# Three response to Ofcom second consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum and related issues.

## Non-confidential

**Date: March 2012**

# Executive Summary.

Hutchison 3G UK Limited ("**Three**") welcomes the opportunity to respond to Ofcom's Second Consultation on Assessment of Future Mobile Competition and Proposals for the Award of 800MHz and 2.6GHz Spectrum and Related Issues (the "**Second Consultation**").

Three agrees with Ofcom's headline policy objectives pursued in both the First Consultation and Second Consultation, namely, Ofcom's objectives to:

i. promote widespread availability of high quality mobile data services throughout the UK;

ii. promote competition, through maintaining four national wholesalers of mobile services; and

iii. maximise coverage of high quality mobile data services.

However, a close reading of the Second Consultation reveals that Ofcom's approach has fundamentally changed. As a result, Ofcom's objectives and wider legal obligations are now unlikely to be met.

First, Ofcom no longer maintains that to be a credible national wholesaler in future UK mobile markets, a fourth national wholesaler will need to be able to compete across the full range of services and, in particular, in those high quality data services that Ofcom seeks to promote. Instead, Ofcom now contemplates an outcome where the fourth national wholesaler is not able to compete effectively in high quality data services (which of necessity include high quality indoor data services).

This is a surprising and significant change of position, which is not adequately explained in the Second Consultation and is not evidently justifiable, as to reach this result Ofcom has:

i. ignored its legal duties under the Amended GSM Directive, requiring it to consider and address potential competition distortions caused by 900MHz spectrum liberalisation (see Section 1 of this Response);

ii. failed to secure its legal duty to promote competition generally and failed to satisfy its wider public law obligations (see Section 1 of this Response); and

iii. moved the goalposts in terms of its own policy objectives without proper explanation or lawful justification (see Section 2 of this Response).

Second, Ofcom no longer believes that the advantages of low frequency (sub-1GHz spectrum) are as clear as it previously believed and accordingly concludes that sub-1GHz spectrum is not now needed to be a credible national wholesaler.

This is also a surprising and unjustifiable change, as Ofcom has:

i. adopted an approach to assessing the available technical evidence as to the importance of sub-1GHz spectrum that is inherently flawed and that disregards real network evidence and industry-standard methodologies to the extent that it risks being irrational (see Section 3 of this Response); and

ii. adopted assumptions as to the future importance of sub-1GHz spectrum that are inconsistent with its previous conclusions and so out of step with widely held and conventional views and the approach consistently taken by other regulators worldwide as to be irrational (see Sections 3 and 4 of this Response).

A proper technical analysis shows that sub-1GHz spectrum will be needed to reach a large proportion of the UK population that cannot be reached by other spectrum.

That technical advantage provides holders of sub-1GHz spectrum with an incomparable competitive advantage, as UK consumers are likely to place a high value on deep indoor coverage that can only be provided with sub-1GHz spectrum. In consequence, a national wholesale operator cannot be credible without sub-1GHz spectrum, whether on the basis of either Ofcom's First or Second Consultation Tests.)

Indeed, Ofcom acknowledges its own uncertainty as to the future importance of sub-1GHz spectrum and prevalence of deep indoor locations. Given the fundamental importance of Ofcom's proposals, which will determine competitive outcomes for many years to come, Ofcom should at minimum adopt a precautionary approach rather than accept a risk of material degradation to competition in UK mobile markets.

Moreover, if Ofcom follows its proposed approach, then it would be alone among Western European Union telecoms regulators in not implementing specific policy measures to address the competitive distortions caused by 900MHz spectrum liberalisation and the underlying competitive advantages of sub-1GHz spectrum, either through redistribution or re-auctioning of 900MHz spectrum, setting effective sub-1GHz spectrum caps, reservation of sub-1GHz spectrum for smaller wholesalers/new entrants or combinations of these measures.

Third, Ofcom's proposals do not guarantee that a fourth national wholesaler will be credible.

Ofcom has considerably understated the risks that a fourth wholesaler will not acquire sufficient spectrum to be credible and the associated costs to consumers if the fourth national wholesaler is not an effective competitor (see Section 5 of this Response).

In addition to not guaranteeing sub-1GHz spectrum to the fourth national wholesaler, Ofcom's proposals do not guarantee that a fourth national wholesaler will have sufficient spectrum to be credible even on Ofcom's own test of what is needed to be credible. This is irrational.

Furthermore, Ofcom's proposed approach for setting annual licence fees ("**ALFs**") is likely to be inconsistent with the Government Direction that ALFs are set at fair market value. Ofcom's approach could lead to ALFs being considerably below fair market value, thereby entrenching the competitive distortions caused by 900/1800MHz liberalisation and risking illegal State Aid (see Section 8 of this Response).

Lastly, Ofcom's proposals do not support maximisation of mobile coverage, as they fundamentally undermine the Government's proposed Mobile Infrastructure Project ("**MIP**"). The MIP is necessary to achieve both the Government and Ofcom's objective of mobile coverage in rural areas beyond current levels. However, by not guaranteeing the fourth national wholesaler access to sub-1GHz spectrum, Ofcom will be denying the large benefits of sub-1GHz spectrum to the entire MIP (see Section 9 of this Response).

Therefore, if Ofcom is serious about its stated policy objectives and meeting its legal obligations, then it must amend its stated Auction proposals. In particular, Three urges Ofcom to:

i. ensure that a fourth national wholesale operator is guaranteed sub-1GHz spectrum by ensuring that all minimum spectrum portfolios ("**MSPs**") include 800MHz spectrum (see detailed proposals in Section 6 of this Response);

ii. ensure that a fourth national wholesaler holds, on its own, the minimum spectrum required to be viable, i.e. no split MSPs;

iii. impose a roll-out obligation (with credible financial consequences for non-compliance) on any MSP-bidder to ensure that the spectrum is used for the benefit of consumers; and

iv. reject the request by Everything Everywhere to liberalise 1800MHz spectrum for LTE use before the Auction, which would otherwise cause a material and lasting distortion to competition.

**Section 1 – Ofcom has not met its legal obligations including those under the Amended GSM Directive.**

In this Section, Three considers Ofcom's legal duties and the framework within which Ofcom must conduct its competition assessment, specifically:

i. Ofcom has not taken the steps required to identify and address competitive distortions caused by its previous liberalisation decisions as required by both the Government Direction (read consistently with the Amended GSM Directive) as well as by representations from the Government and Ofcom.[1] Should Ofcom fail to consider and address these matters it is at risk of misdirecting itself. Additionally, or alternatively, Ofcom will have failed to consult properly in this regard because it has not clarified how, if at all, it is taking account of these competitive distortions.

ii. Ofcom is required under the Government Direction and Amended GSM Directive to identify risks of competitive distortion arising from 900MHz liberalisation in the hands of the incumbents and must address those risks in the Auction design, as far as proportionate and objectively justified. Ofcom has not met these requirements, as:

   a. Ofcom's only assessment of the risk of distortion assumed LTE800 would exert a competitive constraint on UMTS900. The basis for this assumption is no longer credible as the fourth operator may now fail to obtain 800MHz spectrum;

   b. Ofcom's new test for the credibility of a fourth national wholesaler is unlikely to meet the requirements of the Government Direction read consistently with the Amended GSM Directive as it allows the fourth national wholesaler to be left at a lasting disadvantage arising from 900MHz liberalisation;

[1] See Section 1, 1.1. ii.

c. 900MHz liberalisation will significantly distort competition, to the disadvantage of the fourth national wholesaler, without appropriate remedial measures; and

d. although Ofcom's new test of credibility expressly contemplates allowing the fourth national wholesaler to be disadvantaged, Ofcom has not set out any reasons for concluding that it is proportionate to allow such a disadvantage.

More generally and in light of the above, should Ofcom proceed with its current proposals it will fail to meet its statutory duty to promote competition as well as its own objectives set out in the Second Consultation. It will also fail to meet its domestic public law duty to provide adequate reasons, not least for the change to its "credible national wholesaler" test.

**Section 1 Recommendation**

Ofcom should take the necessary steps to identify and address potential competitive distortions caused by its previous liberalisation decisions.

**Section 2 – The revised "credible" wholesaler test does not address the distortion from 900MHz liberalisation or promote competition.**

In this Section, Three considers Ofcom's change to its test for the credibility of a national wholesaler and whether the new test is capable of satisfying Ofcom's legal obligations. Our conclusions are that:

i. Prior to liberalisation of the 900MHz (and 1800MHz) spectrum, there was a competitive mobile data market.

ii. In the absence of remedial measures, liberalisation will distort future competition in the market, because it has introduced fundamental spectrum-related differences in the competitive position of national wholesalers.

iii. All other Western European Union Member States have now addressed the risk of competitive distortion arising from 900MHz liberalisation.

iv. Instead of directly addressing the distortion caused by 900/1800MHz liberalisation, as it should have done, Ofcom seeks to ensure that (at least) four national wholesalers have the minimum spectrum required to be “credible”. This approach could in principle address the distortion caused by liberalisation. However, Ofcom's approach to the question of what is required for an operator to be "credible" is unsustainable.

v. Ofcom has failed to explain clearly why it now accepts the possibility of the fourth wholesaler being significantly disadvantaged and unable to compete in the provision of high quality data services indoors,

vi. Ofcom’s First Consultation test (the “**First Consultation Test**") was capable of addressing the distortions caused by 900/1800MHz liberalisation. Ofcom accepted that a credible wholesaler needs to be able to compete across the full range of services and, in particular, in those higher quality data segments that might go on to form separate markets in the future,

vii. Ofcom’s Second Consultation test (the “**Second Consultation Test”)** is unlikely to meet Ofcom’s legal obligations under the Government Direction (read consistently with the Amended GSM Directive). It is also unlikely to allow Ofcom to meet its statutory duties and policy aims of promoting competition and widespread availability of high quality mobile data services.

viii. Ofcom should adopt a precautionary principle to avoid the risk of material harm to UK consumers after the Auction.

ix. Although subject to a separate consultation (13 March 2012), it is nevertheless noted that Ofcom’s proposal to liberalise Everything Everywhere's 1800MHz spectrum for LTE use before the Auction will aggravate the competitive distortions arising from 900MHz liberalisation and damage the future competitiveness of the mobile market(s).

**Section 2 Recommendation**

Ofcom should revert to its First Consultation Test, to ensure that its chosen test will promote competition and minimise the future distortion arising from liberalisation of the 900MHz spectrum.

**Section 3 – Sub-1GHz spectrum provides a much greater technical advantage than Ofcom acknowledges.**

Section 3 sets out Three's technical review of the comparative benefits of Sub-1GHz spectrum, particularly when compared to 1800MHz spectrum. The conclusions from this section include the following.

i. It is well established that sub-1GHz spectrum provides substantial technical advantages over higher frequency spectrum (including 1800MHz spectrum) especially in relation to the provision of breadth of coverage and depth of indoor coverage. Given this, it is not justified or appropriate for Ofcom to fundamentally change the Auction design proposals based on a re-evaluation of the technical advantages of sub-1GHz spectrum without conducting an appropriate level of technical analysis and evidence to support this change.

ii. The technical analysis that Ofcom does undertake is based on an inappropriate approach. Ofcom fails to model the UK at a national level or based on a real network. Instead it constructs a "synthetic" network, in two sample areas and extrapolates back out to a national level based on a conversion to equivalent national site numbers. Three has identified several key errors in Ofcom's technical modelling including:

- Ofcom's "synthetic" modelling process, using sample areas, predicts extremely unrealistic site numbers for an equivalent national network;
- Ofcom has underestimated the effect of penetrating the external walls of buildings on signal levels when modelling the sample areas
- Ofcom has failed to use signal strength (a minimum measure used in 3GPP standards to determine whether a device can connect to a network) as a parameter when modelling the sample areas; and
- Ofcom's use of two sample areas to draw conclusions at a national level is unsound.

iii. This series of errors compounds so that Ofcom materially understates the advantages of sub-1GHz spectrum - if Ofcom had sense-checked its results against any real network in the UK, the lack of credibility of its findings would have been obvious.

iv. When the flaws in Ofcom's modelling methodology and parameters are corrected and technical analysis is undertaken based on a real network, the advantages of sub-1GHz spectrum are clear.

v. Whilst Ofcom is non-committal about the prevalence of the "hardest to serve" locations where sub-1GHz would be essential to provide coverage our evidence shows that:

- "Hardest to serve" locations are very prevalent and account for a disproportionately large proportion of attempted mobile usage.
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vi. Small cell solutions are simply not realistic to mitigate the impact of not being able to reach these deep indoor and hard to serve locations using a sub-1GHz macrocell solution.

vii. In addition, 800MHz spectrum provides higher data speeds and improved customer experience, particularly for those in weaker signal areas.

**Section 3 Recommendation**

1. Ofcom should conclude that:
   A. there is a high prevalence of deep indoor and hard to serve locations; and
   B. Sub-1GHz spectrum provides material technical advantages in providing coverage to such deep indoor and hard to serve locations which cannot be matched or materially mitigated through the use of small cells or other solutions.
2. If Ofcom is in any doubt regarding the above, it should correct the flaws in its technical modelling and conduct a fresh technical analysis.

**Section 4 – Sub-1GHz spectrum is essential in order to be a credible national wholesaler.**

Section 4 explains that the technical advantage of sub-1GHz spectrum will have a material impact on competition, such that a national wholesaler will not be credible after the Auction without sub-1GHz spectrum. In conclusion:

i. Ofcom has presented little evidence for its conclusion that a fourth national wholesaler can be credible without sub-1GHz spectrum;

ii. Ofcom should assess the risk that a fourth wholesaler without sub-1GHz spectrum will be unable to constrain prices after the Auction;

iii. experience in fixed data communications demonstrates that quality differences will be increasingly important to consumers of mobile data services in the UK;

iv. UK mobile users increasingly demand reliable, deep indoor data coverage at high speeds – coverage and speeds are critical to provide the services that consumers will expect in the future;

v. sub-1GHz spectrum will be essential to be credible after the Auction – without it a fourth national wholesaler will face key disadvantages and may be forced to exit the market or become a marginal player to the considerable detriment of consumers and competition; and

vi. the material advantages of sub-1GHz spectrum are well established in statements from operators (such as Vodafone), academic and industry experts (including Ofcom's own auction adviser) and national telecoms regulators.

For all these reasons, Ofcom should have found that the fourth national wholesaler would not be "credible" without sub-1GHz spectrum under either its First Consultation or its Second Consultation Test.

If Ofcom remains unsure – and its discussion indicates considerable uncertainty on its part – then the safest solution is to guarantee sub-1GHz spectrum to the fourth operator.

| **Section 4 Recommendation** |
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| Ofcom should ensure that all of its minimum spectrum portfolios include 800MHz spectrum. |

**Section 5 – Ofcom has considerably understated the fourth national wholesaler's need for additional spectrum and the risk that it will not acquire sufficient spectrum in the Auction.**

Section 5 sets out Three's analysis of why it is necessary that the Auction design includes protections to ensure that the national wholesaler obtains the spectrum required to be credible. In conclusion:

i. Ofcom has analysed in detail the competitive position of Everything Everywhere and why it may have countervailing advantages which result in it not requiring protection in the Auction in order to acquire additional spectrum. However, Ofcom has erred in not conducting a similarly detailed analysis in relation to the fourth national wholesaler. Yet the fourth national wholesaler is in a materially different position from Everything Everywhere and even with one of the proposed MSPs, would have a much greater need for additional spectrum.

ii. Ofcom finds that there is a material risk that the fourth national wholesale mobile operator – either Three or a new entrant – will not acquire sufficient spectrum to become or remain a credible national wholesaler after the Auction.[2] However, Ofcom has nevertheless considerably understated this risk, as:

   a. the fourth national wholesaler will tend to have a much lower *intrinsic value* for spectrum than any other wholesaler due to the necessary time lag in acquiring new customers and the higher cost of customer acquisition compared to customer retention, among other things; and

   b. the fourth national wholesaler will face a greater risk of *strategic investment* than any other national wholesaler – the other national wholesalers will value spectrum not only on the basis of the opportunities it will give them but also for the likely pay-off from the prospect of limiting the ability of the fourth national wholesaler to compete.

[2] Second Consultation, para 1.20.

| Section 5 Recommendation |
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| Ofcom should reassess the fourth national wholesaler's need for additional spectrum and the risk that it will not acquire sufficient spectrum in the Auction to be a credible national wholesaler. |

**Section 6 – Ofcom should vary its MSPs to ensure that a fourth national wholesaler can be credible**

This Section compares Ofcom's proposed Minimum Spectrum Portfolios (**MSPs**) including whether they provide the minimum spectrum required for a fourth operator to be credible. In conclusion:

i. Three agrees with Ofcom that MSPs 1 and 2 would not be adequate to ensure the continued existence of a fourth credible national wholesaler;

ii. MSP 6, which does not contain any sub-1GHz spectrum, would not be adequate to be a credible national wholesaler and should be removed; and

iii. as an alternative to the removal of MSP 6, Ofcom should consider a new MSP merging together MSPs 5 and 6, consisting of:

   a. 2x5MHz of 800MHz spectrum + 2x15MHz of 1800MHz spectrum + 2x5MHz of 2.6GHz spectrum.

While the merged MSP suffers some disadvantages, in line with comments made in Three's response to the First Consultation, the merged MSP is nevertheless much more likely than MSP 6 to allow a wholesaler to be credible. Moreover, it is also much more likely to be sufficient than the MSP proposed in the First Consultation of 2x5MHz of 800MHz spectrum paired with 2.6GHz spectrum (rather than 1800MHz in this alternative).

| Section 6 Recommendation |
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| Ofcom should remove MSP 6 or, alternatively, combine MSPs 5 and 6. |

**Section 7 – The proposed Auction design does not support Ofcom's objective of a four player market.**

Section 7 sets out Three's analysis of whether Ofcom's Auction design is capable of achieving its objectives. In conclusion:

i. Ofcom's proposed Auction design suffers from a number of important flaws. The combined effect of these is to severely compromise Ofcom's objective of securing a fourth national wholesaler and therefore a four-player market after the Auction, specifically:

   a. There are several potential scenarios where MSPs are split between multiple operators, none of which would hold sufficient spectrum to be credible.

   b. There is no justification for Ofcom's suggestion that these sub-scale operators would necessarily merge to form a fourth credible national wholesaler.

   c.  .

   d. Ofcom is incorrect in setting eligibility points for 800MHz and 1800MHz spectrum as if 2x15MHz of 1800MHz spectrum were a substitute for 2x10MHz of 800MHz spectrum. This is likely to discourage opt-in bidders for the MSPs. Indeed, recent European spectrum auctions show that 2x10MHz of 800MHz is

significantly more valuable than 2x15MHz of 1800MHz, which should provide a starting point for setting eligibility points.

ii. Three proposes an alternative set of MSPs and eligibility points that would address the above issues. In particular, all MSPs should contain at least 2x5MHz of sub-1GHz spectrum and provide enough capacity for a new entrant to be credible.

iii. A roll-out obligation, including financial consequences for non-compliance, should be imposed on all MSP bidders in order to ensure that the spectrum is used for the benefit of consumers.

**Section 7 Recommendations**

Ofcom should:

- amend the MSPs applicable to Three: (i) MSP6 deleted or (ii) MSPs 5 and 6 merged;
- amend the MSPs for a new entrant – all MSPs uplifted by 2x15MHz of 2.6GHz spectrum to ensure a fourth credible operator;
- implement a system of "handicaps" to ensure a level playing field for new entrants;
- reinstate the eligibility points ratio as in the First Consultation;
- specify minimum roll-out obligations for bidders availing themselves of the MSPs; and
- apply material and credible financial consequences for MSP bidders that fail to meet their obligations.

**Section 8 – Ofcom should reinstate the direct linkage between Annual Licence Fees ("ALFs") for 900/1800MHz spectrum with the Auction prices.**

This Section sets out Three's view on the linkage between ALFs and Auction prices. In conclusion:

i. Ofcom should revert to its proposal in the First Consultation to link ALFs with prices paid in the Auction;

ii. Reinstating a direct ALF linkage is consistent with the requirement in the Government Direction to reflect full market value;

iii. Ofcom overstates demand reduction incentives in the Auction with a direct ALF linkage;

iv. Further, Ofcom's new proposed ALF methodology has some significant shortcomings compared to the approach outlined in Ofcom's First Consultation, in particular:

   a. Ofcom's proposed Additional Spectrum Methodology ("**ASM"**) attempts to introduce Vickrey prices (i.e. opportunity cost pricing) instead of market prices into the calculation of ALFs. This would mean lower ALFs than the full market value required by the Government Direction. This would also be likely to constitute impermissible state aid. The ALFs should be based either on the "linear reference" prices proposed in the First Consultation or on Walrasian prices (i.e. an average of the lowest accepted bid and the highest rejected bid for a spectrum block in the Auction).

   b. Ofcom should integrate values from international auctions with comparable spectrum using the recent German and Italian auction prices to define a floor for the ALFs.

v. In addition, Ofcom should adjust the ALFs to reflect:

   a. the higher value of 900MHz spectrum vs. 800MHz spectrum due to earlier device availability; and

b. the option value of relinquishment which substantially increases the value of 900MHz spectrum as compared to 800MHz spectrum.

**Section 8 Recommendations**

- Ofcom should restore the direct linkage between ALFs and Auction prices.
- Ofcom should use international auction prices to establish a floor for the ALFs.
- Ofcom should adjust the ALFs derived from Auction prices to reflect the higher value of 900MHz spectrum vs. 800MHz spectrum.

**Section 9 – Ofcom's proposals do not support maximisation of mobile coverage.**

This Section sets out Three's concerns regarding the interaction of the Auction design with the Government's Mobile Infrastructure Project ("**MIP"**) proposals. It also considers Ofcom's coverage obligation. In conclusion:

i. The MIP will be essential for improving mobile voice coverage and quality, and for maximising coverage of next generation mobile broadband services – as without the MIP or a similar initiative, UK mobile coverage is unlikely to grow beyond its current level;

ii. Ofcom's finding that sub-1GHz spectrum is not needed to be a credible national wholesaler fundamentally undermines the MIP – as the MIP must treat all national wholesalers equally, the Government will need to restrict the MIP sites to use for 1800MHz deployment and above, which will considerably limit the additional mobile coverage achievable; and

iii. Ofcom's finding that sub-1GHz spectrum is not needed to be a credible national wholesaler will perpetuate and extend the existence of partial not spots, itself an important Government and Ofcom concern.

**Section 9 Recommendation**

Ofcom should ensure that at least four national wholesalers are guaranteed access to sub-1GHz spectrum, so that it is possible then to deploy sub-1GHz spectrum on MIP sites.

This document follows the structure set out in this Executive Summary.

# Contents.

# 1. Ofcom has not met its legal obligations including those under the Amended GSM Directive.

*In this Section, Three considers Ofcom's legal duties and the framework within which Ofcom must conduct its competition assessment, specifically:*

i. *Ofcom has not taken the steps required to identify and address competitive distortions caused by its previous liberalisation decisions as required by both the Government Direction (read consistently with the Amended GSM Directive) as well as by representations from the Government and Ofcom. Should Ofcom fail to consider and address these matters it is at risk of misdirecting itself. Additionally, or alternatively, Ofcom will have failed to consult properly in this regard because it has not clarified how, if at all, it is taking account of these competitive distortions.*

ii. *Ofcom is required under the Government Direction and Amended GSM Directive to identify risks of competitive distortion arising from 900MHz liberalisation in the hands of the incumbents and must address those risks in the Auction design, as far as proportionate and objectively justified. Ofcom has not met these requirements, as:*

   a. *Ofcom's only assessment of the risk of distortion assumed LTE800 would exert a competitive constraint on UMTS900. The basis for this assumption is no longer credible as the fourth operator may now fail to obtain 800MHz spectrum;*

   b. *Ofcom's new test for the credibility of a fourth national* wholesaler *is unlikely to meet the requirements of the Government Direction read consistently with the Amended GSM Directive as it allows the fourth national wholesaler to be left at a lasting disadvantage arising from 900MHz liberalisation;*

   c. *900MHz liberalisation will significantly distort competition, to the disadvantage of the fourth national wholesaler, without appropriate remedial measures; and*

   d. *although Ofcom's new test of credibility expressly* contemplates *allowing the fourth national wholesaler to be disadvantaged, Ofcom has not set out any reasons for concluding that it is proportionate to allow such a disadvantage.*

*More generally and in light of the above, should Ofcom proceed with its current proposals it will fail to meet its statutory duty to promote competition as well as its own objectives set out in the Second Consultation. It will also fail to meet its domestic public law duty to*

*provide adequate reasons, not least for the change to its "credible national wholesaler" test.*

### 1.1. Ofcom adopts the right legal framework in many respects but has failed to acknowledge its obligations arising in relation to 900MHz liberalisation.

Three agrees in many respects with the legal framework adopted by Ofcom. Ofcom has rightly identified the Framework Directive, Authorisation Directive, Communications Act 2003, Wireless Telegraphy Act 2006 and Government Direction as relevant. Further, Three agrees that the particular provisions cited by Ofcom[3] are relevant.

Ofcom has erred, however, in not acknowledging that it has a continuing obligation to address the impact of 900MHz liberalisation. Ofcom's obligation stems from the Government Direction read consistently with the Amended GSM Directive as well as from representations by the Government and Ofcom. In failing to consider and address these issues, Ofcom is at risk of misdirecting itself.

Alternatively or additionally, Ofcom has failed to consult properly by not setting out its position on whether it is or is not applying the requirements of the Amended GSM Directive in its assessment of the Auction design proposals.

#### 1.1.1. Ofcom has erred in not acknowledging an obligation to address the impact of 900MHz liberalisation.

*i. Application of the Amended GSM Directive.*

As discussed in this Response and previous submissions, 900MHz spectrum affords considerable advantages over higher frequency spectrum. These widely acknowledged advantages are highly relevant because 900MHz spectrum was only made available to some operators

[3] Consultation, paras 4.5-4.21.

and not others. Its liberalisation therefore affects the competitive balance in UK mobile markets.

It is for these reasons that the European legislature enacted the Amended GSM Directive which required national regulators to identify and address directly distortions arising from 900MHz liberalisation.

Article 1(2) of the Amended GSM Directive imposes two obligations on Member States when implementing its provisions. These are:

To assess whether liberalisation of 900MHz spectrum in the hands of the incumbents is likely to distort competition; and

To address any distortions identified where justified and proportionate to do so.

Recital 14 of the Radio Spectrum Decision[4] similarly noted a risk of distortion from 1800MHz liberalisation and recorded the existence of tools to address it, though it did not impose obligations to the same extent as the Amended GSM Directive in relation to 900MHz liberalisation.

The Amended GSM Directive was implemented in the UK through the Government Direction and the Government Direction must be construed consistently with it.[5]

The Government Direction requires Ofcom to assess likely future competition in mobile telecommunication markets after the conclusion of the Auction and, where it thinks fit in light of that competitive assessment, to put in place appropriate and proportionate measures to promote competition after the conclusion of the Auction (including through the implementation of specific auction rules).[6]

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[4] Commission Decision 2009/766/EC on the harmonisation of the 900MHz and 1800MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community (the "Radio Spectrum Decision")
[5] Case 106/89 *Marleasing SA v La Comercial Internacional de Alimentacion SA* [1992] 1 CMLR
[6] Government Directions, Article 8

The Government Direction was introduced following a competition analysis from Ofcom.[7] The competition analysis supported 900MHz (and 1800MHz) liberalisation in the hands of the incumbents but examined the risk of competitive distortion arising from liberalisation only in the period before Ofcom believed LTE800 would impose a complete competitive constraint on UMTS900.[8] This, Ofcom considered, would be a maximum of four years from mid 2012.[9] Ofcom considered it unnecessary to address at that stage longer term distortions arising from 900MHz liberalisation because it could address them in its Auction design (at least as far as proportionate and justified).

In this regard, Ofcom acknowledged in its Advice to Government ahead of the 900MHz liberalisation that there would be "*short-term and longer-term competition issues*".[10] Ofcom decided to limited its assessment to the short-term issues only because it did not believe that "*considering both short-term and longer-term competition issues together was likely to give a better outcome for consumers than considering them separately and sequentially*" and because it was "*confident that it will be possible to design the auction and/or take other steps so as to effectively promote competition through the award of the 800 MHz spectrum*".[11]

This position was adopted by the Government, which reiterated that longer-term competition issues arising from liberalisation would be

[7] Advice to Government on the consumer and competition issues relating to liberalisation of 900MHz and 1800MHz spectrum for UMTS, Advice to the Secretary of State for Business, Innovation and Skills, Ofcom, 25 October 2010 (the "Ofcom Advice to Government")
[8] Ofcom Advice to Government, paras 4.6 and 6.28 and Annex 8. See also Consultation, para A10.17.
[9] Ofcom Advice to Government, para A8.5.
[10] Ofcom Advice to Government, para.6.28.
[11] Idem.

addressed in the competition assessment required as part of the process to design the Auction.[12]

That was the manner in which Ofcom was to ensure that the UK's obligations under the Amended GSM Directive (as implemented in the Government Direction) were to be satisfied.

Ofcom cannot now argue that its previous short-term competition analysis of itself satisfied the requirements of the Amended GSM Directive. Ofcom remains under an obligation as a matter of EU law to satisfy the outstanding requirements, namely to assess the "*longer term competition issues*" arising from 900MHz liberalisation. Accordingly, the obligation to carry out a wider competition assessment imposed by the Government Direction must be read to include a longer term assessment of the potentially distortive effects of 900MHz liberalisation.

*ii. Three's legitimate expectations.*

In addition to Ofcom's primary obligation to satisfy the requirements of the Government Direction (interpreted consistently with the Amended GSM Directive), when designing and conducting the Auction, Three has a legitimate expectation that Ofcom will do so.

Both Ofcom and the Government have made specific representations that the longer-term effect of the 900MHz liberalisation on competition will form part of the competition assessment conducted in connection with the design of the Auction.

As noted above, Ofcom represented in the Ofcom Advice to Government ahead of the 900MHz liberalisation that "*longer-term competition issues*"[13] arising from 900MHz liberalisation would be considered

[12] Government Statement on the Wireless Telegraphy Act 2006 (Directions to Ofcom) Order 2010 available at http://www.culture.gov.uk/images/publications/10-1237-statement-wireless-telegraphy-ofcom-order-2010.pdf.
[13] Ofcom Advice to Government, para.6.28.

"*separately and sequentially*" to its short-term assessment on 25 October 2010.

In its Advice to Government, Ofcom also represented that the Auction would be designed or other steps would be taken or both "*so as to effectively promote competition through the award of the 800MHz spectrum*".[14] In the circumstances, this statement plainly referred to measures to promote competition in view of the risk of distortion arising from 900MHz liberalisation.

As noted above, the Government also represented that longer-term competition issues arising from liberalisation would be addressed in the competition assessment required as part of the process to design the Auction.[15]

As a result, Ofcom is obliged to - and Three has a legitimate expectation that Ofcom will - consider and address the longer term impact of 900MHz liberalisation in the competition assessment ahead of the Auction.

#### 1.1.2. Ofcom has failed to consult properly.

Ofcom is required to consult on the risk of distortions arising from liberalisation in the period after the Auction, as required by the Government Direction when read consistently with Article 1(2) of the Amended GSM Directive.

Additionally, the consultation process in which Ofcom is engaged must comply with the requirements of domestic public law. Among other obligations, this includes requirements: (i) to provide consultees with sufficient information to allow for a proper and informed response; and (ii)

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[14] Idem.
[15] Government Statement on the Wireless Telegraphy Act 2006 (Directions to Ofcom) Order 2010 available at http://www.culture.gov.uk/images/publications/10-1237-statement-wireless-telegraphy-ofcom-order-2010.pdf.

to conscientiously take into account the product of the consultation when taking the ultimate decision.[16]

Both Three and Everything Everywhere have identified in their previous consultation responses that fundamental aspects of the design for the Auction as set out in the First Consultation (which have been retained and, in some respects, made worse in the Second Consultation) would not promote competition because they fail to take into account and address the long term competitive distortion caused by 900MHz liberalisation. To date, Three has seen no evidence that these concerns have been conscientiously taken into account or considered further by Ofcom.

As a matter of domestic public law, Ofcom's duties when undertaking consultation require it properly to identify the matters upon which the public is being consulted. Therefore, as a result of both the requirements of the Amended GSM Directive and the concerns raised by Three and Everything Everywhere in response to the First Consultation, Ofcom must expressly identify:

- what risks to future competition it is considering and, in particular, whether or not it is considering the risks of distortion arising from liberalisation (as Three considers it must do);

- what risks there are of distortion as a result of liberalisation (if it is considering such risks);

- how those risks are to be addressed; and

- to the extent the risks are not to be addressed, why they are not to be addressed and the anticipated effect of not addressing them.

[16] See *R v North and East Devon Health Authority ex parte Coughlan* [2001] QB 213

### 1.2. The Amended GSM Directive requires Ofcom to identify and address risks of competitive distortion caused by 900MHz liberalisation.

Three does not contend that Ofcom is required to preserve the pre-liberalisation situation for all purposes. However, compliance with the Amended GSM Directive requires Ofcom to assess the distortion likely to be caused by 900MHz liberalisation and to address it to the extent it considers reasonably proportionate. Applied to the present facts, this means that Ofcom must either:

- satisfy itself that the competitive position in the mobile market will be materially the same after the Auction as it would have been had there been no 900MHz liberalisation in the hands of the incumbents;[17] or

- provide compelling justification for any material change or distortion in the competitive position as a result of 900MHz liberalisation in the hands of the incumbents that it contemplates allowing to remain after the Auction.

Notwithstanding Three and Everything Everywhere[18] having raised this issue in their previous Consultation responses, Ofcom has failed to satisfy its obligations in this respect.

In order to lawfully direct itself in this matter, Ofcom must show that either:

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[17] In which context Three notes Ofcom's comment that "*We are therefore not starting from a position where the two holders of 900 MHz, Vodafone and O2, have stronger network capability than their rivals. On the contrary, Everything Everywhere, and to a lesser extent H3G, are currently in a stronger position in terms of network capability for providing UMTS services.*" Para.5.13 Ofcom Advice to Government. Ofcom does not acknowledge that allowing 900/1800MHz liberalisation to undermine this alleged advantage is itself a competitive distortion and nor has Ofcom considered the wider effects of this distortion - that O2 and Vodafone are placed in a far superior competitive position which distorts competition.

[18] For example, see page 17 of "*Everything Everywhere's Response to the Ofcom Consultation*", 13 June 2011

- 900MHz liberalisation has not distorted and is not likely to distort competition; or

- the likely distortions are corrected by the Auction design; or

- it is justified and proportionate to leave the distortions unaddressed, even if that means putting Three at a disadvantage (as is currently proposed).

## 1.3. Ofcom has not met the requirements of the Government Direction read consistently with the Amended GSM Directive.

Three considers that if Ofcom proceeds in line with its proposals in the Second Consultation it will fail to meet its obligations under the Government Direction read consistently with the Amended GSM Directive. This is so for the reasons that follow.

### 1.3.1. Ofcom's competition analysis prior to the Second Consultation was insufficient to satisfy the Amended GSM Directive.

The competition assessment carried out to date is not sufficient to satisfy the UK's obligations under the Amended GSM Directive for the following reasons.

The obligation under the Amended GSM Directive is to assess and address competitive distortions arising from 900MHz liberalisation. This requirement is not time limited and applies to the near and longer terms. Ofcom cannot avoid assessing the longer term impact by simply making assumptions about how the market might develop, such as the assumption that LTE800 will impose a complete competitive constraint on UMTS900. Ofcom must consider and test a range of possible market outcomes and must be particularly cautious about assuming a lack of longer term impact where it has previously acknowledged short- and medium-term impacts, including in Ofcom's Advice to Government.

In any event, the assumptions made in Ofcom's Advice to Government must be revisited in the light of subsequent developments. For example, Ofcom needs to revisit its assumption that "*[d]eployment of LTE in the 800MHz band is expected ultimately to provide the opportunity for a complete competitive constraint on UMTS services in the 900MHz band*"[19] (emphasis added), now that it is proposing to introduce an Auction design that fails to ensure the 900MHz incumbents' competitors will hold 800MHz spectrum. This material change in circumstances means that Ofcom can no longer rely on its previous limited competition assessment.

#### 1.3.2. Ofcom's objective of securing four "credible national wholesalers" is unlikely to be sufficient to meet the requirements of the Government Direction read consistently with the Amended GSM Directive.

The question Ofcom asks itself in the Consultation, namely whether there will be four national wholesalers capable of being competitive across a large proportion of the market, amounts to a misdirection because it does not ensure that the impact of 900MHz liberalisation will be examined. Although the First Consultation did not address the impact of 900MHz liberalisation directly, the test proposed by Ofcom in the First Consultation (and now dropped) would, if properly applied, have resulted in an outcome consistent with what should have been achieved had Ofcom directly addressed the impact of 900MHz liberalisation.

The question Ofcom now asks itself in the Consultation ignores the competitive position that existed before 900MHz liberalisation and the position that would exist currently but for 900MHz liberalisation. This question therefore, will not ensure that Ofcom identifies or addresses distortions that arise from 900MHz liberalisation.

As discussed further in Section 2 of this Response, even if the objective of securing four credible national wholesalers could be capable of meeting the requirements of the Amended GSM Directive, Ofcom's new test of credibility will not do so as it allows the fourth national wholesaler

[19] Ofcom Advice to Government, para 4.6.

to be left at a lasting disadvantage caused by 900MHz liberalisation. This is the consequence of requiring that the fourth national wholesaler be capable of competing across "*a large proportion*" of the market only and not across the whole of the market and/or those markets or segments consisting of higher quality data services (which of necessity include high quality indoor data services). This revised approach is also inconsistent with Ofcom's express objective of ensuring the widespread availability of high quality data services.[20]

#### 1.3.3. It is clear that 900MHz liberalisation will distort competition absent further remedial measures.

The result of applying Ofcom's test is that the fourth national wholesaler is likely to be left at a competitive disadvantage.

As discussed in Sections 3 and 4 of this Response and previous submissions, 900MHz spectrum affords considerable technical advantages over higher frequency spectrum. These advantages have been widely acknowledged by operators, academics and regulators, including Ofcom.

Ofcom's suggestion in the Second Consultation that the technical advantages may not be as significant as previously imagined is based on little or no evidence and is inconsistent with the evidence that is available. Further, Ofcom's modelling is flawed. When corrected, it demonstrates substantial advantages for holders of 900MHz spectrum.

As discussed in Section 4 of this Response, the technical advantages translate into substantial competitive advantages. Consumers will increasingly demand high quality data services deep indoors and sub-1GHz spectrum will be necessary to compete effectively in the provision of the same. In view of the importance of sub-1GHz spectrum, a fourth national wholesaler without it will not, in fact, be credible in a large (and growing) part of the market. Thus, Ofcom's proposals fail to satisfy even the (inappropriately) limited requirements of its new test.

[20] Consultation, para. 1.3.

As discussed in Section 5 of this Response, the previous liberalisation of 900MHz spectrum in the hands of O2 and Vodafone is likely to result in the fourth national wholesaler being left without sub-1GHz spectrum unless special measures are taken in the Auction to guarantee it some of the 800MHz spectrum.

For the reasons discussed in Section 6 of this Response, the existing Minimum Spectrum Portfolios ("**MSPs**") are insufficient to correct the distortion arising from 900MHz liberalisation since they fail to guarantee the fourth national wholesaler sub-1GHz spectrum (or anything that could be an effective substitute).

Accordingly, Ofcom will not succeed in addressing the distortions caused by 900MHz liberalisation unless it imposes additional remedial measures.

#### 1.3.4. Ofcom has not explained why it is proportionate and objectively justified to leave the competitive distortions uncorrected, to the disadvantage of the fourth national wholesaler.

Three accepts that Ofcom's obligation under the Government Direction read consistently with the Amended GSM Directive is to address competitive distortions arising from 900MHz liberalisation only so far as is proportionate and objectively justified. Theoretically, therefore, Ofcom might be able to justify its current position on the basis that it would be disproportionate to take the steps urged by Three.

If that were Ofcom's position, however, it would be required to say so expressly and provide reasons for the same. Ofcom has not done so.

Indeed, it is difficult to see how any decision not to take measures in the Auction to address this distortion could be considered to be rational or proportionate. Specifically, the liberalisation decision conferred significant and unearned benefits solely on the national wholesalers which held 900MHz spectrum. Therefore, it can only be proportionate to ensure that measures in the Auction allow those national wholesalers which did not benefit from the liberalisation decision to compete with the beneficiaries of 900MHz liberalisation in a way which removes the distortive effects of such liberalisation. This necessarily means that the Auction should provide for preferential measures which guarantee sub-

1GHz spectrum for those national wholesalers that did not benefit from 900MHz liberalisation.

### 1.4. Ofcom's proposals fail to promote future competition as they are required to do and fail to meet Ofcom's own objectives.

In addition to its obligation to comply with the Amended GSM Directive, Ofcom remains bound by the express obligation under the Government Direction to put in place appropriate and proportionate measures to promote competition in future mobile markets, where it thinks fit.

It also remains subject to more fundamental obligations drawn from Community and domestic law, including the following principles:

Ofcom must promote and not distort competition between the mobile operators;[21]

Ofcom must allocate spectrum according to objective, transparent and non-discriminatory criteria and pursuant to a procedure that is open, transparent and non-discriminatory;[22] and

Ofcom must ensure that spectrum allocation is managed as efficiently as possible.[23]

Ofcom has once again reiterated its consistently held view that the amount and importance of the spectrum to be made available in the Auction is likely to have a determinative effect on future competition in the

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[21] Treaty on the Functioning of the European Union ("TFEU"), Articles 106 and 107; Directive 2002/21/EC ("Framework Directive"), Article 8(2)(b); Communications Act 2003 ("2003 Act"), ss. 3(1)(b), 3(4)(b), 4(3)(a); Wireless Telegraphy Act 2006 ("2006 Act"), s. 3(2)(d).

[22] TFEU, Articles 106 and 107; Framework Directive, Recital 19, Article 8(3)(c), Article 9; Directive 2002/20/EC ("Authorisation Directive"), Article 5(2) and Article 7(3); 2003 Act, s. 3(3)(a).

