infrastructure operators to compete for wholesale access seekers will be dampened;

    (ii) competition in the retail mobile market will be correspondingly affected;

    (iii) the evidence from national mobile markets in other EU Member States with three competing infrastructure providers points to a risk that competition would be muted that would adversely affect mobile consumers.

Standard of review in a prospective market analysis

11. What Ofcom is effectively undertaking in its competition assessment is an analysis of the impact of a change in the structure of the mobile market following a reduction in the number of infrastructure operators currently active on the market. This is akin to a forward-looking merger analysis in which a national competition authority or the

European Commission seeks to assess the impact on the intensity of competition where a horizontal merger results in the loss of an existing competitor from the market. In this case, Ofcom is seeking to understand the impact on the market if the number of competitors were to fall from four to three as a result of the spectrum auction. The issue to be considered is the burden that a regulatory authority must discharge when undertaking a review of this type.

12. Given that such a forward-looking analysis is, by its very nature, riven with uncertainty, the risk of an error being made is significant. As such, the threshold that a competition authority must overcome when seeking to determine whether a merger should be prohibited is a high one. This has been explicitly confirmed by the European Court of Justice (the "ECJ"):

> *"A prospective analysis of the kind necessary in merger control must be carried out with great care since it does not entail the examination of past events - for which often many items of evidence are available which make it possible to understand the causes - or of current events, but rather a prediction of events which are more or less likely to occur in future if a decision prohibiting the planned concentration or laying down the conditions for it is not adopted."*[10]

13. Whilst this guidance was issued in the context of an appeal against a prohibition decision issued by the European Commission in respect of a merger, the same level of rigour is to be expected of an NRA engaged in an ex ante market review. This is because a market review – like a merger review – involves an NRA making a prediction about how a market may develop.

14. Commenting on the judgment of the ECJ when considering the standard by which Ofcom should be assessed, the Competition Appeal Tribunal (the "CAT") declared in the context of an appeal against a decision by Ofcom to find, following an ex ante market review, that an undertaking was in a position of Significant Market Power (a concept equivalent to dominance in competition law):

> "*The case demonstrates (if it needs to be demonstrated) that theory and surmise is not enough. One must look to see how things operate in practice, and prove whatever has to be proved to an appropriate level of proof. It points out the need to be particularly careful in relation to that*

[10] Case C-12/03 P *Tetra Laval BV v Commission* [2005]

when one is considering future conduct.""[11] [emphasis added]

15. The CAT went on further to endorse the view of the Irish Electronic Communications Panel which also considered the judgment of the ECJ to be highly germane to an ex ante market review carried out by a telecommunications regulatory authority:

> *"it is necessary that this analysis be sufficiently rigorous and thorough so that a clear link can be drawn between existing circumstances and likely future behaviour. To put it another way, because the likelihood of error is greater in a prospective analysis, the prospective analysis must be proportionately more rigorous to account for this possibility."*[12]

16. We therefore turn to the issue of the extent to which Ofcom has applied and satisfied this test in its competition assessment in this case.

Empirical evidence for Ofcom's argument

17. As both the CAT and the ECJ have noted, the state of existing competition in the wholesale and retail access and mobile markets clearly must be the starting point to inform analysis that Ofcom undertakes in this respect. Vodafone has been unable to establish that Ofcom has given due regard to the evidence available to it in its assessment.

18. Both the European Commission and Ofcom have recently found the retail mobile access and origination market to be characterised by vigorous competition.[13] As Ofcom has noted on a number of occasions, profitability levels in the UK are consistently lower than those in other national mobile markets, a fact that is indicative of the competitive intensity in the UK retail mobile market.[14]

19. One of the noticeable features – acknowledged by both the European Commission and Ofcom – of the competitive landscape in the UK retail mobile access and origination market is the presence of numerous virtual mobile network operators ("MVNOs") who provide retail services by virtue of wholesale access arrangements with

[11] *Hutchison 3G UK Ltd v Ofcom* [2005] CAT 39, paragraph 32
[12] Decision No 02/05 of the Electronic Communication Appeals Panel in respect of appeal No: ECAP 2004/01, paragraph 4.23
[13] Case No. COMP/5650, *T-Mobile/Orange*, paragraph 53
[14] Ofcom, *Mobile Evolution. The Mobile Sector Assessment*, 17 December 2009, paragraph 3.23; Ofcom, *Wholesale Mobile Call Termination. Final Statement*, 15 March 2011, paragraph 2.5

mobile network operators. Vodafone estimates that there are at least 16 MVNOs operating in the UK retail mobile market (excluding independent service providers and those MVNOs who have concluded wholesale access agreements with third party aggregators [15]). Vodafone's internal estimates indicate that approximately 11% of subscriptions in the UK retail mobile market are accounted for by MVNOs. The presence of the number of these MVNOs and their ability to act as a credible source of competition to the MNOs is compelling evidence that the UK wholesale access and origination market is clearly effective.

20. Recognition of the role by played by MVNOs can be found in recent analyses of both Ofcom and the European Commission that have both recently found that the wholesale access market is characterised by effective competition. Indeed, the Commission found that some of these MVNOs play a significant role in the UK market in driving competition. This would simply not be possible were the terms of wholesale access arrangements sufficiently uncompetitive or unattractive as to constrain the ability of these MVNOs to compete.[16]

21. Even more significantly, the merger of the UK operations of T-Mobile and Orange has not affected competition in the wholesale access market. Vodafone's experience in practice is that 3 has not to date played a significant role in competing for the custom of wholesale access seekers. Indeed, Vodafone understands that the number of wholesale access arrangements in which 3 has entered over the past five years have been minimal. Vodafone understands that at the time of submission there is only one MVNO (with a negligible retail presence) that has concluded an agreement directly with 3 to use the 3 network.[17] In practical terms, the number of credible competitors between whom wholesale access seekers are able to switch is three. Accordingly, if Ofcom's theory were borne out in reality, the incentives of the three remaining MNOs to compete for wholesale access seekers would have been diminished potentially to the extent that, *in extremis*, the outcome would have been a collective refusal to deal with such parties. However, this has not been the case. Nor has Ofcom adduced any evidence to the contrary.

[15] Aggregators are third parties who conclude wholesale access arrangements and then resell wholesale access to MVNOs that wish to operate in the retail mobile market. Our estimate of the total number of MVNOs is in the region of 40.

[16] Case No. COMP/5650, *T-Mobile/Orange*, paragraph 46. Ofcom's recent Mobile Sector Assessment also found that MVNOs accounted for a significant proportion of the retail mobile market and that two, Tesco and Virgin Mobile individually accounted for a sizeable share. Ofcom, *Mobile Evolution. Ofcom's Mobile Sector Assessment*, 17 December 2009, paragraph 3.20

[17] [✂]

22. Were the auction to result in the emergence of three LTE infrastructure providers, there is accordingly no good reason to conclude that the existing vigorous competition that is evidently an established feature on the competitive landscape in the wholesale access and origination market would be emasculated in any way.

23. Commercial real world evidence therefore illustrates the dangers of seeking to advance a simple hypothesis that a three-player market is more likely to encourage conditions for co-ordination.

International comparisons

24. However, equally dangerous is Ofcom's attempt to draw inferences from international comparisons and to rely upon these inferences when designing the auction. The CAT has already on two separate occasions quite rightly expressed its clear reservations about the value or relevance of facts drawn from other markets when seeking to undertake an analysis of a market that is national in scope:

> *"[i]t is very difficult to draw any conclusions derived from two disparate facts plucked out of the information about a wide range of international markets."*[18]
>
> *"In our view, as noted by the Tribunal in H3G MCT (at paragraph [261]), it is difficult to draw any firm conclusions derived from disparate facts plucked out of the information about a range of international markets."*[19]

25. The manifest scepticism of the CAT about the attempt of Ofcom to place weight on developments overseas is entirely justifiable given that wholesale and retail mobile markets have been consistently defined by the European Commission, numerous competition authorities and NRAs to be national in their geographic scope.[20] Coverage, regulatory regimes and spectrum allocations are all national scope meaning that competition takes place at a national level. But equally relevant to the geographic market definition are: the competitive dynamics, demand conditions and consumer preferences in relation to the provision of mobile communications services will vary widely across national boundaries.[21] Given these

[18] *Hutchison 3G UK Ltd v Ofcom* [2008] CAT 11, paragraph 261
[19] *Vodafone v Ofcom*, [2008] CAT 22, paragraph 127
[20] See for example Case No. COMP/5650, *T-Mobile/Orange*, paragraph 31; Case No.COMP/M.4947 *Vodafone/Tele2Italy/Tele2Spain*, paragraph 13. The variations across national boundaries are also explicitly recognised by the CRF, which provides, pursuant to the provisions of Article 16 of the Framework Directive, that NRAs are charged with undertaking market analyses in their countries precisely because markets are national.
[21] This was acknowledged by the ERG some years ago, (at the time when the European Commission was contemplating the imposition of pan-European retail price caps for

variations across borders in the EU, it is extremely difficult to draw meaningful or reliable conclusions from the experience of other national mobile markets that can then be applied to the UK mobile market.

26. The inherent limitations of international comparisons can be illustrated effectively when the examples cited by Ofcom in support of its assertion about the risks to competition stemming from a market with three players are scrutinised closely. Ofcom cites the cases of mobile wholesale access markets in Spain, France, Italy and Poland, in support of its contention that three player markets are unlikely to be effectively competitive. An examination of each of these cases confirms they are of limited value when considering the UK wholesale access market:

- In Spain, the NRA imposed wholesale access remedies, pursuant to a finding that the market displayed exhibited conditions that were potentially conducive to co-ordination. Although Vodafone has objected to this finding, the situation in Spain is in any event fundamentally distinguishable from that in the UK. The critical difference is that in Spain wholesale access arrangements had still to be concluded at the time when the Spanish NRA had undertaken its market review. The same distinction should also be drawn when assessing the relevance of the French and Italian markets (where, in any event, there is no formal finding that these markets are not effectively competitive).

- By contrast, in the UK market, as noted earlier numerous wholesale access agreements have been concluded over the past five years by Vodafone and its main rivals at infrastructure level. There is no evidence that a change in or migration to a new technology would alter the incentives of the current operators active in the market to enter into such an arrangement.[22]

- In Poland, the most recent market review in 2008 found that the 3 infrastructure operators had all concluded wholesale access arrangements with a number of MVNOs and that retail prices had been declining consistently since 2004. It therefore found the market competitive and therefore found no justification for

international roaming services): "*ERG considers that, in general, retail prices vary amongst member states for good reasons. Consumer preferences may play a large part. Regulation should take full account of these variations in national circumstances*" ERG submission of May 2006 at paragraph 3.15.

[22] With the deployment of its 3G network, Vodafone widened its offering to wholesale partners to include access to both its 2G and 3G networks.

any regulatory intervention. The European Commission, pursuant to the process mandated by Article 7 of the Framework Directive, raised no objections about the substantive finding of the Polish NRA.[23]

- Attempts to rely upon remedies secured by the European Commission in merger cases in Finland and Austria are also of little relevance. As Ofcom itself notes, MVNO activity in these countries was limited, which, as has been demonstrated, is patently not the case in the UK market.

- To the extent that any international comparison is relevant, the case of the Netherlands would appear to be the most instructive in this particular case. As Ofcom correctly notes, the mobile market underwent consolidation in 2007 when Orange's Dutch operation was acquired by T-Mobile which was also active on the Dutch market. This acquisition, resulting in a market outcome with three infrastructure providers, was approved by the European Commission. The Commission established that the move from a four to three player market would not give rise to concerns about potential co-ordination between the remaining competitors. In reaching such a finding, the Commission placed considerable weight on the fact that the highly competitive wholesale access and origination market (with approximately 50 MVNOs having concluded wholesale access arrangements) would be unaffected by the transaction in light of the existing (and recent) evidence. This evidence demonstrated that the MNOs remaining on the market had continued to compete to conclude wholesale access arrangements with third parties wishing to operate on the retail access market. In the view of the European Commission, the incentives of these wholesale access providers to supply access would not be distorted.[24] In examining this evidence, the Commission's approach in that case was entirely consistent with the previous guidance of the ECJ.

27. Ofcom's attempt to adduce 'evidence' from fixed line access markets does not assist in demonstrating the credibility of its argument either. The fixed market is, as Ofcom itself concedes, distinct from mobile access markets. This is a fact that has been recognised by the European Commission (in its Recommendation on Relevant Markets), numerous competition authorities and NRAs. The nature of the wholesale access product and the way in which competition occurs are likely to be very different from that of mobile markets. Moreover,

[23] Case PL/2008/0756: Wholesale mobile access and call origination, Article 7 letter of the European Commission, 26 March 2008
[24] Case No. COMP/M.4748 *T-Mobile/Orange Netherlands*, paragraphs 56-61

Ofcom's ex ante analyses of wholesale fixed access markets have typically been concerned with identifying whether it is appropriate to maintain a finding of Significant Market Power (and accompanying regulatory obligations) on an incumbent fixed provider where access to the infrastructure of that fixed provider is critical to enabling new entry. This is not remotely analogous to the mobile access market where there has always been a number of competing infrastructure providers between whom wholesale access seekers can switch. Tellingly, Ofcom's first analysis of the wholesale access and origination market in the UK as far back as 2003 found that this market was competitive.

28. It is, accordingly, no exaggeration to conclude that examples of markets which bear little or no resemblance to that of the UK wholesale access market should be treated with the utmost caution when undertaking a market review. Equally importantly, Ofcom must examine take into account relevant facts and circumstances in particular in relation to the state of existing competition on the UK wholesale access and origination market. Had it done so when undertaking its analysis, it would not have been possible for it to reach the conclusion articulated in the consultation document.

Alternative remedies

29. So far as Vodafone has been able to discern from the consultation document, the other basis upon which Ofcom reaches its conclusion about the need to preserve a four player mobile market is the decision of the European Commission in the T-Mobile/Orange merger to accept commitments from the merging parties to ensure that 3 remained a viable competitor. From the Commission's readiness to accept remedies from the merging parties to preserve 3's viability as a competitor, Ofcom extrapolates this to make a broad assertion that "only three national wholesalers in UK mobile markets would be a concern".

30. This is, with respect, an inference that is, on any analysis, incapable of being drawn in relation to the wholesale access and origination market in the UK. As has been noted above, 3 has not, in Vodafone's experience, been a credible rival to other MNOs in the provision of wholesale access and origination and has hitherto concluded very few wholesale access agreements. Yet, as described above, this market is clearly characterised by vigorous competition and as such clearly undermines the validity of Ofcom's theory.

31. The alternative explanation is that Ofcom, albeit obliquely, considers that the continued presence of 3 specifically in the UK retail mobile market is beneficial to competition. According to such a theory, the

way in which 3 operates in the UK retail market underlines the need to ensure the preservation of a four-player market. Vodafone would dispute the significance of the role that 3 plays on either the wholesale or retail access origination markets. We note that Ofcom itself, as described in the last Competition Commission (the "CC") review of wholesale mobile termination rates, questioned the role that was played by 3 in the retail mobile market:

> *"It* [Ofcom] *did not accept that H3G was the only material source of competition in the retail market, characterising the claim that H3G was a maverick competitor as unproven and speculative*."[25]

32. The CC also endorsed Ofcom's doubts about the importance of 3 in the retail mobile market:

> *More broadly, we do not accept that H3G has been the only source of innovation in the market. The Interveners have given us evidence of a number of new products and pricing structures that they have introduced, demonstrating that the innovator's role is not exclusive to H3G."*[26]

33. However, if there were any credence to the proposition that 3 was critical to competition in the retail mobile market because of its commercial strategy, Ofcom errs in considering 3 to be interchangeable with any fourth operator (i.e., that any fourth operator would in practice mimic 3's commercial or pricing strategy). There is simply no guarantee that a fourth operator would be more or less likely to adopt the commercial model pursued by 3 to date.

34. If Ofcom's concern in reality is about the continued presence of 3 in the retail mobile market, there are more effective and proportionate ways of ensuring that such an outcome could be achieved. The obvious examples would include:

    (i) allowing the competitive wholesale access market to operate freely, whilst reserving the right to intervene on an *ex post* basis should the market not deliver the desired outcome;

    (ii) attaching a wholesale access obligation (either in the form of an ex ante or a safeguard remedy) to one of the licences being offered in the auction; or

[25] Competition Commission Report, paragraph 5.7.11
[26] Competition Commission Report, paragraph 5.7.31

(iii) reserving a 2x5MHz tranche of spectrum for a non-2G operator, potentially increasing the possibility that 3 would be able to acquire a block of the 800 MHz spectrum.

35. The first two of the above three options are clearly credible. Based on the current state of competition in the wholesale access market, there should be no reason why 3 should be unable to secure a competitive wholesale access product. Moreover, as Ofcom rightly notes, it has a number of powers under the Competition Act 1998 to enable it to intervene where a market does not appear to be functioning effectively.[27]

36. Ofcom rules out the possibility that one or more licences could carry an obligation to deal with third party access seekers on the basis that a market with four infrastructure operators should lead to a competitive outcome. It further suggests that a regulatory obligation (whether in the form of an ex ante or 'backstop' obligation) may disincentivise investment in infrastructure and stifle competition on the wholesale access market. The facts on the ground today indicate strongly that a market with three active players is sufficient to yield a competitive wholesale market.

37. Yet, Ofcom has direct experience of having previously imposed an ex ante obligation upon Vodafone and O2 to provide wholesale national roaming services to 3 a decade ago at the time of the 3G auction. This condition required Vodafone and O2 to negotiate with 3 in the first instance, whilst providing Oftel to intervene to set terms if that proved to be necessary (a power that provided to be superfluous). In that case, O2 negotiated a commercial agreement with 3, thus obviating the need for regulatory intervention. Subsequently, 3 switched to Orange following a competitive tender. In spite of these facts, Ofcom appears to reject the case for such measures without any serious consideration.

38. Vodafone remains unconvinced that it is critical for future competition to ensure that a licence should be reserved for a non-2G operator or a new entrant. However, to the extent that Ofcom considers that such a reservation is justifiable, proportionate and compatible with its statutory duties when allocating spectrum, Vodafone would invite it to make that case and subject it to industry-wide scrutiny.

