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

Non-confidential

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Executive Summary

1 Hutchison 3G UK ("Three") welcomes the opportunity to respond to Ofcom's consultation in relation to the auction of 800MHz and 2600MHz spectrum (the "Combined Auction") proposed for 2012 (the "Consultation")[1].

2 For the reasons that follow, Three supports the broad policy objectives pursued by Ofcom (including the need to maintain four national wholesale operators in the UK market) as well as many of the conclusions it reaches in the Consultation. However, Three is concerned that in developing its proposals for the Combined Auction insufficient weight has been placed by Ofcom on the link between the Combined Auction and the earlier 900/1800MHz liberalisation.

3 Ofcom is obliged to identify any competitive distortions that might have arisen by reason of the 900/1800MHz liberalisation and then to address such distortions in a proportionate manner that promotes sustainable competition. Any decisions reached on the Combined Auction must take careful account of that context.

4 Three believes that certain modifications and clarifications to the proposals are necessary in order to satisfy Ofcom's legal obligations and to secure its policy objectives, most importantly:

(a) Each minimum spectrum portfolio should include spectrum holdings which are equivalent to 2x15MHz of low frequency spectrum to address the low frequency distortion from liberalisation. If a multi-frequency package is included, it must incorporate at least 2x10MHz of 800MHz spectrum.

(b) Each minimum spectrum portfolio should also include additional spectrum to address the capacity distortion of liberalisation and to prevent spectrum being a constraint to an operator reaching and maintain a minimum scale of 20% market revenues.

(c) Reserve prices should be set at a modest uniform level with no distinctions drawn between the minimum spectrum portfolio and the open auction.

(d) The auction design should ensure that clear information is available on the level of demand and the number of opt-in bidders remaining after each round.

(e) The revised annual licence fees ("ALFs") for 900/1800MHz spectrum should continue to be linked to actual auction prices but should also reflect advantages over 800MHz/2.6GHz spectrum including any first mover advantages.

1 "Consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6 GHz spectrum and related issues", Ofcom, 22 March 2011.

1. Auction context: the liberalisation issue and a four player market.

5 Three agrees with Ofcom's conclusion that access to mobile spectrum will be vital to the future commercial success of existing and prospective new entrant mobile network operators. Mobile network operators require ever increasing amounts of spectrum to deliver new technology and applications and satisfy growing consumer demand for smart phones and mobile broadband. The last three years have shown how rapidly this market can develop. Three anticipates that the pace of change will only increase over the coming decade with the launch of 4G/LTE networks.

6 The competitiveness of the future market will depend on all four existing operators having the right spectrum, and enough of it, to be able to service the growing demand for data. Consumers and the economy will suffer, possibly irretrievably, if the wrong decisions are made now. In particular, UK consumers will no longer receive leading, high quality mobile services at reasonable prices.

The liberalisation issue.

7 Missing from the Consultation is a clear acknowledgment that one important function of the Combined Auction is to address any competitive distortions caused by the previous 900/1800MHz liberalisation decision. The two cannot be divorced – any discussion of the Combined Auction proposals needs to include an analysis of the extent to which they operate proportionately and objectively to remedy the competitive distortion arising from liberalisation of 900/1800MHz spectrum as well as to promote competition more broadly.

8 Failure to justify the proposals for the Combined Auction in the context of the liberalisation decision will frustrate Ofcom's policy objectives and will render both the liberalisation decision and any decision made following the Consultation unlawful.

A four player market.

9 Ofcom is required to promote competition in the UK and Three strongly supports Ofcom's view that competition between a minimum of four

national wholesale mobile operators is essential to future competition in mobile markets – maximising consumer and citizen benefits[2] and the UK's economic and social growth[3].

10 However, for Ofcom's conclusions to have any meaningful and substantive effect, each of those wholesalers must be at least theoretically viable beyond the short term. If that cannot be demonstrated now, Ofcom's conclusions will not be supported by a proper analysis of all relevant considerations and will fail to satisfy Ofcom's legal duty to promote competition and efficient use of spectrum.

Three tests.

11 In seeking to ensure that Ofcom complies with its legal obligations and achieves its policy objectives, Three considers that Ofcom should apply three tests:

1. Will the Combined Auction remedy the competitive distortion arising from spectrum liberalisation (both the grant to O2 and Vodafone of preferential access to low frequency spectrum and the creation of disparity in total capacity)?
2. Will the spectrum awarded under the Combined Auction ensure that at least four national wholesale operators are credible and sustainable competitors?
3. Will the Combined Auction avoid spectrum being a source of competitive distortion in the future?

2. Identifying the competitive distortion caused by 900/1800MHz liberalisation.

12 As discussed briefly in this response and at greater length in previous submissions, 900/1800MHz liberalisation will distort competition in UK mobile markets unless measures are taken to prevent it.

13 Although Ofcom has failed to identify specifically the nature and extent of the distortion caused by liberalisation as part of the Consultation, the likelihood of distortion is largely self-evident. It arises because 900/1800MHz liberalisation has resulted in substantially unequal holdings of spectrum which may be used for 3G (and subsequently other technology neutral use).

2 Consultation, para. 1.2.
3 Consultation, para. 1.14.

14 Most importantly, the extensive low frequency 900MHz holdings obtained by O2 and Vodafone provide them with significant technical and commercial advantages in providing mobile data and voice services, including significantly superior geographic coverage, in-building penetration and high potential download speeds, each of which is critical to competition between network operators. These factors have a dramatic impact not only on the quality of the network but also on the perception of a network's quality in the eyes of consumers. And such benefits can be realised at comparatively low cost.