[23] Framework Directive, Recital 19, Article 8(2)(d); 2003 Act, s. 3(2)(a); 2006 Act, s. 3(2)(a).

mobile sector. Similarly, it is clear that the only way to promote competition in future mobile markets is to introduce mechanisms to ensure that four credible national wholesalers are able to compete following the Auction.[24]

Three does not disagree with this as an objective but Ofcom needs to ensure that:

- it has an appropriate test for what it means to be a "*credible*" national wholesaler; and

- its proposals will satisfy that test.

For reasons discussed later in this Response, Three considers that there will not be four credible national wholesalers if Ofcom's current proposals are implemented. This will result in Ofcom failing to meet its statutory duty to promote competition (on any view Ofcom could not be said to have promoted competition as far as is appropriate and proportionate). In order to promote competition, Ofcom must ensure (to the extent reasonably possible) that all future mobile markets are competitive, including the markets for high-quality data services (the test Ofcom rightly set itself in the First Consultation). Accordingly, the new test of a "*credible*" national wholesaler is not appropriate. See in particular Section 2 of this Response.

Indeed, more generally, Ofcom's preferred proposals will not achieve its objective of securing the existence of four credible national wholesalers. For that reason, a decision taken on the basis of these proposals will likely be irrational. See in particular Section 4 of this Response.

Further, Ofcom's current proposals provide Everything Everywhere with an opportunity to use the divestment of 1800MHz spectrum strategically, such that it may effectively determine the outcome of the Auction for Three or a new entrant by blocking access to sub-1GHz spectrum. This is inconsistent with Ofcom's obligation to promote future competition and its

[24] Para. 4.46 Second Consultation

objective of reducing opportunities for strategic bidding.[25] Three considers that it also amounts to a failure to ensure that the procedure for allocating spectrum is open, transparent and non-discriminatory as required by Community and domestic law. See Section 7 of this Response for further discussion.[26]

### 1.5. Ofcom has failed to provide adequate reasons.

Ofcom must also provide reasons for changes to its position between the First Consultation and the Second Consultation. As a result of the significance of the changes, such reasons must be detailed. Accordingly, Ofcom must clearly address and explain the basis for its revised approach to assessing the position of the fourth national wholesaler, including:

- why it has adopted a different test from the First Consultation for whether or not a national wholesaler can be credible; and

- why it would be acceptable to have a fourth and a fifth competitor in the market following the Auction, neither of which would hold sufficient spectrum to be considered credible under any of Ofcom's measures (including those set out in the Second Consultation). Ofcom has not provided any analysis on how two constrained competitors directly competing against each other at the bottom of the market could fulfil the same role as a fourth competitor with sufficient spectrum to compete credibly.

Overall, Ofcom needs to give sufficient reasons to justify why it is willing to undermine the protection necessary to guard against its own main competitive concern (there not being a fourth credible competitor to ensure competition in the market after the Auction).

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[25] Para. 9.8(f) First Consultation.
[26] Article 5(2) Authorisation Directive; para.3 of Schedule 1 Wireless Telegraphy Act 2006.

# 2. The revised "credible" wholesaler test does not address the distortion from 900MHz liberalisation or promote competition.

*In this Section, Three considers Ofcom's change to its test for the credibility of a national wholesaler and whether the new test is capable of satisfying Ofcom's legal obligations. Our conclusions are:*

i. *Prior to liberalisation of the 900MHz (and 1800MHz) spectrum, there was a competitive mobile data market;*

ii. *In the absence of remedial measures, liberalisation will distort future competition in the market, because it has introduced fundamental spectrum-related differences in the competitive position of operators;*

iii. *All other Western European Union Member States have now addressed the risk of competitive distortion arising from 900MHz liberalisation;*

iv. *Instead of directly addressing the distortion caused by 900/1800MHz liberalisation, as it should have done, Ofcom seeks to ensure that (at least) four national wholesalers have the minimum spectrum required to be "credible". This approach could in principle address the distortion caused by liberalisation. However, Ofcom's approach to the question of what is required for an operator to be "credible" is unsustainable;*

v. *Ofcom has failed to explain clearly why it now accepts the possibility of the fourth wholesaler being significantly disadvantaged and unable to compete in the provision of high speed data services indoors;*

vi. *In the First Consultation Ofcom's test (the "**First Consultation Test**") was capable of addressing the distortions caused by 900/1800MHz liberalisation. Ofcom accepted that a credible wholesaler needs to be able to compete across the full range of services and, in particular, in those higher quality data segments that might go on to form separate markets in the future;*

vii. *The test in the Second Consultation (the "**Second Consultation Test**") is unlikely to meet Ofcom's legal obligations under the*

*Government Direction (read consistently with the Amended GSM Directive). It is also unlikely to allow Ofcom to meet its statutory duties and policy aims of promoting competition and widespread availability of high quality mobile data services;*

viii. *Ofcom should adopt a precautionary principle to avoid the risk of material harm to UK consumers after the Auction.*

ix. *Although subject to a separate consultation (dated 13 March 2012), it is nevertheless noted that Ofcom's proposal to liberalise Everything Everywhere's 1800MHz spectrum for LTE use before the Auction will aggravate the competitive distortions arising from 900MHz liberalisation and damage the future competitiveness of the mobile market(s).*

## 2.1. Prior to liberalisation of the 900MHz (and 1800MHz) spectrum there was a competitive mobile data market.

UK consumers have enjoyed the benefits of a competitive retail mobile market. In recent times the market has included four national wholesalers providing retail services directly and nearly 30 MVNOs (including Virgin Mobile and Tesco Mobile) purchasing access from the national wholesalers.

As Ofcom has identified, the evidence of strong UK retail competition includes shifts in market shares (Figure 1), relatively healthy levels of switching between operators, market entry by MVNOs and innovation by service providers with new service and price options.[27]

[27] Consultation, Annex 2, para 2.44.

**Figure 1: 3G retail subscriber shares, 2007-2010**

Source: Three

Ofcom, the Office of Fair Trading and the European Commission have all recognised the competitive impact of the fourth national wholesaler, Three. For instance:

- Three accounts for [redacted] of data volume in the market;
- Three was the first operator to introduce a low cost, flat-rate mobile broadband package; and
- Three has promoted new services like Skype and has pioneered new products such as mobile broadband dongles aimed at a mass-market audience.

This competitive environment developed because each national wholesaler had a similar holding of 3G-capable spectrum in the 2.1GHz band. Until recently, the only 3G-capable holdings were 2x20MHz held by Everything Everywhere (post-merger of T-Mobile and Orange), 2x15MHz held by each of Vodafone and Three and 2x10MHz held by O2. This broad equivalence of 3G-capable spectrum holdings allowed Three, as the fourth national wholesaler, to exert a competitive constraint as the recognised (by the European Commission) 'maverick' in the market.

Prior to 900/1800MHz liberalisation competition was effective because there were no constraints on any of the four operators arising from their 3G spectrum holdings. Each operator could provide comparable 3G data services to its rivals in terms of in-building penetration, coverage, capacity and data rates. All operators were in a similar competitive position and were capable of competing in the provision of 3G data services across a wide range of services, customers and possible future markets.

In Ofcom's terminology, all operators were similarly "credible" before liberalisation. Each had more than 10-15% of the paired spectrum then available for 3G use and each had to provide its 3G coverage using the same high frequency spectrum (2.1GHz). No operator had an early route to LTE or the ability to deliver highest peak data rates using that technology.

Most importantly, all four national wholesalers had an equal opportunity to compete in the provision of <u>future</u> services, and were poised to take advantage of the large strides being made in the mobile industry as changes in technologies, services and customer preferences continue to develop. Indeed, as Three explains in Section 4, the mobile industry is currently in transition to a data-centric model. Due to the dynamic efficiency of the mobile market such fundamental changes will continue.

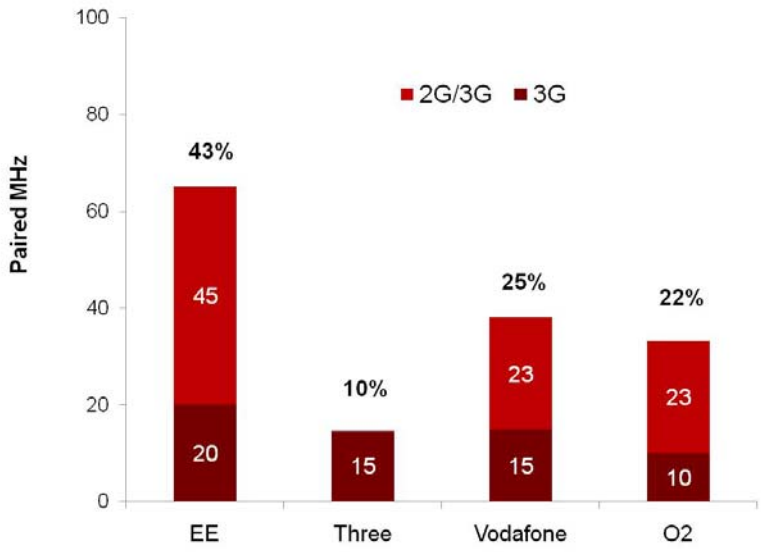
## 2.2. In the absence of remedial measures, liberalisation will distort future competition in the market.

Liberalisation of 900MHz (and 1800MHz) spectrum has put the competitiveness of the market at risk by introducing fundamental and unearned spectrum- related differences in the position of the four national wholesalers. An individual operator's ability to compete will be materially

affected, because low frequency spectrum is now a key differentiating factor between operators. In the absence of remedial measures, this will distort competition in future mobile markets.

In particular, liberalisation has created a large imbalance in operators' 3G spectrum holdings that will extend into an uneven balance in 4G capabilities when all technology restrictions are removed. Figure 2 shows operators' shares of paired spectrum post-liberalisation:

**Figure 2: Spectrum allocation resulting from liberalisation.**




Source: Three

Three explained the nature of the distortion in Section 2 of its response to the First Consultation. The analysis demonstrated that O2, Vodafone and Everything Everywhere have received huge benefits from 900/1800MHz liberalisation:

- Vodafone and O2 are the only operators to benefit from sub-1GHz spectrum. Each has 2x17.4MHz of 900MHz

spectrum (and 2x5.8 of 1800MHz) that can now be used for 3G services. This provides a large competitive advantage in in-building penetration, speeds, and urban and rural coverage – all of the key drivers of competition in future mobile services;

- Everything Everywhere has received a very large uplift in its overall 3G capacity (its total spectrum holdings increasing from 34% to 43% of the spectrum available pre Auction) but no sub-1GHz spectrum;

- Three has obtained no additional spectrum. It has no sub-1GHz spectrum and is the only operator whose share of 3G capable spectrum has dropped substantially, from 25% to just 10%.

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**Table 1: Ofcom's assessment of Three's "credibility"**

| | A: 2.6GHz & below | B: 2.1Ghz & below | C: Sub-1GHz |
|---|---|---|---|
| **1. Capacity and average data rate – near term** | **2x15MHz** | **2x15MHz** | **-** |
| **2. Capacity and average data rate – long term** | **2x15MHz (6%)** | **2x15MHz (8%)** | **-** |
| **3. Early route to LTE** | **-** | **-** | **-** |
| **4. Highest peak data rate with early LTE** | **-** | **-** | **-** |

Source: Consultation, Figure 4.6.

The imbalance in spectrum holdings caused by liberalisation will result in a material disadvantage to operators without sub-1GHz spectrum. It will prevent them from competing on an equal footing in the provision of future services and markets that are currently envisaged (see Sections 3 and 4).

Ofcom must therefore expressly consider and address the potential competitive distortion created by liberalisation of 900MHz spectrum in order to meet its legal obligations under the Government Direction (read consistently with the Amended GSM Directive), or explain why it is not justified and/or proportionate to address them.

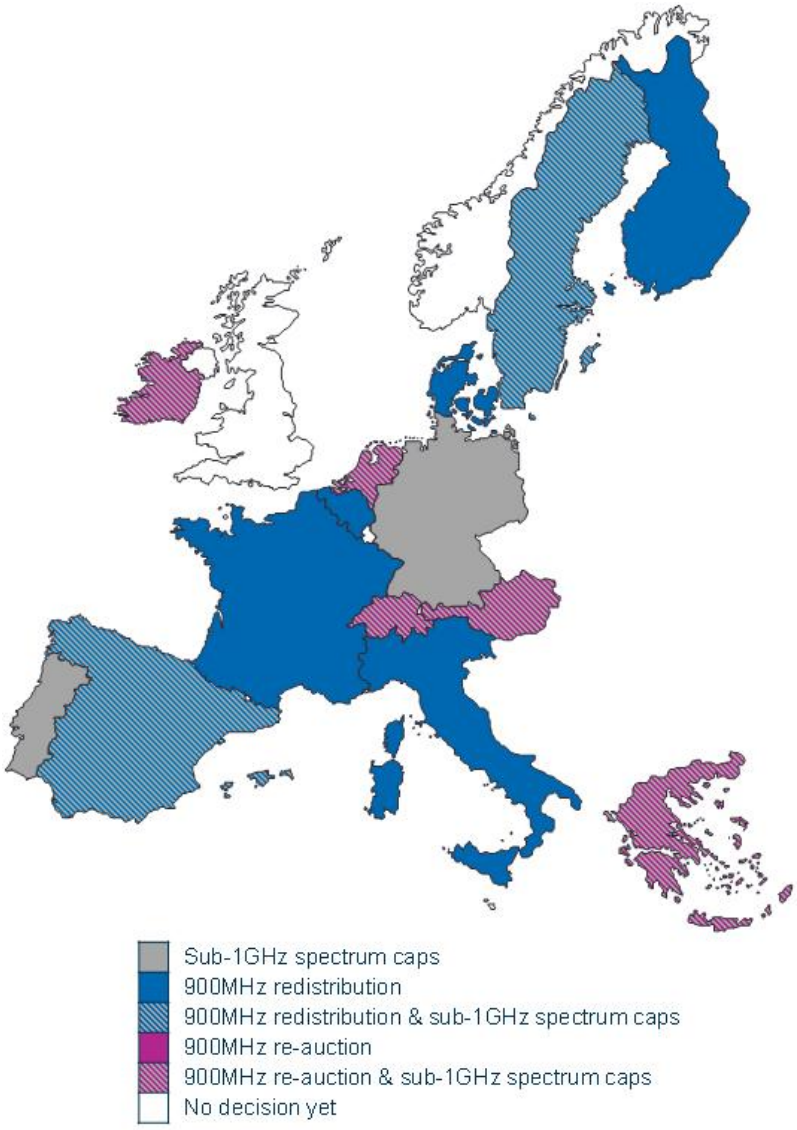
### 2.3. All other Western European Union Member States have now addressed the risk of competitive distortion arising from 900MHz liberalisation.

The Amended GSM Directive and the Radio Spectrum Decision expressly envisage that Member States might address the risk of competitive distortion arising from 900/1800MHz liberalisation through the reallocation of some or all of the existing 900/1800MHz rights of use.

All other Western European Member States[28] have taken specific measures to allow other operators to access sub-1GHz spectrum, either through redistribution or re-auctioning of the 900MHz spectrum, with or without a sub-1GHz spectrum cap (or by reserving sub-1GHz spectrum for smaller wholesalers/new entrants, as in the Netherlands). Figure 3 summarises the measures taken by different regulators across Europe (see Annex C for more details).

[28] i.e. EU-15 ignoring Luxembourg

**Figure 3: All other Western European Union Member States have taken measures to ensure a more even allocation of sub-1GHz spectrum.**




Source: Three

As shown in Figure 3, only in Germany and Portugal did the regulator limit itself to the imposition of sub-1GHz spectrum caps. However:

- in Germany's auction, the operator-specific 800MHz spectrum caps took into account existing 900MHz holdings, so that no single operator would end up with disproportionate amounts of sub-1GHz spectrum; and

- in Portugal, rather than re-auctioning the entire 900MHz band, only one additional lot of 2x5MHz of 900MHz spectrum was auctioned in December 2011. Before this auction 900MHz spectrum was equally distributed between operators, so that no re-balancing measure was necessary.

The sub-1GHz caps applied in other countries are also much lower than the 2x27.5MHz "safeguard" cap proposed by Ofcom. As explained in Annex C, other European regulators have gone much further to prevent excessive concentration of sub-1GHz spectrum. For instance:

- in the Netherlands, Opta took the view that 2×10MHz was the minimum amount of sub-1GHz spectrum required for a mobile operator to remain competitive in the future; and

- in France, ARCEP expressed concern that a fourth 3G operator would be at a competitive disadvantage relative to the three incumbents without 900MHz spectrum, and implemented measures to address that concern.

In summary, in all those countries that have already made a decision on the future use of the 900MHz band, either operators already held comparable amounts of sub-1GHz spectrum or regulators intervened in order to ensure a more even distribution of that spectrum.

## 2.4. Ofcom's approach of ensuring four "credible" national wholesalers could address the distortion caused by liberalisation, but its approach to the question of what is required to be "credible" is untenable.

Ofcom's chosen test must enable it to meet its obligations under the Government Direction (read consistently with the Amended GSM Directive) and to meet its statutory duties, particularly its duty to maximise benefits to consumers, wherever appropriate by promoting competition in future mobile markets.

Ofcom has not expressly set itself the objective of addressing competitive distortion caused by 900/1800MHz liberalisation, either in the First or the Second Consultation. Instead, Ofcom has sought to in both cases to ensure that (at least) four national wholesalers have the minimum spectrum required to be "credible" (as defined by Ofcom) after the Auction.

Three continues to support the conclusion that the presence of four credible national wholesalers is essential to the continued competitiveness of the UK mobile market.

However, in its Second Consultation, Ofcom has changed its "credible wholesaler test" without providing adequate reasons. For the reasons that follow, Ofcom should revert to its First Consultation Test, to ensure that its chosen test allows Ofcom to comply with its legal obligations, statutory duties and policy aim.

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### 2.4.1. Ofcom has failed to explain clearly why it now accepts the possibility of a fourth national wholesaler being significantly disadvantaged.

The Second Consultation represents a fundamental departure from the reasoning supporting the First Consultation in one very material respect. In particular, Ofcom now contemplates the possibility of the fourth national wholesaler being handicapped, unable to compete in the provision of all mobile services.

The only explanation provided by Ofcom is that it now draws a “clearer distinction” between its “main” and “lesser” concerns, which concerns it presents as being “a little broader” than the concerns identified in its First Consultation.[29] Three disagrees with this characterisation. Ofcom has not merely drawn a "clearer distinction" but has made a substantial change on which it relies to justify its conclusion that an operator can be “credible” without sub-1GHz spectrum.

This new conclusion, that sub-1GHz spectrum is not essential to be "credible", does not appear to have arisen from any changed facts. In any event, Ofcom has not adequately explained why it is now willing to contemplate the possibility of the fourth operator being put at a disadvantage when previously it was not. Three considers that Ofcom is obliged, as a matter of procedural fairness, to explain such a fundamental change of approach.

#### 2.4.2. Ofcom’s First Consultation Test was capable of addressing the distortions caused by 900/1800MHz liberalisation.

In its response to the First Consultation, Three supported Ofcom's “credible wholesaler” test.[30] As Ofcom formulated it, the test was capable of ensuring that Ofcom would comply with the Government Direction (read consistently with the Amended GSM Directive).

In particular, in the First Consultation Ofcom proposed that in order be a credible national wholesaler an operator had to be “credible” in the provision of “higher quality data services” (“**First Consultation Test**”).[31] Ofcom found that such services would continue to grow in importance and that separate markets associated with higher quality data services could develop in future.[32] Ofcom identified three possible future higher quality data markets:

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[29] Consultation, para 4.45.
[30] Albeit that Ofcom did not expressly direct itself to apply the test correctly. Response to Ofcom Consultation on Assessment of Future Mobile Competition and Proposals for the Award of 800MHz and 2.6GHz Spectrum, paras 11 and 28.
[31] Consultation on Assessment of Future Mobile Competition and Proposals for the Award of 800MHz and 2.6GHz Spectrum and Related Issues. Paras 5.58-5.60. Also Annex 6, paras 5.101, 5.109-5.115.
[32] Ibid, Annex 6, 5.55-5.56.

- A high quality data market associated with reliable indoor coverage for data services;

- A separate market associated with higher data speeds and better latency (delivered by LTE), distinct from a market associated with lower data speeds (delivered by 2G and 3G); and

- A division of the retail market into services that had priority over other services (e.g. a highly reliable business services compared to a lower priority consumer service) made possible by LTE technology.[33]

Ofcom was concerned that some providers may not have the spectrum required to serve those markets, and would therefore be unable to constrain prices in those markets.[34] It sought to prevent "*a material risk that the competitiveness in at least some possible retail and wholesale markets could be lower in the future compared either to today or what it could be*".[35]

Accordingly, Ofcom set out to ensure that at least four national wholesalers had a reasonable overall portfolio of spectrum, including some low frequency spectrum to be able to credibly offer high quality data services (particularly indoors).[36]

By seeking an outcome where (at least) four players had the spectrum required to provide the best possible services, Ofcom ensured that each operator would be able to compete across a wide range of services, customers and possible future markets. In turn, each would act as a competitive constraint in respect of prices for those services to the benefit of UK consumers.

In principle, the First Consultation Test could be applied in a manner consistent with Ofcom's obligations under the Government Direction (read consistently with the Amended GSM Directive). The First

[33] Ibid, Annex 6, 3.30. Also main consultation, 5.16, 5.22.
[34] Ibid, Annex 6, 3.30 and 5.110-5.111.
[35] Ibid, Annex 6, paras 5.6-5.12, 5.103-5.105.
[36] Ibid, Annex 6 paras 5.57 and 5.109.

Consultation Test takes, as its premise, the need for a competitive situation after the Auction that happens to be similar to that which existed prior to 900MHz (and 1800MHz) liberalisation. It also assumes the need for a post-Auction outcome which is similar to the outcome that might have been expected to exist had 900/1800MHz liberalisation not occurred – where operators would be in a broadly similar competitive position and could potentially compete across a wide range of services and customers.

#### 2.4.3. The Second Consultation Test is unlikely to meet Ofcom's legal obligations under the Government Direction (read consistently with the Amended GSM Directive).

In contrast, the test applied by Ofcom in its Second Consultation ("**Second Consultation Test**") is unlikely to comply with the requirements of the Government Direction (read consistently with the Amended GSM Directive).

In the Second Consultation, the national wholesaler must be "credible" across only a "large" proportion of the overall "market".[37] Ofcom now distinguishes between the "credibility" of a national wholesaler (a "major concern") and the competitive disadvantage it may experience in competing in the provision of particular services or to particular customer segments (a "lesser concern").[38]

In effect, Ofcom has materially lowered the bar for what constitutes a "credible" operator. The Second Consultation Test no longer ensures that (at least) four national wholesalers are in a similar competitive position and are able to compete across a wide range of services, customers and possible future markets. An operator can now be "credible" if it exerts a competitive threat across only a "large" part of the overall "market", even if it is unable to provide some services or serve specific customer segments or possible future markets.[39]

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[37] Consultation, paras 4.72, Annex 6 paras 3.21-3.22.
[38] Consultation, para 4.45.
[39] Consultation, para 4.38 and 4.45.

Ofcom therefore takes as its starting point a situation in which a distortion of competition is permitted. The extent of the distortion allowed includes:

- being a weaker competitor due to lack of sub-1GHz spectrum, for instance in respect of consumers who value quality coverage in harder to serve locations; [40] and

- being a weaker competitor due to lack of data capacity, for instance in respect of customers with high data needs (such as consumers using dongles).[41]

Indeed, Ofcom recognises that a national wholesaler without sub-1GHz spectrum will be at a disadvantage in competing across a wide range of services and customers. That national wholesaler would be a weaker competitor in the provision of good quality coverage than national wholesalers with sub-1GHz spectrum.[42] In spite of this, Ofcom now accepts an Auction outcome where a fourth national wholesaler (Three or a new entrant) does not hold any low frequency spectrum and cannot provide good quality coverage.

Such an outcome differs markedly from the competitive situation that would have existed absent 900MHz liberalisation. For that reason, the Second Consultation Test is unlikely to comply with the Government Direction (read consistently with the Amended GSM Directive). The test is also inconsistent with Ofcom's express objective to promote the widespread availability of high quality data services throughout the UK.[43]

#### 2.4.4. The Second Consultation Test is also unlikely to allow Ofcom to meet its statutory duty and policy aims.

Ofcom's primary duty under Section 3 of the Communications Act 2003 is to further the interests of consumers, where appropriate by promoting competition. Ofcom's policy aim is to promote competition in future mobile markets to the benefit of consumers.[44]

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[40] Consultation, paras 4.83, 4.104, 4.41 and Annex 6, paras 3.138-3.140.
[41] Consultation, para 4.75 and Annex 6, para 3.70, 3.27.
[42] Consultation, para 4.83, 4.104, 4.143. Annex 6, 3.140.
[43] Consultation, para 1.3.
[44] Consultation, para 4.29.

In light of its duties and policy aim, Ofcom is rightly concerned that "*without measures in the auction, competition in mobile markets may not be promoted, resulting in a lower intensity of competition compared either to today or to the degree of future competition that could be promoted*".[45]

The First Consultation Test will achieve Ofcom's statutory duties and policy aim to a greater extent than the Second Consultation Test. Future competition will be more intense (and consumer benefits will be greater) with the First Consultation Test which ensures that (at least) four national wholesalers can compete across a wide range of services, customers and possible future markets, whereas the Second Consultation Test does not.[46]

In effect, the Second Consultation Test is likely to lead to outcomes which, on Ofcom's own analysis, will result in material competitive detriment and consumer harm, as follows:

- if, as Ofcom still considers possible, separate markets develop for certain segments or consumers,[47] the Second Consultation Test does not ensure that at least four national wholesalers are able to serve them or constrain their prices; and

- even if separate markets do not develop, the Second Consultation Test means consumers who demand high quality data services may only have a choice of three or fewer providers. As Ofcom recognises, material consumer detriment may then arise from reduced choice and innovation, even if there remain four "credible" national wholesalers overall.[48]

Further, the likely effect of such a loss of consumer welfare is considerable. As Ofcom notes, even a moderate reduction in competition (e.g. a 1% decrease in consumer surplus sustained over five years) could have a substantial detrimental impact on consumers (net present value of

[45] Consultation, para 4.4.
[46] Consultation, Annex 6, para 2.30.
[47] Consultation, Annex 6, para 2.29
[48] Consultation, Annex 6, para 2.30-2.31.

£1.1 billion).[49] These detrimental outcomes, which arise from limited competition across the full range of services and customers,[50] should not arise with a correct application of the First Consultation Test.

#### 2.4.5. Ofcom should adopt a precautionary principle to avoid the risk of material harm to consumers after the Auction.

One final consideration shows the Second Consultation Test to be the wrong test. In the past, when faced with uncertainty about whether a specific regulatory measure or action by an operator may result in a net benefit or net harm to consumers, Ofcom has rightly given due weight to its overriding statutory duty to promote competition and further the interests of consumers, and adopted a precautionary approach.

That approach is also appropriate here. To decide whether or not to include sub-1GHz spectrum in its minimum spectrum portfolios, Ofcom sets itself the following test:[51]

- does sub-1GHz spectrum provide a significant technical advantage over higher frequency spectrum? – Ofcom is now "less clear" that this is so; and

- if it does, does sub-1GHz spectrum provide a competitive advantage? – Ofcom considers that this depends on two factors: "*whether consumers place sufficient value on good quality coverage in harder to serve locations, and the extent to which this can be provided using small cells solutions*".[52]

As explained above, the mobile market is currently in transition from voice to mobile data. Consumer preferences and expectations are changing fast and new, innovative services will be available with the combination of the "cloud" and the emergence of M2M applications. It is not so long ago that the UK population at large was content with a fixed dial-up internet connection and a basic 2G handset.

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[49] Consultation, Annex 6, para 2.69.
[50] Consultation, Annex 6, para 4.94.
[51] Consultation, para 4.66.
[52] Consultation, Annex 6, 3.120.

Ofcom has recognised in another context that "*it is difficult to assess switching behaviour by customers for a product they have not yet experienced*".[53] If, in the final analysis, evidence is inconclusive and Ofcom is unable to reach a firm conclusion on whether sub-1GHz spectrum will provide a competitive advantage in future, Ofcom should not simply adopt its Second Consultation Test in the hope that low frequency spectrum will ultimately be shown to be unimportant.

If in future UK consumers do place a high value on reliable indoor coverage that can only be provided with sub-1GHz spectrum, the adverse consequences would be significant. They include future consolidation in the industry, which would lead to a material reduction in competitive intensity and substantial consumer harm – all inconsistent with Ofcom's overriding statutory duty.

The risk of such detriments occurring can be easily reduced by reverting to Ofcom's First Consultation Test. Given its duties to further the interests of consumers and promote competition in the relevant markets following the Auction, and the materiality of the potential detriments, if Ofcom is uncertain about the effects it should take a precautionary approach and ensure that at least four national wholesalers have access to sub-1GHz spectrum. It may also be possible to allow Everything Everywhere access to sub-1GHz spectrum, provided it is willing to sacrifice 1800MHz spectrum in return.[54]

For instance, Ofcom is proposing a precautionary approach in the Second Consultation, in relation to the reservation of 2.6GHz spectrum for low power use. Ofcom provisionally concludes that:

> *"The evidential base for reserving 2.6GHz spectrum is mixed. There is a reasonable likelihood that a reservation would lead to the introduction of new services based on low power use[…] While it is possible that low power entry could occur without reservation we have identified that there is*

[53] Review of the Wholesale Broadband Access Markets Statement, December 2010, para 3.18.

[54] See paragraph 38 of Three's response to Ofcom consultation on Assessment of Furture Mobile Competition and Proposals for the Award of 800MHz and 2.6GHz Spectrum.

> *some risk that it might not. Given these risks and the potential benefits to consumers of this entry we are minded to favour reservation of 2 x 10MHz of 2.6 GHz spectrum but we would welcome more evidence on the costs and benefits of such an action which we recognise is a difficult judgement."* [55]

Ofcom has also adopted a precautionary principle in its recent Determination on BT's termination charges for 0845 and 0870 numbers. Faced with uncertainty and the risk of an adverse effect of those charges on consumers, Ofcom concludes:

> *"Given the uncertainty which we have identified as to whether BT's NCCNs would result in a net benefit or net harm to consumers, and in light of our overriding* statutory *duties to further the interests of consumers, we consider it is appropriate for us to place greater weight on this potential risk to consumers from NCCNs 985 and 986".* [56]

Closer to the facts of this case, Ofcom proposed a precautionary approach in its very first consultation on the Application of Liberalisation and Trading to the Mobile Sector. Ofcom then favoured mandatory release of sub-1GHz spectrum by O2 and Vodafone. A precautionary approach, Ofcom said, was the approach most likely to meet its duties and objectives given the uncertainty regarding the future market development:

> *"Ofcom believes it needs to take a precautionary approach. As noted above the UK has a relatively competitive mobile market. There are four roughly symmetric national wholesalers and a fifth, new entrant in H3G; this is a more competitive structure than generally in the rest of the EU and elsewhere. In this context, Ofcom considers that it should seek to protect against the possibility that changes in spectrum policy could upset the balance in the*

[55] Consultation, Annex 6, paras 9.60, 9.67.
[56] Determination to Resolve a Dispute Between BT and Each of Vodafone, T-Mobile, H3G, O2, Orange and Everything Everywhere About BT's Termination Charges for 0845 and 0870 calls, para 9.32.

> *downstream market, as this could have far-reaching adverse effects for competition and consumers. Rather it needs to ensure that its approach to liberalisation of 900 MHz spectrum is likely to ensure that the mobile market continues to be competitive, with the possibility of becoming more competitive […] In relation to the benefits Ofcom has taken into account the need to guard against the risk of a significant reduction in competition if there is significant growth in the demand for mobile broadband services, while recognising that such a growth in demand is uncertain".*[57]

Those words remain relevant. There is still a clear risk that liberalisation of 900MHz spectrum could upset the balance in the downstream market with far-reaching adverse effects for competition and consumers. The balance of benefits and potential harm to consumers points to only one conclusion – Ofcom should adopt a precautionary approach and revert to its First Consultation Test:

- Ofcom's First Consultation Test carries little or no risk, and no obvious detriment to consumers seems to arise from the additional protection it affords (or at least Ofcom is yet to identify any such detriment); and

- On the other hand Ofcom's Second Consultation Test fails to ensure that (at least) four national wholesalers can compete in the provision of all mobile services. This risks future consolidation in the industry, which would likely have far-reaching adverse effects for competition and consumers.

[57] Application of Spectrum Liberalisation and Trading to the Mobile Sector. Consultation (20 September 2007), paras 1.41- 1.52.

## 2.5. Liberalising the 1800MHz spectrum for LTE use before the Auction will aggravate the competitive distortions arising from 900MHz liberalisation and damage the future competitiveness of the mobile market(s).

In its Second Consultation of 13 March 2012, Ofcom proposes to liberalise Everything Everywhere's 1800MHz spectrum for LTE use before the Auction. This will only further damage the future competitiveness of the mobile market(s) and should not be permitted.

Ofcom's analysis in the Second Consultation appears to view Everything Everywhere's early route to LTE with 1800MHz as compensation or a fair trade-off for it not being guaranteed sub-1GHz spectrum. It may be that this influences Ofcom's thinking in relation to liberalisation of the 1800MHz spectrum for LTE.

If so, it represents incomplete reasoning as it fails to recognise that whilst it strengthens the position of Everything Everywhere (an operator without sub-1GHz spectrum but with the largest market share and overall spectrum capacity) it further weakens the position of the fourth national wholesaler as the only national wholesaler not to have benefited from 900/1800MHz liberalisation.

To put this in context, the proposal to allow liberalisation of Everything Everywhere's 1800MHz spectrum for LTE use comes in circumstances where Ofcom foresees access to Everything Everywhere's divested 2x15MHz of 1800MHz spectrum as the potential safeguard for the future credibility of the fourth national wholesaler.

Even if a large quantity of 1800MHz could be a substitute for sub-1GHz spectrum (which Three rejects for the reasons given in this response), Ofcom must surely recognise that it will have less value in circumstances where another operator has already had a 15 month head-start in the launch of the same technology. An already poor substitute is thus made even less valuable.

Three rejects Ofcom's assessment that there will be no lasting effects of the first mover advantage granted to Everything Everywhere. Contrary to Ofcom's view, Everything Everywhere will be able to gain considerable advantages from the 15 month period where it will be the only viable 4G

provider. In a market as dynamic as the mobile market for data, 15 months is a long time and provides a window within which Everything Everywhere can lock in new customers and attract significant market share. It will also be able to build goodwill and gain a reputation as a superior provider of data services.

Ofcom's conclusion is also internally inconsistent. A central part of Ofcom's reasoning is that there is significant and urgent demand for 4G services. Accordingly Ofcom must accept that those customers will move *en masse* to the first mover. Ofcom concludes, however, that the first mover will not thereby gain any lasting advantage. There is no investigation as to how "sticky" these customers may be or why the competitive advantages of winning such a substantial and valuable part of the market for well over a year, with the attendant commercial and reputational benefits, will be soon undone. Such an investigation is even more necessary when the conclusion is implausible.

Whilst users will undoubtedly benefit from early access to LTE, as considered important by Ofcom, they are likely to be net losers in the longer term if the earlier access contributes to the loss of a fourth credible national wholesaler.

| **Section 2 Recommendation** |
| --- |
| Ofcom should revert to its First Consultation Test, to ensure that its chosen test is likely to promote competition and minimise the future distortion arising from liberalisation of the 900MHz spectrum. |

# 3. Sub-1GHz spectrum provides a much larger technical advantage than Ofcom acknowledges.

*Section 3 sets out Three's technical review of the comparative benefits of Sub-1GHz spectrum, particularly when compared to 1800MHz spectrum. The conclusions from this section include the following.*

i. *It is well established that sub-1GHz spectrum provides substantial technical advantages over higher frequency spectrum (including 1800MHz spectrum), especially in relation to the provision of breadth of coverage and depth of indoor coverage. Given this, it is not justified or appropriate for Ofcom to fundamentally change the Auction design proposals on the basis of a re-evaluation of the technical advantages of sub-1GHz spectrum, without conducting an appropriate level of technical analysis and evidence to support this change.*

ii. *The technical analysis that Ofcom does undertake is based on an inappropriate approach. Ofcom fails to model the UK at a national level or on the basis of a real network. Instead it constructs a "synthetic" network in two sample areas and extrapolates up to a national level. Three has identified several key errors in Ofcom's technical modelling including:*

   - *Ofcom's "synthetic" modelling process, using sample areas, predicts extremely unrealistic site numbers for an equivalent national network;*
   - *Ofcom has underestimated the effect of penetrating the external walls of buildings on signal levels when modelling the sample areas;*
   - *Ofcom has failed to use signal strength (a minimum measure used in 3GPP standards to determine whether a device can connect to a network) as a parameter when modelling the sample areas; and*
   - *Ofcom's use of two sample areas to draw conclusions at a national level is unsound.*

iii. *This series of errors compounds so that Ofcom materially understates the advantages of sub-1GHz spectrum - if Ofcom had sense checked its results against any real network in the UK, the lack of credibility of its findings would have been obvious.*

iv. *When the flaws in Ofcom's modelling methodology and parameters are corrected and technical analysis is undertaken*

*based on a real network, the advantages of sub-1GHz spectrum are clear.*

v. *Whilst Ofcom is non-committal about the prevalence of the "hardest to serve" locations where sub-1GHz would be essential to provide coverage, our evidence shows that:*

- *"Hardest to serve" locations are very prevalent and account for a disproportionately large proportion of attempted mobile usage.*

- *.*

vi. *Small cell solutions are simply not realistic to mitigate the impact of not being able to reach these deep indoor and hard to serve locations using a sub-1GHz macrocell solution.*

vii. *In addition, 800MHz spectrum provides higher data speeds and improved customer experience, particularly for those in weaker signal areas.*

*Three's detailed technical analysis is set out in Annex F.*

*Section 3 Recommendations*

1. Ofcom should conclude that:
   a. there is a high prevalence of deep indoor and hard to serve locations; and
   b. sub-1GHz spectrum provides material technical advantages in providing coverage to such deep indoor and hard to serve locations, which cannot be matched or materially mitigated through the use of small cells or other solutions.
2. If Ofcom is in any doubt regarding the above, it should correct the flaws in its technical modelling and conduct a fresh technical analysis.

### 3.1. Ofcom bases critical spectrum decisions on flawed technical analysis and assumptions regarding the prevalence of "deep" indoor or hard to serve locations without requiring an appropriate level of evidence.

Ofcom's conclusion that sub-1GHz spectrum is not essential to be a credible operator underpins a package of Auction proposals which Ofcom acknowledges may impact the competitiveness of the mobile industry for the next 10 years.[58]

Ofcom states in its Second Consultation at paragraph 4.80 that:

> *"The more prevalent and important harder to serve locations are for consumers, the greater the potential advantages associated with lower*

[58] As described in Paragraph 4.4 of the Second Consultation.

> *frequency spectrum.* ***We do not have specific evidence on the prevalence of locations that are particularly 'deep' indoors or difficult to serve.*** *However, given the materially lower certainty of coverage, we consider there is a material risk that coverage at 2.6 GHz would be insufficient to provide a credible national wholesale service. There is also some risk that coverage at 2100 MHz or 1800 MHz is insufficient to provide a credible national wholesale service, however the risk is materially lower."* [Emphasis added]

Three submits that it is not justified or appropriate for Ofcom to fundamentally change its Auction design proposals without an appropriate level of technical analysis and evidence to support this change. The provision of robust and credible technical evidence is reasonable to expect in circumstances when Ofcom's conclusions are contrary to a vast body of reported information and auction results which support findings that sub-1GHz spectrum provides material technical advantages, particularly for indoor coverage.

This is even more important given that Ofcom's findings in this area largely underpin its view of the materiality of the distortion to competition that may arise from Ofcom's previous liberalisation decision. As set out in Section 1, Ofcom must take careful account of such distortions and assess whether it is justified and proportionate (taking into account the liberalisation decision) to leave this risk unremedied, even though it may materially distort competition and disadvantage Three.

In Section 3.4, Three discusses how these inaccuracies have led Ofcom to the conclusion that sub-1GHz is not required for an operator to provide a credible national wholesale service.

In Section 3.5, Three provides an overview of its own detailed analysis of the technical advantages of 800MHz spectrum compared with 1800MHz spectrum based on a real UK mobile network.

### 3.2. Ofcom's technical analysis is flawed, which should have been obvious to Ofcom.

Ofcom has not conducted appropriately detailed or reliable technical modelling relating to the prevalence of deep indoor and hard to serve locations upon which it is reasonable to base decisions. The technical modelling that Ofcom does conduct is highly flawed primarily due to its failure to derive results by modelling a real network. Rather, Ofcom has adopted a synthetic network modelling approach

This approach relies upon multiple assumptions and extrapolation which allows for the introduction of errors in to the model and therefore its outputs. Indeed, as the model runs these errors compound so as to produce highly skewed results (see Section 3.3).

A close review of Ofcom's technical analysis confirms that it does contain several material errors. Such errors include deriving unrealistic site numbers, underestimating signal loss when signals pass through external walls, failing properly to consider whether devices can connect to a network and extrapolating from small sample areas. These errors produce results which are unrealistic and obviously so (see Section 3.4).

Three submits than any reasonable regulator would have sense checked its results against real networks in its jurisdiction and would have realised that its assumptions and results were flawed. The only reasonable alternative is to carry out a modelling exercise based on a real network. Indeed, Three submits that Ofcom should have used this approach so to produce reliable and verifiable results.

Three has modelled its nationwide network and produced nationwide results for indoor coverage. This modelling shows that deep indoor and "hardest to serve" locations are very prevalent and account for a large proportion of attempted mobile usage.

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This is discussed in Sections 3.5 and 3.6.