[27] Indeed, Ofcom suggests that it may also be able to invoke its powers under the ex ante regulatory framework where ex post intervention is inappropriate. In its Mobile Sector Assessment, Ofcom ruled out a review of the wholesale access market or the imposition of any regulatory obligations on MNOs safe in the knowledge that it could "*revisit this decision if, for example, we see evidence of anti-competitive behaviour, including limitations in the supply of wholesale services to access seekers, that cannot adequately be addressed using ex post intervention*." Ofcom, *Mobile Evolution: Ofcom's mobile sector assessment*, 17 December 2009, paragraph 3.49

The central competition concern

39. The critical issue in this consultation for Ofcom should not be to demonstrate that a three player market is unlikely to further the interests of mobile consumers. As we discuss below, it is not necessarily guaranteed that a four player market does deliver positive outcomes for consumers. Instead, what needs to be considered is the extent to which the spectrum auction could lead to the bifurcation of the retail mobile market with deleterious consequences for consumers. This, we would suggest, is somewhat more important than seeking to make a case that a three-player market is *per se* detrimental to competition and consumers.

40. Indeed, the most striking omission in the consultation is Ofcom's failure to give due regard to the risk that its proposals may lead to the creation of a two-tier mobile market. In this outcome, the market is effectively tipped in favour of a market leader that is able to act unconstrained by its competitors or its customers. As the case of the Australian mobile market has already demonstrated, a market with four players does not axiomatically generate a competitive outcome that operates in the interests of mobile consumers. In Australia, the market leader, Telstra, enjoyed a significant commercial (marketing) advantage arising out of its superior infrastructure that allowed it to set tariffs in a way that revealed that its rivals did not exercise any meaningful constraint upon it.

41. In this case, as we explain in the next section, Ofcom's proposals create the very real possibility that EE – an entity with a very significant holding of spectrum in the 1800MHz band – will be able to re-establish the significant competitive advantage that was a source of concern to both the European Commission and the UK Office of Fair Trading at the time of the T-Mobile/Orange merger.

42. In brief, EE is at present, even following its divestment commitments, the only MNO that is very well placed to deploy an existing national LTE network in the short term. This was explicitly recognised in the European Commission's merger approval decision (which resulted in the divestment commitment). However, it is important to recognise that even with a holding of 2 x 45MHz in the 1800 MHz band, EE is clearly able to deploy an LTE network using a 2x20MHz carrier in the short term. In such circumstances, as we demonstrate in the next section, there is no justification for the protection that Ofcom now intends to afford to EE in the auction rules. Moreover, in providing EE with such protection, there is a material risk that it will be able to re-establish and exploit its advantage over its competitors in such a

way that the market becomes 'tipped' in its favour. Such an outcome clearly could not be deemed to be to the benefit of mobile consumers.

43. As we explain further in the next section, this risk of consumer harm is exacerbated by the error that Ofcom has made in relation to the potential for Vodafone's 900MHz spectrum to be exploited for the provision of LTE services in the near term. Vodafone is surprised that Ofcom has formed this conclusion without to date seeking to obtain the input of those industry stakeholders who use the 900MHz frequency to provide mobile communications services. These operators would clearly be well-placed to advise Ofcom about the extent to which the claim expressed in the consultation document is credible. Once it is appreciated that Vodafone is seriously constrained in its ability to use its holding in the 900MHz band in the short and medium term for anything other than its existing services, the risk to competition arising out of further protection to EE is ever more apparent.

44. Clearly, if EE were to be certain to acquire additional spectrum (and in particular in the valuable 800MHz band) from the auction, there is a material risk that Vodafone (which has been given no such guarantee[28]) would unable to compete with EE on coverage and capacity. Whilst Vodafone's 900 MHz spectrum could eventually become available for use in connection with the deployment of an LTE network, the concern for Ofcom must be that in the intervening period, EE is able to entrench itself as the market leader by exploiting its network coverage and quality to such an extent that it is not subsequently possible for rivals to act as a meaningful competitive constraint upon it.

Market definitions

45. Vodafone notes that in undertaking its competition assessment, Ofcom proposes that the launch of very high speed data services across mobile networks could lead to a change in the way that relevant mobile markets are presently defined. Ofcom suggests separate product markets could emerge following the deployment of LTE services that may be confined purely to the provision of data services at the retail level. Its proposed markets include:

    (i) a high quality data market associated with reliable indoor coverage for data services;

[28] Vodafone assumes that this is because Ofcom considers that Vodafone's existing holding of 900MHz spectrum enables it to deploy an LTE network.

(ii) a separate market associated with higher data speeds and better latency (delivered by LTE) which is distinct from a market associated with lower data speeds (delivered by 2G/3G)

(iii) a division of the retail market services that had priority over other services (for example by customer type).

46. Vodafone is surprised that Ofcom should attempt to suggest what the scope of these markets should be given the lack of any economic evidence available at the current time. Indeed, were Ofcom to undertake such an analysis, it would, pursuant to the requirements of the pan-European harmonised regulatory framework governing the communications sector, be required to do so in a way that conformed with well established competition law and economic principles of defining the parameters of relevant markets.[29] This exercise has patently not been undertaken in this consultation document. As an example, Vodafone notes that no consideration has been to given to whether the geographic scope of any of these putative markets should be defined nationally or more narrowly.

47. Given the paucity of evidence currently available to Ofcom about how the deployment of LTE networks might lead to the creation of separate product markets, it would appear premature at best for Ofcom to attempt to identify any such markets even tentatively.

48. Instead, the central issue that Ofcom must address is whether not the proposed auction is, through its design, likely to lead to an outcome in which the market is tipped in favour of an operator that is able to hold a significant proportion of the key raw input that is necessary for the provision of LTE services. This concern applies irrespective of how the market is defined. For the reasons that we identify in this submission, it is this aspect of Ofcom's current analysis that is inadequate and that places Ofcom at odds with its duties and obligations when allocating and managing spectrum.

[29] Framework Directive 2002/21/EC [2002] OJ L 108/33 on a common regulatory framework for electronic communications networks, Article 15(1)

Section 2 – Vodafone's critique of Ofcom's technical analysis

Summary

49. In this section we critique Ofcom's technical analysis in Annexes 7 and 8. More importantly, we criticise the *basis* of Ofcom's technical analysis. Specifically, we demonstrate that there are serious doubts about Ofcom's assertion relating to the possibility for existing 900MHz spectrum to be used in the short to medium term for the deployment of an LTE network. At the end of this section we also provide our estimates of the cost of meeting the proposed coverage obligation. We reveal that Ofcom's proposed coverage obligation is likely to be disproportionate.

50. Ofcom believes that, in the future, holding sub-1GHz spectrum will yield advantages over higher frequencies in terms of coverage – both geographic and in-building. In Annexes 6 and 7 Ofcom establishes that the network performance, along various dimensions, of an operator with access to 2x20MHz of contiguous sub-1GHz spectrum may not be matched by a rival with access to only higher frequency spectrum:

> *These advantages could mean that national wholesalers with a large amount of sub-1 GHz spectrum would have an unmatchable competitive advantage over those without any sub-1 GHz spectrum. By an unmatchable competitive advantage we mean that the national wholesalers without sub-1 GHz spectrum suffer a material competitive disadvantage because they are unable to develop their networks to offer services sufficiently similar to national wholesalers with sub-1 GHz spectrum. This would depend partly on technical differences between wholesalers with different spectrum portfolios and partly on how sensitive consumers are to any such technical differences, such as the quality of deep indoor coverage.*[30]

51. Ofcom uses its technical analysis to ask what combinations of sub-1GHz and higher frequency spectrum are sufficient to match the performance of an operator with 2x20MHz of contiguous sub-1GHz spectrum. The answer to this question determines the specification of the spectrum floors. These floors are required because without their apparent protective effect Vodafone and O2 would allegedly have an incentive to (and be able to) bid strategically in the auction to exclude their rivals; a type of "I'm alright jack, pull up the ladder" strategy. We cover this point in detail in section 3.

[30] 5.41

52. Implicit in this analysis is that **Vodafone and O2 already have sufficient sub-1GHz spectrum to be able to offer higher quality LTE data services in the near future**[31]**.** In annex 6 paragraph 5.71 Ofcom states that it "expect(s) the 800MHz to be used for LTE as soon as it is available" and then in the subsequent paragraph that it "considers that the 800MHz and the 900MHz are broadly equivalent and we treat them the same in our analysis". This treatment is critical to Ofcom's case and yet it fails to examine whether it is true. It assumes that Vodafone does not need to purchase spectrum in the auction in order to compete in the putative higher quality data services market but does not test whether this supposition is valid. In this section we remedy this serious lacuna in Ofcom's analysis.[32]

53. In our introduction we noted that in reviewing the merger between T-Mobile and Orange the Commission concluded that the merged entity had a sufficient holding of spectrum and an established site grid that would enable it to offer 4G services at the maximum 100 megabits per second speed in *"the near future*".[33] The preliminary view of the OFT was that the merged entity would be able to launch a 4G network within two or three years.[34] These documents were written in early 2010 and so, for the purposes of our technical analysis we assume that Vodafone would need to clear sufficient sub-1GHz spectrum to be competitive with EE by early 2013 (or approximately one year after the auction rules are finalised); the date on which the new initial term of the new licences for 800MHz and 2.6GHz will commence and the spectrum is available (recall that Ofcom expects the 800MHz spectrum to be used as soon as it becomes available and that at least one operator will have 95% population coverage by 2017). Put another way, EE will be able to launch an LTE network on its existing spectrum in 2013 and Vodafone needs to be in a position to respond to that competitive threat. The central issue that Ofcom needs to address is whether Vodafone's existing 900MHz spectrum could enable it to respond effectively and promptly to such a competitive challenge.

[31] The 2x15MHz sub-1GHz spectrum floor means that, even if Vodafone (and/or O2) is unsuccessful in the auction, it is assumed to have sufficient sub-1GHz spectrum already to be able to act as an effective national wholesaler. A 'valid' outcome of the auction is that neither Vodafone nor O2 acquires sub-1GHz spectrum and the whole of the band is bought by EE and 3.

[32] The furthest that Ofcom goes is to say in Annex 6 paragraph 5.71 that "if the provision of higher-quality data services with LTE becomes important for consumers, we would expect the holders of 900MHz spectrum to have an incentive to de-fragment that spectrum and re-farm it for LTE in the longer term.". This, of course, does not constitute a meaningful analysis of the practicalities of using 900MHz spectrum for LTE.

[33] Commission Decision, paragraph 120

[34] OFT, Article 9(2) request, paragraph 105

54. We therefore consider the 'on-the-ground' practicalities of clearing either 2x10MHz or 2x15MHz of 900MHz spectrum by early 2013.[35] We do not consider clearing 2x20MHz of 900MHz spectrum because it is more spectrum than we have. We know of only one other Vodafone company — Vodafone Malta — which has access to that amount of spectrum.

55. Our analysis shows that in order to clear 2x15MHz of 900MHz spectrum to use for LTE — to be able to compete with EE or the purchasers of 800MHz spectrum in the auction — by early 2013 [✂]

56. These conclusions are consistent with our previous submissions to Ofcom, the OFT and the Commission on the feasibility of clearing the 900MHz band:

    a. [✂]

    b. [✂]

    c. In a note to the case team handling the merger (included in this response) we re-iterated that [✂]

    d. [✂]

[35] We note that the 900MHz spectrum is not contiguous and therefore the clearing of spectrum would have to be preceded by a re-shuffling of the band plan. It is not clear how long this would take.

Vodafone's LTE options to match the JV's 20MHz (1800) offering

Available spectrum by band	Vodafone	Vodafone with O2	Can Vodafone match a 20MHz carrier with nationwide coverage?
800MHz	Not an option because the BIS rules require Vodafone to divest an equivalent amount of 900MHz spectrum.	Not an option because of the divestment rules.	No
900MHz	✂	✂	✂.
1800MHz	✂.	✂	✂
2100MHz	I✂	✂.	✂.
2.6GHz	✂	✂	✂.

57. The relevant comparator therefore as far as analysis of the relative network abilities of Vodafone, O2 and EE is concerned is 2x10MHz of sub-1GHz (the maximum that Vodafone and O2 can purchase in the auction) versus 2x20MHz of 1800MHz spectrum (the amount of spectrum that the Commission found that the merger entity would have to dedicate to LTE "in the near future").[36]

58. Using *this* comparative analysis Ofcom's technical work shows that EE does not need to acquire any 800MHz spectrum to be competitive in the new data world. Our review of Ofcom's analysis shows that EE can match or better the performance of a 2x10MHz 800/900MHz network by using its allocation of 1800MHz spectrum (post divestment). It is therefore the only operator that does not need to purchase spectrum in the forthcoming auction.[37] Only EE has sufficient spectrum to offer higher quality data services. This was recognised by the European Commission in its merger decision and was the *raison d'etre* behind the requirement that the JV should divest some 1800MHz spectrum so that at least one other operator could match their performance within a similar timescale.[38] Any additional spectrum that EE is able to acquire in the auction will simply strengthen (in terms of capacity and network quality) the LTE

[36] If either Vodafone or O2 were to purchase the divested spectrum then each would be in a comparable position to EE i.e., with the ability to deploy a 2x20MHz carrier at 1800MHz for LTE and the option to purchase sub-1GHz spectrum; although EE would, according to the proposed rules, have the possibility of acquiring more spectrum.

[37] We are ignoring, for the sake of simplicity, the 2x15MHz of 1800 spectrum to be divested by EE. If either Vodafone or O2 were to acquire this spectrum then each would be able to match the performance of a 2x10MHz sub-1GHz operator.

[38] If Ofcom is concerned that EE would be unable to match the performance of a 2x20MHz 800MHz network built by either 3 or a new entrant then the obvious and more proportionate remedy is to cap the amount of spectrum that can be bought by a single operator in the auction.

infrastructure that it is already capable of deploying. It is therefore vital that the auction does not operate in a way that leaves EE unconstrained by credible rivals.

Clearing the 900MHz band

Network Loading

59. Vodafone has a holding of 2x17.4MHz of sub-1GHz GSM spectrum in the 900MHz band and 2x5.8MHz in the 1800MHz band. Vodafone [✂]. The table below shows Vodafone's spectrum holdings and the services provided in the 900MHz and1800MHz bands together [✂].

[✂]

60. ✂:

    a. ✂.

    b. ✂

    c. ✂.

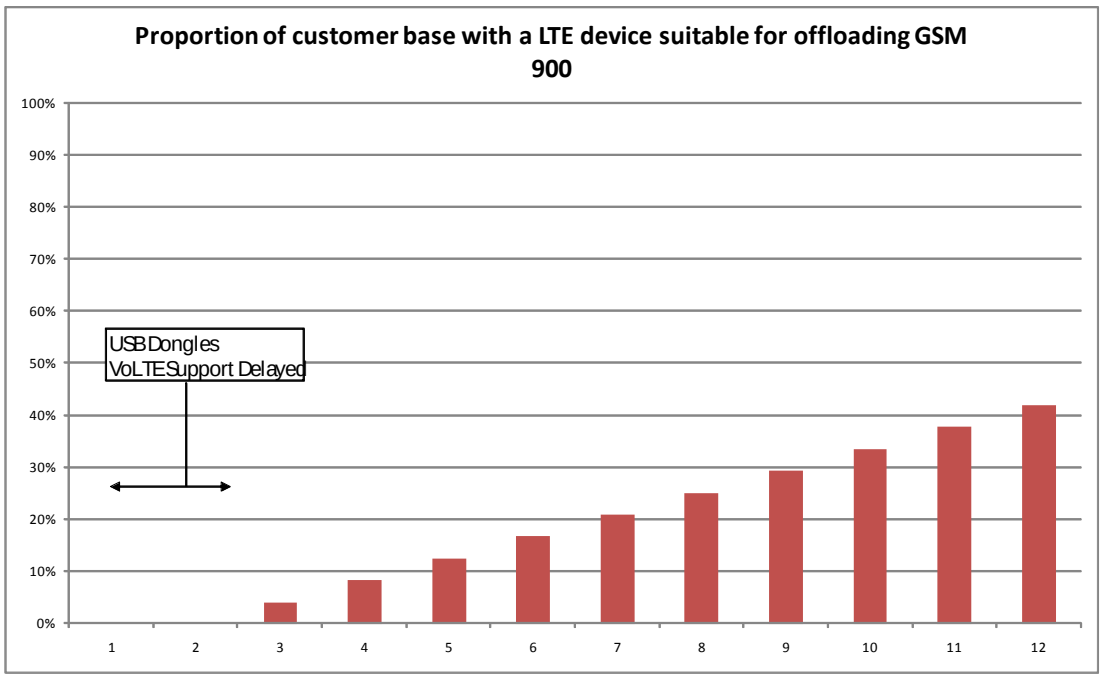
✂

    d. ✂.

LTE device penetration

61. ✂.

62. ✂.



Source: Wireless Intelligence, Analysis: Global LTE network forecasts and assumptions 2010–2015 December 2010.

63. ✂.

64. This exacerbates the problem of clearing spectrum for LTE: ✂

Network loading after spectrum clearance

65. The tables below show how the use of the 900MHz and 1800MHz spectrum bands would be distributed if 2x10MHz and 2x15MHz of our sub-1GHz spectrum were to be re-farmed for LTE in 2013. ✂

✂

✂

66. ✂

Additional site build requirements

67. If Vodafone were to re-farm 2x10MHz for LTE 900 Ofcom has previously estimated[39] that the site to site distance for GSM reduces from 631m to 461m. This reduction is required to maintain the traffic carrying capacity of the GSM network by re-using the available spectrum more often on a denser site grid. This analysis is based on

39 Application of spectrum liberalisation and trading to the mobile sector, 2007, Annex 9

an idealised GSM network and provides an indication of how the GSM network density may need to adjust when 2x10MHz is removed from the available spectrum. We can see from Ofcom's analysis that for a hexagonal network this means that *87%* more sites would be required. We believe that this may be a conservative estimate.

68. Similarly, if 2x15MHz of 900MHz spectrum is cleared then the site distance reduces to 331m and, assuming a hexagonal network, this would mean a *363%* increase in the number of sites required.

69. We have converted Ofcom's estimate of the required reductions in site to site distances into actual site numbers and costs in the table below. ✂.[40]

✂

70. ✂

71. ✂

✂

72. ✂.

73. ✂

74. As Ofcom notes in paragraph 5.37 of the consultation "[i]n theory, deploying more sites could be used to add capacity instead of a greater quantity of spectrum. However, the higher the demand, **the more sites would be required to match capacity and the less feasible it would be, both in terms of practicality and financial viability**…." (our emphasis). We could not put it better ourselves.