15 Moreover, liberalisation has directly altered the established balance of long-term network capacity between operators. Access to spectrum is an absolute constraint on the provision of network services. If the imbalance caused by liberalisation is not addressed this would entrench a substantial distorting factor in the UK market and would lead to marginalisation or exit of network operators with insufficient spectrum holdings.

16 Although the fact of distortion is obvious, identifying the precise nature and extent of that distortion requires a detailed technical understanding of the comparative characteristics of different multi-frequency networks. The technical difficulties of balancing traffic across alternative multi-frequency networks (as considered in part 4) are highly relevant to that analysis.

17 Distortion of competition is already occurring and will continue if it is not addressed by the Combined Auction.

3. Ofcom is right to pursue a policy objective of retaining a minimum of four viable national wholesale mobile operators.

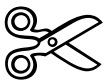
18 Three supports Ofcom's conclusion that the presence of four national wholesale operators is important to competition in UK mobile markets. In fact, cross-country analysis demonstrates a clear correlation between the presence of four national wholesale operators in a market and lower prices for consumers. This observation is reinforced by economic theory. The benefits of a four player market have been amply demonstrated in the UK. UK consumers have seen substantial price benefits as a result of the competitive constraint provided by Three in data markets (and the recent removal of regulatory barriers should now result in more intense price competition in the voice and text markets as well).

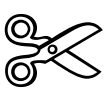
19 Those interested in resisting increased competition in the UK sometimes assert that low prices result in consumers receiving worse quality services. However the evidence both at a network level and a products and services level does not support this – in fact often the opposite is true. The reality is that in the UK and elsewhere four player markets have delivered for given consumers in the form of high quality and very competitively priced mobile services.

20 As Ofcom recognises, the benefits of a four player market will only be felt if each of the four national wholesalers is a credible competitor. Given the increasing importance of being able to provide high quality mobile data in the modern market, a credible national wholesaler will need access to sufficient spectrum to provide good quality national coverage to consumers, whether they are accessing services indoors, on the move or in remote areas[4].

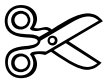
21 As spectrum is a finite resource and a key long term constraint to the provision of mobile services, each national wholesaler must have sufficient holdings to support a market share that is viable over the longer term. And, mobile industry cost analysis and cross-country comparisons show that each operator needs to secure a minimum market share of approximately 20% in order to remain viable over the long run.

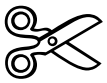
4. Low frequency spectrum of less than 2x10 MHz is insufficient to support a national wholesale operator and would lead to spectral inefficiency.

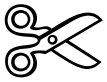
22 

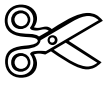
23 

4 Consultation, para. 1.3.

24 

25 

26 

27 

28 For all of the above reasons and as further explained in this response, Three concludes that 2x10MHz of low frequency spectrum is the very minimum requirement for operators without 900MHz liberalised spectrum. And, even 2x10MHz of 800MHz will be substantially inferior to the 2x15MHz of low frequency spectrum that O2 and Vodafone already have as a result of liberalisation.

5. Amendments are needed to the auction design measures for spectrum.

29 An entirely unconstrained auction would present a substantial risk that the liberalisation distortion would be perpetuated and the four player market would fail. This is because the other national wholesale operators have strong incentives to reduce future competition – they would receive a substantial financial benefit if Three ceased to fulfil its current role as a maverick and a competitive constraint on prices in the market. Three's exposure to such marginalisation or foreclosure due to insufficient spectrum holdings has been largely caused administratively by the decision to liberalise all 900MHz and 1800MHz spectrum in the hands of the incumbent operators because this decision has put Three in the position of having significantly lower spectrum holdings relative to its competitors.

30 Three strongly supports the idea of a "minimum spectrum portfolio". Three is concerned, however, that Ofcom's current proposals do not satisfy any of the tests outlined above and will therefore not meet Ofcom's legal obligations or achieve its policy objectives.

Will the Combined Auction remedy the competitive distortion arising from O2 and Vodafone's preferential access to low frequency spectrum?

31 O2 and Vodafone each obtained 2x17.4MHz of 900MHz spectrum through liberalisation. Three estimates that 2G legacy customers could be supported on 2.5MHz of 900MHz spectrum in the short term (together with 2x6MHz of 1800MHz spectrum) and in the medium term this 900MHz spectrum could be entirely cleared.

32 Three therefore supports an approach of providing minimum spectrum portfolios equivalent to 2x15MHz of 800MHz spectrum. However, the proposed spectrum portfolios are not all technically equivalent. Three proposes that packages with only 2x5MHz of 800MHz spectrum are removed from the minimum spectrum portfolios as they are not capable of enabling an operator to match the performance of O2 and Vodafone in terms of capacity, speed or coverage.

33 Subject to the points made below, the minimum spectrum portfolios should comprise:

- 2x15MHz of 800MHz spectrum; or
- 2x10MHz of 800MHz spectrum plus either 2x15MHz of 1800MHz; or
- 2x10MHz of 800MHz spectrum plus 2x20MHz of 2.6GHz spectrum.

Will the Combined Auction redress the capacity distortion caused by 900MHz and 1800MHz liberalisation?

34 Liberalisation has provided Everything Everywhere, Vodafone and O2 with a substantial commercial advantage in terms of capacity. There are a number of mechanisms which Ofcom could impose to redress this, but at a minimum it should ensure that a fourth operator has enough spectral capacity to act as a viable competitor to those operators, having regard to the relative holdings of 3G capable spectrum before liberalisation.