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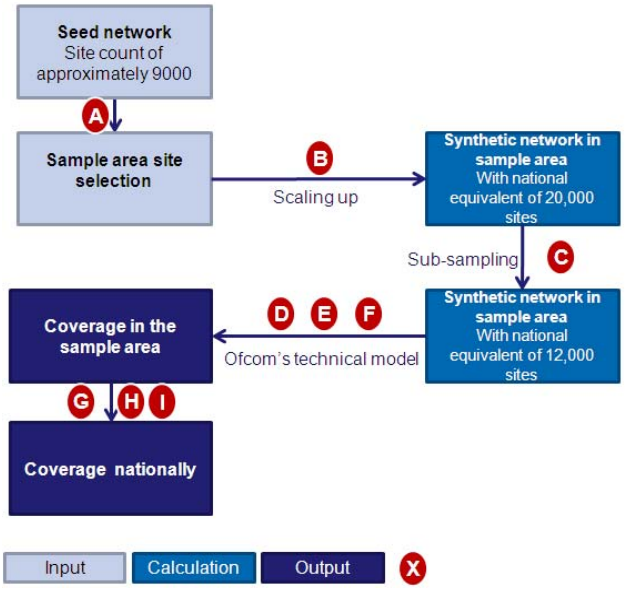
Further, it is unrealistic to suggest that small cells or other solutions can match or materially mitigate the advantages that sub-1GHz spectrum can provides in terms of coverage (see Section 3.8).

### 3.3. Ofcom's technical analysis is flawed because Ofcom should have used a real network as the basis for its technical modelling.

Ofcom models a "synthetic" network in two sample areas, which is intended to compare the properties of the different spectrum including 1800MHz and 800MHz spectrum. However, such a "synthetic" model can never be as good as a national modelling approach based on a real mobile network.

Using a "synthetic" model introduces additional steps, which can give rise to errors. The diagram below shows, at a high level, the steps followed by Ofcom in producing results from this "synthetic" model. It also identifies key areas where errors have been introduced.

**Figure 4: Summary of Ofcom's technical modelling approach**




Source: Three/Ofcom

Importantly, as the model progresses, errors are compounded. The errors in this "synthetic" model are briefly described in the table below.

**Table 2: Summary of Ofcom technical modelling errors.**

| Error | Brief Description of Error | Effect | Impact on indoor coverage results |
|---|---|---|---|
| A | Sampling base 9000 site network (with disproportionate number of sites in key urban and suburban) | Does not reflect percentage of site numbers in key urban and suburban areas in larger networks | Depends on use of results |
| B | Scaling up base network to 20,000 site network | Adds disproportionate percentage of sites in key urban and suburban areas | Overestimates indoor coverage in key urban and suburban areas in the 20,000 site model |
| C | Random sampling of key urban and suburban areas | Will have disproportionate site numbers in key urban and suburban areas | Overestimates indoor coverage in sample key urban and suburban areas |
| D | Use of SINR rather than RSRP approach to determining whether a device connects to the network | Does not consider whether the device is programmed to connect to the network thus assuming coverage when devices will not, in practice, connect | Overestimates indoor coverage results |
| E | Assumptions of external wall loss are too low | Assumes higher level of signal internally than is correct | Overestimates indoor coverage results, particularly |

| | | | |
|---|---|---|---|
| | | | for shallow indoor coverage |
| F | "Min var" parameters are clearly unrealistic | Does not reflect real experience of coverage | "Min var" results in particular overestimate indoor coverage |
| G | Extrapolation from 2 sample areas to national equivalent results | Unsound as no area is properly representative of UK | All results are unsound |
| H | Sample areas not representative | Extrapolations skewed by sample area | Depends on sample.<br><br>Based on West London and Cambridge will overestimate indoor coverage |
| I | Failure to check or calibrate against real network results | Inability to recognize that model contains erroneous inputs and seek to correct | In this case, failure to rectify clear overestimates of indoor coverage |

Source: Three

Three discusses the following modelling issues and errors:

- Ofcom's "synthetic" modelling process, using sample areas, predicts extremely unrealistic site numbers for an equivalent national network (combination of Errors A, B, C, H and I);

- Ofcom has failed to follow an industry standard approach to modelling coverage by not using the RSRP[59] measure of signal strength, the key requirement of the 3GPP standard (Error D);

- Ofcom has underestimated the signal loss when penetrating external walls of buildings (Error E); and

- Ofcom's use of two sample areas to draw conclusions at a national level is unsound (Error G).

Each of these issues individually cause Ofcom to overestimate the level of indoor coverage that can be provided using 1800MHz spectrum. The errors, when combined, cause this overestimate to be very material for both shallow and deep indoor coverage.

The other errors identified in the table above also create distortions which overestimate coverage. Further discussion of all errors and impacts is set out in Annex F.

## 3.4. Specific errors in Ofcom's modelling compound and result in unrealistic results.

**Ofcom's "synthetic" model produces site numbers from sample areas which are not credible when compared to real networks.**

As part of the modelling process, Ofcom creates a "synthetic" network model for sample areas that it translates into unrealistic equivalent national site numbers. This was raised by Three in its response to the First Consultation.[60] However, Ofcom has not further explained or substantiated its approach. At a minimum, the presence of unrealistic site numbers casts serious doubts upon the credibility of any results derived from this model.

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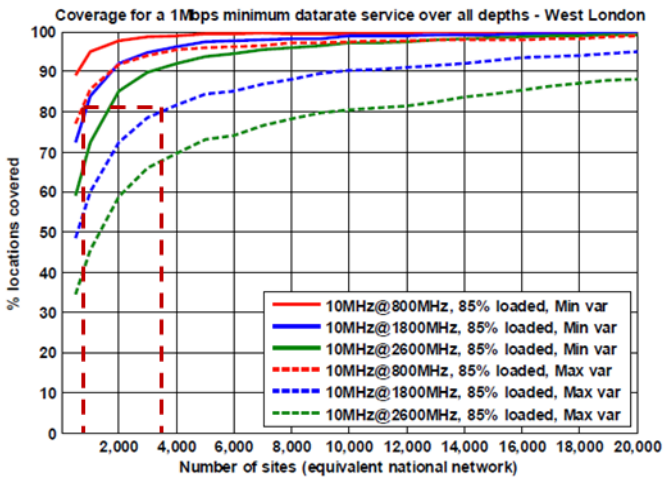
[59] *RSRP is the minimum measure used in 3GPP standards to determine whether a device can connect to a network.*

[60] See in particular Annex 4: Part 1, Section 2.4 "Inconsistencies in Ofcom's estimates of site numbers.

The site number issue is clear from Ofcom's graph below, which compares equivalent national networks with different site numbers with the national indoor population coverage that can be provided using a network of each size. These figures are derived from Ofcom's West London "synthetic" network model.

**Table 3: Ofcom site estimations.**




Source: Ofcom

The model predicts, for example, that it would be possible to provide 80% indoor population coverage using 1800MHz spectrum with under 4000 nationwide network sites. This is entirely unrealistic.

a.

b. Ofcom has failed to follow an industry standard approach to modelling coverage by not using the RSRP[61] measure of signal strength, a key requirement of the 3GPP standard.

Ofcom has not taken into account signal strength in determining whether a mobile device can connect to a mobile network. Yet all 3GPP devices (being nearly 100% of devices) are programmed not to connect unless this 3GPP minimum signal level is available. This failure is likely to have resulted in Ofcom overestimating indoor coverage (by assuming coverage where the minimum signal is not available and devices would not, in practice, connect).

Ofcom's modelling uses signal to interference plus noise ratio (SINR) which, put simply, references the level of interference experienced in a given environment. The 3GPP standard[62] provides that coverage should be calculated using both signal strength (RSRP) and signal to noise ratio (SINR).

Ofcom's approach of only considering SINR is particularly problematic

because, [63] the signal strength value (RSRP) has a greater effect on 1800MHz coverage results than the level of interference (SINR). RSRP is a minimum requirement to determine device connection. Not following this key input of the 3GPP standard has contributed to an overestimation of the indoor coverage of all frequencies and particularly higher frequencies. This approach is out of kilter with good industry practice and is not justified or appropriate in these circumstances.

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[61] *RSRP is the minimum measure used in 3GPP standards to determine whether a device can connect to a network.*
[62] 3GPP (TS36.133).
[63]

**Ofcom has failed to properly account for signal degradation when penetrating the outer wall of buildings when modelling the sample areas.**

Three strongly believes that Ofcom has underestimated the difficulty of penetrating the external wall of buildings and has thus underestimated the difficulty in serving, in particular, shallow indoor locations.

Ofcom's approach to determining indoor signal strength assumes too low a factor for signal loss caused by penetrating the external wall.

Three notes that Ofcom is aware of alternative and more realistic values of signal loss at the external wall. For example, in 2009, Qualcomm conducted modelling on behalf of Ofcom as part of Ofcom's spectrum liberalisation decision and this modelling used significantly higher and more appropriate values for signal losses when penetrating external walls.[64] Ofcom has not explained why it has not adopted similar values in this case.

Ofcom's figures suggest that in-building signal loss becomes the dominant component for building depths only at a depth of 10m or greater. This is not consistent with Three's practical experience in operating a network in the 2.1GHz band, where external wall losses tend to be the dominant effect. Modelling in a real network shows that Ofcom has fundamentally understated the signal loss that takes place at the external wall. This point is crucial for calculating indoor coverage predictions because a higher external wall loss means shallow indoor coverage (1m to 5m) will be much lower than the optimistic predictions made by Ofcom's model.

As a result of this error, Ofcom's building penetration values which it uses to approximate shallow indoor coverage, are substantially understated.

[64] Qualcomm modelling presented in fig 24, pg 58 annex 13, Ofcom further consultation on application of spectrum liberalisation and trading to the mobile sector (2009).

**Ofcom's use of one or two sample areas on which to base conclusions at a national level is unsound.**

Even if Ofcom's indoor coverage results for the two sample areas (Cambridge and West London) were reliable, which they are not, it is unsound for Ofcom to use these results to make conclusions at a national level. Such results can never be as accurate as results derived at a national level, irrespective of the sample area chosen, as described in detail in Annex F.

Any errors in the sample or the algorithm will be magnified when expanded to a national level.

Every area of the UK has its own unique geography, topography, specific clutter characteristics and mast site distributions. Some areas may be more representative of the whole country in terms of network requirements and coverage levels than others. This will in part be due to factors such as population density, topography and clutter type mix being more similar to the national average. However, extrapolating a number of national sites from a specific geographic area is not an accurate reflection of the nationwide site distribution and never will be.

Three submits that it is reasonable to expect that Ofcom would have undertaken a national modelling exercise for a technical analysis that is so central to Ofcom's conclusions. This would not have been a difficult exercise if Ofcom had engaged independent experts or sought real network data from network operators.

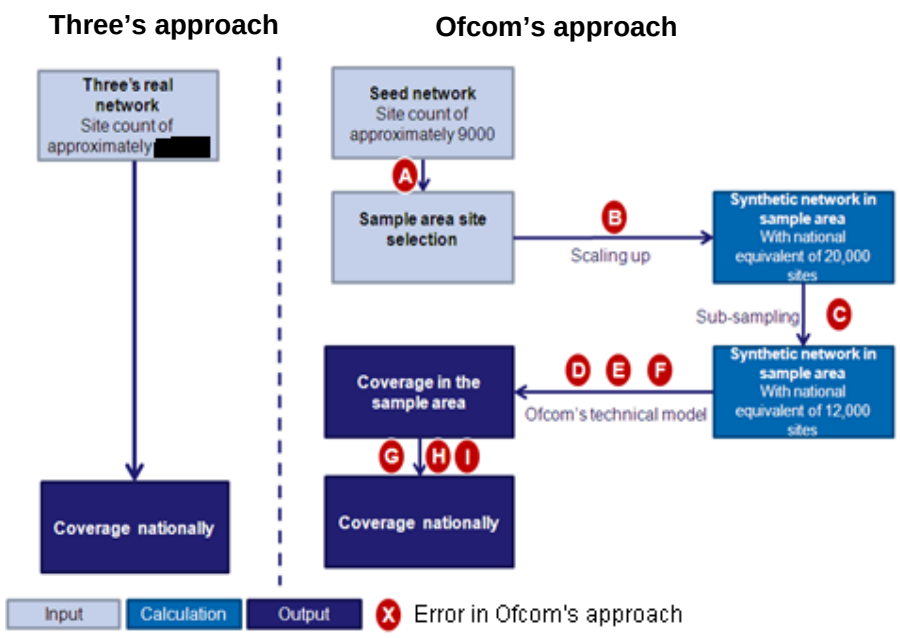
Notwithstanding the general flaw of extrapolating national results from sample areas, Three has concerns about how representative Ofcom's sample areas are. For example, West London has 4 times the population coverage of an average UK geographic area and thus will tend to yield higher population coverage than other areas (see Annex F for further comments regarding the specific sample areas).

## 3.5. Three's technical analysis, based on a real national network, shows that sub-1GHz spectrum provides vastly superior indoor population coverage compared to higher frequency spectrum.

**Introduction to Three's methodology and results.**

Three has carried out its own technical analysis to establish the coverage provided by 800MHz and 1800MHz spectrum across the whole of the UK. This technical analysis is based on modelling Three's actual mobile network to directly generate national network results without extrapolating from small sample areas. This approach eliminates most of the additional stages in Ofcom's approach that can introduce modelling errors.

**Figure 5: Summary of Three's and Ofcom's technical modelling approaches**




Source: Three/Ofcom

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In discussing its results, Three seeks to use similar terminology to Ofcom. In particular, Ofcom recognised that the distinction between easier to serve and harder to serve indoor locations was unlikely to be absolutely dependent on physical depth within a building but rather used the concept of depth as a proxy for distinguishing between relatively easier to serve and relatively harder to serve indoor locations. Three therefore discusses 5m in-building as 'shallow indoor' coverage and 15m in-building represents 'deep indoor' coverage (using Ofcom's definition of 'depth' in both cases).

**UK wide indoor coverage comparison for 800MHz and 1800MHz using Three's 3G network data.**

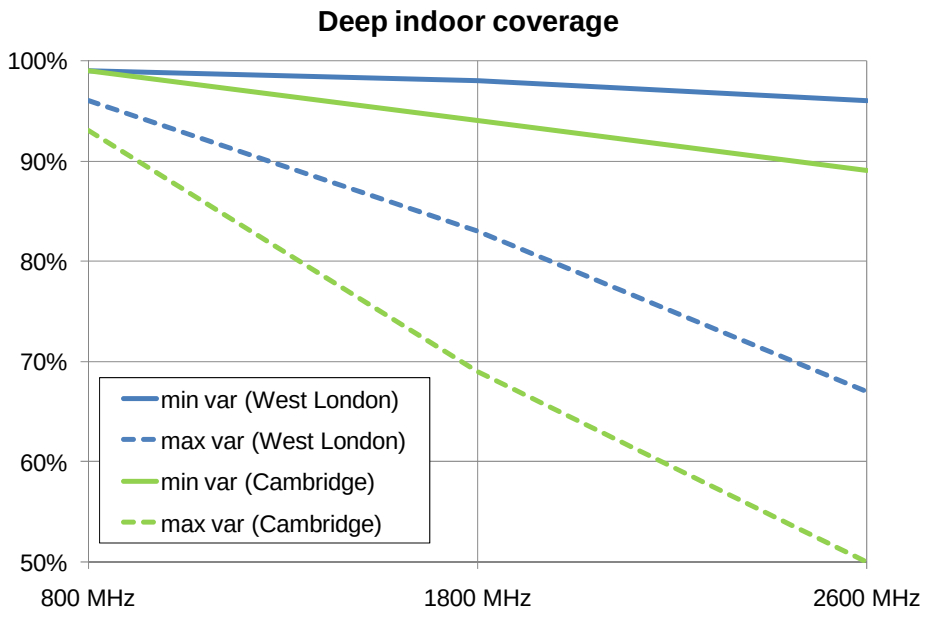
**Summary of Three's technical results when compared to Ofcom's technical results.**

The differences between Ofcom's results and Three's results are very material. Three believes that this difference arises due to the errors in Ofcom's methodology raised in Section 3.2.

Ofcom's results for 800MHz and 1800MHz spectrum are presented as a range (where "min var" gives rise to the lowest predicted difference in coverage between the two bands and "max var" gives rise to the

maximum predicted difference in coverage). The chart below sets out this range.

**Figure 8: Range of Ofcom results.**




Source: Ofcom (Three's plot of Ofcom results)

**Ofcom's "min var" results are not credible.**

Most noticeably, the 'min var' parameter results that Ofcom produces show an extremely low difference between 800MHz and 1800MHz coverage.

Ofcom's "min var" contemplate that 800MHz and 1800MHz spectrum provide virtually identical deep indoor coverage in the West London sample area and very similar deep indoor coverage in Cambridge (see tables below). It also predicts that there is only a 4% difference in indoor

population coverage between 800MHz and 2.6GHz spectrum. This is not credible.

**Ofcom's range of results is unduly broad.**

Ofcom's approach produces an extremely wide range of results, particularly for higher frequencies. For example:

- Ofcom's range contemplates the possibility that 800MHz and 2.6GHz spectrum could provide very similar coverage in deep indoor and hard to serve locations. Yet this is not a possible outcome. It is contrary to a huge body of research. Is contrary to real network experience. It is simply not correct.
- Ofcom's 1800MHz parameters allow for a range of error of 27pp of the UK population.
- Ofcom's 2600MHz parameters allow for a range of error of around 45pp of the UK population.

Basing key policy decisions on such wide-ranging results is not sound.

**Ofcom's overall results materially underestimate the difference in indoor coverage between 800MHz and 1800MHz spectrum.**

.

Table 5: **Ofcom's Results – percentage population covered.**

| Frequency band | Ofcom – West London sample area ('min var') | | Ofcom – West London sample area ('max var') | | Ofcom – Cambridge sample area ('min var') | | Ofcom – Cambridge sample area ('max var') | |
|---|---|---|---|---|---|---|---|---|
| | Shallow indoor (5m) | Deep indoor (15m) | Shallow indoor (5m) | Deep indoor (15m) | Shallow indoor (5m) | Deep indoor (15m) | Shallow indoor (5m) | Deep indoor (15m) |
| **800MHz** | 100% | 100% | 97% | 96% | 100% | 99% | 97% | 94% |
| **1800MHz** | 100% | 99% | 95% | 82% | 97% | 95% | 88% | 69% |
| **Difference** | 0pp | 1pp | 2pp | 14pp | 3pp | 4pp | 9pp | 25pp |

Source: Three

Table 6: **Three results – percentage population covered.**

Source: Three

.

**Figure 9: Comparison of Ofcom's and Three's Results – percentage point population coverage differences**

Source: Three

When the results are converted into a percentage of the UK population who would receive indoor coverage using 800MHz but not using 1800MHz spectrum, it becomes clear that there is a great risk of material technical disadvantage if Ofcom's results are incorrect (as Three submits they are).

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**Table 7: Indoor population coverage 800MHz vs. 1800MHz**.

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### 3.9. Sub-1GHz spectrum can provide unmatchable indoor coverage to deep indoor and hard to reach areas which are very prevalent in the UK.

Three strongly submits that Ofcom should acknowledge that Sub-1GHz spectrum provides a material technical advantage over 1800MHz and other high frequency spectrum.

If Ofcom is in any doubt, then Ofcom should re-do its technical analysis.

As set out in Section 3.8 above, this advantage cannot be bridged through the use of small cells.

*Section 3 Recommendations*

1. Ofcom should conclude that:

    a. there is a high prevalence of deep indoor and hard to serve locations; and

    b. sub-1GHz spectrum provides material technical advantages in providing coverage to such deep indoor and hard to serve locations which cannot be matched or materially mitigated through the use of small cells or other solutions.

2. If Ofcom is in any doubt regarding the above, it should correct the flaws in its technical modelling and conduct a fresh technical analysis.

# 4. Sub-1GHz spectrum is essential in order to be a credible national wholesaler.

*Section 4 explains that the technical advantage of sub-1GHz spectrum will have a material impact on competition, such that a national wholesaler will not be credible after the Auction without sub-1GHz spectrum. In conclusion:*

i. *Ofcom has presented little evidence for its conclusion that a fourth national wholesaler can be credible without sub-1GHz spectrum;*

ii. *Ofcom should assess the risk that a fourth wholesaler without sub-1GHz spectrum will be unable to constrain prices after the Auction;*

iii. *Experience in fixed communications demonstrates that quality differences will be increasingly important to consumers of mobile data services in the UK;*

iv. *UK mobile users increasingly demand reliable, deep indoor data coverage at high speeds – coverage and speeds are critical to provide the services that consumers will expect in the future;*

v. *Sub-1GHz spectrum will be essential to be credible after the Auction – without it a fourth national wholesaler will face key disadvantages and may be forced to exit the market or become a marginal player to the considerable detriment of consumers and competition; and*

vi. *The material advantages of sub-1GHz spectrum are well established in statements from operators (such as Vodafone), academic and industry experts (including Ofcom's own auction adviser) and national telecoms regulators.*

*For all these reasons, Ofcom should have found that the fourth national wholesaler would not be "credible" without sub-1GHz spectrum under either its First Consultation or its Second Consultation Test.*

*If Ofcom remains unsure – and its discussion indicates considerable uncertainty on its part – then the safest solution is to guarantee sub-1GHz spectrum to the fourth operator.*

### 4.1. Ofcom has presented little evidence for its conclusion that a fourth national wholesaler can be credible without sub-1GHz spectrum.

Ofcom is right to find that the distribution of spectrum after the Auction will shape the future competitiveness of the mobile sector for at least the next decade. Ofcom must therefore consider the impact of its Auction design on the future market(s).[65] In any event the Government Direction also requires Ofcom to assess the likely future competitiveness of markets for the provision of mobile electronic communications services after the conclusion of the Auction.

Accordingly, in the Second Consultation Ofcom correctly undertakes to carry out :

> "*an assessment of the likely future competitiveness of markets for the provision of mobile electronic communications services, after the conclusion of the auction. It is therefore a forward looking assessment, based on our analysis as to the likely future competitiveness of mobile markets in light of the evidence currently available to us and our judgement as the regulator".*[66]

Ofcom's key conclusion in the Second Consultation is that an operator can be "credible" in future without sub-1GHz spectrum. But the conclusion is not based on any real assessment of competition in future mobile markets after the Auction. Instead, Ofcom arrives at its key conclusion as follows:

- first, Ofcom redefines its "credible" operator as one which must be credible across a "large" proportion of the overall "market" (see Section 2).[67] It distinguishes between the "credibility" of a national wholesaler (a "main concern") and the competitive disadvantage it may experience in competing for particular services or customer segments (a

[65] Consultation, para 4.4.
[66] Consultation, annex 6, para 1.3.
[67] Consultation, paras 4.72, Annex 6 paras 3.21-3.22.

"lesser concern).[68] This is because the former concern may affect more consumers and there is the "possibility" that there could be chains of substitution between segments of the market;[69] and

- second, Ofcom identifies the quality dimensions needed to be "credible" according to its new definition, which do not include the holding of sub-1GHz spectrum. Permitting a situation where some operators are unable to provide good quality coverage is now a "lesser" concern, and Ofcom is "less certain" that the locations which can only be served realistically with sub-1GHz spectrum (and not with Wi-Fi and femtocells) are likely to be "sufficiently" important in the overall market".[70]

In the final analysis, Ofcom's key conclusion is supported by a bare definition (the "credible" wholesaler) and a factual conclusion which Ofcom admits is uncertain. Ofcom admits that it has "*no specific evidence on the prevalence or importance to consumers of locations that are particularly deep indoors or difficult to serve*" .[71]

As a matter of law, the more significant the issue the greater the requirement for proper evidential support for Ofcom's conclusions. Ofcom's conclusions on this issue rest on a plainly insufficient evidential base. As Section 3 explains, deep indoor locations are very prevalent and an operator without sub-1GHz spectrum would not be able to provide "sufficient" quality of service in "most" indoor locations. In addition, Three does not understand why Ofcom now accepts potential outcomes which plainly conflict with its duty to promote competition to the benefit of consumers (see Section 2):

- Ofcom acknowledges that a separate market may arise for a high quality data service associated with reliable indoor coverage.[72] It follows that an operator without sub-1GHz

[68] Consultation, para 4.45.
[69] Consultation, para 4.44.
[70] Consultation, para. 4.104
[71] Consulattion, Annex 6, para 3.137.
[72] Consultation, Annex 6, para 2.29.

spectrum may not be able to constrain prices in that market, giving rise to significant consumer detriment;

- even if separate markets do not develop, Ofcom admits that its "lesser concern" may give rise to material consumer harm.[73] Specifically, Ofcom concludes that the weaker competition that would result if one or more operators do not have sub-1GHz spectrum is a "lesser" concern than not having four "credible" operators overall. But "lesser" does not in this context mean "small". As Ofcom notes, material consumer detriment may arise from lack of choice and innovation and even small reductions in competitive intensity can give rise to a very significant consumer detriment, in view of the large size of the market.[74]

In summary, Ofcom does not have sufficient evidence to conclude that a national wholesaler can be credible without sub-1GHz spectrum after the Auction. Ofcom should assess the strength of the competitive constraint that an operator without sub-1GHz spectrum would impose:

- in some or all of the possible future markets for "higher quality services" (under the First Consultation Test); or, at least

- if Ofcom does not accept the need to revert to the First Consultation Test, for a "large proportion" of customer segments and services in the "market" (under its Second Consultation Test), but taking account of the points noted above about the size and importance of the segments or markets that would not be addressed.

If, following its analysis, the evidence is inconclusive, Ofcom should adopt a precautionary approach in light of its statutory duties, and attach a greater weight to the risk of significant consumer detriment arising if fewer than four operators are able to constrain prices in future (see Section 2).

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[73] Consultation, Annex 6, para. 2.20-2.31, Figure 5.16.
[74] Consultation, Annex 6, para 2.30-2.31, 2.69.

### 4.2. Ofcom should assess the risk that a fourth national wholesaler without sub-1GHz will be unable to constrain prices after the Auction.

Section 3 established that sub-1GHz spectrum provides a large technical advantage to its holders. The next step is to assess whether that advantage translates into a competitive advantage as well – i.e. whether UK mobile users will be sensitive to quality differences arising from sub-1GHz holdings after the Auction.

For the purpose of that assessment, Three agrees with Ofcom that it is not necessary to formally define markets.[75] What matters is whether operators without sub-1GHz will be able to constrain mobile prices in future. In Three's view, the forward-looking competition assessment should:[76]

- take current market definitions as a starting point;[77] and
- assess the risk that concentration of sub-1GHz spectrum could tip the market after the Auction, leading to a

[75] In particular, we agree that market definition is only a means to an end. With differentiated services, there are no rigid boundaries between services "inside" and "outside" the market. Market boundaries also shift over time when consumer preferences are changing quickly. Where evidence of substitutability is inconclusive, regulators tend to define markets conservatively (i.e. avoiding narrow definitions) and then analyse competitive constraints directly (e.g. in the subsequent assessment of the competitive effect of a merger).
Consultation, Annex 6, para 2.27 and footnote 14.

[76] This is consistent with the approach taken by Ofcom in its First Consultation, when it thought likely that data services would continue to grow in importance and went on to assess whether that could lead to separate markets developing in ways which would be detrimental to consumers. Consultation, Annex 10, para A10.6. It al also consistent with the European Commission's a approach in its decision on the T-Mobile/Orange merger, where it considered that concentration of 1800MHz spectrum in the hands of Everything Everywhere could result in a future bifurcation of the market to EE's advantage. Paras 120-121.
http://ec.europa.eu/competition/mergers/cases/decisions/M5650_20100301_20212_247214_EN.pdf

[77] Both Ofcom and the European Commission have defined a single retail market for mobile voice, text and data services provided over 2G and 3G, and also a single market for wholesale access and call origination services sold to resellers and MVNOs. Both regulators have found that differences between customer types and 2G/3G technology are not large enough to constitute separate markets.

bifurcation between operators able to provide reliable deep indoor coverage at fast data rates and operators only able to provide a much inferior service.

Three explains in the rest of this section why users are likely to be sensitive to quality differences between operators after the auction, such that sub-1GHz will confer a significant competitive advantage to its holders.

### 4.3. Experience in fixed communications demonstrates that quality differences will be increasingly important to consumers of mobile data services in the UK.

This sub-section summarises recent experience in fixed communications for guidance on how sensitive mobile consumers are likely to be to quality differences between mobile operators in an increasingly data-centric mobile market. The evidence is presented in Annex E, from which the following conclusions may be drawn:

- UK consumers have shown a very strong preference for higher quality data services. They have responded quickly and in large numbers to perceived differences in quality, for instance by migrating from dial-up internet connections to ADSL broadband and, more recently, super-fast broadband;

- as the quality gap widens, consumers increasingly begin to differentiate and eventually a 'tipping point' may occur when separate markets come to exist;

- download speeds are a key quality dimension of competition, because consumers increasingly demand services which require higher speeds to work effectively;

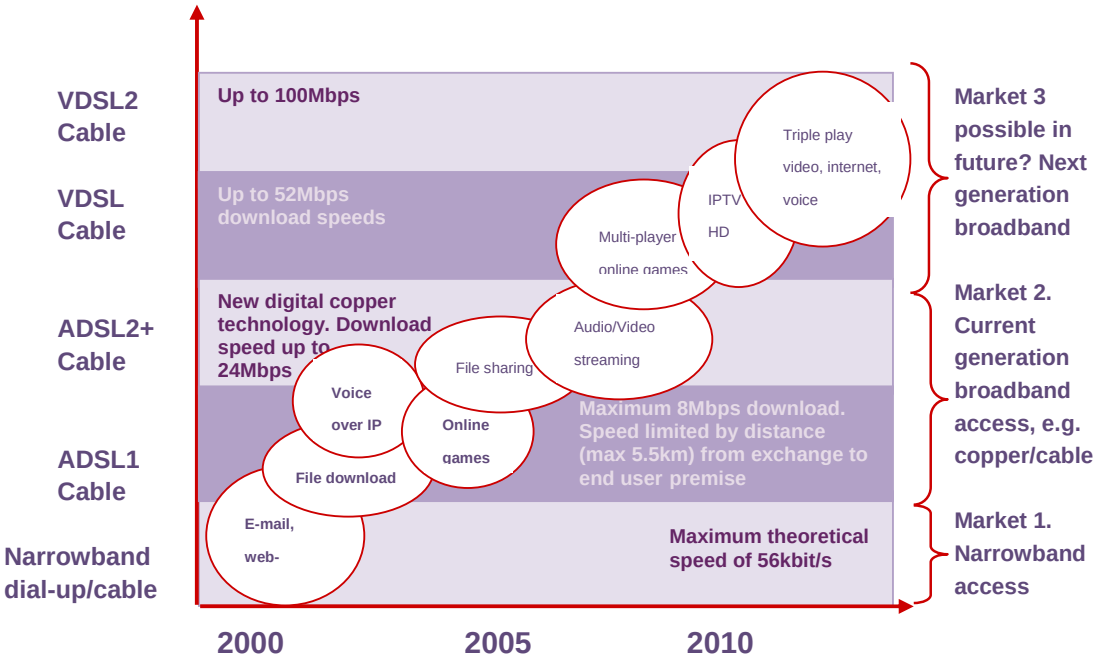
- UK users consume more high-bandwidth services like HD TV streaming as soon as better networks allow them to do so; and

- consumer expectations can rise very quickly when better services appear on the market – as evidenced by the decline in dial-up connections, the continuous increase in

average download speeds and the rapid take-up of broadband and now super-fast broadband.

As a result of increased consumer expectations and technological innovation, in the past decade the retail fixed-line internet access market has bifurcated into separate sub-markets differentiated by quality, and may become even more fragmented in future (Figure 14).

**Figure 14: Market split in the UK residential fixed broadband access market, 2000-2010.**




Source: Three, adapted from Ofcom's Wholesale Broadband Access Market Review [78]

[78] Review of the Wholesale Broadband Access Markets Consultation (23 March 2010), Figure 3.2.

## 4.4. UK mobile users increasingly demand reliable, deep indoor data coverage at high speeds - coverage and speeds are critical to provide services that consumers will expect in the future.

Consistent with the insight drawn from the fixed sector, this section shows that mobile users will increasingly demand high quality data services – in particular reliable, deep indoor data coverage at high data rates.

This section explains that:

- mobile services are in transition from a voice-centric model to a data-centric one; and
- good quality data coverage at high speeds is critical in a data centric-world.

### 4.4.1. Mobile services are in transition from a voice-centric model to a data-centric one.

The retail mobile market is at an earlier stage of development than the fixed internet access market. The market is evolving from the provision of mobile voice (with data as an add-on service) to a data-centric model.

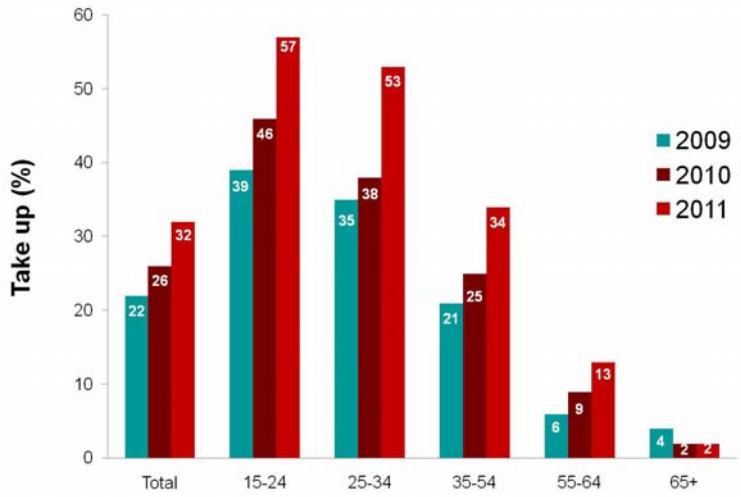
Any assessment of future competition in mobile markets must recognise what Ofcom calls the "*transformative effect of the internet on consumer behaviour*".[79] In a short space of time, handsets have become integrated voice and data devices that support social networking, video streaming and many other applications.

This is having a fundamental impact on consumer behaviour. According to Ofcom's Comms Market Report 2011, over half of UK adults under the age of 35 already use the internet on their mobile phones. Internet use on

[79] Comms Market Report 2011,p. 193.

mobiles is growing rapidly across all age groups (except 65+), as shown in Figure 15.[80]

**Figure 15: Use of internet on mobile phones, by demographic.**




Source: Ofcom's Comms Market Report 2011, Figure 4.5

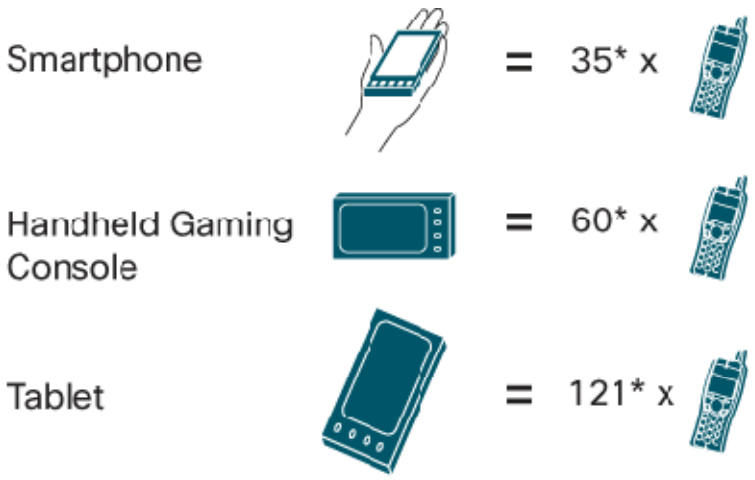
Data volumes transferred over the UK's mobile networks increased by 67% in 2010 and forty-fold between 2007 and 2010.[81] This explosion in the demand for data has been driven by three main factors:

- Widespread adoption of smartphones, tablets and other internet-capable mobile devices, which generate much larger data traffic than 2G handsets (Figure 16);
- Customer migration from PAYG to pay monthly contracts, together with inclusion of data on monthly bundles; and
- Popularity of mobile applications, including social networking, mobile web browsing, e-mail and instant

[80] Ibid, Figure 4.5.
[81] http://consumers.ofcom.org.uk/2011/08/a-nation-addicted-to-smartphones/

messaging, games, location-based services, VoIP, music and video streaming.

**Figure 16: Smart-phones, tablets and consoles generate much more data traffic than standard feature phones.**




Source: CiscoVisual Networking Index: Global Mobile Data Traffic Forecast Update, 2011–2016

The new, data-centric mobile market has brought with it smartphones and mobile broadband accessed via dongles. Ofcom's Comms Markets Report 2011 discusses the following trends: [82]

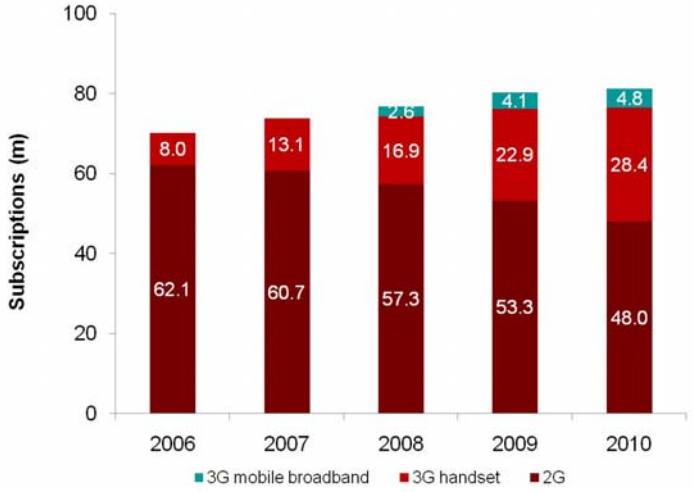
- **smartphones** – connections have exploded since 2009 and amount to 28.4 million at the end of 2010. Smart-phone sales nearly tripled between Q1 2009 and Q1 2011, and 38% of mobile owners now claim to own one;

- **mobile broadband** – uptake of dongles and data-cards has also increased, reaching 4.8 million connections in 2010, although the rate of growth slowed in 2010; and

[82] Ibid, page 49.

- **2G connections** are in sharp decline but still accounted for the majority of subscriptions in 2010 (48 million). The "average UK consumer" of mobile services is still predominantly a user of voice and text (Figure 17).

**Figure 17: UK mobile subscriptions by technology**




Source: Ofcom Comms Markets Report 2011

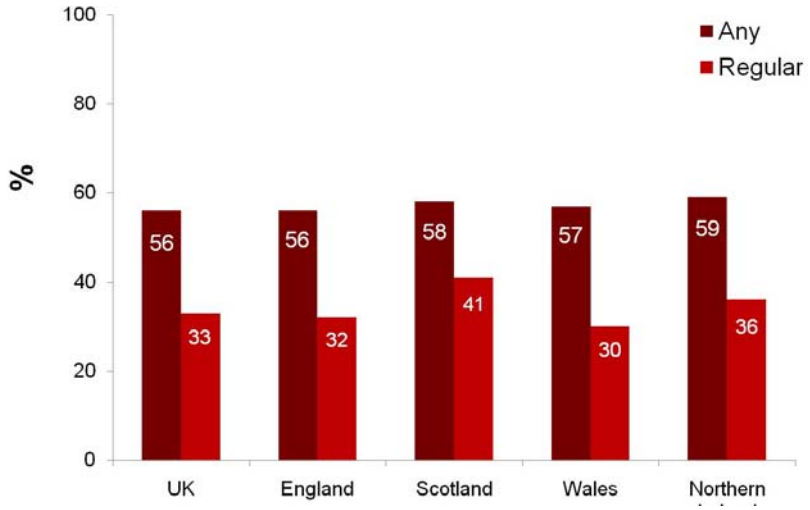
#### 4.4.2. Good quality data coverage at high speeds is critical in a data-centric world.

Network coverage is very important for consumers of traditional mobile voice and text services. Coverage has typically ranked first (or joint first, together with price or customer service) in most customer surveys analysing the main factors leading to choice of provider. Annex D summarises the results of those surveys.

For instance, Ofcom's advisory body, the Communications Consumer Panel, concluded that coverage "*is the most important factor when choosing a provider, more important than cost, quality of customer*

*service or the type of handset available*". [83] It found that 56% of UK adults with a mobile phone had experienced problems with coverage, and a third had experienced problems regularly, as shown in Figure 18.

**Figure 18: Proportion of UK adults with a mobile phone experiencing coverage problems.**




Source: The Communications Consumer Panel. Mobile Coverage: the Consumer Perspective. Research Report October 2009.

In the new data world, coverage is not just important, it is critical. UK mobile users increasingly demand reliable in-building data coverage at high rates, as well as voice coverage. This sub-section explains that:

- mobile use now occurs mostly indoors;

[83] Mobile Coverage: the Consumer Perspective. Research Report October 2009. http://www.communicationsconsumerpanel.org.uk/Mobile_coverage_consumer_perspective.pdf

- customer surveys show that indoor data coverage at high data rates is quickly becoming a key dimension of competition, alongside voice coverage; and

- future services will require reliable in-building coverage at high data rates.

*Mobile use occurs mostly indoors.*

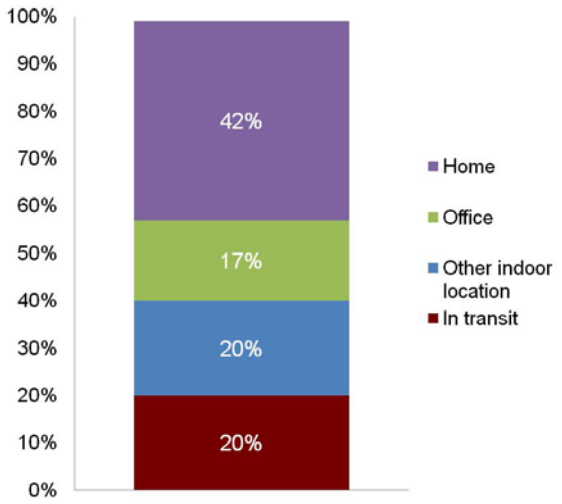
Most mobile use now occurs indoors, for both voice and data.
For voice, estimates from NEC, Analysys Mason and other sources show that around 60% of mobile calls happen indoors.[84] Those estimates are consistent with figures by Strategy Analytics, Swisscom and JD Power.[85]

In relation to data, users also normally access the mobile internet indoors. Smartphone and mobile broadband users typically sit at home, in the office, on the train, at a restaurant, hotel, or other public places to access the mobile internet.