75. [✂] In fact Ofcom appears to concede this in Annex 6 paragraph 6.141 "[a]t some point, LTE900 is likely to be deployed that will be very similar to LTE800, but it seems likely that user equipment for LTE900 will only be available later than for LTE800". Ofcom then attempts to downplay this inconvenient truth by noting in a footnote that "this potential temporary advantage does not disadvantage Vodafone and O2, because they have the option of buying 800MHz in the auction". However, the whole point of the spectrum floors is that they presume that Vodafone and O2 *already have* sufficient spectrum to be competitive. If either *needs* to buy more sub-1GHz

[40] More accurate estimates of the number of additional sites required would require a detailed site by site review. This has not been possible within the time permitted to respond to this consultation.

spectrum then they are in the same position (by Ofcom's analysis) as EE and 3 and the floors must be wrong.

76. [✂] This contradicts Ofcom's provisional conclusion to exclude the 2.1GHz band from its spectrum floors "because we consider it less likely to be used for LTE in Europe in the next 5-10 years".[41]

✂

Network performance comparison

What is the right comparator?

77. In the table below we summarise Vodafone's various LTE options for 2013 using sub-1GHz spectrum.

✂

78. [✂] In this section we use Ofcom's technical analysis to compare the performance of a 2x10MHz sub-1GHz LTE network with that of a 2x20MHz 1800MHz network. We perform the comparison along three dimensions of network performance considered by Ofcom: speed (throughput), coverage and capacity. In terms of speed and capacity we find that the 1800MHz network has a superior performance and that it has no material coverage disadvantage when the existing superior portfolio of sites held by EE is considered and especially if we take into account that there are "other ways of dealing with poor indoor coverage, such as in-building repeaters and femtocells" which "have become a more plausible strategy for EE/H3G to address residual areas of coverage disadvantage".[42]

79. In short, as we have argued all along, Vodafone has [✂]. In none of these three scenarios would Vodafone have an 'unmatchable competitive advantage' versus EE. So even if Vodafone were able to acquire additional spectrum, that still does not provide a justification for a set of spectrum floors which have the effect of skewing the auction to EE's advantage.

Speed (single user throughput)

80. Ofcom's model considers the quality of service provided inside buildings by various spectrum endowments (because most mobile broadband usage occurs indoors at a place of work or in the home).

[41] 5.80
[42] Ofcom, *Advice to Government on the consumer and competition issues relating to liberalisation of 900MHz and 1800MHz spectrum for UMTS*, 25 October 2010 paragraph 1.12

81. The model used by Ofcom shows that 2x20MHz at 1800MHz has a marginal advantage over 2x10MHz at 800MHz in terms of in-building, performance. We see this by comparing charts A7.6 and A7.17/A7.19. If we look at Figure A7.6 (copied below) there are a series of curves describing single user throughput versus population for an 8,000 site network. For 2x20MHz LTE 1800 there are three curves which correspond to 15%, 50% and 85% load. Figures A7.17 and A7.19 plot similar curves for LTE 800 for a variety of carriers.

Figure A7.6

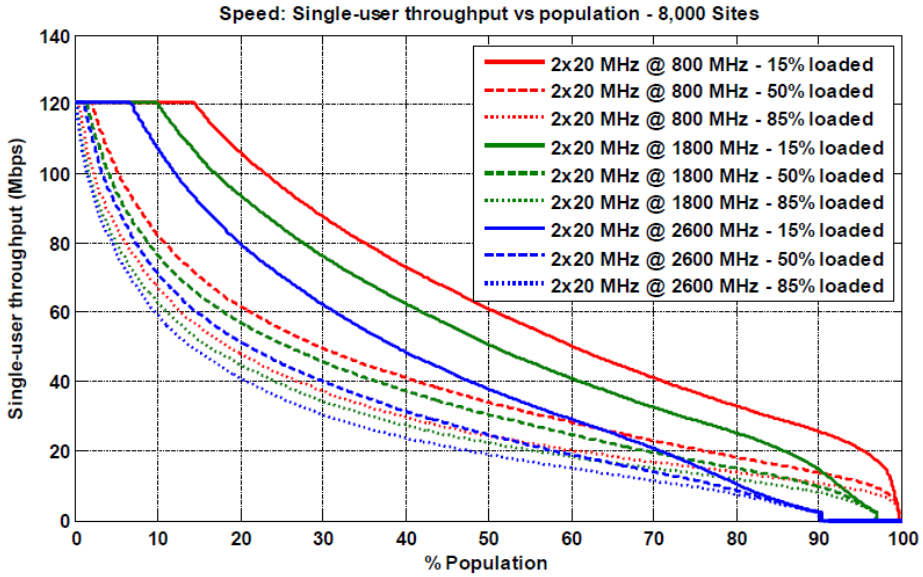


Figure A7.17

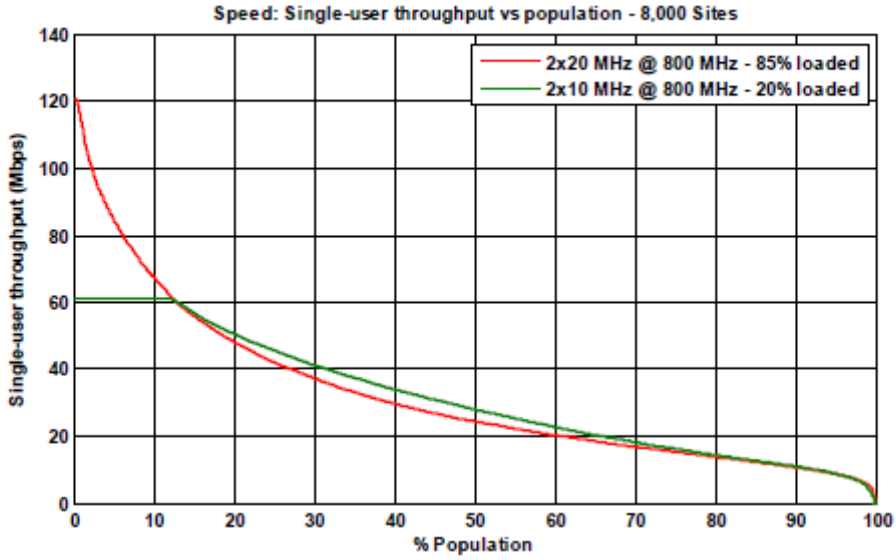
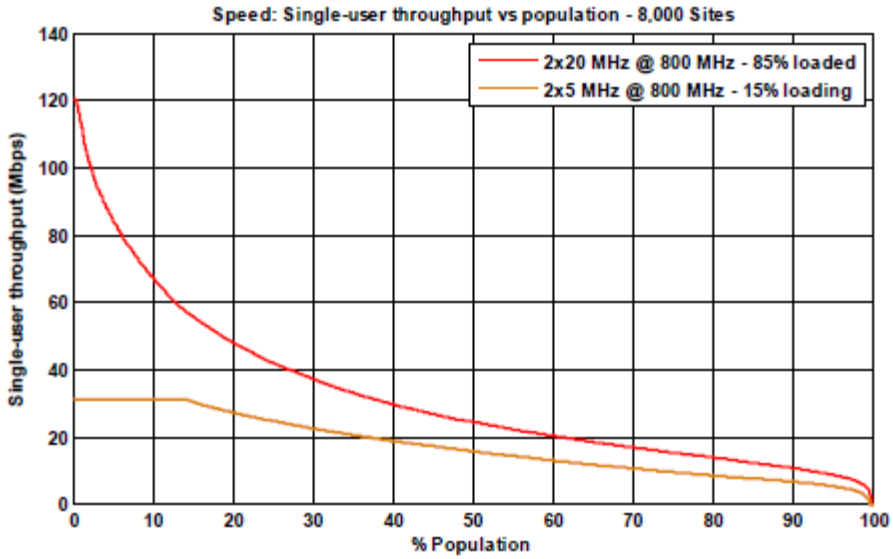
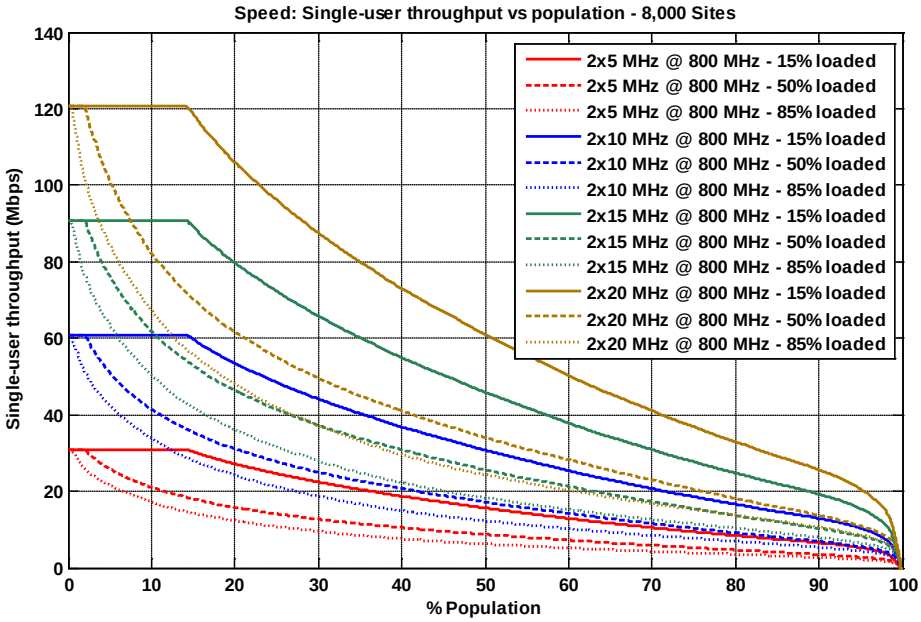


Figure A7.19





82. The data from these curves are tabulated below for LTE 1800 and LTE 800 at a variety of load points and population coverage, the data below are taken from the Ofcom graphs showing the 8,000 site case.

8000 Sites	2x20MHz LTE 1800			2x5MHz LTE 800	2x10MHz LTE 800	2x10MHz LTE 800	2x20MHz LTE 800
Population	15% Load	-	85% Load	15% Load	20% Load	85% Load	85% Load
20%	90Mbps	-	45Mbps	30Mbps	50Mbps	25Mbps	50Mbps
50%	50Mbps	-	20Mbps	17Mbps	30Mbps	12Mbps	25Mbps
80%	25Mbps	-	10Mbps	10Mbps	15Mbps	8Mbps	15Mbps

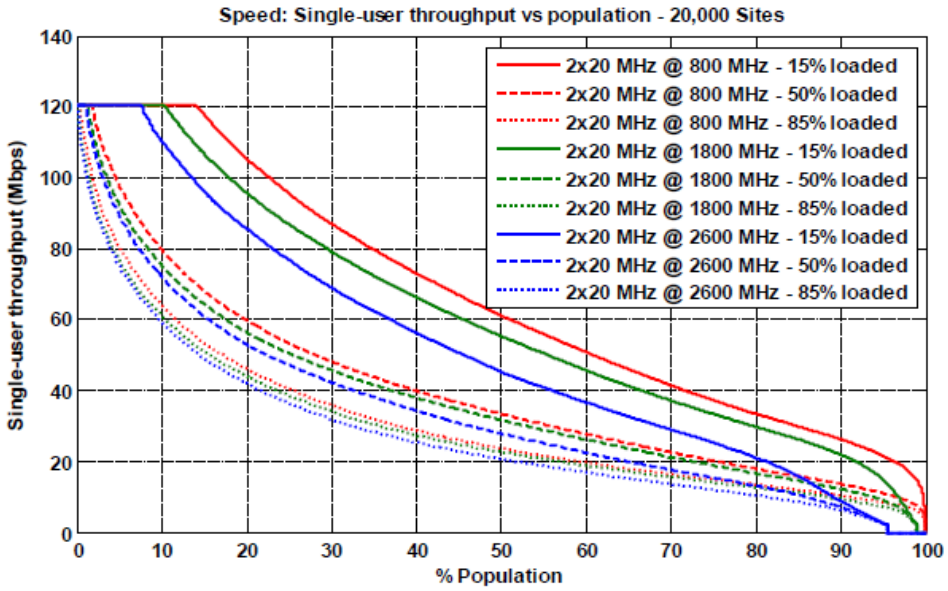
83. Looking first of all at the single user throughput for a 2x20MHz LTE 1800 network at 15% load, we can see that for a given population coverage this outperforms a 2x5MHz and 2x10MHz LTE 800 network at 15% and 20% loads. This shows that at low loads 2x20MHz at 1800MHz can outperform a LTE 800 network with 2x5MHz or 2x10MHz.

84. Making the same comparison but this time comparing a 85% loaded 2x20MHz LTE 1800 network with a 2x20MHz LTE 800 network we can see that the LTE 800 network has a marginal advantage. However this advantage disappears for a 2x10MHz LTE 800 network at high load which is clearly at a disadvantage compared with a 2x20MHz LTE 1800 network.

85. Furthermore, if we recognise that EE has over 20,000 sites we show in the table below that this translates into significant advantage in terms of single user throughput versus an operator with 2x10MHz of sub-1GHz spectrum.

	2x20MHz LTE 1800 20,000 Sites	2x10MHz LTE 800 8,000 Sites
Population	85% Load	85% Load
20%	45Mbps	25Mbps
50%	22Mbps	12Mbps
80%	12Mbps	8Mbps

Figure A7.7



Coverage

86. In paragraph 5.125 of the main body of the consultation of gives a rather odd reason for appearing to ignore EE's greater site numbers in its analysis. Ofcom says that "[t]he longer timescale of the current assessment means that national wholesalers have more scope to vary the site numbers (including possibly through network sharing). We have therefore not relied on extrapolating differences in existing site numbers". We have interpreted this to mean that Ofcom is assuming that the other operators will, in time, be able to match EE's greater site count.

87. In Annex 6 in paragraph 5.89 Ofcom recognises that differences in coverage can be overcome by building more sites; this will "depend on the practicalities and financial cost of building more sites". However, despite the fact that operators have been building networks for nearly thirty years "[t]he available evidence does not allow Ofcom to take a view on this".

88. However, this all rather confused. What is important is that EE's **existing** superior holding of sites does not put them at a disadvantage in terms of future LTE network coverage versus an operator holding sub-1GHz spectrum. Ofcom does not need to speculate about whether EE can build more sites: it already has them.

89. According to Ofcom's analysis from 8,000 sites upwards the 1800MHz operator can achieve more than 95% coverage i.e., well

beyond the point at which it is assumed that it is economic to provide coverage. These comparisons are all based on 2x20MHz of contiguous sub-1GHz spectrum; the population coverage difference would narrow even further if the 800MHz operator had 2x10MHz.

90. As Ofcom noted previously in its decision to allow 2G re-farming any minor coverage differences can be mitigated by the use of in-building repeaters and femtocells (although it now remains "doubtful whether femtocells or other in-building solutions could be used to eliminate differences in quality between sub 1GHz and higher frequency macro networks".[43])

Capacity advantage

91. Ofcom has presented data which provides a comparison the capacity of 2x20MHz 800MHz and 1800MHz networks. Data has not been presented which allows a comparison of a 2x10MHz 800MHz network with a 2x20MHz 1800MHz network. However from the data available we can see that for an 8,000 site network (Figure A7.11) the model suggests that for a:

    a. 2x20MHz LTE 800 network at 85% load, approximately 30% of user would be able to receive a 4Mbps service;

    b. 2x20MHz LTE 1800 network at 65% load, approximately 25% of users would be able to receive the service.

92. These two data points reveal that only 5% more of the population would be able to access the 4Mbps service with a 2x20MHz LTE 800 network. However, if Ofcom presented the case where only half of the 2x20MHz bandwidth was available at 800MHz i.e. 2x10MHz then we expect that this conclusion would change. We would expect that in a loaded network a 2x20MHz LTE 1800 operator would have a capacity advantage over a 2x10MHz LTE 800 network.

93. We also note that Figure A7.11 the LTE 800 network is presented at a higher load than the LTE 1800 network (85% load versus 65%), we would expect that if both networks were presented on a similar load basis then the 5% population advantage would be reduced if not eliminated for the LTE 800 network.

94. We expect the conclusion that 2x20MHz LTE 1800 has a capacity advantage over a 2x10MHz LTE network to hold broadly true for a variety of site counts and service bit rates based on an extrapolation of Ofcom's data.

[43] Annex 6 paragraph 5.91

95. We are awaiting further data from Ofcom in order to complete this analysis.

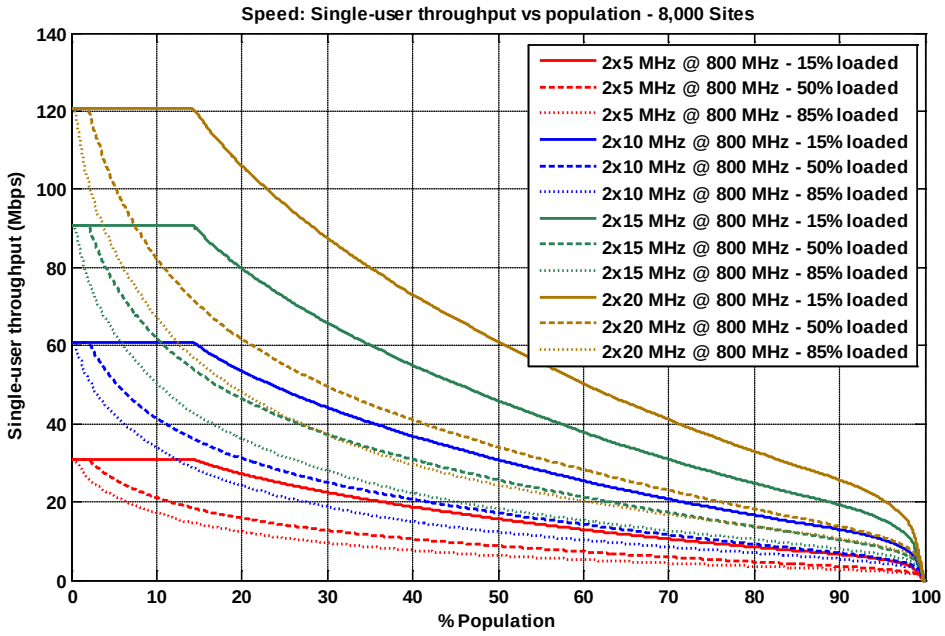
Sensitivity analysis

96. We have examined the sensitivity of our conclusion that EE can better the performance of a 2x10MHz at 800MHz with a 2x20MHz at 1800MHz network. To do this we have compared the performance of these two networks using additional data provided by Ofcom (reproduced in the graph below).