Will the spectrum awarded under the Combined Auction ensure that at least four national wholesale operators are credible and sustainable competitors?

35 Ofcom should set the "minimum spectrum portfolios" to ensure that each operator receives sufficient spectrum to support a sustainable market share, rather than merely trying to redress the low frequency liberalised allocations. This would also address the disparity in total spectrum created by liberalisation.

36 To this end, the spectrum holdings must be sufficient to enable an operator to achieve approximately a minimum 20% market share – as demonstrated by industry cost analysis and cross-country comparisons in order to facilitate sustainable competition. In circumstances where spectrum is scarce and one of the main capacity constraints on an operator's business, a 20% market share requires a similar proportion of available spectrum, both in total and in terms of low frequency spectrum.

37 Designing "minimum spectrum portfolio" rules that will secure that outcome will involve careful consideration of each existing wholesale network operator's particular circumstances. To ensure that a fourth operator is able to achieve 20% of total spectrum and 20% of low frequency spectrum would require the minimum spectrum portfolios to be increased to at least:

- 2x15MHz of 800MHz spectrum; plus
- 2x20MHz of 1800MHz and/or 2.6GHz spectrum.

38 Achieving the same outcome for the other wholesale network operators could be done in a number of relatively straightforward ways and Three does not presume to make suggestions on their behalf here. However, Three does note that in the case of Everything Everywhere, which already has total spectrum holdings well over 20%, the rules might require it to relinquish high frequency spectrum on a 1:1 basis to the extent that it wishes to guarantee its ability to acquire low frequency spectrum. That approach would address one criticism that has been made of minimum spectrum portfolios which is that they guarantee Everything Everywhere an incremental gain on its already superior spectrum holdings.

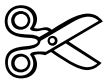
Will the Combined Auction avoid spectrum being a source of competitive distortion in the future?

39 Further, Ofcom needs to do more to avoid large disparities between the holdings of different operators. Economic theory indicates that, all else being equal, the more closely equivalent the access to spectrum, the more intense competition will tend to be and the more efficient the spectrum use. Large disparities in spectrum holdings will tend to encourage spectrum hoarding, to the detriment of competition. This suggests that each operator should be simply allocated 25% of the total low frequency and overall spectrum available (including currently available and new spectrum).

40 Spectrum caps are an important safeguard against substantial disparity in spectrum holdings. The current proposal for a cap of 2x105MHz is too high as it allows one party to acquire 37% of all paired spectrum. Three therefore recommends that the overall cap should be reduced to 2x95MHz (which would prevent any operator from having more than 33% of total paired spectrum) at the most.

6. Three supports the national coverage obligation provided that 2x10MHz of 800MHz spectrum is available in minimum spectrum portfolios.

41 Three supports the Government's objective of a 95% national indoor coverage obligation provided using 800MHz spectrum. However Three notes that the desired data speed of 2Mbps (in a lightly loaded cell) cannot be provided using a 2x5MHz of 800MHz spectrum. This is another reason why the minimum spectrum portfolios should be increased to include a minimum of 2x10MHz of 800MHz spectrum.

42 

7. Other changes to the auction design are needed – reserve prices, bidder choice and integration of the spectrum floor.

43 In addition to the points of principle discussed above, there are also various technical reasons why the proposed auction rules are unlikely to satisfy Ofcom's policy objectives.

44 A combination of the imposition of dual reserve prices and the absence of 'bidder choice' afforded to any party seeking to become a guaranteed spectrum winner may lead to a number of unintended consequences. For example, new entrants and small operators applying for the minimum spectrum portfolios may end up paying significantly more for spectrum than the incumbents. This may discourage bidders altogether or, alternatively, contribute to competitive distortions.[5]

45 The requirement to bid for every minimum spectrum portfolio if a bidder wishes to become a guaranteed spectrum winner is prejudicial to that party's interests. When combined with dual reserve pricing, the forced bidding for all portfolios is likely to lead to entrants either:

- receiving only the portfolio of least interest to its competitors (and therefore of the least competitive value) because the reserve price was lower than the incumbents' bids; or
- being awarded the most over-priced minimum spectrum portfolio because the reserve price was higher than the amount that the incumbents were willing to pay.

46 The leverage problem identified by Ofcom in the Consultation can be addressed effectively without sacrificing the entrant's control over its bidding. Three proposes 'bidder choice': permitting bidders to opt in to the spectrum floor by submitting bids only for packages corresponding to their preferred choice from among the minimum spectrum portfolios.

47 Three therefore strongly believes that the auction design should be modified to remove the dual reserve price mechanism and to permit bidder choice.

5 Higher reserve prices for entrants may discourage them from opting in to the spectrum floor. Without the protection of the spectrum floor, they may ultimately acquire spectrum portfolios that Ofcom would not deem sufficient to be a credible national wholesale operator.

Other auction design issues.