[84] Application of Spectrum Liberalisation and Trading to the Mobile Sector- A Further Consultation, Annex 11, para A11.32.

[85] http://stakeholders.ofcom.org.uk/binaries/consultations/msa08/annexes/msaanalysys.pdf para 56. http://www.jdpower.com/content/press-release/p5rCap4/2012-u-s-wireless-network-quality-performance-study-volume-1.htm

**Figure 19: Location of mobile data use (% of time spent on activity)**




Source: Cisco IBSG Connected Life Market Watch, 2011

Current estimates indicate that between 60% and 86% of mobile data use occurs indoors. Analysys Mason estimates that indoor data use will grow to 90% by 2015:

- Cisco's most recent estimate is that that 80% of the time people connect to the mobile internet from their home, office, or other indoor location, as shown in Figure 19;[86]

- Analysys Mason estimates that the proportion of wireless network traffic generated indoors in Western Europe will increase from 86% in 2011 to 89% in 2016;[87]

- Informa's Mobile Access at Home Report indicates that 81% of mobile data use occurs indoors, at home or in the office;

[86] http://www.cisco.com/web/about/ac79/docs/sp/New-Chapter-for-Mobile.pdf
[87] Wireless Network Traffic Worldwide: forecasts and analysis 2011-2016.

- Ofcom quotes its research for the UHF Strategy Consultation, which showed that only 14% of respondents reported usage exclusively or mainly outside of the home. 59% of users use the mobile internet mostly or exclusively in the home, while 28% use it equally at home and outside.[88]

With most use taking place indoors, path losses, foliage, concrete or brick walls, glass and metal structures make it more difficult to deliver a high quality service, particularly if 1800MHz or higher frequency spectrum is used. This results in weak spots with no signal or only patchy coverage inside office buildings, homes and other indoor locations.

*Customer surveys show that indoor coverage at high data rates is quickly becoming a key parameter of competition.*

Network quality is more important for data services than it is for voice. As discussed above, in fixed broadband download speeds are a key parameter of competition. Due to their mobile nature, in mobile data services "quality" now means both coverage and speed.

Future data growth will come from entertainment applications such as online gaming, video on demand and music streaming. Mobile consumers increasingly demand services that require higher speeds and good indoor coverage. Demand for those services is now suppressed due to the limitations of current networks.

The trend in consumer demand is for widely available, always-connected mobile coverage. To retain and attract subscribers, operators are looking to provide reliable, deep indoor voice coverage and data coverage at rates that approach those of current fixed internet connections.

Consumer expectations are increasing quickly, because of the virtuous circle of network upgrades leading to better devices (e.g. iPhone, iPad), services (e.g. catch up TV, social networking) and applications that raise consumer expectations and which, in turn, require further improvements in network capability.

[88] Consultation, Annex 6, 3.122.

Recent customer surveys highlight the importance of network quality in the new, data-centric market, as shown in Annex D. In summary, "*over the years, the debate around networks has shifted from which operator has the widest network population coverage to which has the best network depth and quality*".[89] Network quality is important for both smartphone and mobile broadband users.

- **smartphone users** – the 2011 Nokia Siemens Networks Annual Acquisition and Retention Study concludes the following:

  *"Network coverage and voice quality were rated as the most important criteria in 2010, and continue to be among the top criteria to retain customers in 2011. However, customers who are classified as heavy users of advanced services [i.e. who use services like sending/receiving e-mails, browsing the web, or download data files once a week] now rank mobile broadband quality alongside voice quality and network coverage in determining to leave or stay with their mobile operator….*

  *The study further reveals that given the rise in smartphone subscriber numbers, heavy users of advanced services will become the most prevalent subscribers in the future. The number of users in this segment increased dramatically by 34% in mature markets in 2011, and more than half of them are below 35 years. According to the study, about 60% of these users expect excellent network quality even if it costs a little more."*[90]

- **mobile broadband** – as Ofcom notes, a YouGov Study has recently emphasised the importance of network quality:

[89] http://ovum.com/2011/11/29/operators-shouldnt-underestimate-the-value-of-their-networks/

[90] Nokia Siemens Networks 2011 "Annual Acquisition and Retention Study", Press Release. Mobile World Congress Barcelona February 13, 2012.

> *"consumer satisfaction for mobile broadband services is strongly linked with network quality. Surveys conducted by YouGov showed customer satisfaction was closely correlated to network dependent attributes such as coverage, speed and reliability of connections. It also found that issues concerning connectivity and speed were among the most common reasons for consumers wanting to switch provider. There is evidence that consumers value network quality above other factors such as value for money and customer services".*[91]

*Future services will demand good in-building coverage at high data rates.*

The transition from a voice-centric model to a data-centric world is only the beginning of a more fundamental set of changes that will unfold in the next decade, with the combination of the processing power of the 'cloud' and the rise of Machine-to-Machine ('M2M') applications.

These improvements will affect the daily lives of millions of consumers in the UK and elsewhere. It is impossible to predict which services will be developed even further or be more popular with consumers in future. But it is clear that an operator with insufficient spectrum of the right kind will not be in a good position to compete in the changing mobile market, to the detriment of consumers.

Mobile operators plan to respond to the ever-increasing demand for greater speeds by deploying LTE. LTE is based on TCP/IP, the core protocol of the internet. It aims to deliver a user experience that more closely resembles that available on fixed networks. LTE networks will behave more like land-line-based IP networks, which represents a paradigm shift in the transition to a data-centric model.

[91] First Consultation, Annex 6, para 4.47.

LTE is a transitional technology. In the short to medium term at least, LTE is expected to deliver a similar performance to HSPA+. Evolutions such as LTE Advanced, which the ITU has recently designated as "true" 4G, will in due course deliver even higher quality services for both residential and business users.

**Residential consumers** will be able to stream, download and share high quality HD and SD video, music and rich multimedia content much more quickly and with fewer "glitches". Mobile video is expected to become common place, as on-demand TV and catch-up TV (e.g. the BBC's iPlayer) are increasingly popular. Cisco estimates that video will represent over 70% of global mobile data traffic by 2016.[92] This is consistent with the experience in the UK fixed broadband market where, as explained in Annex E, use of HD and SD TV streaming and large file downloads are growing more than any other service with the take-up of superfast-broadband.

Users will also enjoy more responsive, real-time services like online gaming. VoIP performance will be greatly enhanced with higher quality sound. Other popular services, including web browsing and uploading content to social networking sites, will take less time to complete. Mobile commerce is also expected to be popular, as users are able to make quick digital (i.e. online) and physical payments with electronic versions of their payment cards.

In addition to the above, **business users** will receive additional benefits in the form of high speed file transfers, high quality real time video-conferencing and tele-presence, including remote working with near-instant access to corporate files.

Table 8 compares some existing services with those that will be possible in future.

[92] Source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011–2016

**Table 8: Higher quality mobile services of tomorrow**

| Service | Today | Tomorrow |
|---|---|---|
| TV/ video on demand | Video streams/downloads, on-demand TV (e.g. iPlayer) | High quality on-demand TV, HD streaming of TV programmes and full-length films |
| Music | Full track downloads | High quality music downloading and storage |
| Rich voice | Real-time audio | High quality VoIP and video conferencing |
| Browsing | Online information | Super-fast browsing |
| Downloads | File downloads | Fast downloading of large files |
| Games | Downloadable and online games | High quality, real-time multi-player online games |
| Messaging | SMS, MMS, e-mail | Photo messages, video messaging |
| M-commerce | Online payments | Mobile handsets as payment devices embedded with NFC, for fast online and physical payments at retailers |
| Mobile data networking | Access to corporate intranets and databases, as well as the use of applications such as CRM | P2P file transfer, business applications, application sharing, M2M communication, mobile intranet/extranet |

Source: Three, adapted from Analysys Mason

Importantly, new services are also expected to emerge in the next decade that will make the mobile device more central to the life of the average consumer. These services require a high standard of quality and, in particular, reliable in-building coverage.

- **Cloud computing** will allow remote devices to transmit to, and receive, data from vast networks with large storage capacity. The “cloud” will allow users to access data, e-mail, video and other applications in their desktops (at home or in the office) via their mobile devices. Processing power will be transferred from mobile devices to the cloud; and

- **M2M** applications have been the "hot topic" in the recent Mobile World Congress in Barcelona.[93] M2M connects remote machines and devices, allowing information to be exchanged between them. An asset (car, domestic appliance, copier, printer, medical device, etc) can be fitted with a SIM card to allow users to monitor its performance remotely.

Analysys Mason estimates that the UK M2M business market will grow to nearly £300m in 2016,[94] as mobile operators certify devices used in a wide variety of industries from consumer electronics to automation (e.g. in-car diagnostics), manufacturing (e.g. inventory monitoring), healthcare and life sciences (e.g. remote monitoring and telemedicine), utilities (e.g. smart metering), transport (e.g. fleet tracking), industrial uses (e.g. remote equipment monitoring) or security and public safety.

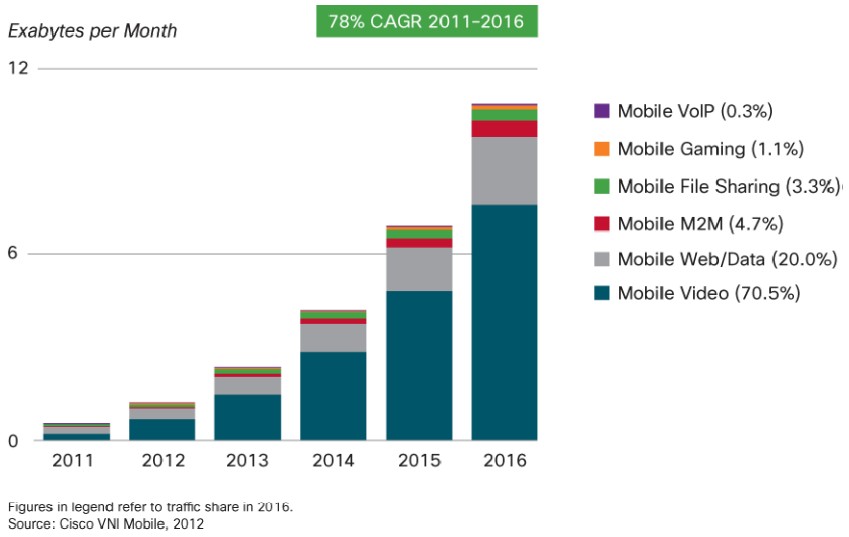
M2M consumer electronics is expected to be hugely popular with consumers in the next 5 to 10 years. Millions of household appliances will have embedded mobile connectivity, allowing users to monitor, adjust and configure them in real time via their mobile devices. For instance, consumers will be able to turn on a house appliance, monitor a CCTV camera or adjust the room temperature via their smartphone, tablet or other mobile device. In the words of Vodafone:

> "*The consumer M2M market is poised for significant growth… M2M is set to become an indispensable component of consumers' personal lifestyles with all kinds of new devices that are designed to make life simpler and more connected*."[95]

Cisco estimates that mobile M2M will be the third largest generator of global mobile data traffic by 2016, after mobile video and web/data, as shown in Figure 20.

[93] http://blog.m2mapps.com/
[94] http://www.beechamresearch.com/article.aspx?id=4
[95] http://m2m.vodafone.com/images/2011/videos/m2m_city/pdf/consumer.pdf

**Figure 20: Mobile M2M will be the 3rd largest mobile data traffic generator by 2016**




Source: Source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update

## 4.5. Sub-1GHz spectrum will be essential to be credible after the Auction.

Against the background described above, this Section explains that an operator without sub-1GHz spectrum will fail Ofcom's First Consultation Test, and it is likely that it will also fail the Second Consultation Test.

### 4.5.1. A fourth operator without sub-1GHz spectrum will face key disadvantages after the Auction.

Of all European operators that bought a new entrant 3G licence at the start of the 2000s, only three remain in the market: the 3 Group (in Austria, Denmark, Ireland, Italy, Sweden and UK), Yoigo (owned by the Swedish incumbent, TeliaSonera) in Spain and Network Norway. All other entrants either:

- became insolvent and closed their operations;
- sold their businesses to existing incumbent operators; or
- did not launch services and have returned their licences.

These failures highlight the difficulties that a fourth operator (Three or a new entrant) faces when trying to compete against the incumbents. As a new 3G entrant in a voice-centric world, Three has faced the same disadvantages as those failed operators in the provision of voice services:

- **lack of scale** – a new entrant needs to reach a minimum scale to recover its fixed costs – predominantly the cost of deploying and running the network. Network deployment in a higher frequency band significantly increases the number of cell sites needed to cover rural, urban and suburban areas, which translates directly into a cost disadvantage relative to rivals of similar scale.
- **barriers to growth** – a fourth operator finds it very difficult to reach scale. In a mature mobile market, the operator can only grow by taking customers from the incumbents. Three has had to overcome customer inertia and barriers to switching in the UK market (e.g. the number porting system), high termination rates and difficulty in getting roaming agreements from rivals; and

Following liberalisation of the 900MHz spectrum, a fourth operator without sub-1GHz spectrum will face even higher barriers in the data world.

#### 4.5.2. Competition for smartphone subscribers will be critical in future.

This part of the response shows that those demanding high quality data services are likely to form a very substantial proportion of all customers in the future. As such, a national wholesaler will need to be able to serve the segment effectively or else it is unlikely to be credible in the mobile market(s) as a whole.

Those subscribers are sensitive to quality differences. As the 2011 Nokia Siemens Networks Annual Acquisition and Retention Study notes:

> *"The study further reveals that given the rise in smartphone subscriber numbers, heavy users of advanced services will become the most prevalent subscribers in the future. The number of users in this segment increased dramatically by 34% in mature markets in 2011, and more than half of them are below 35 years. According to the study, about 60% of these users expect excellent network quality even if it costs a little more."* [96]

#### 4.5.3. There is a clear risk that operators without sub-1GHz spectrum will be unable to constrain mobile prices across the market as a whole (Ofcom's Second Consultation Test).

An operator without sub-1GHz is likely to be unable to constrain mobile prices across a large proportion of the market after the Auction, because its service will not be attractive to the majority of smartphone users, particularly when compared against the service that Vodafone and O2 will be able to provide.

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[96] Nokia Siemens Networks 2011 "Annual Acquisition and Retention Study", Press Release. Mobile World Congress Barcelona February 13, 2012

As Ofcom has noted, following liberalisation, Vodafone and O2 will be able to re-farm at least 2x10MHz of 900MHz spectrum by 2016.

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At that point O2 and Vodafone will be able to provide vastly superior indoor coverage (including in harder to reach locations) with their existing holdings, compared to holders of 1800MHz or higher frequency spectrum. In particular, the current duopoly of sub-1GHz spectrum will provide higher data rate services (e.g. fast mobile web browsing, gaming and music downloads), with good coverage indoors in urban and suburban areas. They will also be able to extend services into rural areas at a lower cost.

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The risk of bifurcation is clear because, as explained in this Section, deep indoor voice coverage and data coverage at fast speeds is now a key dimension of competition. UK smartphone (and mobile broadband) users demand reliable in-building voice coverage and data coverage at high rates to enjoy catch-up TV, fast web browsing or music streaming. There is also a clear risk that future services requiring good quality coverage (such as M2M or other services not currently foreseen) may become key sources of revenue for operators.

More generally, the evidence presented in this section demonstrates that consumer expectations are likely to rise very quickly when better services appear on the market. Data users in the UK have shown a very strong preference for higher quality data services, and their demand for higher bandwidth services consumed indoors is bound to increase as LTE networks are deployed (as shown by the changes in internet use by superfast broadband subscribers in Annex E).

UK users are likely to respond quickly and in large numbers to material quality differences between operators, as evidenced by:

- the large scale migration from dial-up internet connections, rapid take- up of super-fast broadband and consumers'

ever-increasing demand for higher speeds (in fixed internet access); and

- the sharp decline of 2G connections and corresponding explosion of smartphone sales (in mobile).

#### 4.5.4. Operators without sub-1GHz spectrum will be unable to constrain prices in future higher quality data markets (Ofcom's First Consultation Test).

As explained in Section 2, Three's view is that Ofcom should focus on the risk that an operator cannot compete in separate higher quality markets which may naturally arise in the future, as it did with its First Consultation Test. An operator without sub-1GHz spectrum will not be "credible" according to that test, because it will be unable to constrain prices in future higher quality markets.

## 4.6. The material advantages of sub-1GHz spectrum are well established in statements from operators (such as Vodafone), academic and industry experts (including Ofcom's own auction adviser) and national telecoms regulators.

There is a large body of evidence on the advantages of sub-1GHz spectrum, from national regulators (including a recent report by Ofcom itself), operators (such as Vodafone), academics and other parties. The evidence is too extensive to be presented here – a selection of it is presented in Annex C.

In summary, it is well established that sub-1GHz spectrum provides better in-building penetration and speeds and superior coverage per base station (thereby lowering the cost of deployment in rural areas). The general consensus has been summarised in a recent report by Plum:

> *"[t]here appears to be a strong view within the global mobile industry that sub-1GHz spectrum carries a value premium to reflect the flexibility that it provides with regard to rural coverage and in-building penetration".* [97]

This has led most European regulators to take measures to ensure a more even distribution of that spectrum. The dangers of concentration of sub-1GHz spectrum in the hands of a few operators have been highlighted by several regulators, and have been aptly summarised by Professor Cramton in the US context. We understand that Professor Cramton is Ofcom's auction adviser:

> *"The auction of 700MHz spectrum is a critical event for the future of wireless services in America. The 700MHz auction is the last big auction on the horizon and is the only auction ever of large blocks of prized low-frequency spectrum.*
>
> *This low-frequency spectrum is scarce and allows much better propagation than the less scarce higher-frequency spectrum. It enables better coverage at lower cost, especially outside metropolitan areas. These superior physical properties translate into economic considerations — this spectrum will play a crucial role in shaping the industry and its products and prices for decades to come.*
>
> *[…] Action now by the FCC and/or the Antitrust Division can break the current spectrum gridlock and begin a new phase of rapid innovation in the wireless industry as well as increased competition in the wireless, broadband, and video industries. The essential ingredient is sustaining market conditions favorable to new entry and intensified competition, which can most easily occur through ensuring that multiple national competitors have access to nationwide low frequency spectrum.*

[97] Plum consulting: Valuation of public mobile spectrum at 825-845 MHz and 870-890 MHz, A report for the Department of Broadband Communications and the Digital Economy, 15 September 2011

> *Our fear, which is grounded in both economic theory and empirical analysis, is that this pattern of [low-frequency spectrum] consolidation will lead to higher prices, poorer service, and reduced innovation. The 700 MHz auction is the last chance for many years to sustain competitive pressure in the wireless industry. The next phase could be a continuing struggle to rein in the predictable excesses of an entrenched oligopoly."* [98]

Accordingly, the general consensus does not sit well with Ofcom's conclusion that the advantages of sub-1GHz spectrum are "less clear". In support of that conclusion Ofcom:

- cites an interview with Hutchison Whampoa's Group Managing Director. Commenting on the results of the Italian auction, Mr. Fok said that 3 Italia would be able to achieve comparable performance using 1800MHz and 2.6GHz;[99] and

- reviews the evidence on prices achieved in European auctions. It acknowledges that sub-1GHz spectrum is simply "more valuable" than higher frequency spectrum, but that "*it is likely to be too early to tell whether sub1GHz spectrum is necessary to being a credible national wholesaler"*.[100]

Three's view is that the advantages of sub-1GHz spectrum are very clear, as shown in Annex C. Ofcom uses Mr Fok's comments out of context. 3 Italia has been granted 2x5MHz of 900MHz spectrum as part of UMTS liberalisation. As a consequence 3 Italia has a highly beneficial coverage layer to complement its holdings at 1800MHz and 2.6GHz.

Finally, whatever conclusions may be drawn from recent spectrum auctions in Europe, events in non-European countries already

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[98] The 700MHz Spectrum Auction: An Opportunity to Protect Competition In a Consolidating Industry, Peter Cramton, Andrzej Skrzypacz and Robert Wilson, 13 November 2007.
[99] Consultation, Annex 6, para 3.135.
[100] Consultation, Annex 6, para 3.130.

demonstrates that concentration of sub-1GHz spectrum gives rise to adverse effects on competition and consumers (see Annex C).

# 5. Ofcom has considerably understated the fourth national wholesaler's need for additional spectrum and risk that it will not acquire sufficient spectrum in the auction.

*Section 5 sets out Three's analysis of why it is necessary that the Auction design includes protections to ensure that the fourth national wholesaler obtains the spectrum required to be credible. In conclusion:*

i. *Ofcom has analysed in detail the competitive position of Everything Everywhere and why it may have countervailing advantages which result in it not requiring special protection in the Auction in order to acquire additional spectrum. However, Ofcom has erred by not conducting a similarly detailed analysis in relation to the fourth national wholesaler. Yet the fourth national wholesaler is in a materially different position from Everything Everywhere and has a much greater need for additional spectrum.*

ii. *Three agrees with Ofcom's finding that there is a material risk that the fourth national wholesale mobile operator – either Three or a new entrant – will not acquire sufficient spectrum to become or remain a credible national wholesaler after the Auction.*[101] *However, Ofcom has considerably understated this risk, as:*

- *the fourth national wholesaler will tend to have a much lower intrinsic value for spectrum than any other wholesaler without sub-1GHz spectrum – due to the necessary time lag in acquiring new customers and the higher cost of customer acquisition compared to customer retention, among other things; and*
- *the fourth national wholesaler will face a greater risk of strategic investment than any other national wholesaler – the other national wholesalers will value spectrum not only on the basis of the opportunities it will give them but also for the likely pay-off from the prospect of limiting the ability of the fourth national wholesaler to compete.*

[101] Second Consultation, para 1.20.

### 5.1. Even with one of the proposed Minimum Spectrum Portfolios (MSPs), The fourth national wholesaler has a much greater need for additional spectrum than Everything Everywhere.

Ofcom concludes that Everything Everywhere does not need protecting in the Auction as it is only disadvantaged in not having access to sub-1GHz spectrum, whereas it has a number of other advantages:

> "*Everything Everywhere's existing spectrum portfolio has strengths and weaknesses. It has no sub-1GHz spectrum, but we consider it is likely to be able to deliver sufficient quality of coverage to be a credible national wholesaler with its significant holdings of 1800MHz and 2.1GHz spectrum […] Its potential advantages include its share of spectrum, early route to LTE, ability to deploy a 2x20MHz LTE carrier and its large number of existing sites.*"[102]

We agree. Everything Everywhere has a large number of advantages that a fourth national wholesaler does not have.

*Ofcom confirms that Everything Everywhere has a number of significant advantages.*

First, Everything Everywhere has capacity and average data rate advantages. As Ofcom explains, capacity and average data rates are connected. For a given number of customers, the greater the capacity, the higher the data rates those customers will tend to receive.[103] Further, the capacity of a mobile network is a function of the amount of spectrum, the network deployed and technology used.[104]

EE, however, has particularly strong advantages in relation to capacity and, consequently, average data rates because:

- Everything Everywhere has much greater bandwidth than any other national wholesaler: 2x45MHz of 1800 MHz

[102] Para 4.28 of Annex 6.
[103] Para 3.14 of Annex 6.
[104] Paras 3.23 of Annex 6.

spectrum and 2x20MHz of 2100MHz spectrum excluding the 2x15MHz of 1800MHz to be divested. This would amount to 24% of all spectrum and 33% of all sub-2.1GHz spectrum available after the Auction for mobile use (assuming Everything Everywhere did not win any further spectrum in the Auction, which is unlikely);[105]

- Everything Everywhere has a current advantage over all other national wholesalers in terms of network deployed with over 18,000 sites in use;[106] and
- Everything Everywhere will be able to obtain a capacity advantage from the deployment of LTE. As a result of greater spectral efficiency, LTE deployed in large bandwidths of contiguous spectrum will increase capacity relative to the use of existing technology such as HSPA.[107]

As discussed and reinforced in Section 4, analysis by Ofcom and independent analysts[108] shows that data speeds and capacity are important to consumers and are likely to be of ever-increasing importance in the future. As such, this dimension has particular importance for the credibility of a national wholesaler.

Second, while Everything Everywhere suffers coverage disadvantages from a lack of sub-1GHz spectrum,[109] the disadvantage is mitigated to some extent by Ofcom's assessment that EE's large number of base stations will allow it to achieve significantly better coverage from its large holding of contiguous 1800MHz spectrum than a national wholesaler with fewer base stations and less 1800MHz spectrum.[110]

Third, Everything Everywhere will obtain competitive advantages in offering the highest peak data rates. These advantages will exist in both the short and longer term[111] because:

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[105] Paras 4.21 and 4.22 of Annex 6.
[106] Para 4.122 of the main consultation document.
[107] Para 3.52 of Annex 6.
[108] Paras 3.15-3.21 and 3.64-3.66 of Annex 6.
[109] Para 4.27 of Annex 6.
[110] See figures 11 and 12 of Annex 7 which demonstrate the positive relationship between the number of sites and coverage for the 1800MHz band.
[111] Para 3.167 of Annex 6 and para 4.25 of Annex 6.

- Everything Everywhere will be able to deploy LTE sooner than other national wholesalers; and

- Everything Everywhere will be able to deploy LTE in wider bandwidths than any other national wholesaler in the future regardless of any spectrum acquisitions that might be made in the Auction and in bandwidths that are contiguous.[112] The peak data rates achievable depend on the breadth and contiguity of the bandwidths in which LTE is deployed.[113]

Fourth, Everything Everywhere will gain other short and longer term advantages from its early and high bandwidth deployment of LTE. The benefits of LTE are not limited to peak data rates but also extend to greater spectral efficiency, lower latency and better quality of service guarantees.[114] This advantage will only be magnified if Ofcom agrees to vary EE's licence to allow early LTE deployment.

Last, the size of EE's customer base gives it advantages which have the following effects:[115]

- Everything Everywhere would not face the frictions to growth that would be faced by a fourth national wholesaler;[116] and

- Everything Everywhere is more likely to be able to acquire sub-1GHz spectrum in the Auction than a fourth national wholesaler.[117] In particular, Ofcom considers that it is unlikely that Everything Everywhere would be the subject of strategic investment since it would be easier to target the more vulnerable fourth national wholesaler would have.[118]

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[112] Paras 4.22 and 4.23 of Annex 6.
[113] Para 3.169 of Annex 6.
[114] Para 3.175 of Annex 6.
[115] Para 5.105 of Annex 6.
[116] Para 5.182 of Annex 6.
[117] Para 5.204 of Annex 6.
[118] Para 5.204 of Annex 6.

*In contrast, the fourth national wholesaler has few if any of these advantages.*

While Ofcom did no such comparison in the Second Consultation, had Ofcom assessed the specific position of the fourth national wholesaler in a scenario where it held an MSP with no 800MHz spectrum (as opposed to the position of Everything Everywhere in the same situation), it should have been apparent that the fourth national wholesaler would be much less credible.

First, Three or a new entrant's spectrum holding, if it were to win an MSP in the Auction would still result in capacity constraints both in absolute terms (i.e. the proportion of available spectrum it holds) and in terms of its ability to increase capacity through the deployment of more efficient technologies.

In particular, if a new entrant were to win the full MSP, it would give the wholesaler just 5-8% of paired spectrum available after the Auction. This is much less than the 10-15% that Ofcom believes is necessary for an operator be a credible national wholesaler.[119] Indeed, such a holding would not even be comparable to the current amount of spectrum held by O2[120] let alone conferring a capacity advantage on the scale enjoyed by EE.

If Three were to win the full MSP, it would still only hold between approximately 9-13% of the total paired spectrum. Three would almost certainly remain at a disadvantage compared to all other national wholesalers and would still suffer a significant capacity/average data rate disadvantage when compared to EE.

Moreover, if the MSP were split between Three and a new entrant (as might be possible if, for example, the new entrant purchased EE's 1800MHz spectrum before the Auction and did not opt in for the MSPs), Three would only have approximately 8% of total paired spectrum.

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[119] Paras 3.69 of Annex 6.
[120] Undermining the point made by Ofcom in para 8.89 of Annex 6.

Again, both Three and the new entrant would suffer a significant capacity/average data rate disadvantage.

Second, the fourth national wholesaler will not be able to offer the same quality of coverage as EE, as:

- If the fourth national wholesaler were a new entrant, it would not necessarily have a network in place. In the absence of a roll-out obligation, it would seem unlikely that a new entrant would find it economic to deploy a full national network in the short to medium term, not least because it would cost the new entrant considerably more to deploy its network for 1800MHz coverage rather than sub-1GHz coverage. Even if it did have some form of national network (i.e. through access arrangements), it is highly unlikely that it would have a network comparable to EE's within any sensible timeframe; and

- A fourth national wholesaler will have a significantly smaller holding of 1800MHz spectrum than EE. This means Everything Everywhere will be able to achieve better coverage from its 1800MHz holding. By way of illustration, Ofcom's technical analysis suggests that the difference between having 2x5MHz of 1800MHz and 2x15MHz of 1800MHz is worth 5-20% of coverage at 1Mbps, 85% loading in West London.[121]

Third, whether the fourth national wholesaler is Three or a new entrant, without sub-1GHz spectrum it will be disadvantaged by its more limited ability to offer the highest peak data rates in the near or longer term. Specifically:

- Everything Everywhere will almost certainly be able to deploy LTE much earlier than the fourth national wholesaler, in particular because it has had certainty over the ability to do so for much longer. Indeed, it has

[121] Figure 11 of Annex 7.

requested that its licence be changed to allow deployment of LTE and Ofcom appears minded to grant the request in short order. The fourth national wholesaler would only be able to start making preparations after acquiring the spectrum. Further, the fourth national wholesaler will be limited to 2x10MHz of 1800MHz until 30 September 2015. If Everything Everywhere can clear more than 2x10MHz of 1800MHz before that time, which is highly likely, it could achieve an advantage in respect of peak data rates for over three years at least;[122]

- In the longer term, Everything Everywhere retains an advantage in respect of peak data rates because it has a far broader bandwidth of LTE-suitable spectrum than the fourth wholesaler; and

- Also in the longer term, even without any new spectrum, O2 and Vodafone would be able to match or exceed the fourth national wholesaler's peak data rates as they are able to clear up to 2x17.4MHz each of 900MHz spectrum for LTE use.

Finally, in the same way that the large size of EE's business provides it with advantages, the substantially smaller size of Three's or a new entrant's business creates a number of disadvantages, including:

- As Ofcom recognises, the smaller customer base of the fourth wholesaler (probably non-existent in the case of a new entrant) will create frictions to growth;[123] and

[122] Ofcom's suggestion at Annex 8, para. A8.47 that Everything Everywhere "is likely to be able to refarm at least 2x10MHz by the time of the first tranche of divestment is September 2013" considerably understates the speed at which Everything Everywhere has already cleared its 1800MHz spectrum in preparation for launch of LTE services. Namely, Everything Everywhere has stated publicly that it intends to launch LTE services this year, as soon as possible after Ofcom has changed EE's licence to allow LTE services on its 1800MHz spectrum.

[123] Para 5.126 of Annex 6.

- A fourth national wholesaler is less likely to be able to acquire sub-1GHz frequency spectrum in the Auction. We address this further below.

In summary, the conclusions Ofcom should have drawn, on the basis of the discussion above, are that even with a MSP excluding 800MHz spectrum:

- Ofcom cannot reasonably be confident that the fourth national wholesaler will have sufficient capacity/average data rates to be credible;

- The fourth national wholesaler will remain at a substantial disadvantage on coverage compared to O2 and Vodafone and at a disadvantage compared to Everything Everywhere;

- The fourth national wholesaler will remain at a disadvantage because of its smaller customer base; and

- The fourth national wholesaler will have little or no LTE advantage over O2 and Vodafone and will remain at an LTE disadvantage to EE.

Accordingly, the fourth national wholesaler is in a far more vulnerable position than Everything Everywhere and needs new spectrum much more, including sub-1GHz spectrum, to be a credible national wholesaler.

## 5.2. A fourth wholesaler has a much lower *intrinsic value* of new spectrum than any other wholesaler without sub-1GHz spectrum.

Ofcom distinguishes between two sources of value in bidding for spectrum – intrinsic value and strategic investment value:

> *"Intrinsic value. The present value of additional profits a bidder expects to earn when holding the spectrum compared to not holding it, in the absence of any strategic considerations to obtain spectrum to reduce competition in mobile services from the existing level.*

> *Strategic investment value. The present value of additional expected profits earned from bids aimed at affecting the future structure of the market by depriving one or more competitors of spectrum."*[124]

Three agrees with this distinction and notes that the fourth national wholesaler has a lower intrinsic value of new spectrum, especially compared to any other wholesaler without sub-1GHz spectrum, and is at a much greater risk of *strategic investment* than any other national wholesaler.

Ofcom notes that "*a national wholesaler with a smaller existing customer base may find it harder to obtain value from new spectrum if it cannot attract customers onto services using the spectrum as quickly [and that…] A customer base could be relevant because it may take time to acquire customers or is expensive relative to customer retention.*"[125]

Three agrees. Ofcom's conclusion that "*[Three]'s smaller existing customer base is likely to reduce its value of spectrum relative to other national wholesalers to some degree*"[126] understates the difference in intrinsic value between Three and the other national wholesalers.

A smaller national wholesaler or new entrant will have a much lower *intrinsic value* for new spectrum than other larger national wholesalers, especially national wholesalers without sub-1GHz spectrum, as:

- the intrinsic value of new spectrum to a smaller national wholesaler or a new entrant is mainly due to the opportunity to increase market share, especially for smaller existing national wholesalers that are currently spectrum constrained; and

- the intrinsic value of new spectrum to a larger national wholesaler is mainly due to the opportunity to defend

[124] Second Consultation, para 4.148.
[125] Second Consultation, para 5.30.
[126] Second Consultation, para 5.115.

market share, alongside the opportunity to sell new services to existing and new customers.

Accordingly, the intrinsic value of new spectrum will tend to be lower for a smaller national wholesaler or new entrant than for a larger national wholesaler due to:

- the time elapsed for a smaller national wholesaler or new entrant to achieve market share; and

- the higher cost of acquiring new customers compared to retaining existing customers.

The time elapsed for a smaller national wholesaler or new entrant to achieve a sustainable market share will have a material impact on the value of spectrum compared to the value to a larger national wholesaler, which realises the value of new spectrum almost immediately, in protecting its existing market share.

Furthermore, these spectrum valuation differences between a fourth national wholesaler and larger national wholesalers are likely to understate the underlying difference in intrinsic value, in particular, because the cost of acquiring new customers is also much higher than the cost of retaining existing customers. This is due to high customer switching costs in mobile services and other sources of customer inertia.

Therefore, all else equal, differences in the intrinsic value of new spectrum are directly correlated with existing revenue shares as these reflect the higher value to a wholesaler of retaining existing market share compared to acquiring new market share.

The UK 3G auction prices provide further evidence for this analysis: each of the incumbent national wholesalers paid £2.0bn per 2x5MHz block,

whereas the new entrant paid £1.5bn per 2x5MHz following a highly competitive bidding both between incumbents for different lots and between potential entrants for the new entrant licence. The UK 3G auction design specifically took into account the difference in intrinsic value between incumbents and new entrants, and the possibility of strategic investment:

> *"The UK ran the world's first 3G auction. It originally planned to sell just four licences. The problem we faced was that there were also exactly four incumbent 2G mobile-phone operators who had the advantages over any other bidders of existing 2G brand-names and customer bases to exploit, and lower costs of building 3G networks (because of the ability to piggyback on their 2G infrastructure). We were therefore very concerned that an ascending auction might deter other firms from bidding strongly, or even from entering the auction at all. […]*
>
> *However, when it became possible to sell five licences, a straightforward ascending auction made more sense. Because no bidder was permitted to win more than one licence and licences could not be divided, there was no simple way to share the spoils, so 'tacit' collusion would be hard. Even more important, the fact that at least one licence had to go to a new entrant was a sufficient carrot to attract new entrants."*[127]

Namely, all else equal, national wholesalers with the largest existing market revenue shares will have the highest intrinsic value for new spectrum. It follows that national wholesalers with the smallest market revenue shares, and potential new entrants, will have the lowest intrinsic value for new spectrum. In particular, a fourth national wholesaler will have a lower value of sub-1GHz spectrum than any larger national wholesaler without sub-1GHz.

As Ofcom notes: *"[…] in an auction even small differences in intrinsic values – irrespective of the causes – may have a large impact on the auction outcome as they can increase significantly the probability that the*

[127] "How (not) to run auctions: The European 3G telecom auctions", Paul Klemperer, European Economic Review 46 (2002).

*bidder with the highest intrinsic value wins."*[128] Hence, the high likelihood that the fourth national wholesaler will have a much lower intrinsic value for new spectrum is itself strong grounds to put measures in the Auction to ensure that the fourth national wholesaler achieves sufficient spectrum to be a credible national wholesaler.

### 5.3. The fourth national wholesaler is at a greater risk of *strategic investment* than any other national wholesaler.

A fourth national wholesaler is at a much greater risk of *strategic investment* than any other national wholesaler, as there are considerable benefits to larger national wholesalers from the loss of an effective national wholesale competitor. In contrast, while the fourth national wholesaler could theoretically itself enjoy the benefits of strategic investment, namely if a larger national wholesaler itself became the victim of strategic investment, the prospect of this happening is extremely low.

Specifically, the value of new spectrum to larger existing national wholesalers is the opportunity to maintain or increase revenue through:

- retaining and potentially increasing revenues from existing customers; and

- preventing smaller national wholesalers or new entrants from growing and/or continuing to be viable, namely, by limiting competition.

By contrast, the value of new spectrum to a smaller national wholesaler or new entrant is the opportunity to enter and/or grow to a viable size, namely, by increasing competition.

Ultimately, larger operators have a large amount to gain from staying in the market and encouraging market consolidation, whereas the smallest existing operator has the least to lose from early exit of the market.

[128] Second Consultation, Annex 6, para. 5.17.

Furthermore, the likelihood of the fourth wholesaler being the victim of strategic investment is much greater when the fourth wholesaler needs sub-1GHz spectrum to be a credible national wholesaler and one or more of the larger wholesalers already holds sub-1GHz spectrum. This is because the value of strategic investment to the existing sub-1GHz wholesalers – and likely success of strategic investment in foreclosing a fourth wholesaler from being an effective competitor – is even greater in this case.

Indeed, it is well established that an open auction between incumbents and smaller competitors/new entrants will not necessarily lead to an efficient spectrum allocation, as incumbents will tend to bid strategically to exclude smaller rivals and potential new entrants. For example, as highlighted by Ofcom's own auction adviser, Professor Cramton:

> *"Auctions are often assumed to be the most efficient way of distributing scarce inputs. Where market power is present, however, an open auction that treats incumbents and potential new entrants symmetrically, will often produce outcomes that are inefficient and have anticompetitive consequences for post-auction markets. Suppose that an incumbent monopolist already has one licence, and now a second licence is to be sold in an auction. Assume that a new entrant has greater economic value for the second licence than the incumbent does. This is often the case, since an operator's value for additional spectrum typically falls with each additional increment. However, the incumbent enjoys monopoly rents that it wants to retain. Under nearly any economic model, entry would reduce monopoly rents and hence the monopolist's profit. […]*
>
> *Under these assumptions, the incumbent monopolist will win the licence (thereby blocking entry), even though the new entrant is more efficient, whenever the entrant's efficiency advantage is less than the incumbent's loss of monopoly rents were it to fail to deter entry. The greater are the monopoly rents, and hence the worse the monopoly problem is, the more likely it is that the incumbent wins. […]*

> *This is a major difference from auctions where all players start on equal footing. We argue that the dominant low-frequency incumbents' incentives to protect current profits are large, and could undermine the efficiency of the auction outcome. In particular, this distortion leads incumbents to value the new licences more than the true economic value to society and thus is likely to lead to a misallocation of the scarce spectrum. […]*
>
> *This is the great deficiency of an unrestricted auction when incumbents have rents to protect. Symmetric auctions among asymmetric bidders are prone to inefficient outcomes because the interests of consumers are not directly represented in the auction—the responsibility to promote consumers' interests resides with [Government and regulators] when they consider the rules of the auction and the awarding of licences in the public interest. Both those decisions will inevitably shape the structure of the industry far into the future."*[129]

In the 800MHz and 2.6GHz Auction, the most likely bidders are highly asymmetric. They do not start on an equal footing.

First, two of the four current UK national wholesalers already hold highly valuable sub-1GHz spectrum licences, none of which were acquired through an open auction process or have been made available to other wholesalers.

Second, three out of four of the current national wholesalers already hold large amounts of liberalised 2G spectrum. Again, none of which was

[129] The 700MHz Spectrum Auction: An Opportunity to Protect Competition In a Consolidating Industry, Peter Cramton, Andrzej Skrzypacz and Robert Wilson, 13 November 2007. For similar results, see also (1) Cramton, Peter; Kwerel, Evan; Rosston, Gregory; Skrzypacz, Andrzej: Using Spectrum Auctions to Enhance Competition in Wireless Services, 2011; (2) Cramton, Peter; Skrzypacz, Andrzej; Wilson, Robert: Summary: Revenues in the 700MHz Spectrum Auction, 27 June 2007; (3) Moore, Linda: Spectrum Policy in the Age of Broadband: Issues for Congress, 2010; (4) Moelleryd, Bengt G; Markendahl, Jan: Valuation of spectrum for mobile broadband services – Engineering value versus willingness to pay, 22nd European Regional ITS Conference, Budapest, 18-21 September 2011; (5) ComReg: Strategy for Managing the Radio Spectrum 2011 – 2013, 2011.

acquired through an open auction process or has been made available to subsequent wholesale entrants.

Third, an entirely new entrant would have no existing spectrum holdings at all.

Accordingly, in an unrestricted auction, incumbents would be expected to bid both to deter further entry and to foreclose the smaller competitor's ability to compete.

The Second Consultation nevertheless considerably understates the risk of strategic investment in the Auction and associated risks for competition and consumers. In particular:

- Ofcom wrongly finds that sub-1GHz spectrum is not needed to be a credible national wholesaler; and

- Ofcom underestimates the value of strategic investment to the larger national wholesalers, especially the existing holders of sub-1GHz spectrum.