97. The table below tabulates the single user throughput at a variety of load points and population coverage. The table shows that even if Vodafone had access to 2x15MHz of sub-1GHz spectrum the 2x20MHz network would still perform better under all load conditions. This advantage is sustainable beyond 80% population coverage because EE has access to over 20,000 sites.

98. As noted in paragraph 95, we await the further data from Ofcom noted above in order to complete this sensitivity analysis.

	2x20MHz LTE 1800 – 8,000 Sites			2x15MHz LTE 800 – 8,000 Sites		
Population	15% Load		85% Load	15% Load		85% Load
20%	90Mbps		45Mbps	80Mbps		35Mbps
50%	50Mbps		20Mbps	45Mbps		18Mbps
80%	25Mbps		10Mbps	25Mbps		10Mbps



The effect of the proposed auction rules

99. The proposed auction rules permit the outcome detailed in the table below. For the purposes of this analysis we assume that the divested spectrum is bought by O2.

	800MHz	**1800MHz**	**2.6GHz**
EE	2x20MHz	2x20MHz	2x20MHz
Vodafone	2x5MHz		2x20MHz
O2		2x15MHz	
3	2x5MHz		2x20MHz

100. If this is the outcome of the auction (it is not precluded by the rules) **then EE will have a superior network in terms of speed, capacity and coverage**. This risks the "lower competitive intensity in the provision of higher quality data services"[44] that Ofcom is keen to avoid.

Conclusions

101. We can now draw together the treads of our analysis to reach some important conclusions:

    a. Vodafone will be unable to clear either 2x10MHz or 2x15MHz of its 900MHz spectrum by 2013 or anytime soon thereafter;

[44] 5.58

b. ✂;

c. Vodafone, under the proposed rules, will be limited to purchasing 2x10MHz of 800MHz in the auction. EE's current access to 2x20MHz of 1800MHz spectrum will enable them to better the performance of a network using 2x10MHz of sub-1GHz spectrum. EE does not need to buy spectrum in the auction in order to deploy a competitive LTE network.

d. There is no case to skew the auction rules in favour of EE and by doing so Ofcom risks distorting the retail mobile market (or any putative future retail market for higher quality mobile data services that might emerge) by re-establishing the two-tier market that the Commission sought to prevent.

102. Vodafone suggests that Ofcom's case for the current spectrum floors is fatally undermined. In fact, what our submission demonstrates is the need to consider whether other operators should also be subject to caps on 800MHz spectrum because of the risk to competition that emerges from the proposed approach.

Deficiencies in the Ofcom technical model

103. The conclusions that we have drawn from Ofcom technical analysis are fortified by our view that there are several identifiable errors in Ofcom's technical model which exaggerate the relative performance of 800MHz spectrum versus 1800MHz spectrum for LTE:

- The Extended Hata propagation model underestimates the performance of a 1800MHz network relative to a sub 1GHz network;
- Ofcom's method of deriving the Building Penetration loss is flawed; Vodafone's analysis suggests lower values. Ofcom's method penalises incorrectly the performance of an 1800MHz network;
- Ofcom has not accounted for the lower Node B antenna gain at 800MHz - this overestimates the performance of an 800MHz network relative to an 1800MHz network.
- Ofcom has not accounted for the lower UE antenna gain at 800MHz - this has the effect of overestimating the performance of an 800MHz network relative to 1800MHz network.

These and other errors are explained in more detail in Annex 1.

104. We have aggregated all of the errors present in the Ofcom model to show that these contribute to an underestimation of the capability of an 1800MHz network.. Once these errors are corrected we would expect to see the performance of a 2x20MHz 1800 network relative to a sub-1GHz network to improve.

105. The table below shows what we term the ‘factor overestimates’ of the relative performance of the 800MHz band versus the 1800MHz band as a result of errors in the modelling. For example, our factor overestimate of 4.2 in dense urban and urban areas means that if the true coverage advantage of 800MHz over 1800MHz is (say) a factor 2, then using Ofcom parameters would result in an estimate of 8.4 when using a traditional link budget analysis (whereas the true advantage should be less than 0.5). The only way to calculate Ofcom's overestimate of relative site counts would be to re-run Ofcom's simulations with the modified parameters. We have been unable to do this because the original data is unavailable for confidentiality reasons but we suggest that Ofcom re-runs its analysis to correct for the errors that we have identified.

Factor overestimates by area as a result of errors in the Ofcom model

	Dense Urban	Urban	Suburban	Rural
Incorrect implementation of Extended Hata Model	0.0	0.0	0.0	0.0
Use of "Open" rather than "Quasi Open" correction for Rural	0.0	0.0	0.0	0.0
Use of Extended Hata propagation model rather than ray tracing model	2.0	2.0	0.7	-0.9
Use of Saunders & Aragon-Zavala estimate for propagation std dev rather than ITU estimate	0.6	0.6	0.6	0.6
Use of Ofcom rather than Vodafone estimate of BPL	4.8	4.8	4.8	4.8
Use of constant rather than frequency dependent BS antenna gain	2.5	2.5	2.5	2.5
Use of constant rather than frequency dependent UE antenna gain	1.1	1.1	1.1	1.1
Total Link Budget Advantage Overestimate (dB)	11.0	11.0	9.7	8.1
Coverage Area Overestimate Factor (according to Extended Hata model)	**4.2**	**4.2**	**3.6**	**2.9**

Coverage Obligation

106. We believe that Ofcom may have underestimated the cost of achieving the proposed coverage obligation. It is important to remember that whilst Ofcom is able to impose conditions attaching to the rights of use of radio frequencies, it must ensure that any conditions are objectively justifiable, non-discriminatory, proportionate and transparent.[45] As we demonstrate below, Ofcom's current approach is unlikely to satisfy the first three of the above criteria.

Site Requirements

107. Ofcom's objective in setting the coverage obligation is that the costs of compliance are relatively low. Ofcom has estimated what can be achieved by upgrading the existing 2G mobile network of a 900MHz

[45] Authorisation Directive [2002] OJ L108/21, Article 6(1)

operator to LTE using 800MHz spectrum. Ofcom's modelling suggests that a network of around 9,000 sites using a 2x5MHz 800MHz carrier could provide a 2Mbps service, with 90% coverage confidence indoors, to an area within which 95% of the UK population lives.

108. We have conducted a study to quantify the site count required to meet the coverage obligation of 95% indoor population coverage with a 90% probability and providing a 2Mbps service by using the ✂.

109. We find that:

    a. If LTE 800 was deployed on [✂
    ]
    b. We estimate that of the remaining [✂].

110. ✂.

111. ✂.

Costs of compliance

112. We have attempted a rough estimate of the cost of meeting the proposed coverage obligation.

113. ✂.

114. We make the following assumptions:

    a. ✂.

    b. ✂.

    c. Cost assumptions:

    ✂
    d. ✂.

115. Using the above assumptions we estimate that the 10 year NPV cost[46] of the additional expenditure required to fulfill the coverage obligation is around [✂]. This appears considerably higher than Ofcom's estimates and as a consequence it may skew the auction for the block of spectrum associated with the coverage obligation to the advantage of EE (assuming that their costs of compliance would be lower).

[46] Using a 7% discount rate

116. ✂.

Section 3 - Auction Design

This section covers what we believe to be the most important features of the auction: the fear that the operators will bid strategically, the linking of the annual licence fee (ALF) to the prices paid in the auction, the setting of reserve prices and the [✂].[47] We argue that strategic bidding is not a problem because operators lack both the incentive and the ability to bid strategically and that the auction will be distorted by the mechanical linking of the prices paid to the setting of the ALF [✂].

Strategic Bidding

117. Ofcom's specification of spectrum floors is driven by its belief that it must 'force' the outcome of the auction to deliver four national wholesalers because strategic bidding on the part of Vodafone and O2 (and possibly EE) would otherwise thwart this outcome. This line of reasoning is covered in paragraph 5.57:

> *"If only two or three national wholesalers could win access to spectrum portfolios that would allow them credibly to offer higher quality data services, they may have a strategic incentive to bid to achieve this. Expected profits would tend to be higher as a result of lower competition. This could mean that two or three national wholesalers would have an incentive to bid to pay more for the spectrum in order to restrict competition and the number of national wholesalers having such spectrum portfolios. In this case, the concentrated spectrum outcome would not reflect a socially optimal allocation of spectrum, rather it would reflect likely lower competition in the case where there are only two or three credible national wholesalers. These strategic bidding incentives could make an outcome of the combined award with fewer national wholealers with spectrum portfolios for credibly offering higher quality data services more likely."*

118. We believe that there are three important steps in the logic of this case. First, the incentive to bid strategically, second, the ability to bid strategically and last the potential victims of strategic bidding.

[47] Our more detailed comments on the auction are covered in Annex 2

The incentive to bid strategically

119. It is not entirely clear what Ofcom considers to be the possible consequences of strategic bidding. However, given the proposed spectrum caps on sub-1GHz spectrum, it cannot be the case that Vodafone and O2, acting in concert, can exclude EE and 3 from the future supply of higher quality data services. ✂

120. However, as has been considered in some detail in section 1 of this response, there is simply no basis for asserting that a market with only three infrastructure providers is likely to result in competition being adversely affected. The wholesale access and origination market has been characterised by vigorous competition and there is no reason to conclude that this competition would be significantly dampened or even cease if one MNO did not acquire a tranche of 800 MHz spectrum. This undermines the incentive to bid strategically because, in short, there is no pay-off.

The ability to bid strategically

121. Even if there were incentives on certain operators to bid strategically in the auction this outcome will not materialise because its format is **explicitly designed to inhibit tacit collusion between bidders**. In paragraph 9.8f) of the main consultation document, when describing its objectives for the auction Ofcom notes that "[t]o reduce the opportunities for strategic bidding behaviour: the auction rules and procedures should make it difficult for bidders to follow a bidding strategy intended to exclude other bidders from winning spectrum…". Ofcom decides on a combinational clock auction (CCA) and notes in paragraph 9.47 "[o]verall, we consider that our auction design proposals strike an appropriate balance between our different objectives, such as letting bidders express the range of their valuations in full, reducing common value uncertainty and **limiting the opportunities for strategic behaviour**." (our emphasis).

122. A key feature of the CCA auction design proposed is that "[t]here is not full transparency of all bids made in the last round by all bidders; only aggregate and excess demand in each category are revealed" (see paragraph A9.54 of the Annexes). This means that it is not possible for 3 bidders to collude to force out a 4th bidder at 800MHz because a bidder (call him bidder Victor) who is "hoping" for the 3-winner result cannot tell whether other bidders are "playing their part". Victor can only see aggregate demand, and Victor does not know the origin of this demand: it could be from the 4th bidder for instance, the one who Victor is hoping to drive out. Also, even if it may look like a 4th bidder has been driven out, that bidder could have transferred eligibility into other spectrum band that will be brought back later.

123. This analysis is further supported by Ofcom's previous judgements on information policy when preparing for the 2.6GHz auction in 2007 and 2008. In the Discussion paper of August 2007 and the Consultation paper of December 2007, Ofcom had considered revealing the packages submitted by individual bidders (on an anonymised basis) to help reduce common value uncertainty and aid price discovery: see for example paragraphs 1.6 and 3.20 of the December 2007 consultation. However, by the time of the Statement and Information Memorandum of April 2008, Ofcom had decided to reveal only aggregate information, giving this justification (page 241 on "Information Release"): "By not releasing information on individual bids it will become **very difficult** for bidders to bid strategically in a way designed to reduce competition" (our emphasis).

124. ✂

    a. ✂

    b. ✂

125. ✂

126. ✂

The potential victims of strategic bidding

127. If we put to one side the fact that the auction design does not, in the absence of collusion, permit strategic bidding we can see from our critique of Ofcom technical analysis that the potential victims of strategic bidding are very different from those envisaged by Ofcom.

128. EE can never be the victim of strategic bidding because it has sufficient spectrum from its existing holdings to deploy a high speed data network. Indeed, as we show in section 2, Ofcom's own analysis shows that the performance of this network will be superior to a 2x10MHz sub-1GHz network under all loading conditions. Therefore there is no additional profit to be gained by squeezing EE out of the market for 800MHz spectrum.

129. [✂] This is the case because the existing holdings of 900MHz spectrum do not provide a near term substitute for 800MHz for the reasons explained in section 2. This means that Vodafone and O2 could both be the victims of strategic bidding in the auction (and indeed the "guaranteed winner" facility makes this possible) because EE and 3 could between them acquire the entire 800MHz band since their joint permitted acquisition can exceed 2x30MHz.

130. We do not believe that strategic bidding presents a risk in the auction (except by guaranteed winners exploiting this feature). However if Ofcom believes that its design of the auction leaves it vulnerable to such tactical bidding then the 'protection' that it offers individual operators (or types of operator) should be directed at those at risk from strategic bidding: those that are unsuccessful in acquiring the divested 1800MHz spectrum. EE cannot be the victim of strategic bidding and therefore it should not qualify for any degree of protection.

The setting of AIP

131. Ofcom is proposing a radical change in the setting of Administrative Incentive Pricing ("AIP") and to mark the occasion it changes its name to the Annual Licence Fee ("ALF"). However, the consultation document is notable for the absence of any meaningful or compelling explanation of why Ofcom now wishes to depart from its well-established practice. Nor has Ofcom been able to demonstrate that its new approach will be consistent with its statutory duties when managing spectrum; despite its name change the act of charging annual fees is *still subject to the same legal framework*. Indeed, in this case Ofcom cannot mask the fact that this change will introduce a material distortion to the auction and accordingly to future competition in the mobile market.

132. Ofcom proposes to link the ALF for both 900MHz and 1800MHz directly to the outcome of the 800MHz auction (in the case of the former) and the 800MHz and 2.6GHz auction (in the case of the latter).

133. However, a simple example is sufficient to demonstrate that the new calculation of AIP will distort the outcome of the auction.

134. The whole apparatus of the second price rule in auction design is designed to encourage honest bidding and efficient outcomes, whereas the ALF effect creates an incentive for dishonest bidding and inefficient outcomes.[48] It is wholly inadequate for Ofcom to say that it can remove this distortion by introducing ex post adjustments to ensure that holders of 900MHz and 1800MHz spectrum pay the full

[48] Ofcom clearly does not expect the auction to exhibit a 'pure' form of competition in which everyone is a price-taker and no-one is a price-maker (otherwise presumably it would not need reserve prices). Therefore individual bidders do count and therefore it is legitimate to argue that those who pay AIP/ALF will have an incentive to shade their bids.

market value anyway because Ofcom cannot possibly know whether bidders have shaded their bids in response to the method for calculating ALF. In any case it would seem bizarre for Ofcom to run a auction that it knows will be prone to distortion in the hope of correcting for the distortion in the face of imperfect knowledge when it could instead just endeavour to run an auction which is not distorted.

135. ✂

136. ✂

137. ✂

138. As is examined in further detail in the legal analysis, Ofcom's approach to the setting of spectrum fees is not simply lacking in any articulated objective justification but has the clear potential to result in distortions to the bidding process and future competition in relevant mobile markets. On any analysis, Ofcom's proposed approach rides roughshod over the duties and obligations mandated by the CRF when setting spectrum fees. Whilst the Authorisation Directive provides Ofcom with some discretion to levy spectrum fees, this is not an unfettered right. Ofcom is obliged to ensure that its course of action is objectively justifiable, non-discriminatory, proportionate and transparent and gives effect to its duty to promote competition. Regrettably, Ofcom has failed to demonstrate that it has taken account of or met its obligations in its approach to setting spectrum fees.

Ofcom's previous statements on AIP

139. Vodafone is particularly surprised that Ofcom has chosen to ignore this serious drawback to its proposed setting of ALF in its consultation. It cannot be the case that Ofcom is not alive to its potential dangers because they have been cited regularly in previous consultations.

140. For example, in SSRP: The revised Framework for Spectrum Pricing (Proposals following a review of our policy and practice of setting spectrum fees) published in March 2010. Ofcom explained in paragraph 3.105 that "…linking AIP directly to auction prices may distort bidding incentives. For example, if bidders expect the AIP fees they pay on some of their spectrum to be revised in the light of the auction price of spectrum they are bidding for, they may have an incentive to bid less aggressively. In addition, if the direct link between AIP and auction prices affects some bidders' valuations but not others (for instance, if only some bidders' are subject to AIP on their other spectrum holdings), auction results might be distorted".

141. It appears to Vodafone that both conditions for distortion that Ofcom identified in the SSRP are met. The bidders must clearly expect that the AIP paid on some of their spectrum will be revised in the light of the auction price since this is precisely what Ofcom is proposing. Furthermore, this link between AIP and auction prices affects some bidders' valuations rather than others. In the case of Ofcom's current proposal the distortion will definitely affect Vodafone and O2, it may affect EE (and if it does it will be to a different extent) and it will not affect either 3 or new entrants. Again, it is all the more perplexing why Ofcom has not addressed this effect in its consultation.

142. Ofcom also highlighted in the same consultation some of the dangers of setting high fees: "when licences are tradeable, trading activity may be dampened, and may not happen at all because some of the additional value (beyond the market value) that a new user could generate from the spectrum has been captured in the fee. This could inhibit the development of secondary markets." (see paragraph 3.116).

143. This is not a new concern for Ofcom, in paragraph 9.56 of the Spectrum Framework Review: Implementation Plan, Ofcom notes that "[c]are would need to be taken to avoid poor incentive properties being created by an increase in AIP. If the increase were to occur, because a greater value for the spectrum had been revealed, the incentive on spectrum holders to realise the most valuable use might be reduced, because much of the gain would be taken away."

How should Ofcom set the AIP?

144. The BIS Direction from Government requires Ofcom, after the completion of the auction, to revise the annual licence fees paid for 900MHz and 1800MHz spectrum. In full, the Direction says that:

    a. after completion of the Auction OFCOM must revise the sums prescribed by regulations under section 12 of the WTA for 900MHz and 1800MHz licences so that they reflect the full market value of the frequencies in those bands.

    b. In revising the sums prescribed OFCOM must have particular regard to the sums bid for licences in the Auction.

145. It appears to Vodafone that there are two key aspects to this part of the Direction:

    a. The requirement that the annual fees 'reflect the full market value' of the spectrum;

b. The requirement for Ofcom to pay particular attention to the sums bid for the licences.

146. The established principles of Community law mean that the obligations mandated by the pan-European common regulatory framework (the "CRF") must take precedence over any domestic legislation or rules. Thus the Direction cannot be construed in a way that would result in Ofcom failing to give effect to primary duties required by the CRF and transposed into UK law. To the extent that the Government's Direction generates binding effects, Ofcom must ensure that it ensures that it interprets it and applies it in a manner that is compatible with the provisions of the CRF.