48 Generally speaking, the combined auction proposed for the 800MHz and 2600 MHz spectrum is well designed and well suited to the objective of obtaining a four-firm national wholesale market. However, the proposed spectrum floor is only incompletely integrated into the design of the combinatorial clock auction, and some technical changes are needed in order for the auction to perform as intended. In particular, Three suggests the following five changes:

- An augmented information policy in which the disclosed aggregate demand reflects the 'hidden' demand of opt-in bidders and in which Ofcom discloses after each round the number of opt-in bidders who have maintained eligibility for a Minimum Spectrum Portfolio (MSP);
- A new condition whereby bidders who drop out of contention for a MSP in the primary bid rounds cannot return into contention to be a guaranteed spectrum winner in the supplementary bids round;
- A new constraint on bids, preventing bidders from submitting bids that are demonstrably 'infeasible' in light of the spectrum floor;
- A revised clearing condition that allows the primary bid rounds to continue until aggregate demand, including the 'hidden' demand of spectrum floor bidders, is no greater than supply for every category of spectrum; and
- A capping of financial deposits after only two opt-in bidders remain.

9. Maintaining the link between auction prices and liberalised spectrum remains critical.

49 Three supports the linkage suggested by Ofcom (800MHz prices for 900MHz and the average of 800MHz and 2.6GHz prices for 1800MHz) but the annual licence fees for 900MHz and 1800MHz spectrum also need to reflect the first mover advantages associated with earlier availability of the liberalised spectrum and other commercial advantages it carries over 800MHz spectrum, especially considering that Ofcom has not revised the current level of Administered Incentive Pricing (AIP) for 900MHz or 1800MHz spectrum from the date of liberalisation to reflect either its opportunity cost or full market value. If this is not achieved an unlawful state aid will be conferred on the beneficiaries of the liberalisation decision.

50 The remainder of this response follows the structure of this Executive Summary.

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1. Auction context: the liberalisation issue and a four player market.

51 ***This section explains why Ofcom is required to identify and address any competitive distortions created by its previous liberalisation decision as part of the decisions it makes about the Combined Auction. Those decisions must also be effective to promote competition generally which Three agrees requires Ofcom to ensure that its auction design will secure a sustainable market for four national wholesale mobile operators.***

52 Three agrees with Ofcom's conclusion that access to mobile spectrum will be vital to the future commercial success of existing and prospective new entrant mobile network operators. Mobile network operators require ever increasing amounts of spectrum to deliver new technology and applications and satisfy growing consumer demand for smart phones and mobile broadband. The last three years, in which Three has led the market to develop mobile broadband (MBB) as a mass-market proposition, have shown how rapidly this market can develop. Three anticipates that the pace of change will only increase over the coming decade with the launch of 4G/LTE networks.

53 The competitiveness of the future market will depend on all four existing operators having the right spectrum, and enough of it, to be able to service the growing demand for data. Consumers and the economy will suffer, possibly irretrievably, if the wrong decisions are made now. In particular, UK consumers will no longer receive leading, high quality mobile services at reasonable prices.

54 It is against this background that Three welcomes many of the views that have been expressed by Ofcom in the Consultation, including that:

- access to the spectrum offered in the Combined Auction will be vital to the future commercial success of existing and prospective new entrant mobile network operators – and to be a credible national wholesaler, a competitor is likely to need enough spectrum of the right kind to be able to run a national network[6];
- competition between a minimum of four national wholesale mobile operators is essential to future competition in mobile markets – maximising consumer and citizen benefits[7] and the UK's economic and social growth[8];
- there are risks to future competition if bidders could bid for and acquire any amount of spectrum in an open auction and these

6 Consultation, para. 1.3.
7 Consultation, para. 1.2.
8 Consultation, para. 1.14.

risks are sufficient to justify putting in place measures designed to promote competition, namely – that the auction guarantees at least four holders of a "minimum spectrum portfolio" that are capable of providing high quality data services in the future[9]; and

– the bids in the Combined Auction will provide the relevant basis for setting annual licence fees for 900MHz and 1800MHz[10].

55 The one thing that is missing in the Consultation is a clear acknowledgment that one important function of the Combined Auction is to address any competitive distortions caused by the previous 900/1800MHz liberalisation decision. The two cannot be divorced and any discussion of the Combined Auction proposals needs to include an analysis of the extent to which they operate proportionately and objectively to remedy the competitive distortion arising from liberalisation of 900/1800MHz spectrum as well as to promote competition more broadly.

56 Failure to justify the proposals for the Combined Auction in the context of the liberalisation decision will frustrate Ofcom's policy objectives and will render both the liberalisation decision and any decision made following the Consultation unlawful.

1.1. The liberalisation decision.

57 For the reasons discussed in this subsection, Three considers that:

– Liberalisation in the hands of the incumbents, without any remedial measures, would be unlawful given the competitive advantages accruing from liberalisation (as discussed further at Subsection 1.1(a));

– Ofcom could and should have redistributed 900/1800MHz spectrum prior to liberalisation in the same way as has happened in other Member States (as discussed further at Subsection 1.1(b)); and

– Ofcom and/or the Government chose not to redistribute 900/1800MHz spectrum prior to liberalisation but promised to assess and address the competitive impact in the context of the Combined Auction. Ofcom is therefore obliged to ensure that the measures it adopts now are effective to address the competitive distortion arising from 900/1800MHz liberalisation (as discussed further at Subsection 1.1(c)).

9 Consultation, para.1.13, 1.16.
10 Consultation, para. 1.39.

a. The legal basis for 900/1800MHz liberalisation in Europe and the UK.

58 As set out briefly below and in previous submissions liberalised 900MHz spectrum affords considerable technical and commercial advantages over higher frequency spectrum. This technical fact is acknowledged by European Union institutions[11] and by Ofcom itself. In addition, liberalised 1800MHz spectrum can provide substantial capacity advantages in the hands of the benefiting operator.