Section 4 above outlines why Ofcom is wrong to find that sub-1GHz spectrum is not necessary to be a credible national wholesaler. In turn, this leads Ofcom to underestimate the value of strategic investment to the larger national wholesalers, especially the existing holders of sub-1GHz spectrum. In particular, because sub-1GHz is essential for an operator to be credible, this increases the expected pay-off from strategic investment to larger national wholesalers – the elimination of a competitor from the market.

As Ofcom recognises, even relatively small reductions in the intensity of competition could have a substantial economic impact.[130] Ofcom suggests that, if the reduction in competitive intensity reduced consumer value by 1%, that would be equivalent to a £0.2bn loss of consumer surplus over one year, and, if it were sustained over five years, the loss of consumer surplus would have a net present value of £1.1bn.

[130] Second Consultation, para 4.52.

However, in reality, the loss of consumer surplus is likely to be much greater than Ofcom suggests. For example, in Three's response to Ofcom's First Consultation, Three highlighted that consumers in Western European markets with effective 3G entrants (typically four-player markets) have on average benefited from 19% lower mobile voice prices and 28% lower mobile broadband prices than the EU average.[131] Indeed, Ofcom's own evidence shows that UK mobile voice prices in 2011 were almost 50% lower than the average for the UK, Germany, Italy, Spain and France together, and that UK mobile broadband prices were 20% lower.[132]

So, in the UK, with mobile revenues of around £15bn, prices which are 20-50% lower correspond to a consumer-surplus benefit from effective competition of £4-15bn a year or £20-75bn in net present value terms over five years.[133] In comparison, Ofcom's estimates are highly conservative. Ofcom's scenario analysis shows a reduction in consumer surplus of just 0.5%-10% and a corresponding net present value over five years of £0.6bn-£11.2bn.

Accordingly, the value of strategic investment to the larger national wholesalers – namely the additional profit resulting from consolidating the UK mobile market from four national wholesalers to three – could be (at a minimum) a billion pounds each and conceivably tens of billions of pounds each.[134] It follows that this creates considerable incentives and a likelihood that the fourth national wholesaler will be the victim of strategic investment absent appropriate measures in the Auction to prevent it.

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[131] Three response to Ofcom consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum, 7 June 2011, para 161.
[132] Second Consultation, Annex 6, Figure 2.3.
[133] Assuming that, in the absence of a competitive UK mobile market, prices and industry revenues would be 1/120%-1/150% higher, i.e. £19-30bn (not taking into account elasticity of demand). This is consistent with Ofcom's total consumer surplus estimate of £24bn in 2010.
[134] For example, it is widely reported that the recent entry of a new national wholesaler in France (Illiad) has wiped billions of euros from the value of the three incumbent national wholesalers in France (Bouygues, Orange and SFR).

# 6. Ofcom should vary its MSPs to permit a fourth credible national wholesaler.

*This Section compares Ofcom's proposed Minimum Spectrum Portfolios ("**MSPs**") including whether they provide the minimum spectrum required for a fourth operator to be credible. In conclusion:*

i. *Three agrees with Ofcom that MSPs 1 and 2 would not be adequate to ensure the continued existence of a fourth credible national wholesaler;*

ii. *MSP 6, which does not contain any sub-1GHz spectrum, would not be adequate to be a credible national wholesaler and should be removed; and*

iii. *As an alternative to the removal of MSP 6, Ofcom should consider a new MSP merging together MSPs 5 and 6, consisting of:*

- *2x5MHz of 800MHz spectrum + 2x15MHz of 1800MHz spectrum + 2x5MHz of 2.6GHz spectrum.*

*While the merged MSP suffers some disadvantages, in line with comments made in Three's response to the First Consultation, the merged MSP is nevertheless much more likely than MSP 6 to allow a wholesaler to be credible. Moreover, it is also much more likely to be sufficient than the MSP proposed in the First Consultation of 2x5MHz of 800MHz spectrum paired with 2.6GHz spectrum (rather than 1800MHz in this alternative).*

## 6.1. Overview and explanation of Three's assessment criteria.

In Section 4 of the Second Consultation, Ofcom has considered 3 groups of potential MSPs. Its preferred option is Group 2 (consisting of MSPs 3, 4, 5 and 6):

**Table 9: Ofcom's preferred minimum spectrum MSPs**

| | 800MHz | 1800MHz | 2.6 GHz |
|---|---|---|---|
| **MSP 3** | 2x15MHz | | |
| **MSP 4** | 2x10MHz | | 2x10MHz |
| **MSP 5** | 2x10MHz | 2x15MHz | |
| **MSP 6** | | 2x15MHz | 2x10MHz |

Source: Ofcom

This Section draws together the threads of the analysis in previous Sections of this response in order to reach conclusions on which of the MSPs considered by Ofcom would be sufficient to permit the continued existence of a credible fourth national wholesaler.

Three's assessment is by reference to capacity, coverage and indoor speeds experienced by users - as discussed in previous sections - but also possible efficiency of load balancing. This additional criterion is important because the efficiency of spectrum usage is a matter to which Ofcom is required to have regard.

*Coverage*

As discussed in Sections 3 and 4, Three considers that any MSP without low frequency spectrum will not allow a fourth national wholesaler to be credible and enable it to compete effectively in the long term. Further, for the reasons discussed in Section 3, small cells do not provide a proportionate solution.

*Capacity*

In the Second Consultation, Ofcom has concluded that, in order to be a credible national wholesaler, a fourth operator needs at least 10-15% of total spectrum available for mobile use [paras 4.69-4.75]. Three notes that 10-15% of total spectrum (post Auction) is approximately equal to 2x30MHz– 2x40MHz. This is comparable with the pre-Auction spectrum holding of O2 and Vodafone - currently 2x32.5MHz and 2x37.5MHz

respectively. Three, on the other hand, has only 2x15MHz of usable spectrum.

It follows that Three would have to acquire at least 2x15MHz to reach the 10% minimum holding and more to match O2's current position. By contrast, a new entrant would need to acquire 2x30MHz in total to reach the same minimum 10% holding.

*User experience of speed (indoor)*

User experience of speed depends on both coverage and available bandwidth. Users at or beyond the outer limits of coverage will naturally get either no service or service only at greatly degraded speeds. In the harder to reach locations, therefore, the user experience of speed will be driven to a very large extent by the amount of low frequency spectrum held. MSPs that include bandwidths of 2x15MHz of 800MHz or more would support the highest user speeds at the deepest indoor locations.

In principle, though, where a user does have coverage, greater bandwidths will increase the user's experience of speed (assuming the same demand loadings).

Further, user experience of speed will also be influenced by the efficiency of the load balancing achievable in any particular multi-band network. In a multi-band network with a sub-optimal spread of frequencies, the lower frequency will be rapidly filled to capacity and the higher frequency spectrum will be forced to operate over a larger effective footprint (to the extent possible, limited by received signal strength and signal to

interference), substantially constraining the speeds achievable by those using the low frequency and even degrading speeds achievable by those using the higher frequency. The next section discusses how the efficiency of the load balancing achievable is to be measured.

*Efficient load balancing*

In a multi-frequency environment, the optimal speeds will be achieved for all users by keeping effective cell radii for each frequency as small as possible whilst maintaining a similar traffic loading for all frequencies. If the frequencies available, or the bandwidth at each frequency, require heavier loading and/or larger cell radii in order to provide coverage, speeds will fall. Further, it will not be possible to carry as much data because the efficiency of transmission will be affected more by path loss. In short, the spectrum will not be used as efficiently as it could be with a better spread of spectrum holdings.

## 6.2. Three's assessment of the proposed MSPs.

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## 6.3. Alternative MSP.

# 7. The proposed Auction design does not support Ofcom's objective of a four player market.

*Section 7 sets out Three's analysis of whether Ofcom's Auction design is capable of achieving its objectives. In conclusion:*

*i. Ofcom's proposed Auction design suffers from a number of important flaws. The combined effect of these is to severely compromise Ofcom's objective of securing a fourth national wholesaler and therefore a four-player market after the Auction, specifically:*

*a. There are several potential scenarios where MSPs are split between multiple operators, none of which would hold sufficient spectrum to be credible.*

*b. There is no justification for Ofcom's suggestion that these sub-scale operators would necessarily merge to form a fourth credible national wholesaler.*

*c.*

*d. Ofcom is incorrect in setting eligibility points for 800MHz and 1800MHz spectrum as if 2x15MHz of 1800MHz spectrum were a substitute for 2x10MHz of 800MHz spectrum. This is likely to discourage opt-in bidders for the MSPs. Indeed, recent European spectrum auctions show that 2x10MHz of 800MHz is significantly more valuable than 2x15MHz of 1800MHz, which should provide a starting point for setting eligibility points.*

*ii. Three proposes an alternative set of MSPs and eligibility points that would address the above issues. In particular, all MSPs should contain at least 2x5MHz of sub-1GHz spectrum and provide enough capacity for a new entrant to be credible.*

*iii. A roll-out obligation, including financial consequences for non-compliance, should be imposed on all MSP bidders in order to ensure that the spectrum is used for the benefit of consumers.*

## 7.1. In order to be credible, a fourth national wholesaler needs to hold one of the MSPs on its own.

One of the most surprising positions taken by Ofcom in the Second Consultation is that it does not matter whether the MSP is held by a single

operator or is dispersed over multiple operators. Ofcom confirms its position in this regard explicitly in footnote 229 of Annex 6:

> "*… we do not consider it essential that the divested 2x15MHz of 1800MHz spectrum is obtained by the same party as obtains the reserved portfolio*"

Ofcom also summarises this point in its *Addendum to second consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum and related issues of 12 January 2012*, published on 17 February 2012 ("*Addendum*"). In para 2 of the *Addendum*, Ofcom states:

> "*It seems to us that the key issue in this situation is whether it would be sufficient to meet our objective of there being at least four credible national wholesalers, that parties other than EE, Telefónica and Vodafone collectively held (at least) the spectrum in one of the spectrum portfolios we have identified, even if they do not do so individually (Case 1); or whether it is necessary to meet our objective that there is at least one party who on its own holds (at least) one of the identified spectrum portfolios (Case 2)*".

In para 8 of the *Addendum*, Ofcom invites opinions on these two alternative options.

Three notes that Ofcom established the notion of a "minimum spectrum portfolio" in the First Consultation in order to reflect the minimum efficient scale needed to be a credible national wholesaler. Ofcom refers to this at para 1.10 of the Second Consultation:

> "*We considered that there were risks to the future competitiveness of the mobile market if bidders could bid for and acquire any amount of spectrum in an open auction, and these were sufficient for us to take the view that we*

> *should put in place the following measures designed to promote national wholesale competition […] spectrum floors to ensure that after the auction, subject to demand, there are at least four holders of a minimum spectrum portfolio that mean they are credibly capable of providing high quality data services in the future.*"

In our view, this requirement can only be satisfied by a single party on its own. Indeed, if two operators each have half the minimum efficient scale in any industry, one would never say that the two firms together achieve the minimum efficient scale. Rather, one would conclude that neither firm has achieved the minimum efficient scale. This was implied in the First Consultation where Ofcom was unambiguous that *two* firms other than O2 and Vodafone should hold MSPs.

However, as described in the Second Consultation, it is possible that the MSPs will be dispersed over two or more operators. The concerns are greatest under Case 1 of the *Addendum*, but they are also present under Case 2:

- In Case 1, it is considered acceptable if the divested 2x15MHz of 1800MHz spectrum were obtained by Entrant X (before the Auction) and Portfolio 6a of 2x10MHz of 2.6GHz spectrum were won by Entrant Y in the Auction. Given Three's prior holdings of 2x15MHz of 2.1GHz spectrum, the MSP would be dispersed among three operators, with none holding greater than 2x15MHz of spectrum; and

- In Case 2, the Auction could end with Three holding 2x15MHz of 2.1GHz spectrum (2x15MHz of spectrum in total) and with an entrant holding 2x15MHz of 1800MHz and 2x10MHz of 2.6GHz spectrum (2x25MHz of spectrum in total). No operator, except for the three large incumbents, would hold more than 2x25MHz of spectrum, which on Ofcom's own analysis is not sufficient to be a fourth credible national wholesaler.

Three considers that there are at least three difficulties presented by the treatments of Case 1 and Case 2 in the *Addendum*:

- As already noted, there are several scenarios resulting in a market with no credible fourth national wholesaler. Considering possible subsequent mergers does not help (this is discussed below);

- If the divested 1800MHz spectrum were obtained by one opt-in bidder before the Auction, then under the treatment of Case 2, any other opt-in bidder would be placed in an asymmetrically disadvantaged position with respect to the one who held the divested 1800MHz spectrum. This is surprising as in para 8.50 of Annex 6, Ofcom has very specifically concluded that it wants to ensure that Three and any new entrant are able to compete fairly; and

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We discuss each of these difficulties in turn.

*Ofcom's proposals may lead to a dispersion of MSPs among multiple operators.*

We understand that Ofcom's methodology has been to attempt to determine the minimum spectrum portfolio which, when combined with Three's current holdings of 2x15MHz of 2.1GHz spectrum, yields the requisite portfolio to be a credible national wholesaler. This is stated, for example, in para 8.49 of Annex 6:

> *"… we propose to have the same reservation for H3G or a new entrant. This is despite H3G already having 2x15MHz of 2.1GHz spectrum, and the above portfolios being formulated by considering them when added to H3G's 2x15MHz of 2.1GHz spectrum*" (emphasis added).

Ofcom fails to address the difficulty that such spectrum may be dispersed among two or more operators. Its only attempt to do so is rather lacking in substance and fails to address the relevant issues:

> "*If necessary at that point, it might be possible for the two spectrum holdings to be brought together in some way, by network sharing, a trade or a merger, while still retaining at least four credible national wholesalers. In this way we consider that it may be possible for a new entrant to obtain only the reserved spectrum and to become credible in the longer term. We recognise that there could be a strategic incentive on Everything Everywhere, Telefónica or Vodafone to obtain one of these two spectrum holdings to prevent a fourth credible national wholesaler in the longer term. However, if this were through a spectrum trade, it would be subject to a competition assessment at that time*." (Second Consultation, Annex 6, para 8.54.)

It is noticeable that Ofcom does not address the fact that O2 or Vodafone are far more likely to obtain the new entrant's spectrum via merger. Indeed, this would essentially amount to another form of strategic investment. Specifically, O2 and Vodafone would extract greater value from foreclosing the possibility of a credible fourth national wholesaler than the value Three or another entrant would obtain from becoming the credible fourth national wholesaler. For this reason it can be expected that O2 or Vodafone would offer considerably better terms (including price) for the merger.

*Asymmetric positions among opt-in bidders can be resolved through a "handicapping" solution.*

A substantial part of Ofcom's rationale for setting the same spectrum reservation for a new entrant as for Three (despite Three's holdings of 2.1GHz spectrum) is that Ofcom wishes there to be a level playing field for opt-in bidders. As stated in paras 8.50 – 8.51 of Annex 6:

> "*We have considered whether a group of larger portfolios should be specified for a potential new entrant than for H3G. … This could make it harder*

> *for the new entrant to obtain spectrum reserved for a fourth national wholesaler in competition in the auction against H3G. In other words, the new entrant would not have the option of only obtaining a small amount of reserved spectrum, and this might make it less likely to obtain a larger amount of reserved spectrum. Larger portfolios could therefore make it harder for the new entrant. When the amount of reserved spectrum is the same for H3G and a new entrant, then the new entrant can compete on equal terms for the reserved spectrum and has the option of buying any additional spectrum it needs in the normal way in the auction*."

We agree with Ofcom's initial reasoning on this point. If Bidder A is bidding against Bidder B, where Bidder A is bidding for something cheaper and Bidder B is bidding for something more expensive, then Bidder A is more likely to win. This implies that Bidder A might win when Bidder B has a higher valuation. Therefore, the Auction would be inefficiently biased in favour of Bidder A.

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Three considers that this issue can easily be solved and doing so would allow Ofcom to meet its duty to promote competition. Ofcom's current approach appears to be focussed mainly on achieving a symmetric contest for becoming the winning opt-in bidder but at the cost of dispersing the MSP between at least two parties if a new entrant is successful in the Auction

The better approach is for Ofcom to implement auction rules that restore symmetry to the contest for becoming the winning opt-in bidder in scenarios where different opt-in bidders ought to receive MSPs of different sizes (i.e. where at least one is a new entrant and one is not). In Annex B, we describe a “handicap” approach that would go a long way toward levelling the playing field in the bidding for the spectrum reservation without sacrificing its objective.

*Ofcom should impose a roll-out obligation on any opt-in bidder in order to prevent speculative entry.*

In addition, Three considers that a roll-out obligation has to be imposed on any bidder opting in to the minimum spectrum portfolios. This would minimise the risk of speculative entry, when a party acquiring spectrum has no credible plans of rolling out a network and competing effectively with the established operators. More specifically, Three considers that an operator might only qualify for an MSP if it undertakes to comply with the following roll-out obligation (which would then become a licence condition):

i. To provide 50% population coverage by 31 December 2015 with 80% probability that users in outdoor locations within that area can receive the service with a sustained downlink speed of not less than 768kbps in a lightly loaded cell;

ii. To provide and thereafter maintain 80% population coverage by 31 December 2018 with 80% probability that users in outdoor locations within that area can receive the service with a sustained downlink speed of not less than 768kbps in a lightly loaded cell; and

iii. To provide and thereafter maintain 90% population coverage by 31 December 2020 with 90% probability that users in outdoor locations within that area can receive the service with a sustained downlink speed of not less than 1.5Mbps in a lightly loaded cell.

Elements (ii) and (iii) largely replicate the coverage obligations in the 2.1GHz spectrum licences (as amended). However, we suggest an interim roll-out obligation to ensure early roll-out. We further recommend a slight increase in the download requirements in element (iii). This is because 768Kbps was based on 3G single 5MHz carrier technology whereas at least 10MHz will be deployed and this would be either dual carrier HSPA+ or more likely LTE. Both of these technologies would support at least double the speed of UMTS.

In order for this roll-out obligation to achieve its policy objective, financial consequences should be imposed on the MSP winner if it does not meet the roll-out obligation. Such consequences would need to be specific and identified at the time of the Auction and sufficiently substantial to incentivise roll-out. Three suggests that the licence should be drafted to specify an obligation to make additional licence payments equivalent to between 5% and 10% of the Auction price of the acquired spectrum if the roll-out obligations are not met. If Ofcom is not minded to change the drafting of the licence, Three suggests that Ofcom should at least indicate before the Auction that it would be minded to impose substantial financial penalties in the exercise of its enforcement powers if the winner were to fail to meet the roll-out obligations.

### 7.3. Ofcom is treating 2x15MHz of 1800MHz spectrum as a substitute for 2x10MHz of 800MHz spectrum.

In the First Consultation, Ofcom treated 2x15MHz of 1800MHz spectrum as a substitute for 2x20MHz of 2.6GHz spectrum in the spectrum floor.

However, in the Second Consultation, Ofcom appears to be treating 2x15MHz of 1800MHz spectrum as a substitute for 2x10MHz of 800MHz spectrum. Treating the 1800MHz spectrum in such a way is not only counter to the technical analysis that Three has provided during the consultation process, but it is also completely counter to what the outcomes of other European spectrum auctions suggest are the true respective values.

Based on the Eligibility Points per MHz and the Reserve Price per MHz in Table 8.31 of the First Consultation, 1800MHz spectrum was treated as having between one tenth (0.1000) and one sixth (0.1667) of the value of 800MHz spectrum:

**Table 12: Eligibility points and reserve prices proposed in the First Consultation**

| Band | Lot | Eligibility points | Eligibility points per MHz | Reserve price | Reserve price per MHz |
|---|---|---|---|---|---|
| **800MHz** | 2x10MHz | 60 | 3 | £400,000,000 | £20,000,000 |
| **1800MHz** | 2x15MHz | 15 | .5 | £60,000,000 | £2,000,000 |
| **2.6GHz** | 2x10MHz | 10 | .5 | £40,000,000 | £2,000,000 |

Source: Ofcom

This assessment has changed dramatically in the Second Consultation. First, as summarised in Figure 6.10 of the Second Consultation, 1800MHz spectrum is now being treated as having two-thirds (0.6667) of the value of 800MHz spectrum:

**Table 13: Eligibility points proposed in the Second Consultation**

| Band | Lot | Eligibility points | Eligibility points per MHz |
|---|---|---|---|
| **800MHz** | 2x10MHz | 60 | 3 |
| **1800MHz** | 2x15MHz | 60 | 2 |
| **2.6GHz** | 2x5MHz | 5 | .5 |

Source: Ofcom

There would be no reason for Ofcom to assign eligibility points in this way, unless Ofcom was leaning toward setting reserve prices in approximately the same proportion. Satisfying any objective to enable bidders to switch in and out of the 1800MHz band could have been accomplished just as effectively by assigning the 2x15MHz block 30 points (equal to the eligibility points of an 800MHz block) or 15 points (equal to the eligibility points of 2x15MHz of 2.6GHz spectrum). Moreover, with the introduction of the relaxed activity rule of the Second Consultation, it is now possible for bidders to switch in and out of the 1800MHz band without the eligibility points exactly equalling that of other spectrum.

Second, in defining the spectrum reservation, each of Group 1 (smaller portfolios), Group 2 (medium portfolios) and Group 3 (large portfolios) treat 2x15MHz of 1800MHz spectrum as a substitute for 2x10MHz of 800MHz spectrum:

**Table 14: MSPs discussed in the second consultation**

| Small portfolios | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **1** | 2x10MHz | | |
| **2** | | 2x15MHz | |

| Medium portfolios | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **4** | 2x10MHz | | 2x10MHz |
| **6** | | 2x15MHz | 2x10MHz |

| Larger portfolios | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **9** | 2x10 MHz | | 2x20 MHz |
| **11** | | 2x15MHz | 2x20MHz |

Source: Ofcom

Small portfolios 1 and 2 directly substitute 2x15MHz of 1800MHz spectrum for 2x10MHz of 800MHz spectrum. Medium portfolios 4 and 6 each contain 2x10MHz of 2.6GHz spectrum; they only differ in that portfolio 4 has 2x10MHz of 800MHz spectrum while portfolio 6 has 2x15 MHz of 1800MHz spectrum. Large portfolios 9 and 11 each contain 2x20 MHz of 2.6GHz spectrum; they only differ in that portfolio 9 has 2x10MHz of 800MHz spectrum while portfolio 11 has 2x15MHz of 1800MHz spectrum. While Ofcom states that it does not reach the conclusion that 2x15MHz of 1800MHz spectrum is a substitute for 2x10MHz of 800MHz spectrum, it nonetheless appears to be treating them as substitutes. While Ofcom has not yet published its reserve prices, the natural conclusion is that there will be equal reserve prices for 2x10MHz of 800MHz spectrum and for 2x15MHz of 1800MHz spectrum.

*2x15MHz of 1800MHz spectrum is not equivalent to 2x10MHz of 800MHz spectrum as established by the market.*

Recent auctions in Europe provide clear evidence that 2x15MHz of 1800 MHz spectrum is not equivalent to 2x10MHz of 800MHz spectrum.

**Table 15: Auction prices paid for 800MHz and 1800MHz spectrum**

| Country | 800MHz (2x5MHz block) | 1800MHz (2x5MHz block) | Value Ratio |
|---|---|---|---|
| **Germany** | €596,079,167 | €20,871,000 | 28.56 |
| **Italy** | €493,716,666 | €159,000,000 | 3.11 |
| **Portugal** | €45,000,000 | €4,000,000 | 11.25 |
| **Sweden** | SEK342,333,333 | SEK192,857,143 | 1.78 |
| **Average** | | | 11.17 |

Source: Policy Tracker; Cullen International

In the German auction of 2010, the ratio between 800MHz spectrum and 1800MHz spectrum prices was 28.56. This outcome may have been somewhat dependent on the SMR auction format[135] and is possibly an overestimate of the true value ratio. The bidders for the 800MHz spectrum may have had insufficient budget left over to compete heavily for the 1800MHz spectrum. Nonetheless, it is evident that the market judged 800MHz spectrum to be massively more valuable than 1800MHz spectrum in Germany.

In the Italian auction of late 2011, the ratio between 800MHz spectrum and 1800MHz spectrum prices was 3.11.

Less weight should be attached to the ratios found in Portugal and Sweden. In Portugal, the ratio between 800MHz spectrum and 1800MHz spectrum prices was 11.25, but the reserve prices were binding in both spectrum bands (prices did not advance beyond the reserve prices in both bands, and a bit of the spectrum in each band went unsold). In Sweden, the ratio between 800MHz spectrum and 1800MHz spectrum prices was 1.78, but the Swedish auction results clearly understate the

[135] Simultaneous Multiple Round auction (SMRA) format, unlike CCA format, does not allow combinatorial bids and therefore makes spectrum aggregation more difficult.

value ratio. The 1800MHz auction was much more competitive: there were three bidders for two licences in the 1800MHz auction, while there were three bidders for *three* licences in the 800MHz auction. Furthermore, the 800MHz spectrum and the 1800MHz spectrum were sold in two separate auctions - held seven months apart - and the Italian auction occurred between these two auctions.

The arithmetic average of the four value ratios is 11.17. Of course, considerably more weight should be attached to the Italian and German auction results in assessing UK values, as these two auctions provided market-determined prices in a combined auction, in countries of sizes fairly similar to that of the UK.

There is no support in market prices for the ratio of 1.5 that is used by Ofcom. The Italian prices would imply that 2x15MHz of 1800MHz spectrum is equivalent to 2x5MHz of 800MHz spectrum, while the German prices would imply that 2x15MHz of 1800MHz spectrum is equivalent to less than 2x1MHz of 800MHz spectrum.

Ofcom has not yet published the reserve prices; however, if it were to use the ratio of 1.5 for the 800MHz and 1800MHz reserve prices, there would be a real risk of overvaluing the 1800MHz spectrum. This is particularly problematic given that the 1800MHz spectrum is expected to be part of the MSPs and may be awarded to a fourth operator. Clearly, if the 1800MHz reserve price is set above its true market value, no operator would opt in to the spectrum floors and Ofcom would fail in its objective to ensure a four-player market.

We therefore propose that the eligibility point ratios and reserve price ratios of the first auction consultation be reinstated. Note that there is no longer any need to adopt Three's earlier recommendation of increasing the eligibility points associated with a 2x15MHz block of 1800MHz spectrum from 15 to 20. The sole purpose of that earlier recommendation had been to make the points associated with the 1800MHz block an integer multiple of the 10 eligibility points of a 2.6GHz block.

However, in respect of the Second Consultation we note the following:

(1) the size of 2.6GHz blocks has been reduced from 2x10MHz to 2x5MHz, and 15 is an integer multiple of 5; and

(2) the relaxed activity rule has been introduced.

Therefore, it is now possible for a bidder to switch from bidding on 2x15MHz of 1800MHz spectrum to bidding on 2x20 MHz of 2.6GHz spectrum, provided that the price of the former increases more than the price of the latter.[136]

## 7.4. Three's alternative proposal ensures that a fourth operator wins enough spectrum to be credible.

In Section 6, we have proposed an alternative set of MSPs for Three. In this section, we address the issues identified above (i.e. dispersed MSPs, asymmetries and EE's incentives) to generalise our proposal to ensure that the Auction always yields a fourth operator with enough spectrum to be a credible national wholesaler.

Three considers that a credible national operator needs at least either one of the following:

- 2x30MHz of spectrum, inclusive of prior holdings, with at least 2x15 MHz of sub-1GHz spectrum; or

[136] While the first consultation ratios of eligibility points (6:1) and reserve prices (10:1) between 800MHz and 1800MHz spectrum seem appropriate, it is quite possibly the case that the ratios (1:1) between 1800MHz and 2.6GHz spectrum are not appropriate. Ofcom might consider adjusting the latter ratio. For example, Ofcom could assign 40 eligibility points to each 2x5MHz block of 800MHz spectrum and assign 20 eligibility points to the 2x15MHz block of 1800MHz spectrum, while maintaining a level of 5 eligibility points for each 2x5MHz block of 2.6GHz spectrum. This would preserve the first consultation ratio of 6:1 between 800MHz and 1800MHz spectrum, while setting a more realistic ratio of 4:3 between 1800MHz and 2.6GHz spectrum.

- 2x35MHz of spectrum, inclusive of prior holdings, with at least 2x10 MHz of sub-1GHz spectrum; or

- 2x40MHz of spectrum, inclusive of prior holdings, with at least 2x5MHz of sub-1GHz spectrum and 2x15MHz of 1800MHz spectrum.

In determining whether Three or any new entrant meets the requirements to be considered a fourth national wholesaler provider, any acquisition of EE's divestment would be included within the acquirer's minimum required portfolio. In addition, in order to determine whether Three meets the requirements to be considered a fourth national wholesale provider, its existing holdings of 2x15MHz of 2.1GHz spectrum should be taken into account as part of an MSP. However, as we discussed above, there is no economic basis for attributing spectrum in one operator's holdings to another operator's portfolio.

Our proposal consistently requires the entire MSP to be placed in a single operator's hands in order for the spectrum floor's objective to be achieved. Or, to put it differently, if neither Three nor a new entrant reaches the minimum required scale, then the Auction will have failed to result in a fourth credible national wholesaler - and the spectrum floor will have failed as a policy.

Three considers that at least 2x10MHz of 800MHz spectrum should be included in all MSPs (i.e. Portfolios A-D in the table below). If, however, this is not feasible, an additional MSP could be considered that combines 2x5MHz of sub-1GHz spectrum with 2x15MHz of 1800MHz spectrum and provides 2x45MHz of total capacity to a new entrant (portfolio E in the table).

**Table 16: Proposed portfolios for the spectrum floors**

| Portfolio | Sub-1 GHz | 1800MHz | 2.1/2.6 GHz |
|---|---|---|---|
| **A** | 2x15MHz | | 2x15MHz |
| **B** | 2x15MHz | 2x15MHz | |
| **C** | 2x10MHz | | 2x25MHz |
| **D** | 2x10MHz | 2x15MHz | 2x10MHz |
| **E** | 2x5MHz | 2x15MHz | 2x20MHz |

Source: Three

In order for Three to meet this requirement, the incremental spectrum that Three would need to win in the Auction is:

**Table 17: Incremental spectrum required for Three**

| Portfolio | Sub-1 GHz | 1800MHz | 2.1/2.6GHz |
|---|---|---|---|
| **A'** | 2x15MHz | | |
| **B'** ~~———~~ | ~~2x15 MHz~~ | ~~2x15 MHz~~ | ~~----------~~ |
| **C'** | 2x10MHz | | 2x10MHz |
| **D'** | 2x10MHz | 2x15MHz | |
| **E'** | 2x5MHz | 2x15MHz | 2x5MHz |

Source: Three

It is worth noting that Portfolios A', C' and D' are the same as Portfolios 3, 4 and 5 of the Second Consultation.

Portfolio B' has been deleted, since Three reaches the required minimum spectrum portfolio by acquiring 2x15MHz of 800MHz spectrum.

*Scenarios following EE's divestment of 1800MHz spectrum*

There are four scenarios for EE's divestment of 2x15MHz of 1800MHz spectrum which, in turn, determine the incremental spectrum that would need to be acquired by Three or a new entrant to attain the minimum scale required to be a fourth national wholesale provider.

**Scenario 1**: Everything Everywhere divests 2x15MHz of 1800MHz spectrum into the Auction

In this scenario, Three's MSPs correspond exactly to the incremental spectrum required:

**Table 18: Proposed MSPs for Three (Scenario 1)**

| Portfolio | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **A'** | 2x15MHz | | |
| **C'** | 2x10MHz | | 2x10MHz |
| **D'** | 2x10MHz | 2x15MHz | |
| **E'** | 2x5MHz | 2x15MHz | 2x5MHz |

Source: Three

and any new entrant's MSPs correspond exactly to the entire proposed portfolios:

**Table 19: Proposed MSPs for a new entrant**

| Portfolio | 800MHz | 1800MHz | 2.1/2.6 GHz |
|---|---|---|---|
| **A** | 2x15MHz | | 2x15MHz |
| **B** | 2x15MHz | 2x15MHz | |
| **C** | 2x10MHz | | 2x25MHz |
| **D** | 2x10MHz | 2x15MHz | 2x10MHz |
| **E** | 2x5MHz | 2x15MHz | 2x20MHz |

Source: Three

Note that the relevant portfolios for a new entrant contain 2x15MHz more of 2.6GHz spectrum than the corresponding portfolios for Three. In Annex B, we provide a simple remedy for the asymmetry in the competition to become the “opt-in” winner.

**Scenario 2:** Vodafone or O2 acquires EE’s divestment before the Auction.

If Vodafone or O2 acquires EE’s divestment before the Auction, all portfolios that include 2x15MHz of 1800MHz spectrum become unavailable to Three or any new entrant.

Thus, in this scenario, Three would qualify for the following remaining MSPs:

**Table 20: Proposed MSPs for Three (Scenario 2)**

| Portfolio | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **A’** | 2x15MHz | | |
| **C’** | 2x10MHz | | 2x10MHz |

Source: Three

and any new entrant would qualify for the following remaining MSPs:

**Table 21: Proposed MSPs for a new entrant (Scenario 2)**

| Portfolio | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **A** | 2x15MHz | | 2x15MHz |
| **C** | 2x10MHz | | 2x25MHz |

Source: Three

As in Scenario 1, each of the new entrant portfolios contains 2x15MHz more 2.6GHz spectrum than the corresponding portfolio for Three. Again,

Annex B proposes the simple remedy for the asymmetry in the competition to become the “opt-in” winner.

**Scenario 3:** Entrant X acquires EE’s divestment before the Auction.

Suppose that EE’s 2x15MHz of 1800MHz spectrum is divested to a new entrant (“Entrant X”) which chooses to participate in the Auction as an opt-in bidder.

The portfolios that include 2x15MHz of 1800MHz spectrum become unavailable to Three and are deleted from the table indicating Three’s incremental spectrum requirements. Thus, in this scenario, Three is offered the same MSPs as in Scenario 2:

**Table 22: Proposed MSPs for Three (Scenario 3)**

| Portfolio | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **A’** | 2x15MHz | | |
| **C’** | 2x10MHz | | 2x10MHz |

Source: Three

Entrant X is now offered net portfolios reflecting its new 1800MHz spectrum holding:

**Table 23: Proposed MSPs for Entrant X (Scenario 3)**

| Portfolio | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **B’’** | 2x15MHz | | |
| **D’’** | 2x10MHz | | 2x10MHz |
| **E’’** | 2x5MHz | | 2x20MHz |

Source: Three

For completeness, we should also specify the MSPs for any new entrant other than the acquirer of EE’s 1800MHz divestment. All portfolios that include 2x15MHz of 1800MHz spectrum become unavailable to any other

new entrant. Thus, in this scenario, Entrant Y is offered the same MSPs as in Scenario 2:

**Table 24: Proposed MSPs for Entrant Y (Scenario 3)**

| Portfolio | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **A** | 2x15MHz | | 2x15MHz |
| **C** | 2x10MHz | | 2x25MHz |

Source: Three

Each of Entrant Y's MSPs can be formed by adding 2x15MHz of 2.6GHz spectrum to one of the net portfolios offered to Three.

Our main recommendation for remedying the asymmetry in the opt-in competition is to follow the same "handicap" approach as recommended above for Scenarios 1 and 2. However, if only Three and Entrant X are opt-in bidders in the Auction, it would alternatively appear defensible for Portfolios A′ and C′ to be available both to Three and to Entrant X, resolving the asymmetry by making the set of MSPs entirely symmetric.

**Scenario 4:** Three acquires EE's divestment before the Auction

Three is now offered net portfolios reflecting its new 1800MHz spectrum holding:

**Table 25: Proposed MSPs for Three (Scenario 4)**

| Portfolio | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **C'''** | 2x10MHz | | |
| **E'''** | 2x5MHz | | 2x5MHz |

Source: Three

All portfolios that include 2x15MHz of 1800MHz spectrum become unavailable to any new entrant. Thus, in this scenario, a new entrant is offered the following MSPs:

**Table 26: Proposed MSPs for a new entrant (Scenario 4)**

| Portfolio | 800MHz | 1800MHz | 2.6GHz |
|---|---|---|---|
| **A** | 2x15MHz | | 2x15MHz |
| **C** | 2x10MHz | | 2x25MHz |

Source: Three

Each of the new entrant portfolios now contains 2x5MHz of additional 800 MHz spectrum, as well as more 2.6GHz spectrum, as compared to the corresponding portfolio for Three. Again, we would apply the simple "handicap" remedy for the asymmetry in the competition to become the opt-in winner.

Overall, Three considers that our proposed approach would allow Ofcom to achieve its objective of four credible national wholesalers post-Auction. This has always been the intent of the spectrum MSP. By requiring sub-1GHz spectrum in the spectrum floor and by requiring that a single operator hold the entire minimum spectrum portfolio on its own, success of the spectrum MSP can be assured.

Three notes that a well-functioning competition measure can increase revenues as well as improve post-Auction competition. Without sub-1GHz spectrum reserved for a fourth credible national wholesaler, the Auction may amount to three incumbents reaching accommodation for the six blocks, and may result in a Sweden-style outcome.

However, with the spectrum floor properly specified, the prices paid for the 800MHz spectrum will reflect the value of a third incumbent for winning two blocks and establish true market prices.

| **Section 7 Recommendations** |
| --- |
| Ofcom should:<br>• amend the MSPs applicable to Three: (i) MSP6 deleted or (ii) MSPs 5 and 6 merged;<br>• amend the MSPs for a new entrant – all MSPs uplifted by 2x15MHz of 2.6GHz spectrum to ensure a fourth credible operator;<br>• implement a system of “handicaps” to ensure a level playing field for new entrants;<br>• reinstate the eligibility points ratio as in the First Consultation;<br>• specify minimum roll-out obligations for bidders availing themselves of the MSPs; and<br>• apply material and credible financial consequences for MSP bidders that fail to meet their obligations. |

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# 8. Ofcom should reinstate the direct linkage between Annual Licence Fees ("ALFs") for 900/1800MHz spectrum with the Auction prices.

*This Section sets out Three's view on the linkage between ALFs and Auction prices. In conclusion:*

i. *Ofcom should revert to its proposal in the First Consultation to link ALFs with prices paid in the Auction;*

ii. *Reinstating a direct ALF linkage is consistent with the requirement in the Government Direction to reflect full market value;*

iii. *Ofcom overstates demand reduction incentives in the Auction with a direct ALF linkage;*

iv. *Further, Ofcom's new proposed ALF methodology has some significant shortcomings compared to the approach outlined in Ofcom's First Consultation, in particular:*

   a. *Ofcom's proposed Additional Spectrum Methodology ("ASM") attempts to introduce Vickrey prices (i.e. opportunity cost pricing) instead of market prices into the calculation of ALFs. This would mean lower ALFs than the full market value required by the Government Direction. This would also be likely to constitute impermissible state aid. The ALFs should be based either on the "linear reference" prices proposed in the First Consultation or on Walrasian prices (i.e. an average of the lowest accepted bid and the highest rejected bid for a spectrum block in the Auction).*

   b. *Ofcom should integrate values from international auctions with comparable spectrum using the recent German and Italian auction prices to define a floor for the ALFs.*

v. *In addition, Ofcom should adjust the ALFs to reflect:*

   a. *the higher value of 900MHz spectrum vs. 800MHz spectrum due to earlier device availability; and*

   b. *the option value of relinquishment which substantially increases the value of 900MHz spectrum as compared to 800MHz spectrum.*

### 8.1. Reinstating a direct ALF linkage is consistent with the requirement in the Government Direction to reflect full market value.

Ofcom is obliged by the Government's Direction to Ofcom of December 2010 (the "Direction") to set ALFs for liberalised 900MHz and 1800MHz spectrum licences with regard to Auction prices. In particular, para 6 of the Direction states:

> (1) 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.
> (2) In revising the sums prescribed OFCOM must have particular regard to the sums bid for licences in the Auction.

Three considers that Ofcom's initial approach to ALF setting was entirely consistent with the Direction. In para10.1 of the First Consultation, Ofcom states:

> "*Our provisional conclusion is that the use of the amounts bid and licence fees paid in the auction are likely to provide the most reliable basis on which we can determine the full market value of 900MHz and 1800MHz spectrum. This is because, we consider that in the specific circumstances of this award there are significant difficulties in using estimates from technical and cost modelling or from spectrum trades. Moreover, if the auction is sufficiently competitive, the licence fees paid are likely to reflect the prices that would emerge in a well functioning market. Therefore, provided the spectrum auctioned is reasonably comparable to 900MHz and 1800MHz spectrum then we believe that using information derived from the auction is likely to be more reliable than other ways for estimating the full market value. If for some reason we judged that the auction information revealed by the auction was not reliable then we expect that it is likely that we would rely on information from auctions for similar or the same spectrum in other countries as the next best alternative*."

In the Second Consultation, however, Ofcom has departed from this initial interpretation. Instead, Ofcom now states in para A13.91–92 of the Second Consultation:

> " *… we do not propose to adopt a mechanistic link between ALFs and prices paid in the auction and for the avoidance of doubt our March 2011 proposals did not include such a mechanistic link. Rather we intend to use various sources of information to determine full market value for these purposes. However, in light of concerns expressed by some respondents as regards the potential impact on bidding incentives of the specific methodology for deriving estimates of full market value from bids in the auction that we set out in our March 2011 consultation. We have developed an additional approach which we might use alongside other estimates.*"

We understand that Ofcom's change of approach to ALF setting is caused by the incumbents' assertions that the initial proposal will distort bidding in the Auction. For example, in its response to the First Consultation, O2 asserts:

> "*Finally, any decision by Ofcom to establish a causal link between auction prices and ALFs will lead to an asymmetric pricing mechanism in the auction. That is, for every £1 bid by non-2G licensees, the equivalent cost to 2G licensees will be greater than £1 because of the computation of the ALF. Such differential pricing would constitute a state aid, based on case law.*" (para 401, p. 94)

## 8.2. Ofcom overstates demand reduction incentives in the Auction with a direct ALF linkage.

Three understands that the intent behind Ofcom's methodology (in the First Consultation), the Government's Direction, and EU policy is to ensure that the spectrum allocation (including legacy 2G spectrum) is fair and efficient, and to address any distortion arising from liberalisation. While the Government will allow 2G licensees to retain their existing spectrum frequencies, an efficient and non-discriminatory spectrum allocation implies that the ALFs should be set as if the licences had been relinquished into a combined auction and then bought back by the

licensees. The baseline for determining the appropriate "as if" pricing would therefore be a combined auction of 800MHz and 900MHz spectrum.