147. In fact, there can be little room for doubt that the Government's Direction is issued with a view to achieving the core principles of the CRF:

> *"The Secretary of State gives these directions for the purposes of: ensuring the release of additional electromagnetic spectrum for use by providers of next generation wireless mobile broadband: allowing early deployment and maximising the coverage of those services; creating greater investment certainty for operators…"*[49][emphasis added]

148. As we demonstrate below, Ofcom's proposed approach will not achieve the objectives underpinning the Direction. Nor will it be consistent with Ofcom's duties under the CRF.

149. Section 10 of the consultation and Annex 11 set out a framework for linking ongoing annual licence fees for liberalised 900MHz and 1800MHz spectrum to prices paid in the auction. However, the requirement in the Direction to revise the licence fees so that they 'reflect the full market value' whilst having 'particular regard to the sums bid for licences in the auction' **does not mean that Ofcom must apply a mechanistic approach to linking the two. To do so would in this case would be at odds with Ofcom's obligations**;

a. Regard must continue to be had both to obligations under the prevailing EU Framework (for example Article 13 of the Authorisation Directive requiring Ofcom to take into account the principles set out at Article 8 of the Framework Directive to ensure there is no restriction or distortion of competition). Ofcom must also give due regard to its general duties under section 3 of the Communications Act 2003 (most notably the desirability of encouraging investment and innovation,

[49] SI 2010/3024, Section 2

encouraging the availability and use of high speed data transfer services throughout the UK and ensuring the optimal use of spectrum);

b. A mechanical link between the auction and the annual licence fees is highly unlikely to be compatible either with Ofcom's primary obligations under the EU Framework or even its general duties, given its potential to have a significant distorting effect on the auction outcome. ✂

150. It is not sufficient for Ofcom to state that a final decision on annual licence fees will be made following a further consultation after the auction. The clear suggestion is that, assuming a competitive auction, annual licence fees will be linked to the value of winning bids in the auction in a mechanistic way and this alone is likely to lead to distortion in the auction process.

151. Vodafone believes that the fees can be set in a manner that ensures that the application of the Direction is in line with Ofcom's wider duties. To achieve such an outcome, Ofcom must break the link between the sums bid in the auction and the annual licence fees.

152. In the Framework for spectrum pricing consultation Ofcom explains the traditional method for setting AIP: "fee levels are set administratively by reference to the regulator's estimate of the **value** of the spectrum rather than directly by the market as in an auction". (paragraph 1.10 – our emphasis). In paragraph 1.12 Ofcom notes that (our emphasis) "AIP acts as a proxy for **market** prices for scarce spectrum…it promotes optimal use by ensuring that users face a signal of opportunity cost..". Ofcom re-iterates in paragraph 2.52 that "[t]he opportunity cost is the price that would emerge in a well functioning market and reflects the value of spectrum to the best alternative use..".

153. In other words, the traditional method for setting AIP for mobile spectrum already acts as a proxy for the market value of spectrum because it is set by reference to the opportunity cost. Ofcom further emphasises and clarifies this point in its subsequent statement "[w]hen discussing fees to reflect the value of spectrum we have usually meant that these fees would be set at the price that would emerge in a well functioning market. In a well-functioning market, the price of spectrum would be equal to the value of that spectrum in the next highest value use, rather than the value that the current user (for example, a company might place on the spectrum….we have redrafted our AIP principles and methodologies to clarify that we set AIP fees on the basis of opportunity cost." (see paragraph 1.9).

154. In paragraph 10.3 of this consultation Ofcom states that "[w]e consider that full market value is the price that would arise in a well functioning market" and then in the next paragraph "we interpret the term "full market value" to mean that we do not discount our estimate of the price that would occur in a well functioning market". However, this is consistent with applying the traditional method for estimating the market value of spectrum by assessing its opportunity cost ✂.

155. Hence Ofcom can fulfil the requirement that the spectrum fees be set to reflect the 'full market value' of spectrum by using its tried and tested modelling techniques to estimate the opportunity cost of 900MHz and 1800MHz spectrum [✂]. As an approach of this kind does not involve the type of radical departure proposed in the consultation document and as such is more likely to be compatible with Ofcom's duties when levying spectrum fees.

156. Ofcom can have particular regard to the sums bid in licences in the auction by using "market valuations as a cross-check on our own estimates" (see paragraph 4.306 in the Statement on spectrum pricing). In doing so Ofcom would undoubtedly agree that "….auction valuations are in practice affected significantly by the specific circumstances of the award, particularly by the design of any auctions, which means that there are difficulties in finding, or reliably determining, like-for-like-comparisons and that it is important that we find methods of using evidence from observed auction outcomes to inform AIP decisions without distorting bidding or trading incentives." (see paragraph 4.298).

157. Indeed there are many reasons why the sums bid in the 800MHz auction cannot simply be read across to imply a market value for 900MHz:

    a. ✂.

    b. There is an associated cost of clearing the 900MHz spectrum which does not apply to the 800MHz spectrum. ✂.

    c. The 900MHz spectrum is not contiguous and therefore it cannot be readily converted into 2x10MHz blocks.

    d. ✂

    e. There is no current industry focus on LTE 900 and as such availability of handsets and equipment is far more uncertain than for LTE 1800 or LTE 2.6GHz.

f. The number of players versus the spectrum lots (with particular reference to the fact that two lots of spectrum A1 and A2 have potentially serious interference issues).

g. The proposed reservation of spectrum for operators that do not hold sub-1GHz spectrum and impact on the other lots.

h. It may be the case that the current use of 2G for voice is not preventing higher value services from being offered. In the Competition Commission (CC) inquiry into mobile voice call termination charges the CC thought: "[o]ur understanding is that the use of 2G spectrum for voice services is not preventing any higher-value services from being offered, and so, absent the restriction on its use [after re-farming], it is not clear to us that the opportunity cost of 2G spectrum would increase much over and above current 2G AIP fees which focus on cost savings in delivering voice services." (see paragraph 2.9.86)

158. Vodafone submits that Ofcom can set the spectrum fees to reflect the full value of the relevant spectrum bands by using its favoured existing 'least cost alternative' (LCA) methodology to assess the opportunity cost of spectrum and thus its market value. Ofcom has, to date, been convinced that it can perform these calculations robustly and set the level of AIP to incentivise mobile operators to use their spectrum efficiently.

159. The LCA method has the advantage that it will break the hard link between the bids in the auction and the level of ALF. This will remove the risk of distortions within the auction and thus the danger that its outcome will conflict with Ofcom's broader objectives. The amounts bid in the auction can be used to cross-check the LCA calculation subject to any adjustments required by the factors outlined in a) to e) in paragraph 157 above.

Reserve prices

160. Vodafone's believes that reserve prices should be set so as to facilitate an efficient outcome to an auction: in particular, they must be high enough to deter frivolous bidding, but low compared to the expected value of the spectrum (since that expectation may be very wrong). We understand that this has been Ofcom's position in previous auctions and consultations.

161. We do not support attempts to estimate the "market" value of spectrum prior to an auction, and then set reserve prices at or close to that estimated value: this discourages entry, and defeats the

purpose of an auction in finding an efficient allocation of spectrum among bidders at a fair market price.

162. ✂

163. ✂

164. ✂

165. ✂

✂

166. ✂

✂[50]

✂[51]

167. ✂:

✂[52]

168. ✂.

169. ✂.

170. ✂.

171. ✂.

172. ✂.

173. ✂.

174. ✂.

[50] ✂
[51] ✂
[52] ✂

Section 4 – Legal Analysis

Introduction and summary

175. The way in which Ofcom allocates and manages radio spectrum assumes very considerable importance in the communications sector because of the implications for competition in the provision of mobile communications services in the UK. Quite simply, as Ofcom recognises on a number of occasions in its consultation document and other recent spectrum-related publications, spectrum is a scarce resource and a critical raw input for the operation of a mobile network. The way in which this raw input is made available and managed is highly likely to affect the strategic decisions of potential purchasers, which has a corresponding effect on the way competition operates in the downstream retail mobile market.

176. This is evidently why the Community legislature has imposed, on a pan-European basis, clear criteria, duties and obligations that must be satisfied by all National Regulatory Authorities when allocating and managing spectrum. These duties and obligations are articulated in the harmonised pan-European Common Regulatory Framework (the "CRF").

177. As these duties and obligations are clearly enshrined in Community law and must be transposed by all Member States, they must take precedence over any other policy preference of an NRA when designing spectrum auctions or managing spectrum.

178. In this case, Ofcom's design of the framework that will govern the auction of the 800MHz and 2.6GHz bands and its proposals for the way in which licence fees for existing holdings of spectrum in the 900MHz and 1800MHz bands are to be determined constitute a clear breach of its primary duties in relation to spectrum allocation and management.

    (i) In stipulating that EE is to be all but guaranteed a minimum block of spectrum in the 800MHz band, Ofcom's current auction rules is not only discriminatory (in favour of EE), but presents a clear risk of a significant distortion to competition;

    (ii) The risk of a competitive distortion is made more likely by Ofcom's failure to recognise that Vodafone's existing 900MHz spectrum cannot be used to deploy an LTE network in the short to medium term. Thus, EE, afforded additional protection in the auction, will have the ability to operate a superior LTE network unconstrained by credible competitors;

(iii) In explicitly linking the level of future licence fees for 900MHz and 1800MHz spectrum to the outcome of the auction, Ofcom threatens to distort the bidding process that may produce an inefficient outcome in terms of the parties acquiring spectrum in the auction. The outcome of the auction will, of course, have potentially adverse consequences for competition in the retail mobile market.

179. Individually, each of the above errors is sufficient to vitiate any decision on the part of Ofcom to adopt the approach articulated in its consultation document. The cumulative effect of these errors serves to reinforce that Ofcom has proposed an approach that requires considerable further review and remedy before a decision can be made that is robust and capable of withstanding the profound and rigorous scrutiny of industry stakeholders and the courts.

Relevant legal framework

180. The preservation and promotion of competition is the leitmotif of the sector-specific CRF that governs the communications sector. It is specifically at the heart of the Article 8(2) of the Framework Directive that provides for the overarching principles and obligations with which NRAs must comply in performing their duties:

> "*The national regulatory authorities shall promote competition in the provision of electronic communications networks, electronic communications services and associated facilities and services…"* [emphasis added]

Article 8(2) elaborates further by explaining how NRAs should seek to realise this objective:

> *"(a) ensuring that users, including disabled users, derive maximum benefit in terms of choice, price, and quality;*
>
> *(b) ensuring that there is no distortion or restriction of competition in the electronic communications sector;*
>
> *(c) encouraging efficient investment in infrastructure, and promoting innovation*."

181. However, the ability to acquire and exploit radio spectrum is critical to parties that wish to operate mobile *networks* and offer wholesale and retail access services. The allocation and management of radio

spectrum is therefore inextricably linked to competition in mobile markets. As such, it is explicitly deemed by Article 8(2) of the Framework Directive as one of the ways in which NRAs are to promote competition:

> *"encouraging efficient use and ensuring the effective management of radio frequencies and numbering resources."*

182. Article 8(2) of the Framework Directive is further reinforced by Article 9(1), which requires NRAs to ensure that the management of radio spectrum are to give effect to the objectives of Article 8(2). To limit the scope for NRAs simply to assert that their approach to spectrum is compliant with the Article 8(2) obligations, the Community legislature has overlaid the basic duty of NRAs with an additional obligation to ensure that the way in which in spectrum is allocated by NRAs is not arbitrary:

> "[NRAs] *shall ensure that the allocation and assignment of such radio frequencies by national regulatory authorities are based on objective, transparent, non-discriminatory and proportionate criteria*."

183. The Framework Directive is further bolstered by the provisions of the Authorisation Directive which requires NRAs to ensure that where rights of use of radio frequency are to be limited, those NRAs must give due consideration to the interests of consumers and the need to further competition in relevant markets.

184. To the extent that an NRA wishes to levy fees for the usage of spectrum by holders, NRAs should also be conscious that such charges may affect the behaviour of undertakings using the spectrum. They are accordingly required to ensure that when such charges are levied, the NRA must, pursuant to the provisions of Article 13 of the Authorisation Directive: (i) ensure that such fees bring about efficient use of the resource; and (ii) consider their impact on competition in relevant markets:

> *"Member States may allow the relevant authority to impose fees for the rights of use for radio frequencies or numbers or rights to install facilities on, over or under public or private property which reflect the need to ensure the optimal use of these resources. Member States shall ensure that such fees shall be objectively justified, transparent, non-discriminatory and proportionate in relation to their intended purpose and shall take into account the objectives in Article 8 of Directive 2002/21/EC (Framework Directive)."* [emphasis added]

185. The Recitals to the Directive provide further insight into the intention of the Community legislature in linking spectrum fees to Article 8 of the Framework Directive. in expressing the view that:

> *"Such fees should not hinder the development of innovative services and competition in the market."*[53]

186. What is also evident from the provisions of Article 13 of the Authorisation Directive is that the setting of such fees must have a clear objective and the fees set are proportionate to that objective. The guiding principle though laid down by the Authorisation Directive is that the use of such charges must seek to ensure optimal use of the spectrum. Thus, an NRA must first provide clear and robust reasoning in support of a decision to levy fees for the right of use of spectrum. Where a clear objective can be identified, the way in which the NRA chooses to give effect to that objective is governed by the principle of proportionality. The concept of proportionality is well-established in Community law and requires that the public body in question must ensure that adopt the least burdensome way of its achieving its objective.[54]

Incompatibility of the auction design with Ofcom's legal duties

187. The overview of the legal framework in Section 2 leaves both Ofcom and industry in no doubt that the way in which Ofcom allocates spectrum must be pro-competitive both by object and effect. The extent to which the outcome of its auction rules will inhibit competition in the mobile market should therefore be at the forefront of Ofcom's deliberations.

188. Regrettably Ofcom has neglected to give due consideration to this primary obligation when designing its auction framework and rules. Ofcom's current auction framework presents a clear risk that competition and consumers will be adversely affected. This is a material error that would render any decision giving effect to the approach in the consultation document invalid and place Ofcom in breach of its duties.

189. The errors committed by Ofcom in designing its auction framework relate to:

[53] Authorisation Directive [2002] OJ L108/21, Recital 32
[54] Case C-310/04 *Kingdom of Spain v Council & Commission* [2006]

(i) The need to ensure that four national infrastructure providers are present on the mobile market following the spectrum auction;

(ii) the need to ensure that an 1800MHz operator (namely EE) secures a minimum 5MHz of 800MHz spectrum;

(iii) the failure to adequately investigate whether those MNOs operating in the 900MHz band are in reality able to deploy an LTE network using that spectrum in the short to medium term.

A three-player market

190. In the interests of brevity, we do not repeat the detailed critique of Ofcom's competition assessment that is set out in section 1. Suffice it to say that Ofcom has not justified its contention that a three player market in the UK will be damaging to competition in retail and mobile markets. The premise upon which its auction design is currently based (i.e. that the auction must deliver a four player market) is accordingly questionable to say the least.

191. Ofcom is, as a matter of law, required to undertake an ex ante assessment of the type being contemplated by examining the actual real-world evidence from the relevant markets in question. This it has unfortunately failed to do. Indeed, had any assessment been undertaken with reference to the available evidence, it simply would not have been able to arrive at the view articulated in the consultation document. The fact that Ofcom is forced to rely upon a number of extraneous international comparisons in support of a highly dubious claim only serves to reinforce Vodafone's conclusion.

Protecting Everything Everywhere

192. As we have explained in some detail earlier in our submission, the creation of EE in 2010 raised the spectre of a bifurcated mobile market because of the significant concentration of 1800MHz spectrum in the hands of EE. Such an outcome would clearly not operate in the interests of mobile consumers.

193. Whilst the spectrum divestment commitment secured by the European Commission as part of the merger review process has reduced the risk of such an outcome, Ofcom neglects completely to take into account that EE is still well placed, by virtue of a significant holding of 2x45MHz in the 1800MHz band, to deploy an LTE network in the short to medium term. Ofcom has adduced no incontrovertible evidence that calls into question this assessment. This ability to launch an LTE network provides EE, in the near term, with a

significant timing and commercial advantage over its competitors that would leave EE relatively unconstrained by any credible rivals. This bifurcated market clearly would not operate in the interests of mobile consumers.

194. Given the scope for such an outcome, the justification for providing EE with any protection in the auction is highly tenuous.

195. Vodafone is therefore left to assume that Ofcom considers that EE should be guaranteed a minimum holding in the 800MHz band out of a mistaken belief that those MNOs operating in the 900 MHz band are able to deploy an LTE network using their existing 900MHz holding. Indeed, Ofcom suggests that 900MHz spectrum confers an unmatchable advantage upon those currently operating in that band. However, as has been demonstrated in this submission, 900MHz spectrum will not be available for exploitation in the context of LTE deployment for at least five years.

196. Once the limitations of the 900MHz band are accepted, the concerns about Ofcom's proposed course of action in respect of EE are heightened. With a guaranteed minimum 5MHz of valuable spectrum in the 800MHz band, EE will be able to deploy a network that is superior both in terms of coverage and network quality. As an operator holding 900MHz spectrum, Vodafone would be unable to meet this competitive challenge in the short to medium term. Accordingly, EE will enjoy a significant commercial advantage that will enable it to entrench itself as the unrivalled market leader in the provision of next generation mobile services.

197. So far as Vodafone is able to discern from Ofcom's competition assessment, its concern – not formally articulated – appears to be that 3 may be unable to obtain 800 MHz spectrum. This though is an entirely separate matter from why EE should be guaranteed a minimum block of spectrum from the auction. If Ofcom considers that it is critical for 3 or a non-2G operator to be able to have access to a tranche of 800MHz spectrum, then it is incumbent upon Ofcom to justify why this is necessary with reference to its obligations under the CRF. As we have explained in the main body of our submission, the competitive nature of the current wholesale access and origination market should ensure that 3 should be able to conclude an agreement with an LTE infrastructure provider in the event that it were unable to secure a block of spectrum.

198. However, even if Ofcom were able to provide a compelling case for reserving a block of spectrum for 3 or any other non-2G operator (and were consistent with its legal obligations), the reservation of a minimum amount of spectrum for EE constitutes regulatory

intervention that would go far beyond what is necessary to achieve Ofcom's objective.