59 The advantages are relevant here because 900/1800MHz spectrum is only available to some competitors and not to others. Its liberalisation will therefore impact the competitive balance in UK mobile markets.

60 It is for these reasons that the European legislature acted to require national regulators to identify and address distortions arising from liberalisation. Thus, Article 1(2) of the amended GSM Directive[12] specifies that "where justified and proportionate" Member States "shall" address distortions arising from existing allocations of the 900MHz band. Similarly, Recital 14 of the Radio Spectrum Decision,[13] dealing with 1800MHz liberalisation, notes the risk of distortion and the existence of tools to address it.

61 These instruments reflect more fundamental obligations. In outline, the following broad principles can be drawn from Community and domestic law:

- Ofcom must promote and not distort competition between the mobile operators[14];
- Ofcom must allocate spectrum according to objective, transparent and non-discriminatory criteria and pursuant to a procedure that is open, transparent and non-discriminatory[15]; and
- Ofcom must ensure that spectrum allocation is managed as efficiently as possible[16].

11 See recital (6), Directive 2009/114/EC of the European Parliament and of the Council (900MHz) and the Commission's decision in Case No COMP/M.5650 T-Mobile/Orange (1800MHz).
12 Council Directive 87/372/EEC on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community as amended by Directive 2009/114/EC of the European Parliament and of the Council.
13 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.
14 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).
15 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).
16 Framework Directive, Recital 19, Article 8(2)(d); 2003 Act, s. 3(2)(a); 2006 Act, s. 3(2)(a).

62 As the 900/1800MHz spectrum in the UK was originally distributed unevenly between mobile operators, liberalisation in the hands of the incumbent 2G licence holders without proportionate remedial measures gives rise to a breach of the amended GSM Directive but also the breach of fundamental duties under the Common Regulatory Framework.

63 It would also involve the grant of unlawful state aid. Case C-431/07 P Bouygues SA v Commission (2 April 2009) recognises that spectrum is a valuable state resource, the grant of which can amount to an unlawful aid unless the anti-competitive advantage is cured by particular measures or broader regulatory controls.

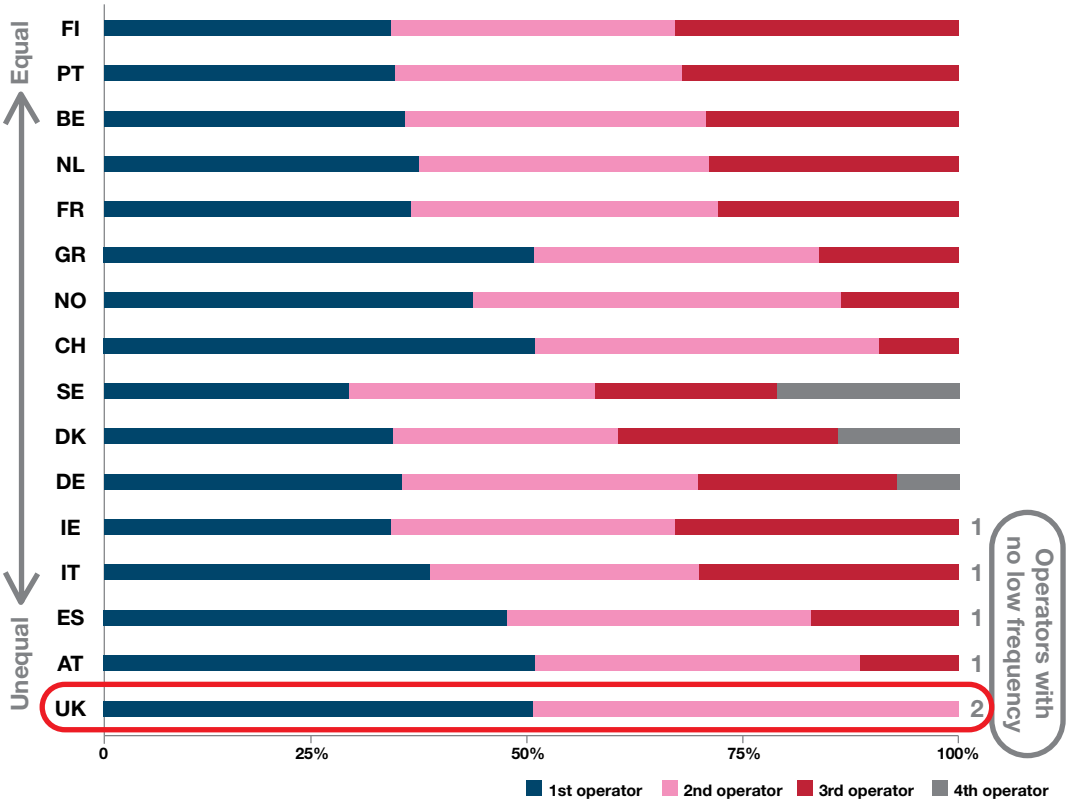
64 In principle, therefore, it would be unlawful to liberalise 900/1800MHz in the hands of the UK's 2G/3G incumbents without identifying any competitive distortions caused by liberalisation and addressing those distortions with proportionate remedial measures.

b. European approaches to liberalisation of 900/1800MHz spectrum.

65 The amended GSM Directive and the Radio Spectrum Decision expressly envisaged in their text 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. This is what nearly all Member States have chosen to do where there were some operators who only had access to 2100MHz spectrum. Some Member States have gone as far as to completely reallocate the existing 900MHz spectrum.