Accordingly, any incentive that a 2G licensee has for demand reduction in the Auction due to the linkage of the ALFs to auction prices[137] is exactly the same incentive for demand reduction that the 2G licensee would have if it had relinquished its 2G licences and were required to bid for them in a combined auction with linear pricing, such as an Simultaneous Multi Round Auction (SMRA). For example:

- If a bidder held three blocks of liberalised spectrum and were bidding for a fourth block — and if the ALF for its three liberalised blocks were determined by the clearing price in the auction — then the bidder would optimally shade its bid, relative to value, on the fourth block in order to take account of the probability that its marginal bid would increase the ALF that it would pay on its three liberalised blocks.[138]

- Alternatively, if a bidder were bidding for four blocks of spectrum in a SMRA auction, then the bidder would optimally reduce its demand, relative to value, on the fourth block in order to take account of the probability that its marginal bid would increase the price that it would pay on its inframarginal three blocks.[139]

Moreover, a comparison of the bidder's exact calculations in the first case and in the second case above shows that the effects are precisely the same in both cases (provided that the ALFs are set so as to be financially equivalent to the clearing price in the auction).

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[137] This is discussed extensively by Ofcom in the Second Consultation, paras A13.11–A13.46.
[138] These incentives are discussed in detail in second consultation, paras A13.11–A13.46.
[139] These incentives are discussed, for example, in L. Ausubel and P. Cramton, "Demand Reduction and Inefficiency in Multi-Unit Auctions," 2002.

Thus, other wholesalers', and Ofcom's, assertions that there is a difficulty with "a causal link between auction prices and ALFs" are incorrect. Indeed, establishing a direct link between auction prices and ALFs is no more objectionable than requiring 2G licensees to relinquish their spectrum into a combined auction conducted using an SMRA format.

### 8.3. Ofcom's proposed Additional Spectrum Methodology (ASM) is significantly flawed and should not be used.

In the Second Consultation, Ofcom introduces an "Additional Spectrum Methodology" (ASM), which appears to be similar to Vickrey pricing[140] . As such, there are at least five fundamental objections to the ASM:

i. The prices given by the ASM are systematically lower than full market value. The ASM is contrary to Ofcom's own interpretation of the requirements of the Government Direction and does not achieve "full market value". As such, it may amount to an impermissible State aid.

ii. The ASM can produce extremely low and unstable prices. Ofcom has rejected Vickrey pricing for price determination in the Auction and chosen the core-selecting mechanism instead.[141] The same factors that lead Ofcom to reject Vickrey pricing in the Auction should also lead to rejection of the ASM's pricing approach, namely, extremely low and unstable prices).

iii. The ASM suffers from a "missing bids" problem. The ASM is an *ad hoc* construct that produces prices that can be substantially lower than Vickrey pricing due to "missing" bids.

iv. The ASM is ad hoc and without objective basis.

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[140] Vickrey prices are the opportunity cost that each individual winning bidder imposes on others by virtue of winning. They are equal to the higher of the reserve price for the bidder's winning package and the value of the bidder's winning bid less the amount by which the total value of all winning bids would be reduced if that bidder's bids were omitted.

[141] Para A10.2-A10.4 of the First Consultation.

v. The ASM's pricing is contrary to the goals of Ofcom's wider competition policy objectives. The ASM's approach, by unjustifiably providing discounts to the three UK operators with largest market shares, would act opposite to the goals of competition policy.

We discuss these objections in turn.

**The prices given by the ASM are systematically lower than full market value.**

The pricing approach of the ASM runs directly counter to the Government Direction's requirement to set ALFs by reference to full market value for which market prices are the best estimate. In particular:

- The market price — or, more technically, the "Walrasian" price — is a combination of the lowest accepted bid and the highest rejected bid. By contrast, a Vickrey-like approach involves charging the highest rejected bid for one unit, the second highest rejected bid for the next unit, the third highest rejected bid for another, and so forth, (each of these calculations excludes the bidder's own bids).[142] The ASM's prices are intended to represent the opportunity cost of allowing a bidder to retain all of its liberalised spectrum blocks, not the marginal value of one such block. As such, the ASM prices are consistently lower than market prices and therefore would be incompatible with the Government Direction.

- The ASM's prices, just like Vickrey prices, are bidder-specific and are generally lower for bidders with higher quantities. Therefore, one wholesaler may be charged a lower ALF than another wholesaler, based solely on holdings of liberalised 2G spectrum.

[142] As defined in W. Vickrey, "Counterspeculation, Auctions, and Competitive Sealed Tenders," Journal of Finance, 1961

Furthermore, if Ofcom wished to improve upon the linear reference prices proposed in the First Consultation, it should consider using Walrasian prices (or their approximation if Walrasian prices do not exist), rather than using the ASM. This is because Walrasian prices would have the following advantages:

- the concept of Walrasian equilibrium provides an appropriate notion of market equilibrium for competitive markets – and therefore Walrasian prices provide an appropriate notion of market prices or market values –as required by the Government Direction;

- by contrast, the ASM and the linear reference prices attempt to apply a notion of opportunity cost in the auction to inframarginal units and, contrary to the Direction, would yield a systematically lower measure than market prices or values;

- with its focus on marginal units, Walrasian prices suffer less from a "missing bid" problem than either linear reference prices or the ASM (which, as discussed further below, suffers from a severe "missing bid" problem); and

- both Walrasian prices and linear reference prices have the benefit of not being bidder-specific.

For the avoidance of doubt, Three would be content with use of either Walrasian prices or linear reference prices in determining the ALFs on 900MHz and 1800MHz spectrum, but considers the proposed Additional Spectrum Methodology to be deeply flawed and unacceptable.

**The ASM can produce extremely low and unstable prices.**

Ofcom has rejected Vickrey pricing for the Auction, in favour of core-selecting mechanisms (such as ”Vickrey nearest”). This is because, in

environments violating the substitutes' conditions, the Vickrey prices are generally outside the core and may be uncompetitively low.[143]

The same factors that lead to the rejection of Vickrey pricing in the Auction should also lead to rejection of the proposed ASM (please see Annex G where we provide examples of ASM producing extremely low prices). In the Annex, we provide two examples where the prices paid for 800MHz blocks are approximately £200 million, while the ASM produces prices for 900MHz blocks of approximately £0 – 10 million only.

**The ASM suffers from a "missing bids" problem.**

Even if opportunity cost were the right pricing measure, then the bids needed to ascertain opportunity cost would not necessarily be generated in the Auction. There are a variety of reasons for this "missing bids" phenomenon, including:

- the relevant quantity of spectrum is not being offered in the Auction;
- bidding for the relevant quantity of spectrum is not permitted by the spectrum caps;
- bidding for the relevant quantity of spectrum is not permitted, due to the prohibition on "infeasible bids" (see Second Consultation, paras 7.28 – 7.35); and
- a bidder has no incentive to submit a bid that has minimal chance of winning and whose only role is to set an opponent's ALF.

For example, one of Ofcom's suggested comparisons for identifying the ALF for EE's 2x45MHz of 1800MHz spectrum is para A13.69c):

> " *the additional amount that bidders other than Everything Everywhere would have been willing to pay if the total amount of spectrum on offer in the auction had included an additional 2x45*

[143] See, for example, L. Ausubel and P. Milgrom, "Ascending Auctions with Package Bidding," Frontiers of Theoretical Economics, 2002

*MHz of 1800MHz spectrum (as a proxy for the 2x45MHz of 1800 MHz spectrum retained by Everything Everywhere)*".

However, bidders in the Auction will each only be able to bid for 2x15MHz of 1800MHz spectrum –as that is the supply of 1800MHz spectrum in the Auction (assuming that EE's divestment goes into the Auction).

We illustrate the problem of 'missing bids' by the following hypothetical examples.

Example 1 ("missing bids").

We assume that Vodafone, O2 and Three's valuations for 1800MHz spectrum are £X, £Y and £Z, respectively, per 2x15MHz block, where X > Y > Z. Moreover, each of these bidders would ideally like to acquire 2x30MHz of 1800MHz spectrum if this amount of spectrum were available in the Auction.

Accordingly, the amount that bidders other than Everything Everywhere would have been willing to pay for 2x60MHz of 1800MHz spectrum (the quantity if an additional 2x45 MHz is included) would be £(2X + 2Y).

Nevertheless, the amount that they are willing to pay for the 2x15MHz actually in the Auction is £X. Therefore, the additional amount that bidders other than EE would have been willing to pay for an additional 2x45MHz is £(X + 2Y). Hence, the true opportunity cost of 2x45MHz of 1800MHz spectrum is £(X + 2Y).

However, the necessary bid data will not in fact be generated in the Auction. Indeed, Vodafone, O2 and Three are permitted to bid for only 2x15MHz of 1800MHz spectrum, since that is the supply of 1800MHz spectrum in the Auction. So, if these were the only bidders for 1800MHz spectrum, the only bids in the Auction for the 1800MHz spectrum will be £X, £Y and £Z.

Repeating the calculations of the previous paragraph using only the bid data, the amount that bidders other than Everything Everywhere would have been willing to pay for 2x60MHz of 1800MHz spectrum (the quantity if an additional 2x45 MHz is included) would appear to be only £(X + Y +

Z). The amount that they are willing to pay for the 2x15MHz actually in the Auction is £X.

Therefore, the additional amount that bidders other than EE would have been willing to pay for an additional 2x45MHz would appear to be only £(Y + Z). The estimated opportunity cost would then be less than two-thirds of the actual opportunity cost. This example illustrates that the ASM is highly unreliable.

Example 2 (impact of spectrum caps).

A similar problem arises in attempting to determine the opportunity cost of Vodafone's or O2's 900MHz spectrum. The bids needed to ascertain this opportunity cost will not be generated in the Auction, due to the spectrum cap. For example, Ofcom states the suggested comparison for identifying the ALF for O2's 2x17.4MHz of 900MHz spectrum in para A13.69a):

> "*the additional amount that bidders other than Telefónica would have been willing to pay if the total amount of spectrum on offer in the auction had included an additional 2x15MHz of 800MHz spectrum (as a proxy for the 2x17.4MHz of 900MHz spectrum retained by Telefónica)*".

We assume that the values of Vodafone, Everything Everywhere and Three for 800 MHz spectrum are £A, £B and £C, respectively, per 2x5MHz block, where A > B > C. Moreover, each of these bidders would like to acquire 2x30MHz of 800MHz spectrum.

Then the amount that bidders other than O2 would have been willing to pay for 2x45 MHz of 800 MHz spectrum (the quantity if an additional 2x15 MHz is included) would be £(6A + 3B).

The amount that will be actually paid for the 2x30 MHz in the Auction is £6A. Therefore, the additional amount that bidders other than O2 would have been willing to pay for an additional 2x15 MHz is £3B.

However, the necessary bid data will not be generated in the Auction. Vodafone is permitted to bid only for 2x10MHz of 800MHz spectrum, due to the spectrum cap. Everything Everywhere and Three are each

permitted to bid for only 2x25MHz of 800MHz spectrum, due to the spectrum cap. Repeating the calculations of the previous paragraph using only the bid data, the amount that bidders other than O2 would have been willing to pay for 2x45MHz of 800MHz spectrum would be only £(2A + 5B + 2C).

The amount that they will be paid for the 2x30MHz actually in the Auction is £(2A + 4B). Therefore, the additional amount that bidders other than O2 would have been willing to pay for an additional 2x15MHz would appear to be only £(B + 2C). The estimated opportunity cost would then be lower than the actual opportunity cost of £3B. This further shows that the methodology is unreliable.[144]

Example 3 (exclusion of 'infeasible bids').

In Three's response following the First Consultation, we observed that bidders should be excluded from submitting "infeasible bids", as otherwise such bids could be used to bid up clock prices and impose costs on opponents.

Ofcom now recognises this concern. In the Second Consultation, Ofcom says:

> "*We agree with consultation responses on this issue that it is desirable, and important for the purpose of meeting our objectives for the auction, to prevent bids that cannot win from influencing prices. We therefore propose to prevent bidders from making such bids by identifying ahead of the first Primary Bid Round a list of packages (Permissible Packages) for each bidder that excludes those packages that cannot win in any circumstances. The list would remain the same throughout the Principal Stage.*"[145]

However, at the same time that Ofcom inserted the prohibition on "infeasible bids", it also proposed the ASM that sometimes requires such infeasible bids in order to calculate opportunity cost. For example, in Example 2 above, such bids were needed to establish EE's value for

[144] Obviously the identical problem also occurs in determining the opportunity cost of Vodafone's 900MHz spectrum.
[145] Para 7.31

2x30MHz of 800MHz spectrum in order to calculate the opportunity cost of Vodafone's or O2's 900 MHz spectrum. However, suppose that EE's divestment of 1800MHz spectrum goes to Vodafone or O2. Then, any bid by Everything Everywhere for more than 2x20MHz of 800MHz spectrum cannot win under any circumstance, as 2x10MHz of 800MHz spectrum are reserved for the MSP, therefore would be prohibited as infeasible.

Indeed, the Second Consultation appears to be self-contradictory in supposing that the necessary bids will be available to calculate true opportunity costs as it prohibits the submission of some of the necessary bids. Or, to put it differently, the ASM could produce values for the ALF where bidders in the Auction would be willing to pay more than the ALF for the licences, simply on account that the bidders were not permitted to submit the relevant bids.

For the avoidance of doubt, Three is not suggesting that infeasible bids should be permitted in the Auction, but that the ASM should not be used for setting ALFs as it is can be shown to be flawed and unreliable.

**The ASM is ad hoc and without objective basis.**

The procedures of the ASM appear to be arbitrary. one clearly ad hoc aspect of Ofcom's outlined procedure is that the standard of comparison for different bidders' spectrum is not necessarily the same.

For example, for O2's and Vodafone's existing 1800MHz spectrum, Ofcom considers that the only relevant comparison is how much other bidders would have been willing to pay for a comparable quantity of 2.6GHz spectrum (para A13.69e) and f)).

However, for EE's existing 1800MHz spectrum, Ofcom considers that one of the relevant comparisons is how much other bidders would have been willing to pay for a comparable quantity of 1800MHz spectrum (para A13.69c) and that a second relevant comparison is how much other bidders would have been willing to pay for a mixture of 800MHz and 1800MHz spectrum (para A13.69d).

Ofcom has not provided any explanation for this apparent lack of consistency.

**The ASM's pricing is contrary to the goals of Ofcom's wider competition policy objectives.**

Ofcom has determined that it is appropriate to intervene in the auction market by implementing MSPs. This is because Ofcom considers that ensuring a fourth credible national wholesaler will produce much lower consumer prices and greater consumer surplus. Therefore, Ofcom is specifically favouring outcomes which result in a fourth credible national wholesaler. We strongly support this approach.

Indeed, one of the strongest justifications for Ofcom's intervention in the Auction is that the three large existing wholesalers have a strong strategic incentive to foreclose a fourth credible national wholesaler. In comparison, the fourth wholesaler only has a meaningful incentive to bid the intrinsic value that can be realised from a MSP or other spectrum package. Each of the three large wholesalers has the incentive to bid up to the sum of the intrinsic value of a given spectrum package plus the wholesaler's share of the strategic investment value resulting from a market structure comprising only three credible national wholesaler. Moreover, if there were no intervention in the Auction, the Auction would be likely to conclude with only three credible operators, as Ofcom rightly concludes.

We note that the ASM approach creates similar strategic investment incentives, whereby holders of 2G licensees are able to bid up the Auction prices of 800MHz spectrum in order to foreclose competition, without any consequence to the ALFs for their 900MHz and 1800MHz spectrum holdings. This is because the ASM significantly underestimates full market value of the spectrum in the Auction and weakens the linkage between the Auction prices and the ALF.

### 8.4. Ofcom should adjust the ALF to reflect that 900MHz spectrum has higher market value than 800MHz spectrum.

### 8.5. Ofcom should also adjust the ALF to reflect the option value of 900MHz and 1800MHz relinquishment.

Another source of materially greater value of the liberalised 900MHz and 1800MHz licences is that they can be relinquished at any time, resulting in no further ALF payments. In comparison, no equivalent option exists for the holders of the 800MHz and 2.6GHz licences during the initial 20-year term. Accordingly, the opportunity for holders to relinquish the 900MHz and 1800MHz – and reduce total ALF payments – embeds a considerable option value into the licences.

Indeed, ALFs will by definition be paid annually on the liberalised licences; Ofcom has already specified that the ALFs will be calculated as an annuity whose present value is equivalent to the corresponding Auction price. However, there is considerable uncertainty in future licence values; over a fairly short time interval, the value sub-1GHz spectrum could increase by 50% — or it could decrease by 50%. The liberalised 900MHz licences and the auctioned 800MHz licences fare quite differently under such circumstances.

For example, if sub-1GHz spectrum values increased by 50%, both 800MHz and 900MHz licensees benefit equally from large capital gains. However, if sub-1GHz values decreased by 50%, 800MHz licensees suffer large capital losses, while 900MHz licensees have the option to relinquish their licences. Afterward, they would be free to bid for the licences in subsequent auctions, should they wish, and pay only the market price — avoiding the associated capital loss.

We urge Ofcom to conduct a careful study to value the free option associated with relinquishment. It is evident that the option value is

considerable. Failing to incorporate the option value of relinquishment into the ALF calculation could also amount to impermissible State aid.

## 8.6. Overall, Ofcom should reinstate the direct linkage between 900/1800MHz ALFs and the Auction prices.

- As discussed above, Ofcom should not use the ASM for setting ALFs. This ASM methodology is flawed and consistently understates corresponding full market value of spectrum.

- The ALF should be set using Ofcom's initial proposal of the linear reference prices.

- Alternatively, Ofcom could specify a combination of the lowest accepted bid and the highest rejected bid for an 800 MHz block[146] (so called Walrasian prices).

- We agree with Ofcom that external benchmarks should be used to reduce the risk of ALFs being set below full market value if the Auction is not fully competitive and in order to ensure ALFs meet the requirements of the Government Direction. In Section 7, we have reviewed recent European

[146] More precisely, Ofcom should use a pre-determined convex combination of the lowest accepted and highest rejected bids for each of the categories of 800MHz spectrum in the auction, weighted by the number of licences in each category, plus one sixth of the total of all winning 800MHz assignment stage bids as its measure of market price for 800 MHz spectrum from the auction.
We define the lowest accepted bid in a category to be:
Max { linear reference price for a category , the decrease in maximized bid revenues if there were one fewer lot in the category }.
We define the highest rejected bid in a category to be:
Max { the reserve price, Max N { ( the increase in maximized bid revenues if there were N additional lots in the category) / N } }
Note that, with substitute preferences, this definition of lowest accepted bid coincides with the highest Walrasian price, and this definition of highest rejected bid coincides with the lowest Walrasian price.

auctions and concluded that auctions in German and Italy are the most relevant.[147]

Therefore, we propose that the 900MHz ALF should be based on:

Max {UK 800MHz auction price, International comparison price}.[148]

- To obtain the ALF basis for 900 MHz spectrum, Ofcom should add an appropriate measure of the amount by which the value of 2x5MHz of 900MHz spectrum exceeds the value of 2x5MHz of 800 MHz spectrum.
- 
- Finally, the ALF should be based on a multiple of the auction-determined measure of value, to reflect the option value of relinquishment.
- 

The ALF would be calculated as an annuity whose present value is equivalent to this value.

We also support Ofcom's proposal of interim ALF. In A13.98, Ofcom states:

> "*If new developments led to a delay in the award of the 800MHz and 2.6GHz bands, we would also expect to consider whether to update current fee levels for 900MHz and 1800MHz spectrum ahead of the auction. We would therefore consider whether it*

[147] Both auctions were competitive and mobile markets are reasonably similar to the UK.
[148] We suggest that Ofcom should average the MHz*pop prices for sub-1GHz spectrum from the German auction of 2010 and the Italian auction of 2011. This results in a comparable price of €485 million per 2x5 MHz block. Converted at an exchange rate of 1.2 € per £, this is equivalent to £404 million.

> *might be suitable to introduce interim revised ALFs ahead of fully implementing the Direction after the auction*."

We further propose that the interim ALF be implemented as soon as possible. Namely, the interim ALF should be calculated based on 100% of the German-Italian auction price to provide the 2G licence holders an incentive to facilitate a speedy auction and because this price is the best estimate of the value of UK licences until the Auction takes place.

**Section 8 Recommendations**

- Ofcom should restore the direct linkage between ALFs and Auction prices.
- Ofcom should use international auction prices to establish a floor for the ALFs.
- Ofcom should adjust the ALFs derived from Auction prices to reflect the higher value of 900MHz spectrum vs. 800MHz spectrum.

# 9. Ofcom's proposals do not support maximisation of mobile coverage.

*This Section sets out Three's concerns regarding the interaction of the Auction design with the Government's Mobile Infrastructure Project ("**MIP**") proposals. It also considers Ofcom's coverage obligation. In conclusion:*

*i. The MIP will be essential for improving mobile voice coverage and quality, and for maximising coverage of next generation mobile broadband services – as without the MIP or a similar initiative, UK mobile coverage is unlikely to grow beyond its current level;*

*ii. Ofcom's finding that sub-1GHz spectrum is not needed to be a credible national wholesaler fundamentally undermines the MIP – as the MIP must treat all national wholesalers equally, the Government will have to restrict the MIP sites to use for 1800MHz deployment and above, which will restrict the additional mobile coverage achievable; and*

*iii. Ofcom's finding that sub-1GHz spectrum is not needed to be a credible national wholesaler will perpetuate and extend the existence of partial not spots, itself an important Government and Ofcom concern.*

## 9.1. The MIP will be essential for improving mobile voice coverage and quality, and for maximising coverage of next generation mobile broadband services.

The Government has committed to invest £150m in mobile infrastructure to improve the coverage and quality of mobile network services for those consumers and businesses that live and work in areas of the UK which are the hardest to serve.

In particular, the Government has established a joint team from DCMS, BDUK and Ofcom, to run the MIP and achieve its objectives. It has specified that the objectives of the MIP are:

– to improve the coverage and quality of mobile network services for the five to ten per cent of consumers and businesses that live and work in areas of the UK where existing mobile network coverage is poor or non-existent; and

– to extend coverage to 99 per cent of the UK population. [149]

Three greatly welcomes the Government's commitment to improving mobile coverage and the specific objectives of the MIP. In particular, through the MIP and Ofcom's proposed coverage obligation, the Government and Ofcom have recognised a clear need to extend both mobile voice and mobile broadband services to rural areas, beyond the level that might otherwise be commercially viable.

Three will continue to engage closely with the Government's MIP team to help implement this project.

Ofcom has recognised that, since the First Consultation, the MIP "*has opened up the possibility of additional infrastructure being available to support the delivery of new mobile broadband services into rural areas*."[150]

In particular, Ofcom's preferred approach to coverage is to specify a coverage obligation by reference to existing 2G coverage (of all existing 2G networks in combination), plus the additional mobile voice coverage provided by the MIP (to the extent that the MIP infrastructure is capable of supporting 4G network equipment). It is clear from the Second Consultation that Ofcom strongly supports the MIP and that Ofcom's proposed coverage obligation relies on the success of the MIP.

As the Government has recognised, it is not commercially viable for national wholesalers to extend mobile communications services into remote rural areas significantly beyond current coverage levels without a specific obligation and/or associated commitment to do so. Indeed, the Government MIP team has specifically recognised that the current extent of 2G mobile services is probably the maximum commercially viable level of geographic coverage. For that reason, neither the Government nor Ofcom is likely to achieve their objectives of extending mobile voice and

[149] Page four of Industry Stakeholder Engagement Paper January 2012, release 1.0 available here: http://www.culture.gov.uk/images/publications/Mobile_Infrastructure_engagement_Rel_1_0.pdf

[150] Second Consultation, para. 5.2.

mobile broadband coverage without imposing a specific obligation to do so and an effective plan to assist with such roll-out.

Accordingly, the MIP is critical for the Government to achieve its objective to extend mobile voice coverage into rural areas and for Ofcom to implement its mobile broadband coverage obligation to the maximum benefit of citizens and consumers.

Overall, Three strongly supports Ofcom's proposed approach to the coverage obligation. In addition, Three agrees with Ofcom that a 2x10MHz block of 800MHz is necessary to deliver the coverage obligation cost effectively and that it would be disproportionate to apply this to more than one 800MHz license. Ofcom should also specify, at a minimum, that the coverage obligation will support 2Mbps download speed to 90% UK population coverage.[151]

## 9.2. Ofcom's finding that sub-1GHz spectrum is not needed to be a credible national wholesaler fundamentally undermines the MIP.

Ofcom's position in the Second Consultation that sub-1GHz spectrum is not needed for a national wholesaler to be credible fundamentally undermines the wider MIP programme, as:

- the Government is clear that the MIP must secure the participation and equal treatment of all four national wholesale mobile operators;
- there is common agreement among the four national wholesalers that the best technical solution for the MIP is "hosted sites" on which each wholesaler deploys their own spectrum;

[151] To provide assurance that indoor coverage is likely at any given location the minimum signal level should be set at around -83dBm calibrated using agreed radio planning tools.

- to secure equal treatment of all wholesalers, the MIP must be limited only to spectrum that is accessible to all wholesalers, namely high frequency spectrum; and

- limitation to high frequency spectrum will nevertheless materially compromise the MIP's objectives and value for money it will achieve – compared to what could be achieved with sub-1GHz spectrum – due to the greatly inferior geographic propagation characteristics of sub-1GHz spectrum.

#### 9.2.1. The Government is clear that the MIP must secure the participation and equal treatment of all four national wholesale mobile operators.

The Government's recent MIP consultation is clear that the MIP should secure the participation of all four national wholesalers, so that the benefits of the MIP are available to all UK citizens. Specifically, the Government has stated that "*[t]he procurement is dependent upon achieving consensus from the existing mobile spectrum licence holders*."

The consultation is also clear that the MIP must ensure the equal treatment of all wholesalers: one of the design principles of MIP is to *"offer equal access to spectrum owners to any government funded infrastructure."*[152]

Such a requirement is also necessary in order to ensure that the MIP is compliant with State Aid rules: "*[t]he procurement is dependent upon […] gaining State Aid clearance from the European Commission*".[153] Even beyond State Aid requirements, it is a key objective of the MIP "to enable the removal of 'complete' voice not-spots without converting them to 'partial' not-spots",[154] confirming the Government's intention that the MIP must provide extended mobile coverage for customers of all national wholesalers, not just a subset of national wholesalers.

[152] Page 6 of Government Consultation.
[153] DCMS MIP Consultation.
[154] DCMS MIP Consultation.

The Government's MIP team has also unambiguously confirmed these requirements, both in bilateral discussions with national wholesalers and in a recent industry workshop on the MIP.[155]

#### 9.2.2. There is common agreement among the four national wholesalers that the use of "hosted sites" on which each wholesaler deploys their own spectrum is the best technical solution for the MIP.

The MIP consultation asked for industry views on the best technical solution for the implementation of the MIP; in particular, whether hosted sites or wholesale access would offer a better technical solution.

The Government's MIP team has confirmed that there was a consensus among the four national wholesalers that hosted sites, on which each wholesaler deploys their own equipment and associated spectrum, is the best technical solution for the MIP. The MIP team also confirmed that a near industry consensus, including potential infrastructure bidders and equipment vendors, favoured a hosted site approach.

At the recent industry MIP workshop, no participants advocated wholesale access, namely where some national wholesalers make use of another wholesaler's spectrum through wholesale access arrangements, as an effective or workable solution.

#### 9.2.3. To secure equal treatment of all wholesalers, the MIP must be limited only to spectrum that is accessible to all wholesalers, namely high frequency spectrum.

In planning and procuring the MIP infrastructure, a key consideration in the design of that infrastructure will be spectrum available to each national wholesaler.

This is because the spectrum available to each national wholesaler will determine the geographic area that can be covered by a given cell site. In turn, this will determine the optimum location of cell sites to allow the

[155] BDUK/Intellect "Mobile Infrastructure Project Concept Viability Workshop", 7 March 2012.

required number of prospective consumers and geographic areas to be covered in order to maximise the benefit to consumers.

As demonstrated in this response, sub-1GHz spectrum has considerably superior geographic propagation characteristics than high frequency spectrum.

However, given Ofcom's finding that sub-1GHz spectrum is not necessary to be a credible national wholesaler, Ofcom's auction proposals do not guarantee that all wholesalers will hold sub-1GHz spectrum post-Auction.

Accordingly, in order to secure the equal treatment, and participation, of all national wholesale mobile operators, the Government will need to plan, procure and design the MIP on the basis of the "lowest common denominator" – i.e. lowest frequency – spectrum that all national wholesalers currently hold or will have reasonable assurance of holding in the future, namely, 2.1GHz or potentially 1800MHz. Similarly, the Government will also need to prescribe that wholesalers only use spectrum on MIP infrastructure that is commonly held across all national wholesalers.

Otherwise, should the Government procure the MIP around spectrum only held by a subset of national wholesalers, or allow wholesalers to use any mobile spectrum on the MIP, this will result in highly unequal treatment of respective national wholesalers, as:

- the wholesaler(s) without access to sub-1GHz spectrum would be at a significant technical, coverage and thereby commercial disadvantage compared to the wholesalers with access to sub-1GHz spectrum; and

- in contrast, wholesalers with access to sub-1GHz spectrum would be able to cover more customers, generate greater revenues and considerably enhance their brand value through an unearned coverage advantage.

Moreover, the MIP's objectives will not be met, in particular:

- the MIP will not be able to achieve its objective of "*the removal of 'complete' voice not-spots without converting them to 'partial' not-spots*" and would not maximise benefits to all consumers;

- there will not be equal access to government funded infrastructure offered to spectrum owners;

- consensus from the existing mobile spectrum licence holders will not be achieved; and

- State Aid clearance from the European Commission is unlikely to be granted.

Indeed, unless the MIP were limited to spectrum held by all national wholesalers, then the MIP would be at high of risk constituting an unlawful State Aid. This would not be justified under Article 107(3)(c) TFEU, as, in applying the test under Article 107(3)(c), the Commission will need to consider whether access to the State-funded infrastructure is non-discriminatory, alongside the potential distortions of competition and the effect on trade.

Other than prescribing that higher-frequency spectrum is the only spectrum allowed to use the MIP, the Government is left with few, if any, options to address the adverse effects described above.[156]

#### 9.2.4. Limiting the MIP to high frequency spectrum only will nevertheless materially compromise the MIP's objectives and value for money.

If the MIP were limited to high frequency spectrum only, then this would severely compromise the MIP's coverage objectives in comparison to being able to base the MIP on sub-1GHz spectrum if that spectrum were

[156] In its recent consultation response on the MIP proposals, Three mooted the possibility that it might theoretically be possible to compensate for the disadvantage by offering a financial advantage such as through reduced operating costs for the fourth national wholesaler. On further reflection, however, Three has concluded that the scale of the disadvantage is likely to be too great to compensate in this way.

accessible to all national wholesalers. This is due to the greatly superior propagation characteristics of sub-1GHz spectrum.

While Ofcom evidently recognises the "*advantages of lower frequency spectrum in terms of delivering breadth of coverage*",[157] it considers current 3G coverage delivered on high frequency spectrum – of around 90% UK population coverage – is sufficient to be a credible national wholesaler. In contrast, Ofcom notes that 2G networks, delivered on sub-1GHz spectrum, already provides outdoor coverage to around 99% of UK premises.[158] Hence, it is clear that high frequency spectrum alone will not be effective achieving the Government's objective of improving the coverage and quality of mobile network services to consumers and businesses that live and work in areas of the UK where existing mobile network coverage is currently poor or non-existent.

As an illustration, the MIP team's initial not spots analysis shows that 13,000 out of 252,000 premises in Cumbria, a predominantly rural are, are in outdoor total not-spots,[159] namely, outdoor mobile voice premises coverage in Cumbria is currently 95%. In contrast, Three's outdoor population coverage in Cumbria, as recently shared with Ofcom, is [redacted]. Three's lower coverage chiefly reflects Three's higher frequency spectrum: deploying sub-1GHz spectrum onto Three's existing sites in Cumbria would increase outdoor population coverage to [redacted].

Three currently has [redacted] sites in Cumbria. Three estimates that adding a further [redacted] sites in Cumbria using existing spectrum would increase outdoor population to [redacted], thereby contributing little to reducing existing total not-spots. However, if Three were able to deploy sub-1GHz spectrum onto the new and existing sites, then outdoor population coverage would increase to [redacted], thereby removing four out of five existing premises in Cumbria from total not-spots.

[157] Second Consultation, para. 4.78.
[158] Second Consultation, para. 4.78.
[159] Not spots database provided to Three, assessed at -92dBm signal strength.

### 9.3. Ofcom's finding that sub-1GHz spectrum is not needed to be a credible national wholesaler will perpetuate and extend the existence of partial not-spots.

Ofcom's finding that sub-1GHz spectrum is not needed to be a credible national wholesaler will perpetuate and extend the existence of partial not-spots. This is because existing "partial" not-spots – where less than four national wholesalers currently provide mobile coverage – are primarily due to differences in sub-1GHz spectrum holdings.

In particular, most partial not-spots arise where the two existing holders of sub-1GHz spectrum (O2 and Vodafone) offer coverage, but the two existing wholesalers that do not have sub-1GHz spectrum, are unable to offer coverage.

Ofcom has specifically identified partial not-spots as an important coverage issue that needs to be addressed.[160] The Government is also clear that the MIP must remove total not-spots, not just convert them into partial not-spots.

Nevertheless, Ofcom's current Auction proposals, by not guaranteeing sub-1GHz spectrum to four national wholesalers, which Ofcom recognises has advantages for delivering national coverage, will expressly perpetuate the existence of partial not-spots and greatly extend them into new and future services.

[160] For example, Mobile not-spots: An update on our research, Ofcom, November 2010.

# Annex A. Three's answers to Ofcom's questions.

**Question 4.1: Do you agree with our assessment of the competition concerns relating to wholesale national competition that could arise with no measures to promote competition?**

We answer this point in detail in Sections 2, 4 and 5 of our response.

**Question 4.2: Do you agree that option 4 should be adopted to promote national wholesale competition?**

We answer this point in detail in Sections 2, 4, 6 and 7 of our response.

**Question 4.3: Do you agree that the portfolios in group 2 (middle portfolios) of option 4 are likely to be the most appropriate and proportionate implementation of this option.**

Section 7 sets out in detail our recommendations on what we believe to be the most appropriate design of the portfolios.

**Question 4.4: Do you believe that geographically split licences for a particular block of 2.6GHz spectrum between standard power use and lower power use is likely to create significant additional benefits for consumers?**

We do not see that there is any significant benefit to adopting the geographically split licences proposal.

**Question 4.5: Please provide your views including the reasons for them on which options you believe should be taken in relation to promoting low power shared use of 2.6GHz spectrum.**

We have no additional comments beyond the points we made in our response to the first consultation document.

**Question 5.1: Do you have comments on the proposal to include a coverage obligation in at least one of the 800MHz licences, and the proposed extent of such a coverage obligation?**

We agree that such an obligation should be placed on one 800MHz licence and discuss this in more detail in Section 9.

**Question 5.2: Do you have any comments on which of the two approaches proposed for the specification of such an obligation would be preferable: Approach A, which would require the licensee to provide 4G mobile data service to an area within which at least 98% of the UK population lives; or Approach B, which would require the licensee to provide the specified mobile data service with coverage comparable to the combined mobile voice coverage of today's 2G networks and in addition to provide the same service with coverage comparable to that of the additional mobile voice coverage achieved through the MIP, in those areas where MIP infrastructure is capable of supporting a 4G mobile data service?**

We agree with Approach B but are concerned that the current auction design (in so far as not all wholesalers are guaranteed sub-1GHz spectrum) will undermine the objectives of the MIP. Our reasoning is discussed in Section 9.

**Question 5.3: Do you have any comments on our assessment that it is unlikely to be proportionate to impose such a coverage obligation on more than once licensee?**

We agree with Ofcom's assessment on this point.

**Question 5.4: Do you have any views on the costs and benefits of a wholesale access obligation on the licensee with the coverage obligation in respect to those areas beyond existing 2G mobile voice coverage.**

Wholesale Access models have multiple drawbacks:

1. Practically, it is extremely difficult to negotiate commercially acceptable roaming rates. In our experience, commercial national roaming rates are typically too high (due to lack of competition). If set by a regulator, wholesale rates are often disputed by operators.
2. It is often not technically feasible to restrict roaming to the MIP sites only. Customers would be forced to roam on the wholesaler network in a wider area than the coverage extension (so called "forced" roaming). This would increase roaming costs and more critically would provide inferior customer experience.
3. The Wholesale Access model would need to ensure spectrum and handset compatibility. For example, the wholesaler will deploy 800MHz spectrum to meet the obligation, but under current proposals not all operators will have this spectrum and therefore may only sell handsets for 1.8GHz, 2.1GHz and 2.6GHz spectrum, their customers will not be able to benefit from extended coverage.
4. For all the reasons above the regulatory and compliance costs would be disproportionate and the practical issues would be extremely difficult to properly address.
5. Overall, we do not recommend this model for delivering extended coverage.
6. The Government MIP team has confirmed that the same views about the drawbacks of wholesale access are shared by all current national wholesalers and many other industry participants.

**Question 5.5: Do you have any comments on the possibility that we may in certain limited circumstances consider granting concurrent licenses as set out in paragraphs 5.88 to 5.93?**

We have no comments on this point.

**Question 6.1: Do you agree with our revised proposals for the packaging of the 800MHz band?**

For the reasons set out in this response, we believe that under the current proposals it seems unlikely that the fourth operator will be able to win 800MHz and therefore have no detailed comments on this point at this time.

However if Ofcom were to revise these proposals to ensure that the fourth wholesale were guaranteed 800MHz spectrum then we would urge Ofcom to consider whether the current packaging proposals combined with the auction rules are likely to result in the fourth operator being allocated the bottom block(s) of 800MHz and therefore being at greater risk of interference. Ofcom, in the First Consultation, felt that allocation of these blocks to the fourth operator would be unfavourable. We consider that same reasoning would continue to hold in light of revising its view about the importance of sub-1GHz spectrum.

**Question 6.2: Do you agree with our revised proposals for the packaging of the 2.6GHz band?**

We agree that the use of 2x5MHz 2.6GHz lots for paired spectrum provides for more flexibility that the previous proposal of 2x10MHz lots.

We are concerned that the sale of unpaired spectrum in 5MHz lots (with the associated restricted blocks) might result in the TDD spectrum being broken up into small block sizes that don't necessarily represent the most efficient use of this spectrum. In our experience unpaired spectrum tends to be acquired and used in larger blocks, and the need for the restricted blocks between licensees has the potential to result in significant wastage. Three remains of the opinion that the unpaired spectrum should be in minimum 25MHz lots.

**Question 7.1: Do you agree with our revised proposals for the number of eligibility points that should attach to each lot?**

We do not agree with the ratio of eligibility points between 800MHz and 1800MHz lots, see Section 7 which sets out our recommendations on this point.

**Question 7.2: Do you have any comments on the proposed auction rules as explained in section 7, Annex 11 and Annex 12?**

See Section 7 and Annex B for our comments on the proposed auction design.

**Question 8.1: Do you have any comments on the Additional Spectrum Methodology as one of the several sources of information for estimating the full market value of spectrum?**

See Section 8 and Annex G for our views on this point.

**Question 8.1: Do you have any comments on our updated thinking on estimating full market value for the purposes of revising ALF as set out in this section and Annex 13?**

See Section 8 and Annex G for our views on this point.

**Question A7.1: We would welcome comments on any aspect of the data, assumptions and modelling methodology we have used in our technical analysis, in particular our approach to serving users in a range of both easier and harder to serve locations.**

Section 3 and Annex F details our assessment of Ofcom's technical modelling methodology.

**Question A7.2: We would welcome any additional information, in particular from current operators, on the choice of parameters making up our Min var and Max var cases.**

Section 3 and Annex F discusses our views on the Min var and Max var cases.

**Question A8.1: Do you agree with our assessment of when Everything Everywhere, Vodafone and Telefonica are likely to be able to refarm their existing 2G spectrum? In particular, do you agree with our views on the importance of user devices and the likely availability and take-up of devices that use different technologies and bands? Please state reasons for your views, including if appropriate your views on handset roadmaps and the practical constraints which apply to those roadmaps.**

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# Annex B. Handicaps to level the playing field for the opt-in competition.

Ofcom is concerned that the bidding would not be particularly competitive in an asymmetric auction. In particular, if Bidder A is competing with Bidder B for becoming the opt-in winner, and if Bidder A's MSP is smaller than Bidder B's MSP, Ofcom is concerned that the contest is biased in favour of Bidder A. Under such circumstances, we propose to mitigate this difficulty by providing a "handicap" to Bidder B. This simple modification to the auction procedures would ameliorate the asymmetry and level the playing field for becoming the opt-in winner.

In so doing, the proposed "handicap" takes away any excuse for Ofcom to sacrifice its higher objective of ensuring adequate competition in the post-auction market for mobile services. With the proposed handicap in place, the MSPs can be set so as to ensure that the auction ends with a fourth national wholesaler who, on its own, holds sufficient spectrum to be a credible national wholesaler.

For any opt-in bidder, the implicit subsidy provided by winning the spectrum MSP approximately equals:

(Final clock prices – Reserve prices), evaluated at the winning MSP.

For example, suppose that the final clock price for 800MHz spectrum is £230 million and that the final clock price for 2.6GHz spectrum is £30 million, while the reserve price for 800MHz spectrum is £200 million and the reserve price for 2.6GHz spectrum is £20 million.

Suppose that first opt-in bidder is competing to buy 2 blocks of 800 MHz spectrum + 2 blocks of 2.6 GHz spectrum, while the second opt-in bidder is competing to buy 2 blocks of 800MHz spectrum + 5 blocks of 2.6GHz spectrum. The implicit subsidy provided to the first opt-in bidder is approximately:

2 x (£230 million – £200 million) + 2 x (£30 million – £20 million) = £80 million.