Promotion of competition: conclusion

199. In light of the clear and compelling risk to competition and consumers arising out of Ofcom's proposed course of action, we would strongly urge Ofcom to reconsider its approach before proceeding further. Specifically, we would invite Ofcom to:

    (i) examine in greater detail the current state of competition on the wholesale access and origination market before drawing any conclusion about the minimum number of infrastructure providers needed to ensure that the UK mobile market remains effectively competitive in future;

    (ii) demonstrate precisely why EE should be guaranteed a minimum amount of 800MHz spectrum from the auction. For clarity, Vodafone does not object to the fact that EE is able to secure additional spectrum in this band. Rather, given the significant concentration of 1800MHz spectrum in its hands, EE should – like Vodafone and O2 – be required to compete in the bidding market with no additional protection from the regulator;

    (iii) undertake a considerably more thorough investigation into the timeframe within which 900MHz spectrum could conceivably used to deploy an LTE network.

200. Until these matters are addressed, Vodafone remains of the view Ofcom is in clear breach of its primary obligations under the CRF to ensure that spectrum allocations are based on objectively justifiable, transparent and non-discriminatory criteria and further the interests of competition.

<u>Setting the Annual Licence Fees</u>

201. Ofcom proposes a radically new approach to the setting of spectrum fees in its consultation document in which the level of the fees for existing 900MHz and 1800MHz spectrum holdings are to be explicitly linked to the outcome of the auction. Ofcom is of course able to contemplate the introduction of changes to the way in spectrum fees are set. However, given its obligation to ensure that any fees are transparent and proportionate, the starting point must be to understand the rationale underpinning its proposed approach. In this respect, the consultation document is conspicuous for the absence of a clearly articulated rationale.

202. Hitherto, spectrum fees have been levied with a view to ensuring that spectrum – a scarce resource – is used efficiently. In 2003, when contemplating spectrum trading, Ofcom commented more generally on the use of spectrum fees:

> "*Both spectrum trading and administrative incentive pricing have the intention of encouraging users to make efficient use of spectrum assignments.*"[55]

203. Such a rationale for the use of spectrum fees would be consistent with Ofcom's duty under Article 8 of the Framework Directive and Article 13 of the Access Directive to ensure the optimal use of spectrum (a duty that is also reflected section 3(2) of the Communications Act).

204. The previous methodology adopted by Ofcom in determining spectrum fees was explicitly designed to achieve Ofcom's objectives with respect to the efficient management of spectrum (reflected in the use of the term Administrative Incentive Pricing or "AIP"):

> *"As mentioned above, Ofcom has the general duty to promote the efficient use of spectrum under the 2003 Act. AIP is an important mechanism for fulfilling this duty. This is because AIP signals to spectrum users the value of the spectrum resource that they are currently using or could potentially make use of. Ensuring that users pay AIP for their spectrum creates the proper incentive for users to only use spectrum that they value as highly as any other potential user. This implies that those users to whom spectrum is worth less than AIP will not have the incentive to use this spectrum. Hence, AIP can promote the efficient use of spectrum by creating incentives that ultimately lead to the allocation of spectrum to those who value it the most."*[56]
> [emphasis added]

205. When Ofcom last amended its approach to the setting of AIP, it sought to establish that its new methodology continued to achieve its broader obligations under the CRF:

> *"In line with Indepen's recommendations, Ofcom has applied an amended methodology for determining AIP, setting each AIP fee in relation to both the value of the*

[55] [insert ref to 2003 consultation on spectrum trading
[56] Ofcom, *Spectrum Pricing. A statement on proposals for setting Wireless Telegraphy Ac licence fees*, 23 February 2005, paragraph 2.9

spectrum in existing uses and its value in other potential uses for each band. ***Thus, AIP will give incentives for spectrum to move to the most valuable uses****. Ofcom believes that AIP should continue despite the advent of spectrum trading, as AIP can continue to promote greater efficiency. Provided AIP fees are set conservatively, trading should not be impaired."*[57] [emphasis added]

206. In this case, Ofcom has provided no explanation for the radical departure underpinning its approach to the setting of spectrum charges in its consultation document. Equally significantly, Ofcom does not appear to have given meaningful consideration in the consultation document to how its proposed new approach will be compatible with its obligations in relation to the efficient management of spectrum.

207. Indeed, the sole reason for its new approach to spectrum fees appears to be that the level of the 900MHz and 1800MHz spectrum fees must, at the behest of HM Government's Direction of 2010, be linked to the 'market value' of the spectrum being sold in the forthcoming auction for the 800MHz spectrum. The fact that HM Government has issued a direction relating to the level of future spectrum fees is not and cannot be a sufficient justification for Ofcom's proposed approach. Indeed, if HM Government's Direction is in fact the sole or main reason for Ofcom's change in approach, Ofcom would need to be satisfied that the new approach would realise its Community obligations. To the extent there is any risk that Ofcom considers that the Government's Direction gives rise to a conflict with Ofcom's duties under the CRF, Ofcom would, as a matter of law and as an independent NRA, first be required to give effect to its Community obligations when setting spectrum fees. However, as we have demonstrated in this submission, it is possible to construe the Government's Direction in a way that does not give rise to a risk that Ofcom has failed to comply with its duties when levying spectrum fees. In fact, it is clear on the face of the Direction that HM Government recognises that its Direction, in its totality, should seek to give effect to the requirements of the CRF in respect of spectrum allocation and management.

208. If Ofcom does indeed have an alternative justification for a change in its approach, then it should submit that new reasoning for consultation amongst industry stakeholders before proceeding further. Currently, Vodafone has serious doubts that Ofcom has been able to demonstrate that its proposed approach to the setting of spectrum fees is objectively justifiable.

[57] Ofcom, *Spectrum Pricing. A statement on proposals for setting Wireless Telegraphy Ac licence fees*, 23 February 2005, paragraph 2.12

209. If the Government's Direction is capable of being deemed to constitute a justification for the way in which spectrum fees are henceforth to be determined, Ofcom must be satisfied that the Direction can be construed in a way that enables Ofcom to discharge its primary obligations under the CRF when managing spectrum and setting fees.[58] To the extent that HM Government's Direction would place Ofcom at odds with its wider obligations under the CRF, as a matter of law, those obligations must prevail over any contradictory directions issued to Ofcom by HM Government.

210. In essence, this means that Ofcom must interpret the Direction in a way that does not result in the bidding process in the forthcoming auction being distorted because of the potential impact of any distortion on the development of future competition in the mobile market.

211. Ofcom contends that the Direction requires that spectrum fees for 900MHz and 1800MHz spectrum must be revised and set in a way that reflects the full market value of the 800MHz spectrum. As has been demonstrated in this submission, there is a clear risk that this approach may skew the incentives and behaviour of 900MHz operators in the bidding process for the 800MHz auction. The potential exists for an inefficient outcome to arise in which a 900MHz operator does not acquire spectrum even though – absent the link between AIP and the auction outcome – it should be incentivised to compete vigorously on the bidding market to acquire the spectrum concerned. The spectrum concerned in this case is critical to the deployment of innovative high speed data communications services. It is accordingly all the more essential that Ofcom ensures, from the perspective of discharging its statutory duties, that its approach to setting the level of the fees does not lead to or encourage distortions in incentives to invest or to competition in the provision of mobile communications services.

212. Ofcom suggests that the scope for such an outcome will be eliminated because of its ability to intervene post-auction if it considers that the bidding process has not resulted in the spectrum being sold for 'full market value'. However, this is a deeply unsatisfactory proposition from a legal perspective. It effectively

[58] Section 13 of the Wireless Telegraphy Act 2006 specifically requires that Ofcom must take into account its duties under section 3 of the same Act when levying spectrum fees. Section 3(2) gives effect to the principles of the CRF by requiring Ofcom to promote: *"(a) the efficient management and use of the part of the electromagnetic spectrum available for wireless telegraphy; (b) the economic and other benefits that may arise from the use of wireless telegraphy; (c) the development of innovative services; and (d) competition in the provision of electronic communications services."*

provides Ofcom with an untrammelled right to dictate essentially what it considers should be the outcome of the auction. Bidding parties are left in the invidious position of being forced to second-guess the circumstances in which Ofcom may elect to exercise what appears to be entirely discretionary power. It is, on any objective analysis, offensive to the principle of legal and regulatory certainty upon which industry stakeholders depend and which is particularly critical to determining bidding behaviour in the context of an auction process.

Spectrum fees: conclusion

213. Ofcom's proposed approach to the setting of spectrum fees appears to serve no clear purpose in terms of the efficient use of spectrum or future competition in mobile markets. Ofcom does enjoy, pursuant to the provisions of the Authorisation Directive, the ability to set such fees. However, the right to levy these fees does not exist in a legal or regulatory vacuum: the Community legislature has clearly appreciated that such fees should not operate in a way that adversely affects competition.

214. Parliament itself has recognised the intention of the Community legislature through the enactment of section 13 of the Wireless Telegraphy Act 2006, which in effect requires Ofcom to take into account the principles of the CRF when levying spectrum fees. Thus, the setting of fees is not an end in itself and is inextricably linked with Ofcom's overarching duty to preserve and promote competition.

215. In this particular case, there is a clear risk that Ofcom's proposed course of action will distort the auction which will have implications for the development of competition in the mobile market. As such, Vodafone is unable to understand how Ofcom has been able to reconcile its approach to its duties. In these circumstances, we would strongly urge Ofcom to remedy these material errors along the lines suggested in this submission before competition and consumers are adversely affected.

Section 5 – Conclusions

216. In this section we briefly summarise the conclusions of our analysis of Ofcom's proposals.

Spectrum Floors

217. Ofcom has got its analysis and therefore its remedy badly wrong. Vodafone's existing holding of sub-1GHz does not bestow upon it an 'unmatchable competitive advantage'. Vodafone cannot build an LTE network which trumps the performance of EE's 1800MHz LTE network by deploying 2x20MHz of sub-1GHz spectrum because it does not hold sub-1GHz spectrum that it can use for LTE in the timescales required.

218. This is why the Commission required EE to divest 2x15MHz of 1800MHz spectrum. It felt it necessary to ensure that at least one other operator could match the performance of the JV's LTE network. If it thought that Vodafone and O2 could compete with EE by using their existing endowments within the timescales necessary then it would not have been necessary to require the divestment of the block of 1800MHz spectrum. The Commission stated in its notification that "…the parties [T-Mobile and Orange] will be able to offer superior network quality in terms of maximum download speed, and potentially also in terms of consistency of provision of lower download speeds. The parties will also have a significant time advantage due to the uncertain timing of the auction and the time needed to clear the sub 1GHz spectrum. In addition, the 2600 MHz spectrum presents lower coverage performance compared to the 1800 MHz spectrum, which makes it hardly suitable for areas other than urban".[59]

219. Ofcom has done no analysis to indicate the facts on which the Commission has made its decision have changed. It has not suggested that EE's ability to launch a 20MHz LTE network 'in the near future' has been compromised or that its 'significant timing advantage' over the other operators has been undermined and it has failed to examine the practicalities of clearing the 900MHz band for LTE. Moreover, Ofcom's own technical analysis demonstrates that EE would enjoy better headline speeds and capacity and equivalent coverage to a 10 or 15MHz sub 1-GHz network.

220. The impact of the spectrum floors is therefore to advantage unfairly the outcome of the auction in favour of EE. In effect, EE is virtually guaranteed at least 2x5MHz of sub-1GHz spectrum; possibly at the reserve price. More importantly, Ofcom appears ready to allow the

[59] Paragraph 128

possibility for EE to bifurcate the market to its own advantage by purchasing 20MHz of 800MHz spectrum and 2x20MHz of 2.6GHz spectrum. We show one possible outcome of the auction and the sale of the divestment spectrum in the table below:

Potential holdings of spectrum for LTE in 2013

✂

221. ✂

Strategic Bidding

222. According to Ofcom's analysis Vodafone and O2 and will have the motive and the opportunity in the auction to bid strategically in order to restrict competition and inflate the profit pool. If Ofcom is right then the same incentive applies to EE who has sufficient 1800MHz spectrum to run a high quality data network. EE could bid strategically (by acquiring 2x25MHz) to ensure that neither Vodafone nor O2 could build a network to rival its own.

223. But Ofcom is not right. Going from four to three national operators will not significantly dent competition. More importantly, though the CCA auction is *explicitly designed to rule out strategic bidding*. Ofcom cannot base its decisions on the basis that "[t]hese strategic bidding incentives could make an outcome of the combined award with fewer national wholealers with spectrum portfolios for credibly offering higher quality data services more likely".[60]

Distortions in the auction

224. We have identified three potentially very serious distortions in the auction: the linking if the ALF to the amounts paid in the auction, the specification of the coverage obligation and [✂]

225. Ofcom is well aware, from what it has said previously, that linking the setting of ALF to the amounts paid in the auction risks distorting its outcome and yet it fails to consider this material risk in the consultation.

226. Ofcom must ensure that the way in which it takes into account the Direction from Government does not contravene its overriding duty to promote competition. We suggest that it can do this without distorting the outcome of the auction (and therefore competition within the market) by adapting its existing methodology. The failure to adapt its proposals in this manner will put Ofcom in breach of its existing duties.

[60] 5.57

227. Vodafone appreciates that the coverage of mobile networks is important issue. Nevertheless we are concerned that the proposed obligation may be so onerous as to make the relevant lot unattractive to any operator at any price; or alternatively skew the auction to the advantage of a particular operator. The specific level of the obligation requires further dialogue between the operators and Ofcom.

228. ✂.

229. ✂.

Legal Duties

230. Ofcom notes early on in its consultation document the relevant provisions of the legal framework that govern its actions when allocating and managing spectrum. Regrettably, it has failed to demonstrate that it would be in compliance with this legal framework if it were to adopt the approach proposed in the consultation document.

231. In the first instance, there is plainly a dearth of evidence that underpins the basic assumptions or basis on which Ofcom has structured its auction design and process. This manifests itself most obviously in the contention that an auction that results in a market with three infrastructure providers will be damaging to competition. It is difficult to see how Ofcom is able to proceed on this assumption when the evidential base that it has adduced to justify it is negligible at best.

232. However, the glaring error that stands out in the consultation document is Ofcom's inability to appreciate that the course of action upon which it proposes to embark is not simply discriminatory but creates a serious risk of a distortion to competition in the mobile market. This is most evident in its failure: (i) to appreciate the position of strength from which EE operates even before the auction has begun; and (ii) to adequately investigate its theory that 900MHz can in reality be exploited for the deployment of an LTE network. Had these matters been adequately addressed as part of Ofcom's analysis preceding the consultation, the risk of the bifurcation of the mobile market would have become apparent.

233. Indeed, when these issues are considered carefully, the case for providing EE with protection in the auction process simply does not stand up to scrutiny. Instead, what should be a legitimate subject for further consideration is the need for the imposition of specific caps

upon operators in the 800MHz band to limit the scope for the bifurcation of the mobile market becoming a reality.

234. Ofcom's errors in respect of the assumptions underpinning its auction design are then compounded through the way in which it proposes to link the level of spectrum charges to the outcome of the auction. It is not simply that Ofcom has failed to justify why it is proposing a radical departure from the previous methodology adopted to set spectrum fees (which was designed to achieve Ofcom's duties). The approach mooted in the consultation document presents a real and compelling risk that the incentives of some parties in the bidding process may be distorted. This distortion to bidding incentives would potentially generate an inefficient outcome that would have an impact on competition on the mobile market.

235. In light of the above points, any decision by Ofcom to adopt the approach outlined in the consultation would constitute a clear breach of its overriding duty to promote competition and consumers. We therefore urge Ofcom to revisit its analysis and reconsider its assumptions underpinning its auction design before proceeding further. We would also invite Ofcom to review its approach to the setting of spectrum fees. Specifically, it is critical that Ofcom develops a methodology that is capable of objective justification in its own right and that will not create the prospect of a distortion to the auction process or future competition in the mobile market.

A way forward

236. If the auction is simply allowed to run without restrictions then there is a possibility that the smallest operator (and others) will fail to acquire any sub-1GHz spectrum; not because the other MNOs will bid strategically but because they simply put a higher value on the spectrum. This is what happens in a market and it is what happened in the German auction. All the current available evidence suggests that those unsuccessful operators would then successfully conclude a commercial wholesale arrangement with one of the successful bidders. Failing this, Ofcom could intervene *ex post* or even *ex ante* by attaching a wholesale access obligation to one or more of the 800MHz lots (as it currently contemplates).

237. ✂.

238. Failing this Ofcom should just let the auction run. The only restriction necessary is that no operator should be allowed to acquire more than 2x10MHz of 800MHz in order to prevent the bifurcation of the market that the Commission was keen to prevent.

Section 6 – Answers to specific questions

Mobile spectrum bands

Question 4.1: What use, if any, would you make of the top 2x10 MHz of the 800 MHz band in the second half of 2012 if it were available for use? What would be the benefits for citizen and consumers of such availability?

✂

Question 4.2: If we were to offer shared access low-power licences in some way, do you have any comments on the appropriate technical licence conditions which would apply for the different options?

Vodafone believes that Ofcom should not offer shared access low-power licences, because these will not lead to an effective use of spectrum nor provide significant benefits to citizens or consumers. They will however, indirectly harm consumers by reducing the spectrum available to mobile networks and thus increasing costs.

If Ofcom were to offer shared access, then this should be limited to the minimum amount of spectrum, and not shared with high power networks. We believe that Ofcom will find it impossible to define licence conditions for shared high and low power use that would enable potential bidders to quantify the potential impact of the lower power use, which would inherently be ill-defined in terms of potential geographic extent and usage. They would therefore not be able to make relative valuations of the different lot categories in the 2.6GHz band, and the efficiency of the auction as a whole would be significantly compromised.

Competition assessment and future mobile markets

Question 5.1: Do you agree that national wholesalers need a reasonable overall portfolio of spectrum to be credible providers of higher quality data services? In particular, do you agree that national wholesalers need some sub-1 GHz in order credibly to be able to offer higher quality data services? Please state the reasons for your views.

The MNO's rather than Ofcom should determine the portfolio of spectrum that they require to deliver higher quality data services. However, a proper comparison of Vodafone's possible deployment of LTE using sub-1GHz spectrum versus EE's using its 1800MHz spectrum — using Ofcom's technical analysis — demonstrates that EE does not require any sub-1GHz spectrum to offer a competitive service in this putative market.

Question 5.2: Do you agree there is a material risk of a significant reduction in the competitive pressures, at least to provide higher quality data services, in retail and wholesale markets without measures in the auction to promote competition? Please state the reasons for your views.

We do not agree that there is a material risk of a significant reduction in competitive pressure. The evidence shows that a market of three infrastructure based wholesalers is sufficient to generate a vigorously competitive market.