66 Figure 1 below shows the current distribution of low frequency spectrum among operators in each Western European country.

Figure 1: Low frequency spectrum allocation among Western European countries.



Source: Cullen International.

67 This illustrates that, in the UK, low frequency spectrum is held exclusively by two operators among four and that following 2G liberalisation, the UK now has the most unequal holdings of low frequency mobile spectrum in Western Europe.

68 Ofcom's approach of simply liberalising 900/1800MHz spectrum in the hands of incumbents was highly unusual in Western Europe. Table 1 below highlights the different approaches to liberalising 900/1800MHz across Western European countries. In some countries the approaches are proposals which have not yet been implemented.

Table 1: Approaches to 2G liberalisation across Western European countries.

	Spectrum re-auction	Spectrum re-allocation	No change	Undecided
Austria	X			
Belgium		X		
Denmark		X		
Finland		X		
France		X		
Germany				X
Greece				X
Republic of Ireland	X			
Italy		X		
Netherlands	X			
Norway				X
Portugal			X	
Spain		X		
Sweden		X		
Switzerland		X		
UK			X	

Source: Cullen International.

69 It can be seen that of all Western European countries only the UK and Portugal propose, or have decided, not to take measures to re-distribute liberalised spectrum. And in the case of Portugal the 900MHz spectrum was already equally distributed between the existing operators, which is far from the case in the UK.

c. Relevance of the UK liberalisation decision for the Combined Auction.

70 Ofcom chose to liberalise 900/1800MHz spectrum without requiring reallocation of spectrum as a precondition[17]. Ofcom relied[18] on a Government direction[19] which was itself made on the basis of a competition analysis provided by Ofcom[20]. This underlying Ofcom analysis was expressly limited to the impact of liberalisation in the period

17 Statement on variation of 900 MHz and 1800MHz Wireless Telegraphy Act licences (Ofcom, 6 January 2011) (the "January Statement").
18 Ibid, para.3.19.
19 Article 4, Wireless Telegraphy Act 2006 (Directions to Ofcom) Order 2010 (the "Government Direction").
20 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").

before the Combined Auction when 800MHz/2.6GHz spectrum would be available as a substitute for the liberalised spectrum[21]. Ofcom concluded on that basis that no further competition assessment was required before variation of the 900/1800MHz licences[22] which implemented their liberalisation decision.

71 Ofcom's liberalisation decision was therefore based on an incomplete competition analysis. That approach was only capable of being lawful because:

(1) the Government represented that the competition analysis would be completed at a later date – there would be a second competition assessment in connection with the auction design where Ofcom would be free to revisit the conclusions in the Ofcom Advice to Government[23]; and

(2) Ofcom indicated its confidence that any possible distortion of competition should be expected to last for only a short period (i.e. up to the date of the Combined Auction) and that it would be able to take appropriate steps to promote long term competition after the Combined Auction[24]. The obligation to conduct the assessment and impose appropriate measures was subsequently put on a legislative basis in the Government Direction[25].

72 It is implicit from Ofcom's previous advice that it recognised that 900/1800MHz liberalisation could lead to a distortion of competition in relevant markets if there were significant delay in the 4G award and/or absence of specific measures to promote future competition. Moreover, Three relied on the Government and Ofcom's previous promises in deciding not to challenge the variation of the 900/1800MHz licences.

73 In the circumstances, given the context in which the Government Direction was made, Ofcom is now under an obligation to ensure that the measures imposed following the Consultation are effective to address any distortion caused by 900/1800MHz liberalisation. To do otherwise would invite challenge on one or more of the following bases:

– failure to comply with the requirements of the Government Direction either on a literal interpretation of the legislation as drafted or, insofar as necessary, on the basis of the Marleasing interpretation

21 See Statement on the Wireless Telegraphy Act 2006 (Directions to Ofcom) Order 2010 (Minister for Culture, Communications and Creative Industries, 26 October 2010) (the "Government Statement"). See also Annex 8, Ofcom Advice to Government.
22 January Statement, para.3.19.
23 The Government Statement.
24 Ofcom Advice to Government, para.6.27-28; January Statement, para.3.25.
25 Article 8.

required to achieve consistency with the requirements of the amended GSM Directive;
- breach of the requirements of Article 1(2) of the amended GSM Directive in its own right;
- irrationality in the failure to uphold legitimate expectations; and/or
- grant of unlawful state aid since only a proper application of remedies following the Consultation can be sufficient to remove the advantage afforded through 900/1800MHz liberalisation.

74 In Section [2] below, Three identifies the substantial distortion of competition that has resulted from the 900/1800MHz liberalisation. In Section [5] below Three sets out the specific auction design measures that are required to address that distortion.

1.2. A four player market.

75 Ofcom's policy objective of securing a sustainable competitive market between a minimum of four national wholesale mobile operators is correct and fully consistent with its legal duties. On no view could this be regarded as an unlawful exercise of Ofcom's discretion.

76 As discussed above, Ofcom is obliged to ensure that the measures taken after the Consultation are effective to address the competitive distortion caused by 900/1800MHz liberalisation. However, the Government Direction is not limited to the impact of 900/1800MHz liberalisation but requires Ofcom to take "appropriate and proportionate measures" to "promote competition" in mobile markets generally. Ofcom also has the broad general duties to promote competition and optimise spectrum efficiency which are referred to above.

77 Three supports the view Ofcom has formed that it should pursue a policy objective of seeking to ensure that four credible national mobile wholesalers will remain following the Combined Auction. Indeed, with specific reference to its own circumstances, Three would argue that it was logically the only conclusion open to Ofcom and one from which it should not now depart.