With the same price assumptions, the implicit subsidy provided to the second opt-in bidder is approximately:

2 x (£230 million – £200 million) + 5 x (£30 million – £20 million) = £110 million.

In this example, the appropriate "handicap" to provide to the second bidder is thus the difference between £110 million and £80 million. That is, the appropriate handicap is £30 million. In other words, the appropriate

handicap is the (Final clock prices – Reserve prices), *evaluated at the difference in the MPPs between the contestants*.

We will now state this more generally. For any opt-in bidder *i*, let $MPP_i$ denote the set of minimum portfolio packages applicable to bidder *i*. For any given final clock prices, define $MPP_i^{min}$ as follows:

$$MPP_i^{min} = \min_{\sigma \in MPP_i} \left\{ \left( \text{Final clock prices} - \text{Reserve prices} \right), \text{ evaluated for portfolio } \sigma \right\}$$

In a two-bidder asymmetric contest between opt-in Bidder A and opt-in Bidder B, the appropriate handicap, Handicap(B), to give to Bidder B is:

$$\text{Handicap(B)} = MPP_B^{min} - MPP_A^{min}, \text{ if } MPP_B^{min} > MPP_A^{min}, \text{ and zero otherwise.}$$

In words, $MPP_A^{min}$ is the amount of the implicit subsidy that Bidder A is likely to win and $MPP_B^{min}$ is the amount of the implicit subsidy that Bidder B is likely to win. To the extent that $MPP_B^{min} > MPP_A^{min}$, Bidder B should receive a handicap equal to the difference.

The way that the "handicap" would be applied is as follows. Under Ofcom's current rules, Ofcom would determine whether Bidder A or Bidder B wins the spectrum floor by calculating a first solution to the winner determination problem subject to Bidder A receiving an allocation that includes one of Bidder A's MSPs, and by calculating a second solution to the winner determination problem subject to Bidder B receiving an allocation that includes one of Bidder B's MSPs. If the first solution is greater than the second solution, then Bidder A is the winning opt-in bidder; otherwise, Bidder B is the winning opt-in bidder. However, note that selecting Bidder A reduces the solution of the winner determination problem (as compared to the maximum, unconstrained by the spectrum floor) by approximately $MPP_A^{min}$, while selecting Bidder B reduces the solution of the winner determination problem (as compared to the unconstrained maximum) by approximately $MPP_B^{min}$. Thus, to the

extent that $MPP_B^{min} > MPP_A^{min}$, Bidder B is at a disadvantage (by approximately the difference) in being selected.

Taking a handicap approach, we would alter the calculation as follows. Ofcom would again calculate a first solution to the winner determination problem subject to Bidder A receiving an allocation that includes one of Bidder A's MSPs, and again calculate a second solution to the winner determination problem subject to Bidder B receiving an allocation that includes one of Bidder B's MSPs. If the first solution exceeds the second solution by more than the amount Handicap(B), then Bidder A is the winning opt-in bidder; otherwise, Bidder B is the winning opt-in bidder. The specified handicap is a good first-order approximation to the amount needed to negate the bias and to select whichever opt-in bidder has the higher value for spectrum. Thus, it does a reasonably good job of levelling the playing field and symmetrising the competition for opt-in winner.

With three or more opt-in bidders, the analogous approach continues to work. The simplest specification is to say that we add $MPP_A^{min}$ to the solution of the winner determination problem subject to Bidder A receiving an allocation that includes one of Bidder A's MSPs, we add $MPP_B^{min}$ to the solution of the winner determination problem subject to Bidder B receiving an allocation that includes one of Bidder B's MSPs, we add $MPP_C^{min}$ to the solution of the winner determination problem subject to Bidder C receiving an allocation that includes one of Bidder C's MSPs, etc. The opt-in winner is the opt-in bidder for whom the adjusted solution to the winner determination problem is the greatest.

We have presented a workable solution that provides a viable national wholesaler if there is at least one opt in bidder and presented a plan for making opting in to these large portfolios more attractive to a new entrant. Clearly, Ofcom can meet its stated goal of obtaining a viable fourth national wholesaler according to its own standards. Ofcom can mitigate the reduction in competition to be opt-in winner that arises from asymmetries that creating a viable fourth national wholesaler inherently requires.

# Annex C. Importance of sub-1GHz spectrum according to regulators, mobile operators, academics and other parties.

## Introduction

In its Second Consultation Ofcom concludes that the technical advantages of sub-1GHz spectrum are "less clear".[161] Three's view is that the advantages are very clear. This Annex presents statements on the importance of sub-1GHz spectrum made by national regulatory authorities (NRAs), mobile operators, academic institutions, industry bodies and other industry stakeholders.

In summary, it is well established that sub-1GHz spectrum provides better in-building penetration and speeds and superior coverage per base station (thereby lowering the cost of deployment in rural areas) than higher frequency spectrum.

Accordingly, the dangers of excessive concentration of sub-1GHz spectrum have been highlighted by national regulators and academics. In recent auctions, most European regulators have taken measures to allow other operators to access sub-1GHz spectrum, either through redistribution of 900MHz spectrum, re-auctioning of 900MHz spectrum and/or a spectrum cap on sub-1GHz spectrum.

The rest of this Annex is structured as follows:

- Sub-section 2 provides an overview of statements made by Western European regulators;
- Sub-section 3 presents statements by regulators outside Europe;
- Sub-section 4 summarises examples arising from mobile operators and industry associations;
- Sub-section 5 considers statements made by academics;

[161] Consultation, para 1.24.

– Sub-section 6 examines statements from consultants; equipment vendors and other industry stakeholders;
– Sub-section 7 examines some country case studies (US and Hong Kong).

## C1. Statements by Western European Regulators ('NRAs').

### The European Commission's Decision on the T-mobile/Orange Merger.

In its decision on the merger between Orange and T-mobile, the European Commission recognised the superior propagation characteristics of 900MHz spectrum relative to 1800MHz or higher frequency spectrum:

> *"… different frequency bands present different propagation characteristics: lower frequency spectrum (e.g. 900 MHz) is generally preferable to higher frequency spectrum (e.g. 1800 MHz or 2600 MHz) as lower frequency signals generally travel further and penetrate more deeply into buildings than do higher frequency signals".* [162]

### Ofcom's view on the advantages of lower frequencies.

Ofcom did not always hold the view that the advantages of sub-1GHz spectrum are "less clear" and has made numerous statements that are much more aligned with the consensus view presented in this Annex. To cite one, in its First Consultation Ofcom's view was as follows:

> *"Sub-1 GHz spectrum gives advantages over higher frequencies in terms of coverage. It allows a significantly greater geographical area to be served than higher frequency bands would, for the same number of sites*

[162] Case No COMP/M.5650 – T-MOBILE/ ORANGE Notification of 11/01/2010 pursuant to Article 4 of Council Regulation No 139/2004,
Paras 120-121.http://ec.europa.eu/competition/mergers/cases/decisions/M5650_20100301_20212_247214_EN.pdf

> *(because signals travel further at lower frequencies). It also tends to provide substantially better signal quality and higher download speeds (throughput) within buildings than higher frequencies since lower frequency signals are better at penetrating solid objects. 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-1GHz spectrum."* [163]

Curiously, after its Second consultation Ofcom has published a report on Rail Not-Spots stating the following:

> *"Delivering a useable signal into train coaches is also frequency dependent. Lower frequencies (<1GHz) have better indoor penetration properties compared to higher frequencies, such as those above 1 GHz. Therefore, GSM900 is likely to provide a better signal onboard trains compared to GSM1800 assuming similar terminal devices are used - this would benefit those users on a GSM900 network. Coverage to indoor locations is challenging regardless if it's in a train car, building etc. Depth of coverage is another challenge in providing a mobile service to a train. Passengers in the middle of the train (or deeper within the train) have to also overcome "body loss" from other passengers, this weakens the signal further to those mobile users onboard the train".* [164]

**The approach taken by Western European Regulators to liberalisation of the 900MHz spectrum.**

In general, most European regulators have recognised the importance of sub-1GHz spectrum. 900MHz spectrum was often unevenly distributed

[163] Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues, Ofcom, 22 March 2011.

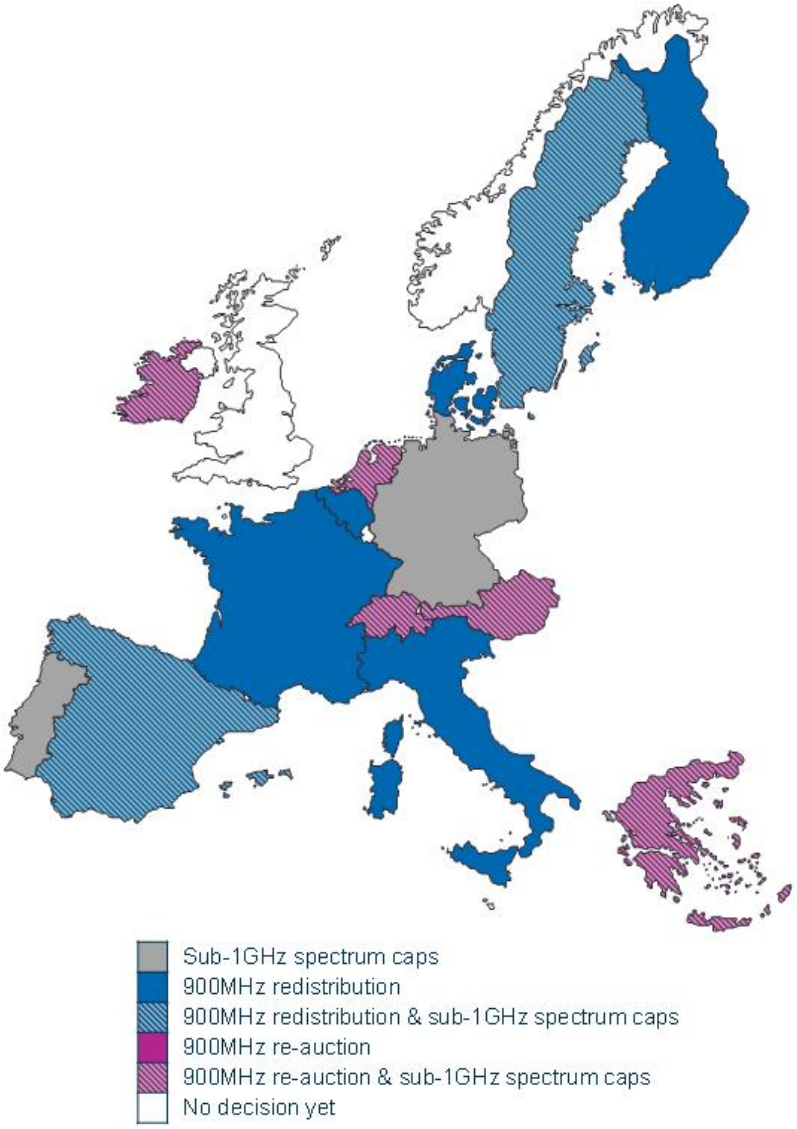
[164] Rail not-Spots. Technical Issues and Practical Solutions Jan 2012. http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/not-spots/rail-not-spots.pdf

between operators, especially in countries, like the UK, where 3G-only operators had entered the market.

Faced with this situation, European regulators have generally concluded that, absent remedial measures, liberalisation of GSM spectrum would adversely affect competition. In order to prevent that outcome, many regulators have taken measures to ensure a more even distribution of low frequency spectrum.

This has generally been achieved either through redistribution or re-auctioning of 900MHz spectrum (with or without a sub-1GHz spectrum cap where an auction for 800MHz band has taken place). Figure C1 summarises the measures taken by different NRAs across Europe.

**Figure C1: Western European regulators' policy measures relating to sub-1GHz spectrum**




Source: Three

Only in Germany and Portugal did the regulator limit itself to the imposition of spectrum caps. However:

- in Germany's auction, the operator-specific 800MHz spectrum caps put in place took into account their 900MHz holdings, so that no single operator would end up with disproportionate amounts of sub-1GHz spectrum. As Ofcom noted "*the regulator imposed caps which effectively limited two wholesalers (T-Mobile and Vodafone) to 2x22.4MHz and all other potential bidders to 2x20MHz of sub-1GHz spectrum. In contrast, it did not impose any caps on the higher frequency spectrum in the auction, indicating their greater concerns regarding excessive concentration in the sub-1GHz bands*." [165]

- In Portugal, rather than re-auctioning the entire 900MHz band, only one additional lot of 2x5MHz of 900MHz spectrum was auctioned in December 2011. It was won by Vodafone. Nonetheless, before this auction 900MHz spectrum was equally distributed between operators, so that no re-balancing measure was necessary.

As Ofcom noted in its First Consultation, several regulators have adopted sub-1GHz spectrum caps in combination with redistribution or re-auctioning, citing the advantages of that spectrum. For instance:

- *Sweden's regulator cited the sub-1GHz spectrum as* being *"well suited for area coverage and indoor coverage" and imposed 2x10MHz caps in its recently completed 800MHz auction;*

- *In* Ireland's *upcoming auction of the 800MHz, 900MHz and 1800MHz bands, the regulator has proposed a sub-1GHz cap of 2x20MHz. It identified sub-1GHz spectrum as "particularly important for competition in a service market such as this" and cited a technical study which identified the significantly fewer number of sites that a 900MHz network needed to achieve the*

[165] Ofcom: Consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum and related issues Annex 6: Competition Assessment, Annex 6, para 5.97

*same service level as a network using higher frequency spectrum.*

– *In its upcoming* auction *of all mobile spectrum bands, Switzerland's regulator has proposed a sub-1GHz cap of 2x30MHz, highlighting its relative importance by citing the bands' "good propagation characteristics".*

– *Spain's regulator has proposed a 2x20MHz sub-1GHz cap for its upcoming auction of all mobile spectrum bands."* [166]

The Spanish telecoms regulator has also noted the advantages of sub-1GHz spectrum in its spectrum auction consultation paper:

> *"In effect, due to its physical properties, not all frequency bands have identical characteristics. Low frequency bands (800 and 900MHz) allow for greater coverage area per base station and better in-building penetration. For that reason, its use allows operators to reduce the cost of deployment in rural areas and improve coverage (and available broadband speeds) in urban areas".* [167]

Other regulators have explicitly noted their concern about operators without sub-1GHz spectrum being at a competitive disadvantage. For instance, in the Netherlands, the Dutch NRA (Opta) took the view that at least 2x10MHz of 800MHz are required to ensure that Dutch operators remain competitive in the future:

> *"Based on research, 2×10MHz is considered as the minimum amount of low-frequency spectrum required (for a mobile operator) to remain competitive* in *the future. […] A potential outcome of the auction could thus be that two new entrants*

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[166] Ofcom: Consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum and related issues Annex 6: Competition Assessment, Annex 6, para 5.97

[167] http://www.cmt.es/cmt_ptl_ext/SelectOption.do?tipo=pdf&detalles=09002719800a4a14&nav=busqueda_resoluciones&hcomboAnio=2010&hcomboMes=0&categoria=todas, page 12

> *each acquire 2×5MHz of the reserved spectrum. This would be just enough* spectrum *to compete with existing service offers but would constrain new entrant operators in their ability to provide competitive broadband services in the future".*[168]

Similarly, in a recent report for the GSMA, NERA summarises the French regulator's concern that a fourth 3G operator would be at a competitive disadvantage if it does not hold any 900MHz spectrum:

> *"ARCEP's proposals for refarming the 900 MHz and 1800 MHz spectrum have always been closely linked to its plans to license a fourth 3G operator. In making this link, Arcep has noted, in particular, the characteristics and value of the 900 MHz band relative to higher frequency bands, specifically that the 900 MHz spectrum is advantageous for rural coverage, as lower frequency spectrum can cover wider areas with fewer cell sites, and that it provides superior in-building penetration. Accordingly, it has expressed concern that a fourth 3G operator would be at a competitive disadvantage relative to the three incumbents if it did not have access to 900 MHz spectrum."* [169]

In summary, in all European countries that have already made a decision on the future use of the 900MHz band, operators either already held comparable amounts of sub-1GHz spectrum, or regulators intervened in order to ensure a more even distribution of that spectrum.

**Ireland's ComReg's discussion of site requirements.**

On behalf of Ireland's regulator ComReg, Vilicom carried out a calculation of the number of sites required to provide coverage to 95% of the population and 80% of the geographic area of the Republic of Ireland using different spectrum bands. Table C1 shows the results for spectrum in the 900MHz, 1800MHz and 2.1GHz bands. An operator in Ireland

[168] Netherlands Auction Rules, 18 May 2001, Section 2.2 (Translated from Dutch)
[169] NERA: 900 MHz and 1800 MHz band refarming case study France, 30 November 2011.

could nearly halve the number of required coverage sites by using 900MHz instead of 1800MHz.[170]

**Table C1: Vilicom's estimates of number of sites required**

| UMTS Band | Number of sites |
|---|---|
| **900MHz** | 533 |
| **1800MHz** | 1013 |
| **2.1GHz** | 1243 |

Source: Vilicom

## C2. Statements by regulators outside Europe.

### The US Federal Communications Commission (FCC) and Department of Justice (DoJ).

The FCC has acknowledged the significant coverage advantages of 700MHz spectrum and the ensuing competitive advantage it provides over higher frequency spectrum. The FCC discusses the superior characteristics of 700MHz spectrum on its website:

> *"The location of the 700 MHz Band – just above the remaining TV broadcast channels – gives it excellent propagation characteristics. This allows the 700 MHz signals to penetrate buildings and walls easily and to cover larger geographic areas with less infrastructure (relative to frequencies in higher bands)".*[171]

The FCC's 15th Mobile Wireless Competition Report 2011 has a lengthy discussion of the advantages of 700MHz over 1700MHz and 1900MHz in

[170] Vilicom: UMTS Network Design & Cost – Estimation for National UMTS900, UMTS1800 & UMTS2100 Networks, 2009.
[171] FCC: http://www.fcc.gov/encyclopedia/700-mhz-spectrum

terms of in-building penetration and rural coverage, in agreement with the view of the US DoJ:

> *"It is well established that lower frequency bands – such as the 700 MHz and Cellular bands – possess more favorable intrinsic spectrum propagation characteristics than spectrum in higher bands. As a result, "low-band" spectrum can provide superior coverage over larger geographic areas, through adverse climates and terrain, and inside buildings and vehicles. Several commenters in this and related proceedings have noted the advantages of lower frequency spectrum for coverage in rural areas. The Commission has also noted, in particular with respect to 700 MHz band spectrum, that lower frequency spectrum has "excellent propagation" characteristics that, in contrast to higher frequency bands such as PCS and AWS spectrum, "make it ideal for delivering advanced wireless services to rural areas."*
>
> *In its consideration of mobile wireless competition issues, the DOJ has noted the differences between the use of lower and higher frequency bands. Furthermore, regulators in other countries have recognized the distinctive characteristics between lower and higher frequency bands. As lower frequency spectrum is becoming available for mobile services in other countries, some regulators have adopted or are considering policies intended to help facilitate the wider distribution of this newly available spectrum. More specifically, low-band spectrum can provide the same geographic coverage, at a lower cost, than higher-frequency bands, such as the 1.9 GHz PCS band, the 1.7/2.1 GHz AWS band, and the 2.5 GHz band".*
>
> *"The National Institute of Standards and Technology (NIST) developed a propagation model comparing the 700 MHz, 1.9 GHz, and 2.4 GHz spectrum bands. It concluded that the favourable propagation characteristics meant that coverage using the same transmission power differed significantly, translating into the need for less infrastructure: while it required nine cells at 2.4 GHz and four cells at 1.9*

> *GHz to span 100 meters squared, it was projected to require only one cell at 700 MHz. Similarly, an analysis using the Okumura-Hata model shows that rural, suburban, and urban cell sizes at 700 MHz are more than three times larger than cells in the PCS band".*
>
> "*[…] given the superior propagation characteristics of spectrum under 1 GHz, particularly for providing coverage in rural areas and for penetrating buildings, providers whose spectrum assets include a greater amount of spectrum below 1 GHz spectrum may possess certain competitive advantages for providing robust coverage when compared to licensees whose portfolio is exclusively or primarily comprised of higher frequency spectrum".* [172]

**FCC approval of AT&T acquisition of Qualcomm licences.**

In its order to approve of AT&T's acquisition of 700MHz licenses from Qualcomm, the FCC reiterated its opinion (and the DoJ's) on the advantage of sub-1GHz spectrum:

> *"Commission noted that the characteristics of spectrum below 1 GHz make it particularly suitable for wireless broadband services, and that* lower-*frequency spectrum possesses superior propagation characteristics that create certain advantages in the provision of mobile service, especially in rural areas. RCA contends that low-frequency spectrum is particularly valuable in reaching rural areas and point out that even Applicants' experts concede that "all else being equal, lower-frequency signals carry further and may penetrate buildings more readily than higher frequency signals.""*
>
> *"As both the Commission and DOJ have recognized, spectrum resources in different frequency bands can have widely disparate technical characteristics that affect how the*

[172] FCC: Fifteenth Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services, 2011, paras 293-307.

> *bands can be used to deliver mobile services. The more favorable propagation characteristics of lower frequency spectrum, (i.e., spectrum below 1 GHz) allow for better coverage across larger geographic areas and inside buildings. The Commission has expressly contrasted the value of lower frequency spectrum – which has "excellent propagation" characteristics – with higher frequency bands such as PCS and AWS spectrum, which "make it ideal for delivering advanced wireless services to rural areas."* [173]

## C3. Statements by mobile operators and industry associations.

### Vodafone Hutchison Australia

In February 2010, Vodafone Hutchison Australia highlighted the advantages of 700MHz spectrum over 1800MHz spectrum in its reply to the Australian Government's Digital Dividend Green Paper, citing Ofcom's work:

> "*The propagation characteristics of the digital dividend will enable better coverage than comparable high band spectrum. All other things being equal, lower frequency signals, such as those at 700 MHz, can travel further and pass through walls more easily than higher frequency signals (for example, those in the 2.5 GHz and 1800 MHz range). This will translate into better services for consumers, especially indoors, which is critical for ensuring a high quality user experience for mobile broadband services…The digital dividend is also essential if VHA and other Australian mobile network operators are to deploy next generation mobile networks over a wide geographic footprint."* [174]

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[173] FCC: Application of AT&T Inc. and Qualcomm Incorporated For Consent To Assign Licenses and Authorizations, WT Docket No. 11-1, 22 December 2011, paras 46 and 49.

[174] http://www.dbcde.gov.au/__data/assets/pdf_file/0018/127035/Vodafone_Hutchison_Australia.pdf

Vodafone Hutchison Australia explains the benefits of its new 850MHz spectrum on its website:

> *"The 850MHz frequency provides a number of advantages for our customers. Because of the lower frequency (compared to other frequencies used on the Vodafone network), 850MHz is able to better penetrate through obstacles - such as buildings. This improved signal strength means data can be transmitted to a compatible device faster than when there is poor signal strength. Our 850MHz network is designed to deliver our customers better call quality and fewer dropped calls, plus better data speeds, both for compatible smartphones and mobile broadband devices".* [175]

**Telstra and Optus**

Two other Australian operators, Telstra and Optus, have also acknowledged the advantages of lower frequency spectrum.

In its response to the Australian Communications and Media Authority, Optus noted that *"the 520MHz-820MHz band...has wider coverage and deeper penetration into buildings*".[176] Optus executives have publicly highlighted the advantage of sub-1GHz spectrum:

> *"UMTS900 has been critical in bringing up that depth of coverage into people's homes, so they get a similar experience in both voice and data coverage, making it a more economically feasible solution for expansion. […] UMTS900 is ideally suited for Australia. The extended reach of this frequency means we can deliver better quality and wider*

[175] http://www.vodafone.com.au/personal/aboutvodafone/network/network-850/index.htm

[176] http://www.acma.gov.au/webwr/_assets/main/lib100667/strategies%20for%20was%20discussion%20paper%20-%20optus%20response.pdf

*coverage across sparsely populated areas, as well as enhanced depth of coverage."* [177]
Andrew Smith, Director, Mobile Core Engineering for Optus

The Telstra website reads:

> *"Ever wondered why some mobiles don't work as well as others in certain places? Coverage and signal strength are important factors…While most other 3G networks run on a frequency of 2100 Megahertz, the Next G network runs on the 850 Megahertz frequency. This lower frequency allows for superior in-building coverage so the Next G network works better in more buildings, car parks and lifts, in more places, more often".* [178]

**Verizon**

In the US, the President and CEO of Verizon explained the in-building penetration advantages of 700MHz spectrum in a 2010 presentation for investors in the following words: "*I will tell you in my career in wireless I have never had the opportunity to have this kind of spectrum and be able to use it*." [179]

The advantages of 700MHz and 800MHz over 1900MHz and higher frequency spectrum were illustrated by means of the following slide: [180]

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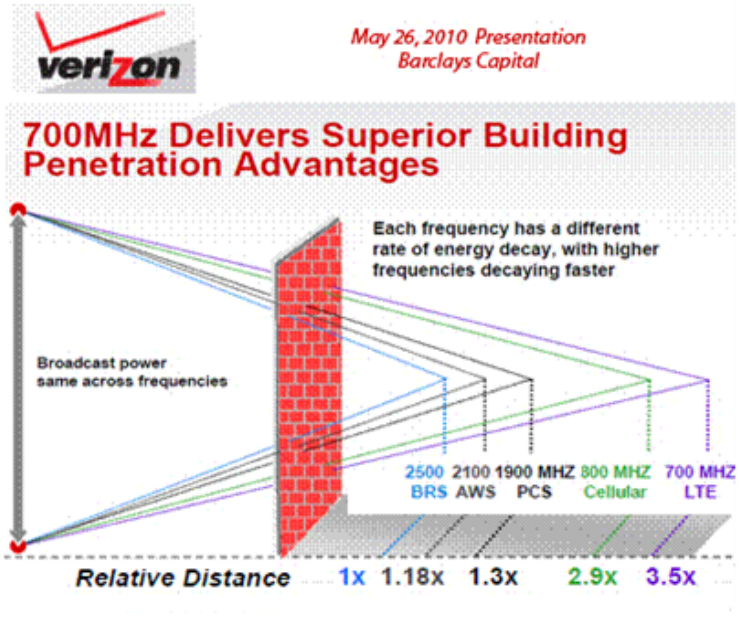
[177] GSA UMTS900 Operator Case Study – Optus Australia, www.gsacom.com/gsm_3g/info_papers.php4

[178] http://www.telstra.com.au/mobile-phones/coverage-networks/network-information/nextg/

[179] Statement of Lowell McAdam, Verizon Communications - EVP, President and CEO Verizon Wireless, Verizon at Barclays Capital Communications, Media and Technology Conference, May 26, 2010, Transcript available at http://news.vzw.com/investor/20100526_transcript.pdf

[180] http://www22.verizon.com/idc/groups/public/documents/adacct/event_965_precol.pdf, slide 8.

**Figure 13: In-building penetration advantages of sub 1GHz spectrum, according to Verizon**




Source: Verizon, May 2010 Presentation to Barclays Capital

**The GSMA**

The GSMA contracted Ovum Consulting to conduct a market study on the issues affecting UMTS in the 900MHz band. The GSMA stated that:

> *"The report indicates that UMTS900 provides between 44% (in urban areas) and 119% (rural areas) increased coverage per Node-B compared with UMTS2100. This is primarily due to the propagation characteristics of the lower frequency band and leads directly to lower capex and increased mobility benefits […]These lower costs are primarily due to the radio propagation characteristics in the lower band which provide greater reach of UMTS900 and improved in-building coverage. If the cost savings are reinvested to enable the operator to reach a larger customer base by extending geographic coverage, then the*

*NPV improvements of 39% - 105% are indicated in Western Europe and Asia Pac."* [181]

Table C2 shows the figures calculated by Ovum for the increase in coverage area per Node-B using 900MHz spectrum vs 2.1GHz

**Table C2: Percentage increase in coverage area per Node-B ($km^2$)**

| Frequency | Dense urban | Urban | Suburban | Rural |
|---|---|---|---|---|
| **900MHz vs 2.1GHz** | 87% | 44% | 60% | 119% |

Source: Ovum for GSMA

**GSM Europe**

In a response to the Radio Spectrum Policy Group (RSPG) public consultation on 'EU spectrum policy implications of the digital dividend', the Europe division of the GSMA explains the value of sub-1GHz spectrum to services requiring wide coverage:

*"The beneficial propagation characteristics of low frequency spectrum, including the ability for signals to travel further and be less sensitive to obstacles, are well documented. To this end, the spectrum between 300MHz and 1 GHz, some of which is to be released as a result of digital switchover, is particularly suited to terrestrial mobile use, including mobile TV which de facto demands wide area coverage."* [182]

**The Global Mobile Suppliers Association (GSA)**

The Global Mobile Suppliers Association (GSA) represents the worldwide leading GSM/EDGE, WCDMA-HSPA, and LTE suppliers. A case study by the GSA discusses the benefits to Optus, Australia's second-largest

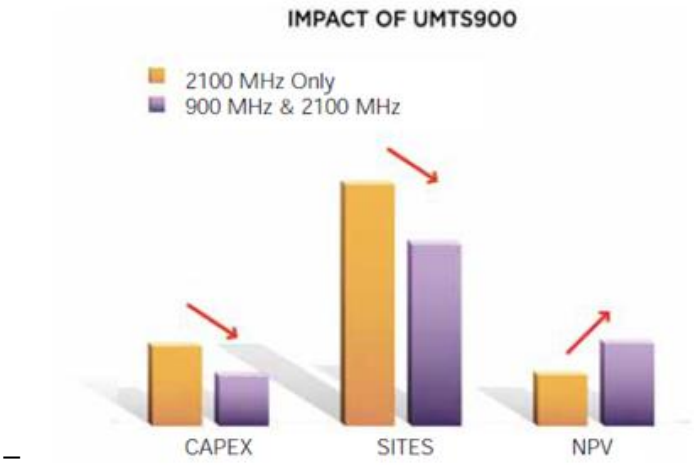
[181] Ovum Consulting: Market Study for UMTS900 - A report to GSMA, 2007
[182] GSME: Response to the RSPG public consultation related to the draft Opinion on 'EU Spectrum Policy Implications of the Digital Dividend', 15 December 2006, page 2.

MNO, of using the 900MHz band rather than the 2.1GHz band for its expansion of UMTS coverage beyond urban areas:

> *"When Optus originally proposed extending its network, UMTS2100 was its only option, but using the 2100 MHz band would have required an investment of at least AU$800 million, and possibly much more. With UMTS900, the company was able to reduce actual costs to under AU$500 million because UMTS900 minimized the number of additional sites that needed to be built."* [183]

These cost figures are summarised in Figure C2

**Figure C2: Network Capex, sites and NPV 900MHz and 2.1GHz**




Source: GSA

[183] GSA: UMTS900 A case study Optus, 2009

The report goes on to explain how sub-1GHz spectrum can directly result in a competitive advantage:

> *"By being able to offer greater coverage for wireless data services throughout the country, Optus has been able to grow its wireless data market share and better serve its customer base. This demonstrates how having access to sub-1GHz spectrum can directly result in a competitive advantage. In addition to cost savings, the ability to use existing infrastructure dramatically reduced the time needed for deployment."*

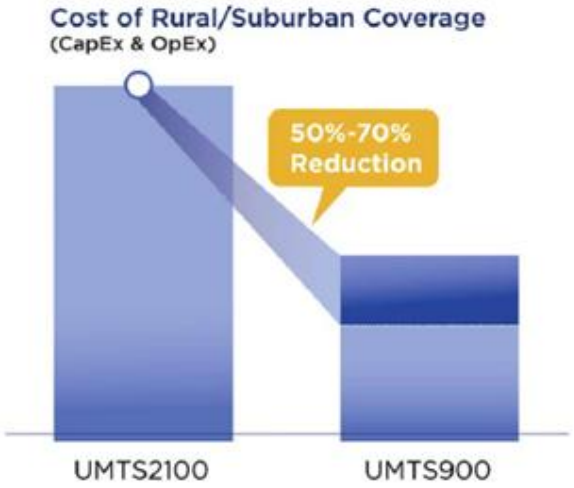
A separate GSA case study discusses the cost savings that Elisa, Finland's leading MNO, could expect from using the 900MHz rather than the 2.1GHz band for UMTS:

> *"[...] the performance of UMTS900 and UMTS2100 is the same with typical data rates ranging from 2 Mbps to 5 Mbps and maximum peak data rates of up to 7 Mbps, but UMTS900 provides a much larger coverage area." […] "As a result, UMTS900 can provide the same coverage with two to three times fewer cell sites than UMTS2100 […][. Conventional wisdom says that the cost of a large mobile network is directly proportional to the number of cell sites it requires."* [184]

Consequently, the total cost of coverage (including capex and opex) could be between 50% and 70% lower using the sub-1GHz band, according to the GSA, as shown in Figure C3 below.

[184] GSA: UMTS900 A case study, 2008, pages 1 and 3

**Figure C3: Cost of coverage with 2.1GHz and 900MHz bands**




Source: GSA

Similarly, a GSA global status update on UMTS900 summarises the benefits of 900MHz spectrum over 2.1GHz spectrum for 3G services as follows:

> *"Deploying 3G voice and mobile broadband coverage at 2100 MHz in all areas is too expensive, impractical and takes too long for many operators. Radio propagation path-loss at 900 MHz is much less, and for the same service offering and coverage the number of sites at 900 MHz is less than half that needed at 2100 MHz, with faster rollout time. Indoor coverage is also improved when using 900 MHz."*[185]

[185] GSA: UMTS900 Global Status – GSM/3G Market/Technology update, 2012

## C4. Statements by academics.

### Professor Peter Cramton

Three understand that Professor Cramton is Ofcom's adviser on the auction. Professor Cramton highlighted the importance of sub-1GHz spectrum in a joint academic paper on the risks to competition of concentration of sub-1GHz spectrum holdings in the hands of some operators.[186] It is worth quoting Professor Cramton in full:

> *"The auction of 700MHz spectrum is a critical event for the future of wireless services in America. The 700MHz auction is the last big auction on the horizon and is the only auction ever of large blocks of prized low-frequency spectrum.*
>
> *This low-frequency spectrum is scarce and allows much better propagation than the less scarce higher-frequency spectrum. It enables better coverage at lower cost, especially outside metropolitan areas. These superior physical properties translate into economic considerations — this spectrum will play a crucial role in shaping the industry and its products and prices for decades to come.*
>
> *The dominant low-frequency incumbents' incentives to protect current profits are large, and could undermine the efficiency of the auction outcome. In particular, this distortion leads incumbents to value the new licenses more than the true economic value to society and thus is likely to lead to a misallocation of the scarce spectrum.*
>
> *Action now by the FCC and/or the Antitrust Division can break the current spectrum gridlock and begin a new phase of rapid innovation in the wireless industry as well as increased competition in the wireless, broadband, and video industries. The essential ingredient is sustaining market*

[186] The 700MHz Spectrum Auction: An Opportunity to Protect Competition In a Consolidating Industry, Peter Cramton, Andrzej Skrzypacz and Robert Wilson, 13 November 2007.

*conditions favorable to new entry and intensified competition, which can most easily occur through ensuring that multiple national competitors have access to nationwide low frequency spectrum.*

*Our fear, which is grounded in both economic theory and empirical analysis, is that this pattern of [low-frequency spectrum] consolidation will lead to higher prices, poorer service, and reduced innovation. The 700 MHz auction is the last chance for many years to sustain competitive pressure in the wireless industry. The next phase could be a continuing struggle to rein in the predictable excesses of an entrenched oligopoly."*

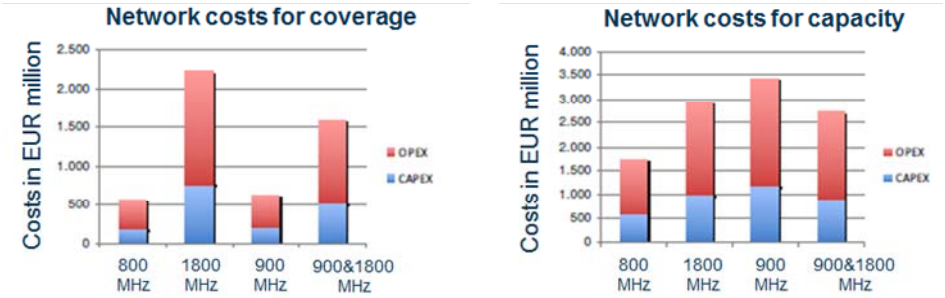
**Technical University of Vienna from work for BNetzA**

BNetzA, the German regulatory authority, instructed the Institute for Telecommunications (ITC) of the Technical University Vienna (TU Wien) to conduct a study on the possible adverse effects on competition of liberalising the 900MHz and 1800MHz bands.

The study found that the total network cost (for coverage as well as capacity) in Germany of using the 1800MHz band is around EUR 5,200 million, while that of using the 800MHz band is only around EUR 2,300 million. Consequently, using 800MHz represents a cost saving of around EUR 2,900 million or 55%. Its findings are shown in Figure C4 below. [187]

[187] Mecklenbraeuker, Christoph ; Geigg, Peter: Frequenzverteilungsuntersuchung der moeglichen Flexibilisierung im 900/1800 MHz Band, 2011

**Figure C4: Network costs for coverage and capacity, 800MHz, 900MHz, 1800MHz**




Source: Technical University of Vienna

**Jan Markendahl of Sweden's Royal Institute of Technology**

At the 22nd European Regional ITS Conference Jan Markendahl of Sweden's Royal Institute of Technology and Bengt G. Moelleryd of PTS (the Swedish NRA) presented a paper on the valuation of mobile broadband spectrum. The paper reached conclusions to others captured in this review:

> *"With spectrum in the 800 and 900 MHz bands* coverage *can be provided with fewer base station sites compared to higher frequency bands like 2.1 and 2.6 GHz. […] the 1800MHz band is not sharing the same coverage characteristics as the sub-1 GHz band […] The type of frequency band is also essential as lower frequency bands like 800 and 900 MHz provide better coverage compared to the 2.1 and 2.6 GHz bands. Hence, the value of 800MHz can be expressed as the additional cost if the*

> *capacity and coverage would be provided by deployment of networks in higher bands."* [188]

In a separate paper Jan Markendahl et al calculate network capex with different amounts of 800MHz spectrum, noting how different frequencies affect the competitive marketing positioning between mobile operators:

> *"The radio range for 800 MHz is roughly twice that for carrier frequencies in the bands 2.1 – 2.6 GHz[…]. The main conclusion from the analysis is that the disadvantage of not having access to spectrum in 800 MHz force the operator to deploy a network in 2.6GHz which means that capex would be 3.5x higher in Germany, and at least six times higher in Sweden […]*
>
> *The difference between varying amounts of spectrum in 800 MHz is not only of financial significance but also of strategic importance. Because spectrum is not only establishing coverage and capacity, it is also playing a vital role in the competitive marketing positioning between mobile operators. The stakes are high in the competition on the mobile broadband market and spectrum is a key factor in this strategic positioning".* [189]

The paper also argues that sub-1GHz spectrum allows for a faster time-to-market as many operators have dimensioned their network for 900MHz GSM spectrum. Reaching the same LTE coverage with supra-1GHz spectrum would require rolling out more sites for coverage, which would take time. It concludes that this is a competitive disadvantage that can lead to long-term impacts on market share.

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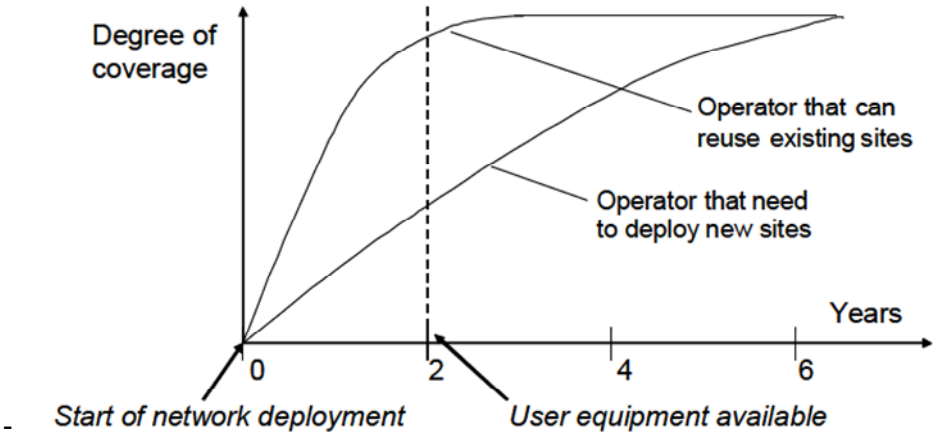
[188] Moelleryd, Bengt G; Markendahl, Jan: Valuation of spectrum for mobile broadband services – Engineering value versus willingness to pay, 22nd European Regional ITS Conference, Budapest, 18-21 September 2011

[189] Markendahl, Jan; Mäkitalo, Östen; Mölleryd, Bengt G.: Spectrum valuation derived from network deployment and strategic positioning with different levels of spectrum in 800 MHz, 2010

**Figure C5: Coverage lag due to lack of existing sites**




Source: Markendahl et al

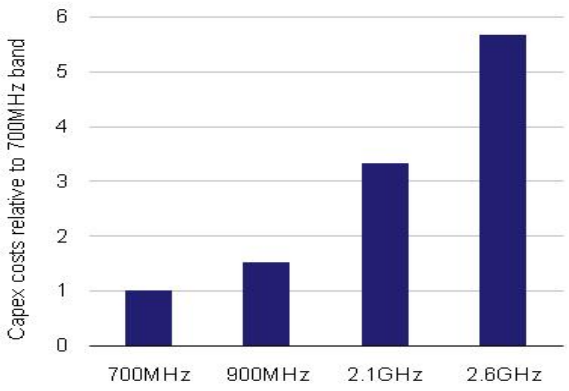
At the 21st European Regional ITS Conference in Copenhagen, Markendahl et al presented a paper on the trade-off between more spectrum and more base stations in light of expanding demand for mobile broadband spectrum.[190] Most interestingly, this paper studies how network capex varies with different amounts of spectrum, as described in the following extract:

> *"Azcoitia et al (2010) examine the value of spectrum, or rather the impact on capex depending on the spectrum band, by applying Long Run Incremental Cost (LRIC) model. It concerns deployment of a green field network for a country, like Spain, divided in four geotypes: dense urban, urban, suburban and rural."*

[190] Markendahl, Jan; Mäkitalo, Östen; Mölleryd, Bengt G.; Werding, Jan: Mobile Broadband Expansion Calls for More Spectrum or Base Stations - Analysis of the Value of Spectrum and the Role of Spectrum Aggregation, 21st European Regional ITS Conference, Copenhagen 2010

Figure C6 below shows the network capex of a hypothetical nation-wide operator carrying 15% of mobile traffic in Spain. The network capex of using 2.1GHz is 3.3x as high as that of 700MHz and 2.2x as high as that of using 900MHz.