Question 5.3: Do you agree there is a risk of potentially beneficial sub-national RAN uses not developing without measures to promote competition? Please state the reasons for your views.

The experience of the DECT guard band does not provide any evidence of sub-national operators providing potential benefit to citizens and consumers. The low transmit power limit that is inherent to shared use of spectrum substantially reduces the utility of spectrum compared with a single operator exclusively using the spectrum. Sub-national RAN use can only make effective use of spectrum if the number of users actively sharing the spectrum outweighs the low utility of the spectrum to each of them.

For the DECT guard band, there was a case (though weak) that the collective use of spectrum could create opportunities that exploit the availability of GSM handsets for speech services. This is not the case for 2.6GHz spectrum: the potential new services that could be delivered in this spectrum but not in the DECT guard band all involve data. Given the low power limit proposed (and required) these services could be delivered just as effectively using WiFi, and at much lower equipment cost.

Question 5.4: Do you agree with the analysis that at least four competitors are necessary to promote competition?

No. Please see section 1. The evidence shows that a market of three infrastructure based wholesalers is sufficient to generate a vigorously competitive market.

Question 5.5: Do you agree that the specific measures we propose to take to ensure there are at least four holders of such spectrum portfolios are appropriate and proportionate?

No it is completely unjustifiable, discriminatory and disproportionate to skew the auction to the relative advantage of EE. EE does not require sub-1GHz spectrum to be able to deploy a competitive LTE network; this was recognised by the European Commission at the time of the merger clearance and indeed was the *raison d'etre* behind the spectrum divestment requirements. The specification of the spectrum floors allows EE the opportunity to re-establish

the bifurcation of the market that the Commission's remedy was designed to avoid.

All the current available evidence suggests operators unsuccessful in the auction would then successfully conclude a commercial wholesale arrangement with one of the successful bidders. Failing this, Ofcom could intervene *ex post* or even *ex ante* by attaching a wholesale access obligation to one or more of the 800MHz lots (as it contemplates in this consultation).

✂.

Question 5.6: Given the measures we propose to take to ensure four holders of spectrum portfolios sufficient credibly to provide higher speed data services, do you agree that it would not be appropriate or proportionate to introduce a regulated access condition into the mobile spectrum licences to be awarded in the combined award?

The current wholesale market is vigorously competitive and yet it is only supplied by three national wholesalers. It would be disproportionate to impose access conditions in an auction which has been deliberately constructed to deliver four national wholesalers.

Question 5.7: Do you consider that we should take measures to design the auction to assist low-power shared use of 2.6 GHz? If so, what specific measures do you consider we should take?

No, please see our answer to question 5.3. There is no evidence that low power operators would provide any significant benefits to citizens and consumers. On the other hand, assisting low power use could indirectly harm consumers, by reducing the spectrum available for mobile networks, and thus increasing costs that would be passed on to consumers.

Mobile coverage and related issues

Question 6.1: Do you have any comments on the proposal to include in one of the 800 MHz licences an obligation to serve by the end of 2017 an area in which 95% of the UK population lives, while providing a sustained downlink speed of 2Mbps with a 90% probability of indoor reception?

We support the imposition of a coverage obligation into a single licence. Multiple coverage obligations will risk the uneconomic duplication of investment and infrastructure.

Ofcom's modelling suggests that a network of around 9,000 sites using a 2x5MHz 800MHz carrier could provide a 2Mbps service, with 90% coverage confidence indoors, to an area within which 95% of the UK population lives. ✂.

Do you think there is another way of specifying a coverage obligation that would be preferable?

Ofcom's objective in setting the coverage obligation is that the costs of compliance are relatively low. In order to achieve this we believe that the percentage population level will need to be reduced significantly.

Question 6.2: We would welcome views and evidence on the costs and benefits of imposing an additional coverage obligation focussed on particular geographical areas, and if such an obligation were to be imposed what might be the appropriate specification of geographic areas?

It is difficult to calculate the cost of additional coverage without knowing the specific areas involved. However, imposing an additional coverage obligation will simply exacerbate the problem that the obligation is costly to provide.

If particular areas were to be specified then this should 'paid for' by reducing the overall coverage obligation. For example, one licence could have a population coverage of 80% plus coverage in named specific geographic areas.

In practice however we see little prospect that the specific less densely populated areas to be served could be decided in sufficient time for the auction to be run in the early part of 2012.

Question 6.3: Do you have any comments or evidence on whether an additional obligation should be imposed to require coverage on specific roads

Please see our answer to question 6.2.

Question 6.4: Do you have any comments on our proposal not to use the combined award to address existing not-spots?

We support this decision. It would take considerable time to identify and agree and specify the relevant not-spots

Question 6.5: Do you have any comments on our proposal not to impose 'use it or sell it' obligations but to consider including an additional power to revoke during the initial term of the licences?

We do not support 'use it or sell it conditions'.

Non-technical licence conditions for 800 MHz and 2.6 GHz

Question 7.1: Do you have any comments on the proposals relating to the duration of the initial licence period, our rights to revoke the licence during this period, the charging of licence fees after the end of the initial period and our additional revocation powers following the initial period?

We are generally supportive of the proposed terms. However, as ever, we would appreciate some clarification on what constitutes "spectrum management reasons".

Question 7.2: Do you have any comments on the proposal to amend the spectrum Trading Regulations to apply to the auctioned licences in the 800 MHz and 2.6 GHz bands, to include a competition check before we consent to a spectrum trade of mobile spectrum and not to allow transfers that would increase the number of 2.6 GHz low-power licensees?

We support making the 800MHz and 2.6GHz tradeable. We commented on the proposed competition check in our response to the recent consultation. We stated that "to the extent that Ofcom ultimately determines that the introduction of an *ex ante* competition assessment is necessary, considerably greater clarity will be required – in terms of the legal standard of review and the procedural framework that will be adopted for the assessment of proposed trades – than is apparent in the consultation document. Further action in respect of these issues is necessary to ensure that the legal and regulatory certainty that is critical to industry stakeholders considering investment decisions is not undermined." These comments still apply.

Question 7.3: We welcome views on the merits of the proposed approach to information provision; in particular concerning the type of information that may be helpful and any impacts that publication of information might have both on licence holders and the wider spectrum market.

This looks like an open-ended opportunity for Ofcom to ask for information but without any clear benefit. Interested parties who may wish to use the spectrum are free to approach the relevant operators; this is what happens (very effectively) at the moment. There is no need for Ofcom to facilitate this process. Publication of information about base station deployment is commercially sensitive.

Spectrum packaging proposals for the 800 MHz and 2.6 GHz award

Question 8.1: Do you agree with the way in which we are taking account of the main factors relevant to spectrum packaging and why? Question 8.2: Are there other factors that we should consider to develop our approach to packaging? If so which ones and why? Question 8.3: Do you agree with our packaging proposals for the 800 MHz band? Please give reasons for your answer.

✂ See our answer to question 8.7 below.

Question 8.4: Do you agree with our proposal not to allow relinquishment of 900 MHz spectrum and why? Do you have any other comments regarding our packaging proposals for the 900 MHz band?

✂.

Question 8.5: Do you agree with our proposal not to allow relinquishment of 1800 MHz spectrum and why? Do you have any other comments regarding our packaging proposals for the 1800 MHz band?

✂.

Question 8.6: Do you agree with our proposal not to make provisions to include 2.1 GHz spectrum in this auction and why?

✂.

Question 8.7: Which aspects of our packaging proposals for the 2.6 GHz band do you agree with and why?

Ofcom currently proposes that the TDD spectrum in the 2.6GHz band is sold in a single block of 50MHz with guard bands of 5MHz at each end of the block, "clean" spectrum is 40MHz. ✂

✂.

Question 8.8: Do you agree with our proposed approach for eligibility points and why?

We believe that it is reasonable for eligibility points to scale with the reserve prices, and for both to roughly reflect the relative values of spectrum. Accordingly, we have no objection to Ofcom's proposal about eligibility points.

We do note that Ofcom's proposal suggests a value per MHz at 1800 that is approximately the same as the value at 2600, rather than an average of the values at 800MHz and 2.6GHz (see also our responses to Questions 10.1 and 10.2). ✂.

Question 8.9: Which approach to reserve prices do you think would be most appropriate to secure optimal spectrum use in the interests of citizens and consumers, and why?

Vodafone's position on reserve prices is that they should be set so as to facilitate an efficient outcome to an auction: in particular, they must be high enough to deter frivolous bidding, but low compared to the expected value of the spectrum (since that expectation may be very wrong). We understand that this has been Ofcom's position in previous auctions and consultations.

We do not support attempts to estimate the "market" value of spectrum prior to an auction, and then set reserve prices at or close to that estimated value: this discourages entry, and defeats the purpose of an auction in finding an efficient allocation of spectrum among bidders at a fair market price.

✂

✂

Auction design and rules proposals for the combined award

Question 9.1: Do you agree with our proposals for the auction design and why?

Our detailed comments on the auction design are contained in Annex 2.

✂.

Question 9.2: Do you have any comments on the proposed auction rules as explained in section 9, Annex 9 and Annex 10?

Please see the answer to question 9.1.

Question 9.3: Do you have any comments on how we should approach the payment of deposits and licence fees?

We have no specific comments.

Revising annual licence fees for 900 MHz and 1800 MHz

Question 10.1: Do you have any comments on our proposal to use 800 MHz price information as derived from the auction to estimate the full market value of 900 MHz spectrum?

Please see section 3. We believe that this proposal carries with it a very significant risk of distorting the outcome of the auction and should not be contemplated. We suggest an alternative method calculating the ALF in section 3.

Question 10.2: Do you have any comments on our proposal to use an average of 800 MHz and 2.6 GHz price information as derived from the auction to estimate the full market value of 1800 MHz spectrum?

Please see our answer to question 10.1.

Question 10.3: Do you have any comments on the proposed approach to convert lump sum amounts into annual payment?

We strongly oppose this method of calculating the ALF. We also fail to see why the payments are spread over 20 years rather than an indefinite period.

Annex 1 – Shortcoming in the Ofcom technical model

A detailed description of the issues identified in Section 2 (see paragraphs 103 to 105) follows in sections 1 to 4 below. The subsequent paragraphs summarise other issues identified by Vodafone.

1. As noted in a response to a previous Ofcom consultation, the Extended Hata propagation model 0 is not a particularly good model for comparing different frequencies due to breakpoints in the model which occur at 1500 and 2000MHz. This can be clearly seen if we examine a graph of the instantaneous rate of change of pathloss with frequency (the "frequency exponent") predicted by this propagation model. The breakpoints at 1500 and 2000MHz can be clearly seen. Hence the Ofcom study comparing 800, 1800 and 2600MHz is effectively using 3 different propagation models.

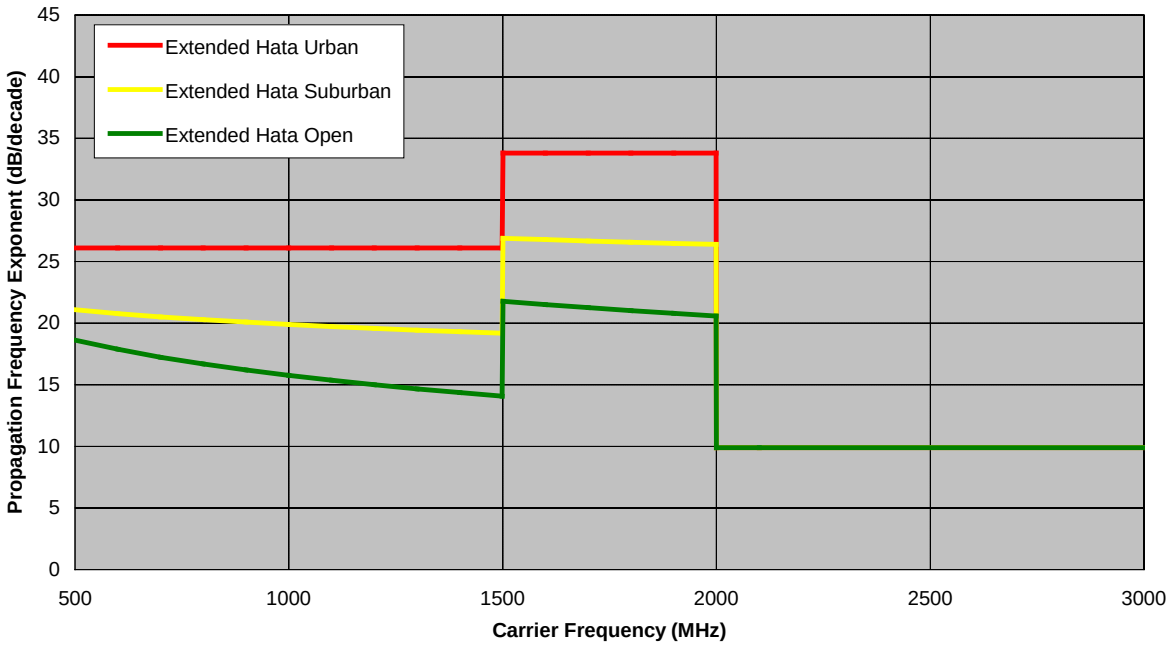


Figure 1: Instantaneous Frequency Exponent Displayed by the Extended Hata Propagation Model

The high value of the instantaneous frequency exponent predicted by this model between 1500 and 2000MHz means that this model generally overestimates the exponent that applies between a lower frequency and a frequency close to the 2000MHz boundary. Vodafone has investigated the variation in propagation loss with frequency using a calibrated ray-tracing tool. Whilst some variation of the frequency exponent with frequency is apparent, it was found to be reasonable to model the frequency exponent as constant (for a given clutter type) across the range of frequencies being considered. The values in Table 1 are used by Vodafone in our studies of this issue:

Clutter Type	Frequency Exponent (dB/decade)		
	Estimated by Vodafone	Estimated by Extended Hata Model	
		Between 800 and 1800 MHz	Between 800 and 2600 MHz
Urban	✂	31.6	27.0
Suburban	✂	25.1	21.8
Rural (Quasi Open)	✂	20.5	18.2
Rural (Open)	✂	20.5	18.2

Table 1: Frequency exponents for different clutter types

✂ Note that the 18.2 dB/decade frequency exponent predicted by the Extended Hata model for rural areas (both open and quasi open) is better (i.e. lower) than occurs for line of sight propagation, which has a frequency exponent of 20 dB/decade.

Hence we believe that, in practice, the frequency exponent will typically be lower than that suggested by the Extended Hata model in urban and suburban areas, and slightly higher in rural areas. Hence the propagation loss in the simulated area will not vary with frequency by as much as Ofcom suggests. The literature in the public domain also suggests that practical frequency exponents do not cover the extreme range predicted by the Extended Hata model. For example, Sakawa et al [4] predict a frequency exponent of between 21.4 and 22.8 dB/decade for macro sites (c.f. 20 – 26 dB/decade estimated by Vodafone and 18 – 31 dB/decade predicted by the Extended Hata model).

2. Ofcom does not provide any new reference material to justify their assumptions regarding the building penetration loss, but instead refer to their previous consultation [7]. That consultation justified its choice of values for its base case by comparing these to the “best fit” straight line through a set of building penetration loss measurements compiled from public sources (see Figure 25 in [7]).

   Unfortunately, the use of a best fit straight line (linear regression) is inappropriate in this case, since the collated measurements are for a number of different buildings measured at different frequencies using different methodologies. This can be seen if we consider a simple hypothetical example of measurements on three buildings, all of which display a frequency dependence exponent of 3.3 dB/decade.

   We see that the fact that the measurements of the three buildings have been made at different frequencies results in linear regression predicting a wholly erroneous relationship between building penetration loss and frequency (in this case, it suggests that penetration losses actually fall as the frequency increases). It can also be seen that the correct way to

analyse the data is to compute the regression curves individually for each building, and then compute the average of the slopes and intercepts for each of these regression curves to determine the best fit line through the data.

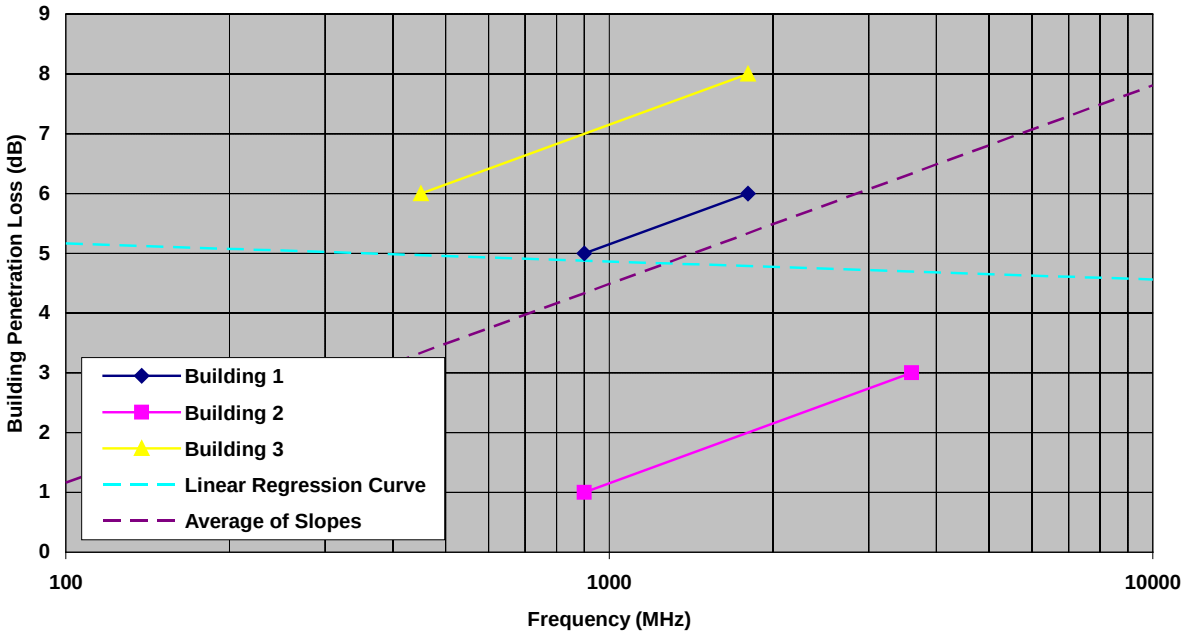


Figure 2: A demonstration of the inappropriateness of linear regression for estimating building penetration losses

Ofcom's new assumptions for the building penetration loss (depth 2+) show a frequency dependence of the penetration loss of 14.8 dB/decade between 800 and 1800MHz, and 18.6 dB/decade between 800 and 2600 MHz. The results of the literature studies on building penetration loss surveyed by Vodafone are summarised in Figure 3 below. This diagram uses most of the sources that were used by Ofcom [7], but each researcher's results are given equal weight, irrespective of the number of measurements that were reported in their results. By averaging the slopes of the regression curves through each researcher's results, Vodafone finds only a weak dependence of building penetration loss on frequency, with the average slope being only 1.6 dB/decade, which is much lower than the values assumed by Ofcom. This is in line with our own measurements, which show very little difference between 900 MHz and 2100MHz.