78 Whilst any design for the Combined Auction must be neutral as between potential purchasers, Ofcom is entitled and required to take account of the following:

- Three's positive impact shows the importance of having a larger number of competitors in the market and/or the particular competitive benefits of having one or more smaller enterprises in the market (whether incumbent or a new entrant); and
- Three, in the manner in which it competes on price and product offerings, plays a particularly significant role in the promotion of competition in the relevant markets in the UK. If Three (or any other new market entrant which plans on competing in a similar manner) were effectively excluded from or substantially hindered in the relevant markets for want of spectrum, competition would not be promoted. It would be restricted.

79 These conclusions are, of course, very much consistent with the view of the Commission in its investigation of the T-Mobile/Orange merger[26].

80 As part of the Orange/T-Mobile merger process, a general concern was expressed by the European Commission, the OFT and Ofcom in relation to the concentration of the UK mobile market to a three-player market. In the OFT's referral request it was made clear that:

> *"... the OFT is concerned that the loss of H3G as a source of competitive pressure could have a very significant adverse impact on competition in mobile telephony and mobile broadband services in the UK as it would in effect represent a '5 to 3' transaction in a market characterised by very substantial barriers to entry and growth."*[27]

81 This concern was shared by the Commission, which concluded that:

> *"the merger could in a worst case scenario lead to a concentration from 5 to 3 players."*[28]

82 The Orange/T-Mobile merger was clearly considered with the risks of a concentration of the market to three players at the forefront of the minds of all involved, and was approved on the basis that the commitments provided by the parties would help avoid such a concentration. If the Combined Auction fails to give effective protection against a reduction in competition to a three player market, this would risk undermining an important basis on which the Orange/T-Mobile merger was approved.

83 At a minimum, a national regulator should be slow to reach conclusions inconsistent with those of the Commission.

26 As discussed further at section 3.1(a) below
27 Office of Fair Trading Article 9(2) Request, COMP/M.5650 – Orange PCS Limited/T-Mobile UK Limited – paragraph 78
28 Case No COMP/M.5650 – T-Mobile/ Orange, para. 108

84 Further, and in any event, for the reasons explained in the Consultation, it is right that Ofcom should take a precautionary approach to any uncertainty given its duties (under the Competition Act 2003, the Direction and the Framework Directive) to further the interests of consumers and promote competition in the relevant markets following the Combined Auction.

85 All these policy matters are primarily for the expert regulatory judgment of Ofcom. If the policy objective is to be meaningful, though, and consistent with Ofcom's duties under the Government Direction and the amended GSM Directive to assess and promote (or avoid distortion to) competition over the longer-term, it is essential that the fourth national wholesaler must be sustainable as a credible competitive force over the longer term.

86 Indeed, the logical conclusion of the argument may be that the fourth operator must be at least capable of achieving a market share equal to that of any of the other three national wholesalers and to have the spectrum needed to do that.

87 In Section [3] below, Three explains why Ofcom was right to conclude that reducing the number of national wholesalers would be likely to reduce competitive intensity. This is particularly the case in respect of the evidence relating to Three's positive impact on the UK mobile market.

1.3. Using a three test approach to assess the Combined Auction proposals.

88 In seeking to ensure that Ofcom complies with its legal obligations and achieves its policy objectives, Three considers, for the reasons set out above, that Ofcom should apply three tests:

1. Will the Combined Auction remedy the competitive distortion arising from 2G spectrum liberalisation (both the grant to O2 and Vodafone of preferential access to low frequency spectrum and the creation of disparity in total capacity)?
2. Will the spectrum awarded under the Combined Auction ensure that at least four national wholesale operators are credible and sustainable competitors?
3. Will the Combined Auction avoid spectrum being a source of competitive distortion in the future?

2. Identifying the competitive distortion caused by liberalisation.

89 *In this section Three explains why it is clear that:*
- *900/1800MHz liberalisation has resulted in unequal holdings of spectrum which may be used for 3G (and subsequently other technology neutral use);*
- *extensive low frequency holdings provide certain operators with significant technical and commercial advantages in providing mobile data services, which distorts the market;*
- *unequal spectrum holdings have a direct impact on the capacity of each operator's network, which distorts the market further; and*
- *distortion of competition is already occurring and will continue and this should be addressed by the Combined Auction .*

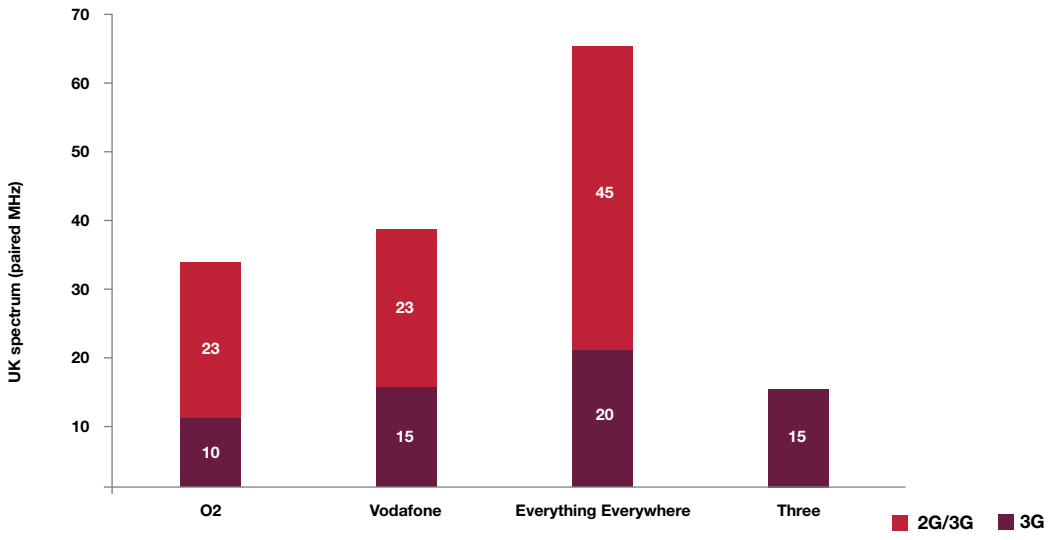
2.1. 900/1800MHz liberalisation has detrimentally altered the balance of 3G spectrum holdings previously set through competitive market mechanisms.