**Figure C6: Capex costs of rolling out a network in Spain by band (relative to cost of using 700MHz band**




Source: Azkoitia et al

## C5. Statements by consultants, equipment vendors and other industry stakeholders.

### Ericsson

In its response to the European Commission's public consultation on the Radio Spectrum Policy Programme, Ericsson points out that for the right mix of spectrum, sub-1GHz spectrum is essential:

> *"To provide sufficient coverage and capacity it is essential to ensure a mix of sub 1-GHz bands, having the propagation characteristics necessary to give full area coverage, with*

*spectrum also higher up in the frequency range where more bandwidth is easier to find."* [191]

**Nokia Siemens Networks (NSN)**

NSN summarises the benefits of rolling out WCDMA at 900MHz rather than 2.1GHz as follows:

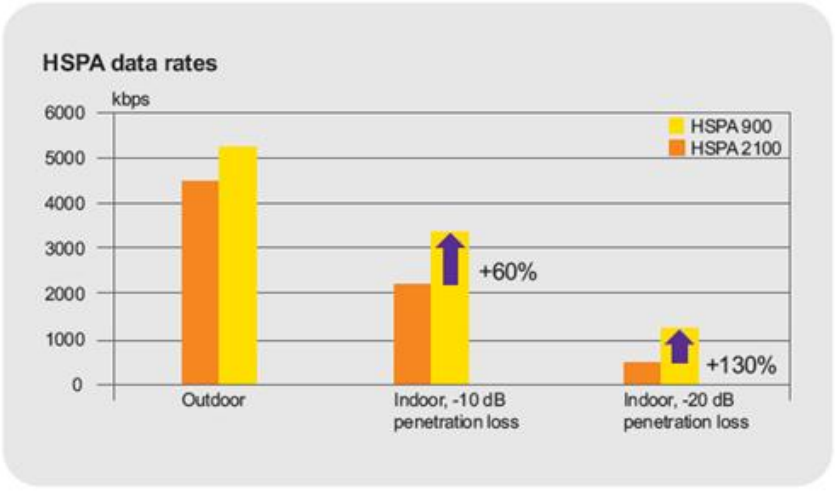
1. *"The coverage-driven rollout advantage of cells that are 2.8 times larger;*
2. *Total Cost of Ownership reduced to 40% compared with 2100 MHz networks;*
3. *Cost-efficient 3G coverage of large areas, with 65% fewer sites compared with WCDMA in the 2100 MHz band;*
4. *Improved data rates and coverage indoors"* [192]

Point 4 is illustrated in Figure C7. Due to the lower indoor penetration loss at 900MHz, customers would experience up to a 130% improvement in data rates when deep inside buildings.

[191] Nilsson, Mats: Ericsson comments on European Commission Public consultation on the Radio Spectrum Policy Programme, 23 December 2009

[192] Nokia Siemens Networks: WCDMAFrequency Refarming: A Leap Forward Towards Ubiquitous Mobile Broadband Coverage, 2008

**Figure C7: Higher indoor speeds with lower frequency spectrum**




Source: Nokia Siemens Networks

### Motorola

In a newsletter, Motorola points out that operators with 700MHz spectrum can convert their lower network costs into a competitive advantage through lower retail pricing:

> *"The Federal Communications Commission (FCC) in April 2008 auctioned 62 megahertz of spectrum in the 700 MHz band. The band is highly prized because the low frequency allows signals to travel farther and provide better in-building coverage than higher frequencies such as 1900 MHz. As a result, operators need fewer base stations to cover an area, which translates into lower overhead costs—a major asset for any operator looking to be aggressive on the pricing front."* [193]

[193] Motorola eZine: LTE's Spectrum of Opportunity, http://www.ezine.motorola.com/serviceprovider, October 2008

### Analysys Mason

In its viewpoint on the valuation of spectrum, Analysys Mason explains that fewer sites are required to increase coverage with low-frequency spectrum:

> *"When planning to improve coverage, the operator could deploy additional base-station sites using its existing spectrum. Alternatively, the operator could obtain low-frequency spectrum with better propagation characteristics, meaning that signals travel further and thus cover larger areas with fewer base stations."* [194]

### Plum Consulting

Australia's current 800MHz licences will expire in 2013. The Department of Broadband Communications and the Digital Economy commissioned Plum Consulting to value the licenses in order to inform the setting of reissue prices. Plum found that:

> *"[t]here appears to be a strong view within the global mobile industry that sub 1 GHz spectrum carries a value premium to reflect the flexibility that it provides with regard to rural coverage and in-building penetration. International benchmarks suggest that the value of the 800 MHz band is now likely to exceed substantially the original auction value".* [195]

### Director of ITU Radio Communication Bureau

PolicyTracker.com recently interviewed Francois Rancy, the director of the ITU Radio Communication Bureau, about the World Radiocommunication Conference's agreement over a second digital dividend.

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[194] Analysys Mason, Viewpoint: Spectrum: valuing that which has no intrinsic value, July 2011

[195] Plum consulting: Valuation of public mobile spectrum at 825-845 MHz and 870-890 MHz, A report for the Department of Broadband Communications and the Digital Economy, 15 September 2011

> *"Rancy said the 700 MHz agreement satisfied the ITU goal of meeting everyone's needs. "The use of the 700 and 800 band provides a way to deploy broadband mobile at a network price which is about one fourth of the price at 2 GHz: you can understand that many of these countries are into making progress quickly."*[196]

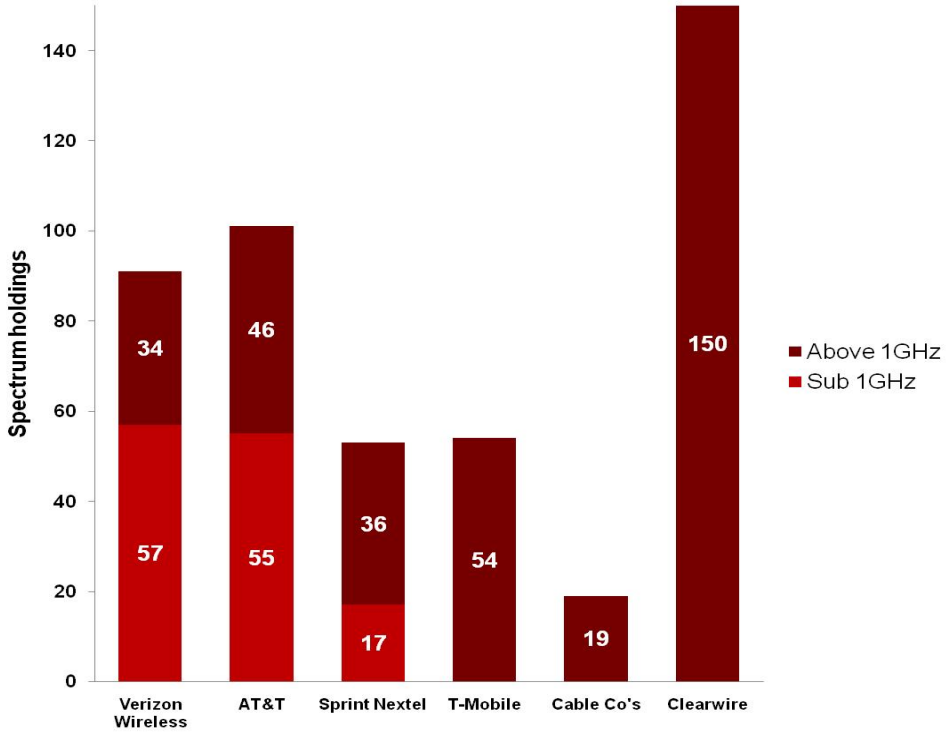
## C6. Country case studies.

### US Case Study

In the US, the two dominant low-frequency incumbents, AT&T and Verizon, acquired almost all the 700MHz spectrum in the 2008 auction. The US mobile communications market has since become progressively more concentrated. US regulators have recently blocked the merger of AT&T and T-Mobile USA to prevent further loss of competition. Figure C8 shows spectrum holdings below and above 1GHz by operator.

[196] PolicyTracker: https://www.policytracker.com/headlines/wrc-ends-with-agreement-on-201csecond-digital-dividend201d, referenced 21.02.2012

**Figure C8: US spectrum holdings above and below 1GHz**




Source: Morgan Stanley Telecommunications Services Global Mobile: How Data Shifts Market Shares or Promotes Consolidation (Sep 2011)

A recent investor report by Morgan Stanley explains how the increased importance of data and smart-phone growth, coupled with excessive concentration of sub-1GHz spectrum is leading to a duopoly in the US in favour of AT&T and Verizon. The report concludes as follows:

> "*Market share shift to top players. Differentials in spectrum availability have driven a clear shift towards the top [two players in] the US. […] In the US, an effective duopoly has developed between the top 2 operators Verizon and AT&T […] Over the last three years they have gained +5.1pp revenue*

> *market share, on our estimates. As the majors continue to grow, the two challenger operators (Sprint and T-Mobile USA) find it difficult to compete.*
>
> *[…] Smaller operators like T-mobile and Sprint in the US have networks that do not compare to AT&T and Verizon in terms of investment spent, spectrum or route to LTE speeds. […] The challenger model becomes vulnerable as smartphones become more important. Weaker challengers become more likely consolidation targets – like T-Mobile in the US. […] Unlike voice, network reputation can justify a premium for data charges. In some markets, operators are charging a premium for data based simply on their network brand and reputation*."[197]

A recent investor report by Sanford Bernstein suggests that Sprint could be forced to file for bankruptcy protection in future. The reason is that Sprint will be at a disadvantage against AT&T and Verizon until it has a comparable LTE network. While AT&T and Verizon are rolling out initial LTE services in 700MHz, Sprint will use its iDEN spectrum at first, and will not achieve the same levels of coverage as its main rivals until well into 2013.[198]

**Hong Kong Case Study**

In its response to Ofcom's proposed variation of 900MHz and 1800MHz mobile spectrum licences,[199] Three has previously put together a number of case studies demonstrating the benefits of UMTS900 in different countries.

CSL, Hong Kong's second largest mobile network operator, successfully refarmed sufficient 2G spectrum to launch a UMTS900 service in January 2010. This has given CSL a powerful network, with much better in-building coverage, outdoor coverage and speed. CSL brought its

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[197] Morgan Stanlyy. September 13, 2011 Telecommunications Services Global Mobile: How Data Shifts Market Shares or Promotes Consolidation

[198] http://www.rethink-wireless.com/2012/03/20/bankruptcy-risk-sprint.htm

[199] Three UK: Three response to Ofcom's proposed variation of 900MHz and 1800MHz mobile spectrum licences, Confidential, 29 November 2010

UMTS900 HSPA network into commercial use in January 2010, providing full coverage of the region with better indoor coverage and better performance at the cell edge.

CSL's strategy of refarming its 900 MHz spectrum for 3G has paid off in terms of coverage and data performance. Mr. Robbiati, Chief Executive Officer of CSL, described the expected benefits:

> *"Deployment of mobile services using UMTS in the 900 spectrum range is designed to* increase *outdoor coverage and in-building penetration rates; something that is vitally important in the high density urban environment of Hong Kong; we are exploiting this unique advantage with the recent launch of our Next G Home Broadband Service."*[200]

This unique advantage was affirmed by wireless consultancy Celfinet[201] in a discussion of signal strength measurements. By deploying UMTS900, CSL has outperformed the competition in most data test configurations, particularly in terms of downlink and uplink data throughput.[202] CSL's best benchmark rating by far was indoor coverage, thanks to its refarming of 900MHz spectrum for 3G.

Celfinet Sales and Marketing Director Pedro Lopes announced the results at a CSL press conference:

> *"For good indoor coverage, you need a minimum signal strength of -60dBm for* good *in-building communications,[…] We measured CSL's 900-MHz signal at -52.4dBm."*

By comparison, 3G networks in the 2100MHz band were measured at higher than -65dBm, giving UMTS900 a 10dB+ gain for indoor coverage. This shows that UMTS900 can outperform a UMTS2100 network in terms of customer experience providing significant competitive advantage for UMTS900 operators.

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[200] Tanner, John C: UMTS900 gives CSL an edge in network performance: study, June 23, 2010 telecomasia.net

[201] Celfinet is an independent consultant firm based in Portugal specialising in testing wireless technology

[202] Evidenced and shown through tests by Portugal-based wireless consultancy Celfinet.

# Annex D. The importance of network coverage to consumers.

## Introduction

Section 4 explains that the mobile market is currently in transition from a voice-centric to a data-centric model. Good coverage has been an important requirement for consumers of traditional mobile voice and text services. In an increasingly data-centric world, coverage and speed become the key dimensions of competition.

This Annex summarises the results of customer surveys and the increasing importance of network quality to UK consumers:

- Sub-section 2 summarises survey evidence [redacted];
- Sub-section 3 explains the increasing importance of network quality in a data-centric world according to customer surveys.

## D1. Importance of coverage in a voice-centric market

As Ofcom has found, good coverage has been an important requirement for consumers of traditional mobile voice and text services.[203] Coverage has typically ranked first (or joint first, together with price, voice quality or customer service) in most customer surveys analysing the main factors leading to choice of provider.

Concerns about coverage have led Ofcom to launch its work on mobile non-spots to improve mobile coverage across the UK. Ofcom has recognised that mobile coverage is important to UK consumers and citizens and raises wider public policy concerns, as the reliance that society places on mobile phones increases.[204]

There is much evidence regarding the key drivers of customer satisfaction and the impact that poor voice coverage has had on brand consideration, network perception and customer churn for operators lacking sub-1GHz spectrum. We summarise some of the evidence below.

*Residential consumers*

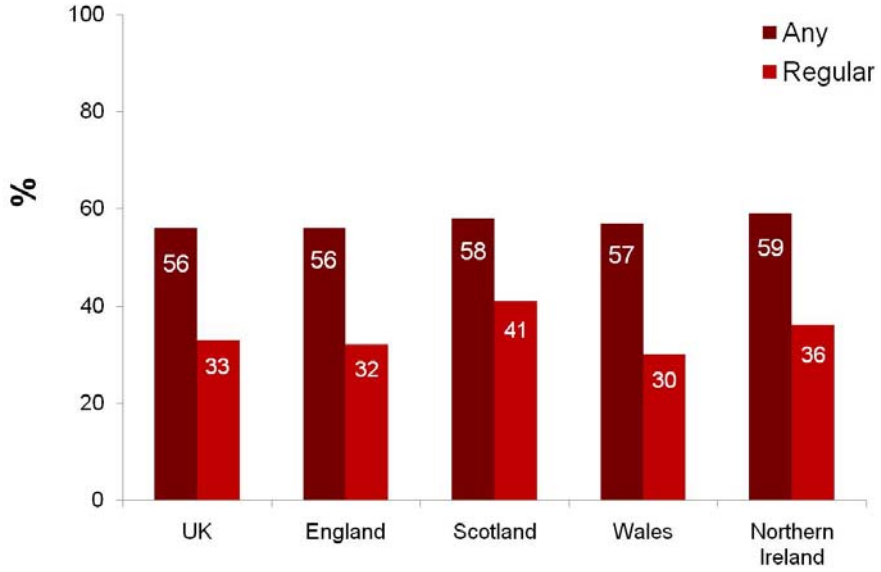
[203] Application of Spectrum Liberalisation and Trading to the Mobile Sector – a Further Consultation, Annex 11, para A11.30.
[204] Mobile Coverage Information for Consumers (Aug 2011), para 1.1.

Ofcom's advisory body, the Communications Consumer Panel, concluded in its 2009 report on mobile coverage that coverage "*is the most important factor when choosing a provider, more important than cost, quality of customer service or the type of handset available*".

The report showed that 56% of UK adults with a mobile phone had experienced problems with coverage, and a third had experienced problems regularly, as shown in Figure D1.[205]

[205] Mobile Coverage: the Consumer Perspective. Research Report October 2009. http://www.communicationsconsumerpanel.org.uk/Mobile_coverage_consumer_perspective.pdf

**Figure D1: Percentage of UK adults experiencing problems with coverage**




Source: The Communications Consumer Panel, Mobile Coverage: the Consumer Perspective. Research Report October 2009.

Similarly, research conducted by Ofcom for the Consumer Rights Review found that poor coverage was the number one complaint on mobile networks.[206] This is consistent with Ofcom's findings in its 2009 Mobile Evolution Report, which gathered feedback from consumer organisations and individuals, amongst which:

- "...*coverage is a key concern for consumers and second only to value for money tariffs*..." – Which?

[206] Futuresight, Consumer Complaints Review, Qualitative and Quantitative Research Findings 10 July 2008, Figure 3.

- "...*poor mobile network coverage [is] one of the most significant causes of consumer detriment in the mobile phone sector..."* – Consumer Focus

- "*signal and reception problems are one of consumers' most-mentioned concerns regarding mobile phone services.[…] Such findings resonate with the results of our consumer tracking survey which found that coverage is the key (unprompted) concern for mobile consumers*" – Ofcom. [207]

*Business consumers*

Ofcom's 2009 research on the Business Consumer experience concluded that "*coverage and customer service were the most important reasons behind satisfaction but* were *also the two single most important causes of dissatisfaction. This indicates that some aspects of communications services are so important that they can have a significant impact on the level of satisfaction*".[208]

The Communications Consumer Panel reached similar conclusions. Its 2009 report on mobile coverage showed that 91% of small business respondents reported difficulty with mobile coverage, and a third of all those surveyed said that this was a regular experience. 27% of respondents said they experienced frustrations around the unreliable nature of the connection. [209]

[207] Mobile Evolution. Ofcom's Mobile Sector Assessment December 2009, para 2.34-2.36, 5.15-5.18.http://stakeholders.ofcom.org.uk/binaries/consultations/msa/statement/MSA_statement.pdf

[208] The Business Consumer Experience December 2009, para 1.11. http://stakeholders.ofcom.org.uk/binaries/research/consumer-experience/bce.pdf

[209] Mobile Coverage: the Consumer Perspective. Research Report October 2009.

## D2. Importance of network quality in a data-centric world

Recent customer surveys highlight the importance of network quality in the new, data-centric market. In summary, "*over the years, the debate around networks has shifted from which operator has the widest network population coverage to which has the best network depth and quality*".[210]

Network quality is important for both smart-phone and mobile broadband users.

- **smart-phone users** – the 2011 Nokia Siemens Networks Annual Acquisition and Retention Study concludes the following:

  *"Network coverage and voice quality were rated as the most important criteria in 2010, and continue to be among the top criteria to retain customers in 2011. However, customers who are classified as heavy users of advanced services [i.e. who use services like sending/receiving e-mails, browsing the web, or download data files once a week] now rank mobile broadband quality alongside voice quality and network coverage in determining to leave or stay with their mobile operator….*

  *The study further reveals that given the rise in smartphone subscriber numbers, heavy users of advanced services will become the most prevalent subscribers in the future. The number of users in this segment increased dramatically by 34% in mature markets in 2011, and more than half of them are below 35 years. According to the study, about 60% of these users expect excellent network quality even if it costs a little more."*[211]

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[210] http://ovum.com/2011/11/29/operators-shouldnt-underestimate-the-value-of-their-networks/

[211] Nokia Siemens Networks 2011 "Annual Acquisition and Retention Study", Press Release. Mobile World Congress Barcelona February 13, 2012

- **mobile broadband** – as Ofcom notes, a YouGov Study has recently emphasised the importance of network quality: [212]

  *"consumer satisfaction for mobile broadband services is strongly linked with network quality. Surveys conducted by YouGov showed customer satisfaction was closely correlated to network dependent attributes such as coverage, speed and reliability of connections. It also found that issues concerning connectivity and speed were among the most common reasons for consumers wanting to switch provider. There is evidence that consumers value network quality above other factors such as value for money and customer services".*

[212] First Consultation, Annex 6, para 4.47.

# Annex E. The fixed internet access market provides a good example of how sensitive UK consumers are to quality differences.

### Introduction

To assess whether mobile consumers will be sensitive to quality differences in an increasingly data-centric mobile market, it is very instructive to look at the fixed-line internet access market.

As a result of increased consumer expectations and technological innovation, the retail fixed-line internet access market has effectively split in the past decade into separate sub-markets differentiated by quality, and may become even more fragmented in future.

- Sub-section 1 explains that internet use patterns are very similar between PC and mobile internet users;
- Sub-section 2 discusses the importance of high quality (in fixed communications, high speeds) to UK consumers;
- Sub-section 3 discusses how the retail internet access market has split based on speeds in the last decade.

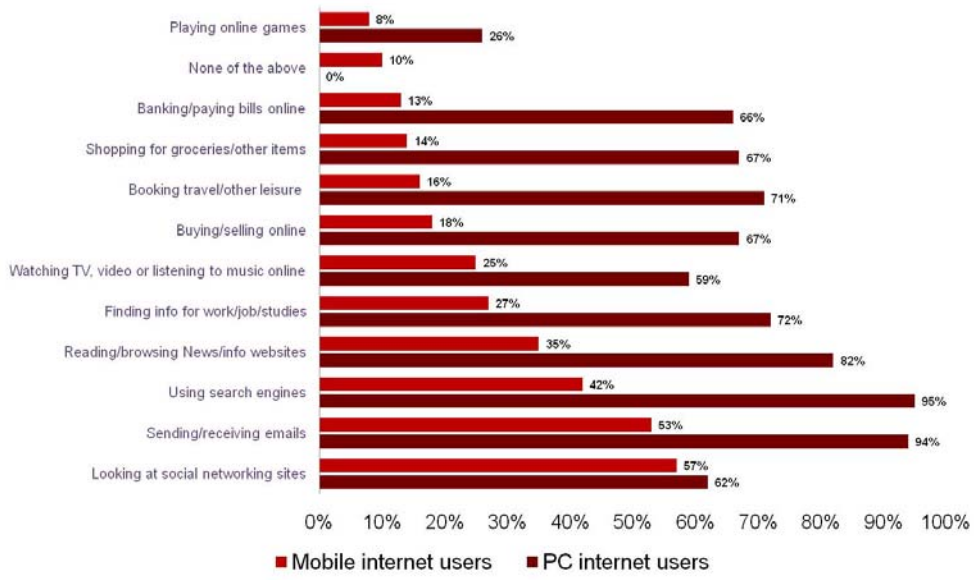
### E1. Internet use patterns are very similar between PC and mobile users.

The average mobile user in the UK is only starting to discover the data services that mobile networks can deliver, but she has been using similar services via her fixed broadband connection for some time.

Ofcom's Comms Markets Report 2011 compares internet use by PC and mobile users with the following results:

- more consumers use the internet on PC that on mobile, across all service categories – this is unsurprising given the relative maturity of both markets; but
- relative patterns of internet use are very similar between PC and mobile users, as shown in Figure E1.

**Figure E1: Comparative use of internet by PC and mobile users**



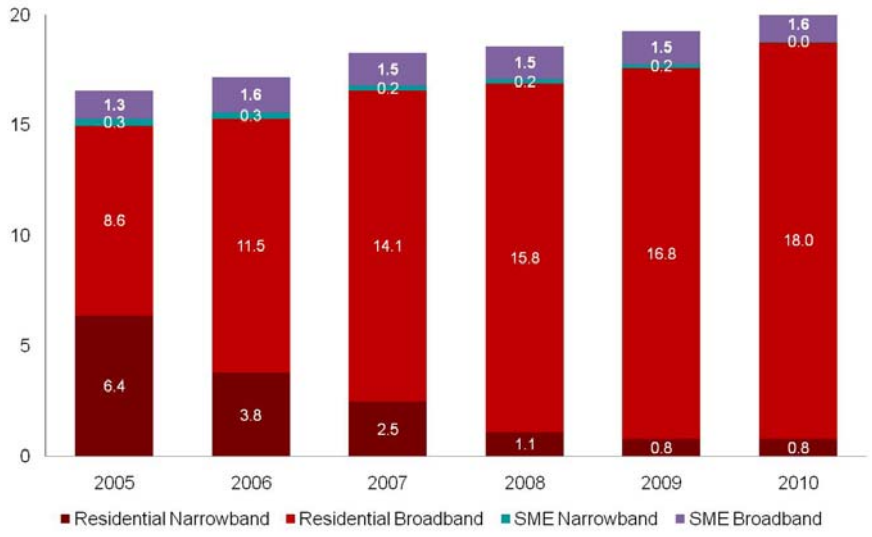

Source: Ofcom Comms Markets Report 2011, Figure 4.6

## E2. Download speeds have been a key parameter of competition between fixed-line operators.

Driven by the availability of better services, since the early 2000s UK consumers have migrated from dial-up narrowband to faster broadband connections delivered by ADSL, cable and (for business customers) leased lines and SDSL.

This large-scale migration is shown in Ofcom's Comms Market Report 2011. Residential dial-up narrowband connections in 2010 account for a residual 800k, representing households that either cannot receive broadband or are satisfied with poor dial-up speeds.

**Figure E2: UK residential and small business fixed internet connections**




Source: Ofcom Comms Markets Report 2011

Average UK broadband download speeds are continuously increasing and have now reached 6.8Mbit/s, up from 3.6Mb/s in 2009. Ofcom has found that UK consumers are moving to faster broadband services in a short space of time: 47% of UK broadband connections had a headline speed above 10Mbit/s in May 2011, compared to 42% in November 2010, 24% in May 2010 and only 8% in April 2009.[213]

But the increased popularity of services like catch-up TV or file sharing is testing current fixed networks. ADSL cannot deliver a high quality service for demanding applications like HD Internet TV, which are increasingly popular. Ofcom research shows that customer satisfaction is 93% for

[213] UK Fixed Line Broadband Performance, May 2011, paragraphs 1.3-1.4. http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/bbspeeds2011/bb-speeds-may2011.pdf

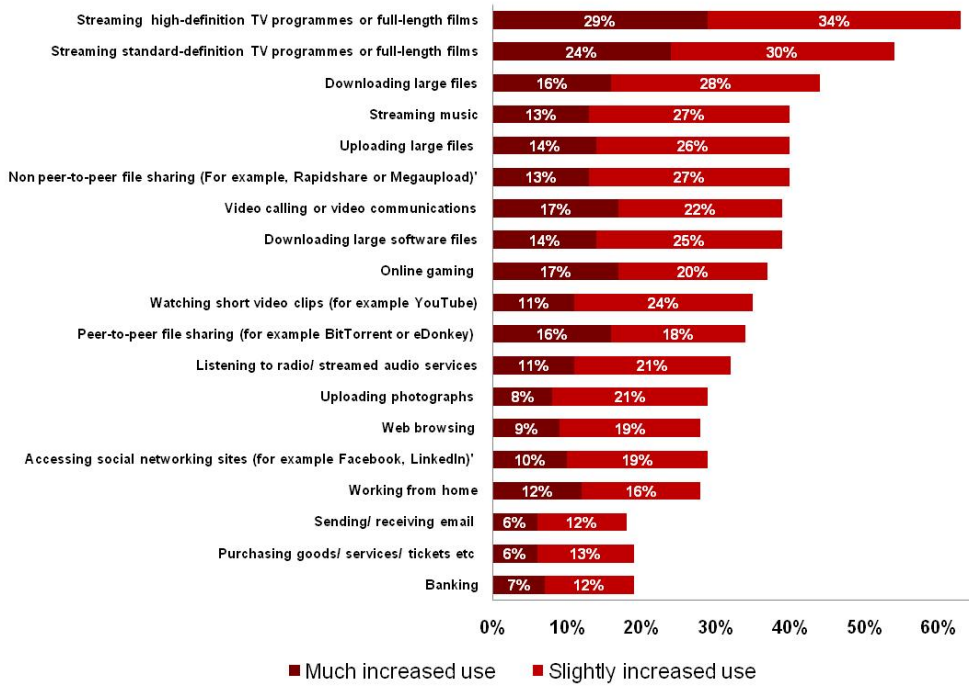
fixed-line customers using their broadband connection mainly for web browsing, but only 67% for those streaming or downloading TV programmes.[214]

To satisfy consumers' ever increasing demand for better services, operators are deploying superfast broadband over Next Generation Networks (NGN). NGNs can deliver speeds of up to 50 Mbit/s (Fibre to the Cabinet) or 100Mbit/s (Fibre to the Premise). By May 2011, 500,000 UK households had already adopted superfast broadband, representing a fivefold increase from 2010.

Ofcom's Comms Market Report 2011 presents the results of its research on super-fast broadband use, concluding that here is "strong evidence" that super-fast broadband is changing the way in which consumers use the internet, as users enjoy the higher quality of service it offers.[215]

[214] http://news.bbc.co.uk/1/hi/technology/7817748.stm
[215] Comms Markets Report 2011, page 256.

**Figure E3: Change in internet use compared to previous broadband connection**




Source: Ofcom Comms Markets Report 2011, Figure 5.13

Nearly two-thirds of respondents said that with super-fast broadband they have increased their use of HD content streaming, and over half increased their streaming of SD content. The lowest increases were for services which benefit less from faster speeds, such as email, purchasing goods/services/tickets and online banking.

Separate research by Ofcom shows that fixed-line internet access operators have started to differentiate their offers by providing higher upload speeds, which are particularly valued by consumers who upload

user generated content, share large files or use real-time two-way video and games, which are increasingly popular. [216]

## E3. The retail UK fixed access internet access market has split in the past decade.

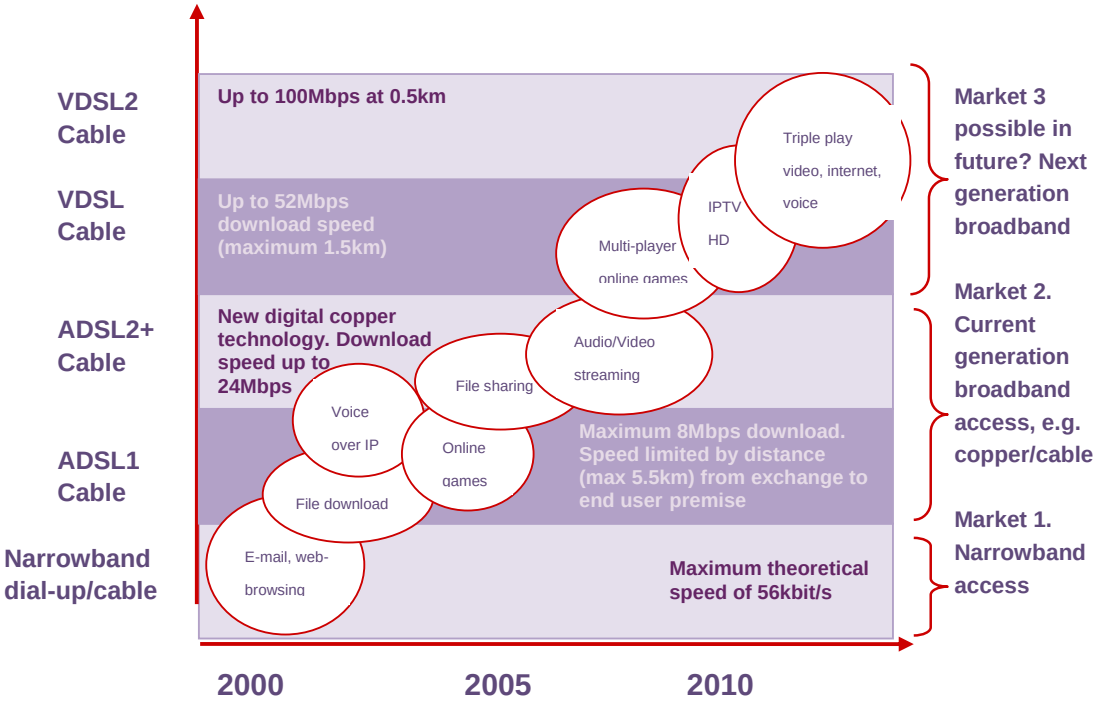
In its most recent review of the market Ofcom has concluded that:

- consumers do not view dial-up narrowband and broadband access services as closely substitutable, due to large differences in quality;
- consumers view asymmetric broadband access based on ADSL, cable and fibre as sufficiently close substitutes at present. There is also currently a single market for different broadband speeds, including from NGN fibre networks. Current broadband packages offer specific clusters of speed (e.g. 2Mbit/s, 8Mbit/s and 20Mbit/s) with higher speed services commanding higher prices. Consumers currently see the range of price/speed options as potential substitutes;
- however, as new applications require higher speeds, Ofcom considers that separate markets may develop based on speed (e.g. if viewing of HDTV on TV sets accessing online content becomes the norm, fibre-based broadband access could become a separate market). Ofcom concludes that it is too soon to say if, or when, this might happen;
- consumers do not consider symmetric broadband internet access (leased lines or SDSL) closely substitutable with asymmetric broadband, as they can deliver higher quality (e.g. bandwidth guarantee, lower latency, dedicated connectivity between business sites and equal maximum upload and download speeds);
- residential and business customers are in the same market. [217]

[216] Ibid, para 1.14.

Figure E4 shows how the residential fixed internet access market in the UK has effectively split based on speeds.

**Figure E4: Market split in the UK fixed broadband access market, 2000-2010**




Source: Three, adapted from Ofcom Wholesale Broadband Access Market Review [218]

Several conclusions are very relevant to the assessment of likely consumer behaviour in the new data-centric mobile market:

[217] Review of the Wholesale Broadband Access Markets Consultation (23 March 2010), paras 3.61-3.168. Also Statement, paras 3.8-3.29.
[218] Review of the Wholesale Broadband Access Markets Consultation (23 March 2010),, Figure 3.2.

- UK consumers have shown a strong preference for higher quality data services. They will respond quickly and in large numbers to perceived differences in quality. Services that provide a similar user experience (e.g. current generation ADSL and cable) may be seen as broadly substitutable. However, If the quality gap is large enough in the eyes of consumers, it will lead to a break in the market;

- Download speeds are a key quality dimension of competition, because consumers increasingly demand services which require higher speeds to work effectively. Users increase their consumption of high bit rate services like HD and SD video streaming as new technologies appear;

- Consumer expectations can rise very quickly when better services appear on the market, as evidenced by the decline in dial-up connections and the rapid take-up of super-fast broadband;

- Customer expectations and technological innovation feed off each other. Upgrades in network capabilities allow better services and applications, which in turn raise customer expectations and trigger further rounds of investment in network capacity and innovation.

# Annex F. Technical analysis and review of Ofcom technical modelling.

# Annex G. An example demonstrating low and unstable prices in the ASM.

**Illustrative example**

In this hypothetical example, we assume:

- **Supply**: 6 blocks of 800MHz spectrum (2x5MHz each) and 14 blocks of 2.6GHz spectrum (2x5MHz each)
- **Reserve prices** are assumed to be: 30 million for 800 MHz blocks and 5 million for 2.6GHz blocks.
- **Bidders**: There are four bidders. Each bidder is interested in acquiring 2 blocks in the 800MHz band and 4 blocks in the 2.6GHz band.
- **Bids**: Consider the following set of bids submitted through both the Primary Bid Rounds and Supplementary Bids Round (winning bids are highlighted in red)

**Table G1: Submitted bids**

| Bidder | Bidder 1 | Bidder 2 | Bidder 3 | Bidder 4 |
|---|---|---|---|---|
| **Bid** (package) – bid amount in millions | (2,4) – 480m | (2,4) – 490m | (2,4) – 470m<br>(2,3) – 440m | (2,4) – 450m<br>(0,4) – 80m<br>(0,3) – 60m |

Source: Three

- **Payments**: Based on linear reference prices, Bidder 1 and Bidder 2 pay 420 million, Bidder 3 pays 390 million and Bidder 4 pays 30 million.

**ASM methodology**

Suppose that Bidder 1 is a bidder with current holdings of 2x17.4MHz in 900MHz band and 2x5.8MHz in 1800MHz band (i.e. O2 or Vodafone).

According to section A13.69, the ALF calculation for such a bidder will involve two hypothetical scenarios (i.e. scenarios a) and e) or scenarios b) and f) from A13.69).

The baseline bid amount of bidders other than Bidder 1 is 990 million= (490+440+60).

*Calculation for 2x17.4MHz in 900MHz using ASM*

According to the Consultation, it might be appropriate to consider the additional amount that bidders other than Bidder 1 would have been willing to pay if the total amount of spectrum on offer in the Auction had included an additional 2x15MHz of 800MHz spectrum (as a proxy for the 2x17.4MHz of 900MHz spectrum retained by Bidder 1).

In this case:

- **Modified supply**: Original Supply – Winnings of Bidder 1 + Additional Spectrum

  Modified supply: (6, 14) – (2, 4) + (3, 0) = (7, 10).

**Table G2: Submitted bids, excluding bids submitted by Bidder 1**

| Bidder | Bidder 2 | Bidder 3 | Bidder 4 |
|---|---|---|---|
| **Bid** (package) – bid amount in millions | (2,4) – 490m | (2,4) – 470m<br>(2,3) – 440m | (2,4) – 450m<br>(0,4) – 80m<br>(0,3) – 60m |

Source: Three

The total bid amount of bidders other than Bidder 1 is again 990. Thus, according the ASM, the additional amount bidders other than Bidder 1 are willing to pay is 0 (990-990).

*Calculation for 2x5.8MHz in 1800MHz using ASM*

According to the Consultation, it might be appropriate to consider the additional amount that bidders other than Bidder 1 would have been willing to pay if the total amount of spectrum on offer in the Auction had included an additional 2x5MHz of 2.6GHz spectrum (as a proxy for the 2x5.8MHz of 1800MHz spectrum retained by Bidder 1).

- **Modified supply**: (6, 14) – (2, 4) + (0, 1) = (4, 11).

**Table G3: Submitted bids, excluding bids submitted by Bidder 1**

| Bidder | Bidder 2 | Bidder 3 | Bidder 4 |
|---|---|---|---|
| **Bid** (package) – bid amount in millions | (2,4) – 490m | (2,4) – 470m<br>(2,3) – 440m | (2,4) – 450m<br>(0,4) – 80m<br>(0,3) – 60m |

Source: Three

The total bid amount of bidders other than Bidder 1 is 1020 (490 + 470 + 60). The additional amount bidders other than Bidder 1 are willing to pay is 30 million (1020-990).

Therefore, the total amount that bidders other than Bidder 1 are ready to pay for additional spectrum that is equivalent to Bidder 1's current holdings is just 30 million, according to the ASM approach. This is an extremely low valuation, given the bids.

An important problem with the proposed ASM methodology is that it considers only a very limited number of possible scenarios (6 for all bidders) selected seemingly at random. The next section demonstrates that bidders other than Bidder 1 in fact have very high valuations for Bidder 1 holdings.

**Additional Scenario: Calculation for 2x17.4MHz in 900MHz and 2x5.8MHz in 1800MHz using ASM**

In the spirit of the Consultation, it might be appropriate to consider the additional amount that bidders other than Bidder 1 would have been willing to pay if the total amount of spectrum on offer in the Auction had included an additional 2x15MHz of 800MHz spectrum and 2x5MHz of 2.6GHz spectrum (as a proxy for the 2x17.4MHz of 900MHz and 2x5.8MHz of 1800MHz spectrum retained by Bidder 1).

- **Modified supply**: (6, 14) – (2, 4) + (3, 1) = (7, 11).

**Table G4: Submitted bids, excluding bids submitted by Bidder 1**

| Bidder | Bidder 2 | Bidder 3 | Bidder 4 |
|---|---|---|---|
| **Bid** (package) – bid amount in millions | (2,4) – 490m | (2,4) – 470m<br>(2,3) – 440m | (2,4) – 450m<br>(0,4) – 80m<br>(0,3) – 60m |

Source: Three

The total bid amount of bidders other than Bidder 1 is 1410 (490 + 440 + 450). The additional amount that bidders other than Bidder 1 are willing to pay is 420 million (1410-990).

This example clearly demonstrates that the valuations (additional bid amounts) derived using the ASM approach can differ by orders of magnitude depending on the exact selection of ASM cases (paragraph A13.69 lists only six possible alternatives).

One might incorrectly conclude that modifying the ASM approach to evaluate all current holdings of any particular bidder will completely resolve the low-price problem, as occurred in the last calculation. However, it can be easily demonstrated that this is not the case in general.

Consider a slightly modified example where Bidder 4 bids 450 for (2, 6) instead of bidding for (2, 4). The winning allocation and prices stay exactly the same. The ASM calculation (additional bid amount for 2x15MHz of 800MHz spectrum and 2x5MHz of 2.6GHz spectrum) for this modified example proceeds as follows.

The baseline bid amount of bidders other than Bidder 1 is still 990 million (490+440+60).

- **Modified supply**: (6, 14) – (2, 4) + (3, 1) = (7, 11).

**Table G5: Submitted bids, excluding bids submitted by Bidder 1**

| Bidder | Bidder 2 | Bidder 3 | Bidder 4 |
|---|---|---|---|
| **Bid** (package) – bid amount in millions | (2,4) – 490m | (2,4) – 470m<br>(2,3) – 440m | (2,6) – 450m<br>(0,4) – 80m<br>(0,3) – 60m |

Source: Three

The total bid amount of bidders other than Bidder 1 is 1020 million (490 + 470 + 60). Therefore, the additional amount bidders other than Bidder 1 are willing to pay for all Bidder 1's holdings is again 30 million (1020-990).

These examples clearly demonstrate that the ASM approach produces highly unstable results and cannot be relied upon in setting the ALF for the liberalised 2G spectrum.

# Annex H. Differences in user experience of speed between MSPs with and without 800MHz.