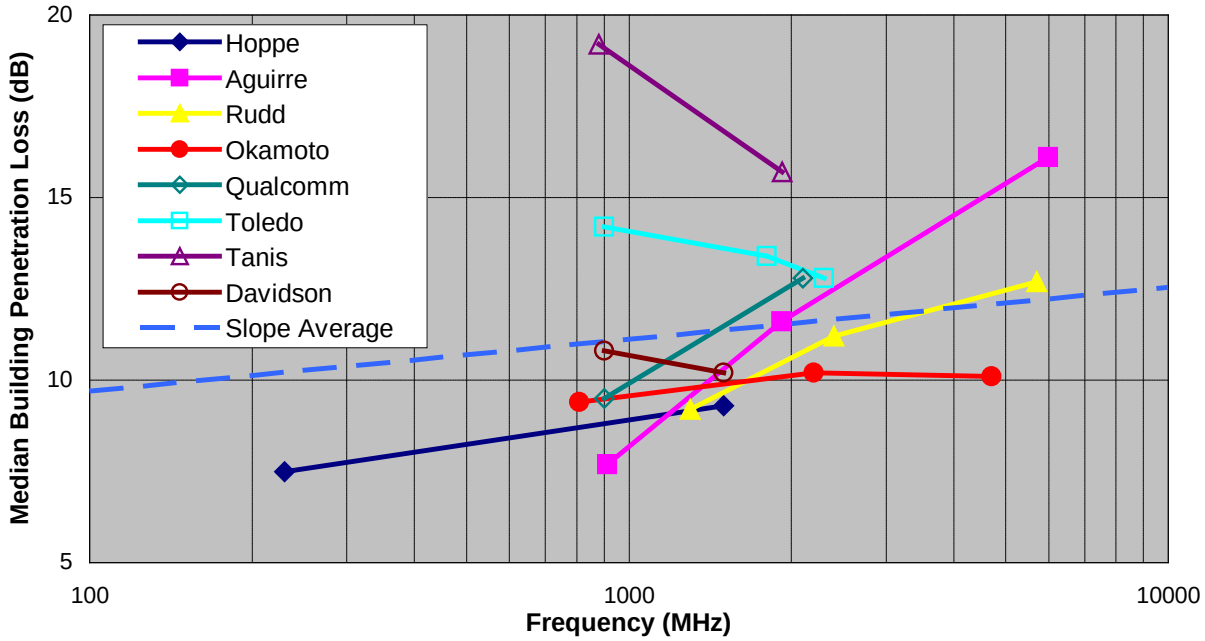


Figure 3: Frequency dependence of building penetration loss

The sources of this data are the following:

- R. Hoppe et al. “Measurement of Building Penetration Loss and Propagation Models for Radio Transmission into Buildings”, IEEE Vehicular Technology Conference, VTC Fall 1999.
- S. Aguirre et al. “Radio Propagation into Buildings at 912, 1920, and 5990 MHz Using Microcells”, IEEE 3rd Annual International Conference on Universal Personal Communications, 1994.
- R.F. Rudd, “Building Penetration Loss for Slant-Paths at L-, S- And C-Band”, IEE 12th International Conference on Antennas and Propagation, ICAP 2003.
- Okamoto H., Kitao K. & Ichitsubo S., “Outdoor-to-Indoor Propagation Loss Prediction in 800-MHz to 8-GHz Band for an Urban Area”, IEEE Transactions On Vehicular Technology, Vol. 58, No. 3, March 2009.
- “Optimization of the 900 MHz Spectrum for 3G use”, Qualcomm, from Deploying UMTS900 Conference, March 2008.
- A.F. Toledo et al., “Propagation into and within buildings at 900, 1800 and 2300 MHz”, IEEE 42nd Vehicular Technology Conference, 1992.
- W.J. Tanis et al. "Building penetration characteristics of 880 MHz and 1922 MHz radio waves”, IEEE 43rd Vehicular Technology Conference, 1993.

- Davidson et al., Measurement of Building Penetration into Medium Buildings at 900 and 1500 MHz", IEEE Transactions On Vehicular Technology, Vol. 46, No. 1, February 1997.

3. In addition to overestimating the degree to which the above effects are detrimental at higher frequencies, Ofcom also ignores the frequency dependence of antenna gains, which provides a benefit at higher frequencies (as antenna gains are higher at higher frequencies for a given physical antenna size). This effect can be seen clearly from the data sheet for the Kathrein 742 265 [8], which is the reference antenna used in Ofcom's own study.

   A plot of antenna gain against frequency for this antenna is given below:

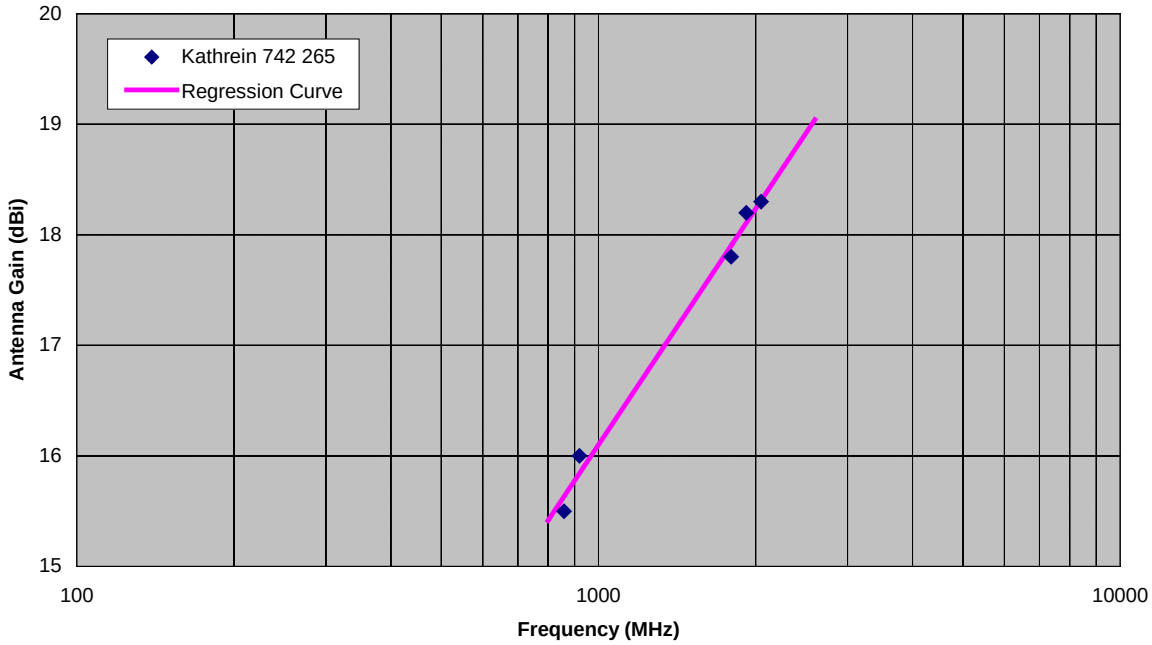


Figure 4: Antenna Gain of Kathrein 742 265

Using the regression curve, we can therefore estimate a reasonable antenna gain at the frequencies of interest:

Frequency (MHz)	Antenna Gain (dBi)
800	15.4
1800	17.9
2600	19.0

Table 2: Estimated Base-Station Antenna Gains

We see that the estimated base-station antenna gain at 800MHz is 2.5 dB lower than that at 1800MHz, and 3.6 dB lower than that at 2600MHz. As the base-station EIRP per 180 kHz resource block is assumed constant by Ofcom at 45 dBm, this implies an assumption by Ofcom that the RF power at the antenna input is lower at higher frequencies. No justification is given for this assumption, which is unlikely to be true in practice, and anyway would represent an additional cost of operating an LTE network at lower frequencies. Even if true, the impact of the lower base-station antenna gain on the uplink link budget should be considered by Ofcom, as increasing the downlink transmit power does not compensate for the reduced antenna gain on the uplink.

4. Ofcom also assume that the UE antenna gain is frequency independent at 0 dBi. Whilst this is achievable at both 1800MHz and 2600MHz if set as a design target for a single band terminal, it is unlikely that this could be achieved at 800MHz due to the wide bandwidth (up to 20MHz) assumed for LTE. Also, in practice, terminals are multi-band devices which will often use the same antenna for several bands. Wideband antennas are inherently less efficient at lower frequencies, as dictated by the Chu-Harrington limit [9], which gives the minimum required antenna volume for 100% efficiency for a given centre frequency and fractional bandwidth. This is shown in Figure 5 below:

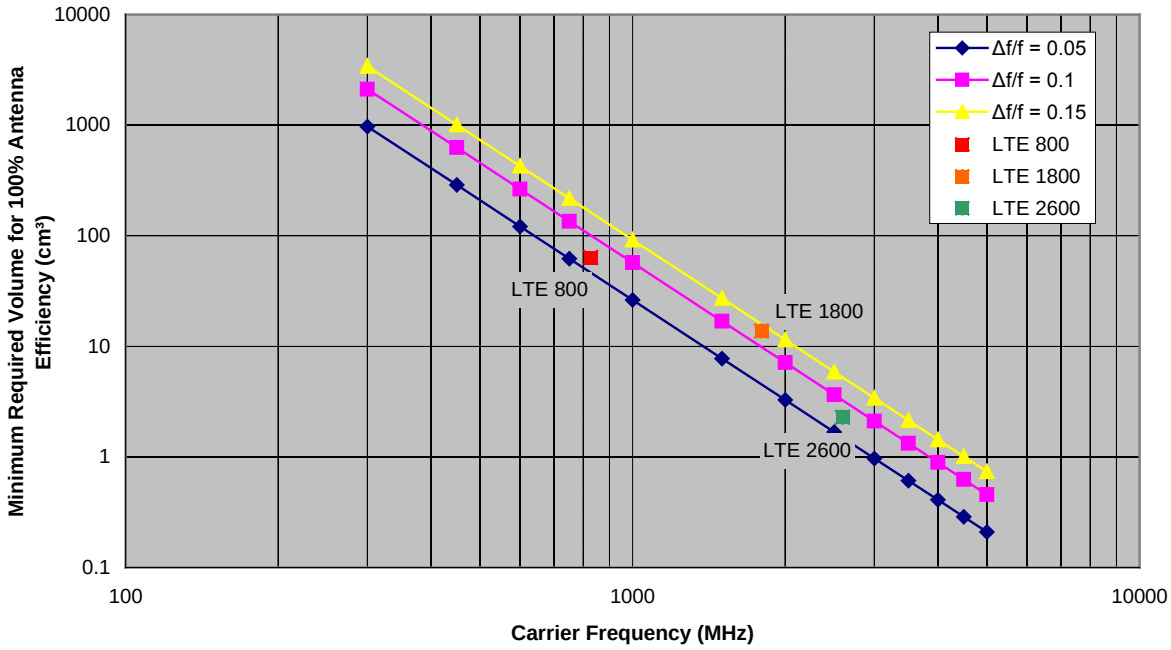


Figure 5: Required antenna volume according to the Chu-Harrington limit

The minimum volume required for 100 % efficiency in the 800MHz band is therefore some 4.6 times that required in the 1800MHz band and almost 29 times that required for the 2600MHz band. Hence antenna gains at lower frequencies will be lower than those at higher frequencies for

practical terminal designs. The exact difference will depend on the terminal design, and specific figures are difficult to come by. Some examples are given for third-party antenna designs in table 3.

Manufacturer	Part	Low Band		High Band		Exponent (dB/decade)
		Frequency (MHz)	Gain (dBi)	Frequency (MHz)	Gain (dBi)	
Ethertronics	Prestta Penta Band P522303 [10]	860	1.4	2045	2.8	3.7
Skycross	SMT-8TO25M [11]	920	1.8	2450	4.3	5.9
Antenova	Calvus Penta Band A10340 [12]	862	1.7	1848	3.0	3.9

Table 3: Example antenna gains for multi band antennas

Although intended for mobile handsets, the gains quoted were measured using reference boards rather than terminals, are hence the absolute gains are not representative of those achieved in actual UE designs, particularly when body loss is taken into account. However, there is a clear trend for antenna efficiency to increase with frequency. Vodafone assumes a conservative figure of 3.3 dB/decade (i.e. 1 dB/octave) for the frequency exponent of the UE antenna gain. For wideband antenna designs, the exponent will be higher. It therefore follows that, if Ofcom is assuming a UE antenna gain of 0 dBi at 2600MHz, than a value of -0.5 dBi should be used at 1800 MHz and -1.6 dBi at 800MHz.

5. The assumed base-station locations are stated to be “representative of existing mobile operators’ macro networks”, but no details are given as to how the sites were selected. In particular, it is not clear whether smaller deployments are selected as strict subsets of the largest deployment (equivalent to 20,000 sites nationally), or whether the selected sites are optimised for each size of deployment. Constraining site location options for a given network size is likely to lead to a sub-optimum deployment for that particular network.

Suggest we take the point out as it casts some doubt on the fundamentals of the scaling to a larger area. We can critique the coverage obligation via the work from cornerstone.

6. Ofcom consider four clutter types (Dense Urban, Urban, Suburban and Rural), but do not define the characteristics of areas which are categorised by these terms. The clutter definitions are important for the Extended Hata propagation model 0, which was used by Ofcom for propagation modelling. In particular, it must be assumed that the "rural" clutter type is mapped to the "open area" environment defined in, as this is not otherwise stated. The Extended Hata model can trace its origins back to Okumura, who defined an open area as:

> *"No obstacles like tall trees or buildings in the propagation path and a plot of land which is cleared of anything 300 to 400m ahead, as, for instance, farm-land, rice field, open fields, etc."*

In fact, flat open land which matches Okumura's definition of "open" is relatively rare in the UK, found in places such as Cambridgeshire, Lincolnshire and the Somerset levels. The rural land in the Ofcom study area is dominated by hillier features such as the Chilterns to the north west of London, and the North Downs to the south. This classic English "rolling hills" terrain is better characterised as "quasi open" land, as defined by the TIA and others [3].

The rolling nature of the terrain means that propagation is not as good as would be predicted by the "open area" environment in 0, and hence the coverage that can be expected from an LTE network is similarly reduced. Since some 16.1 % of the population within the simulated area are assumed by Ofcom to live in "rural" areas (and presumably a much higher percentage of the simulation area, though this figure is not given by Ofcom) this overestimate of coverage could be significant.

7. The standard deviation of the propagation loss is modelled by Ofcom as:

$$\sigma_s = 0.65 \cdot \log(f_c)^2 - 1.3 \cdot \log(f_c) + A$$

where *A* is a clutter dependent constant. The source of this equation is given as Saunders and Aragon-Zavala [5], but no justification is given for using this equation over any of the others that appear in the literature. In particular, Ofcom ignore the relevant ITU recommendation [6], which gives a formula for the standard deviation as:

$$\sigma_L = K + 1.3 \cdot \log(f)$$

where *K* is again a clutter dependent constant. Ofcom should provide a justification for using a formula for the propagation loss standard deviation which has a higher frequency dependence than that recommended by the ITU.

8. Ofcom introduce a new category of building penetration loss, which is named "depth 2+". This is defined as being:

   > *"a building penetration depth midway between the 'depth 2: base case' and 'depth 2: rising faster with frequency'"*

   The name selected for this category, and its definition, suggest that deeper in-building penetration is being considered than the depth 2 base case used in a previous Ofcom consultation [7]. This is misleading, however, since both "depth 2: base case" and "depth 2: rising faster with frequency" refer to different assumptions for the same depth of in-building penetration. Hence the new "depth 2+" category is actually assuming the same depth of in-building penetration as was assumed for the depth 2 categories in the previous consultation.

   In fact, the previous Ofcom consultation considered three categories for depth 2 penetration. These were:

   - No Variation with Frequency (Constant)
   - Increasing with Frequency (Base case)
   - Increasing with Frequency (Rising at higher rate)

   It was noted in [7] that the different assumptions for these categories regarding building penetration loss and its variation with frequency related to "*differing opinions regarding the physics of in-building penetration, rather than to different service levels*". In the current consultation, Ofcom have assumed a greater dependence of building penetration loss on frequency than was assumed in the base case of their earlier consultation without providing any new evidence or even a justification for this revised assumption.

9. Ofcom assume that the standard deviation of the building penetration loss is frequency dependent for depth 2+ but not clutter dependent (see Table 8.4). They do not provide any justification for this assumption. Measurements made by Vodafone suggest that the standard deviation of the building penetration loss is proportional to the median penetration loss, and that it is unusual for the standard deviation to be more than one third of the median. This is logical, as otherwise the modelling would suggest a significant probability of there being a building penetration gain, which is somewhat unlikely.

10. Ofcom assume that some data throughput can be achieved with SINRs as low as -10 dB (see Table 8.5). However, this is to ignore the ability of the downlink control channels to operate at such a low SINR. The least robust control channel is the PDCCH, which must be decoded by a UE before any data can be received on the PDSCH. In [13], it was shown that this channel starts to become unreliable for SINRs below -5 dB, and the BLER is close to unity for SINRs as low as -10 dB. Vodafone believe that no significant data throughput can be achieved for SINRs lower than about -6 dB due to the increasing unreliability of the PDCCH, and hence Ofcom are overestimating the coverage that can be achieved with LTE by assuming that significant data throughput is possible for SINRs down to -10 dB.

11. There are a couple of errors in the calculation of the outdoor power threshold required to meet the proposed coverage obligation (Section A8.96):

    - the assumed body loss of 5 dB is not included
    - the mean building penetration loss for suburban areas of 7.2 dB used in the calculation refers to depth 1 and not depth 2+ as stated

    However, note that correcting these errors would raise the required power threshold, so we should not bring them to the attention of Ofcom. In addition, the assumed UE antenna gain is anyway too high at 0 dBi, so these errors compensate for this nicely.

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[12]. http://www.antenova.com

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Annex 2 - Auction Design Details

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