90 Prior to 900/1800MHz liberalisation, 3G capability (using the 2.1GHz 3G spectrum) was relatively evenly distributed between operators following allocation by competitive auction in 2000 (O2, Orange and T-Mobile each originally acquired 2x10MHz, and Three and Vodafone acquired 2x15MHz).

91 Liberalisation of 900/1800MHz spectrum has led to a 150% increase in the total 3G spectrum in the UK mobile market, from 2x59.4MHz to 2x150.8MHz. However, the benefits have not been distributed evenly across the market and liberalisation has caused a fundamental shift in the balance of 3G capabilities of the various operators, without the benefit of a competitive process.

92 Figure 2 illustrates the significant distorting effect 900/1800MHz liberalisation has had on the total allocation of spectrum suitable for future mobile services between different operators.

Figure 2: Effect of 2G liberalisation decision on mobile spectrum holdings



Source: Ofcom.

93 It can be seen that Everything Everywhere, O2 and Vodafone each received significant benefits from liberalisation.

94 Table 2 below provides further detail of the benefit that each incumbent operator received.

Table 2: UK 3G spectrum holdings before and total 3G capable spectrum holdings[29] after 2G liberalisation.

	Everything Everywhere	O2	Three	Vodafone	Total
2.1GHz 3G spectrum	2x20.0MHz	2x10.0MHz	2x14.6MHz	2x14.8MHz	2x59.4MHz
3G spectrum shares before liberalisation	34%	17%	25%	25%	100%
900MHz 2G/3G spectrum	–	2x17.4MHz	–	2x17.4MHz	2x34.8MHz
1800MHz 2G/3G spectrum	2x45MHz	2x5.8MHz	–	2x5.8MHz	2x71.6MHz
Total 3G spectrum	2x65.0MHz	2x33.2MHz	2x14.6MHz	2x38.0MHz	2x150.8MHz
3G capable spectrum shares after liberalisation	45%	22%	10%	25%	100%

Source: Three.

95 Notably, Vodafone and O2 were the only operators to benefit from low frequency spectrum, each receiving 2x17.4MHz of 900MHz spectrum that can now be used for 3G services. Everything Everywhere received a huge uplift in its overall 3G capacity via 1800MHz liberalisation, its total spectrum holdings increasing from 34% to 45% of the spectrum available.

96 Three is the only wholesale mobile operator whose percentage share of 3G capable spectrum is less now than it was before liberalisation. Indeed, its share of 3G capable spectrum has dropped substantially, from 25% to just 10%. Furthermore, it (together with EE) obtained no valuable low frequency 3G capable spectrum.

29 The table shows spectrum holdings prior to the Combined Auction. It excludes 2.1 TDD spectrum and assumes that Everything Everywhere divests 15MHz of 1800MHz spectrum and does not allocate this elsewhere.

2.2. 900MHz liberalisation has given O2 and Vodafone a substantial technical and commercial advantage which risks irretrievably distorting the market.

97 900MHz liberalisation gives O2 and Vodafone a clear competitive advantage in geographic coverage, in-building penetration, urban coverage, service quality and download speeds – in other words all of the key drivers of competition in future mobile services.

98 The Consultation correctly recognises that:

- *"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 (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."*[30] and
- *"These advantages [of sub-1GHz spectrum] could mean that national wholesalers with a large amount of sub-1 GHz spectrum would have an unmatchable competitive advantage over those without any sub-1 GHz spectrum. By an unmatchable competitive advantage we mean that the national wholesalers without sub-1 GHz spectrum suffer a material competitive disadvantage because they are unable to develop their networks to offer services sufficiently similar to national wholesalers with sub-1 GHz spectrum."*[31]

99 The current market situation following 2G liberalisation, where two out of four operators own low-frequency spectrum and the remaining two do not, will lead to a material distortion of competition unless specific remedial measures are taken.

100 This Subsection next briefly recaps the advantages of sub-1GHz spectrum for:

- Geographic coverage (as discussed at Subsection 2.2(a));
- Outdoor population coverage (as discussed at Subsection 2.2 (b));
- In-building penetration (as discussed at Subsection 2.2(c));
- Network perception (as discussed at Subsection 2.2(d)); and
- Download speed (as discussed at Subsection 2.2 (e).

30 Consultation, para. 5.40.
31 Consultation, para. 5.41.

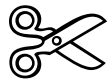
a. Geographic coverage.

101 Lower frequency spectrum and sub-1GHz spectrum in particular, has superior propagation characteristics relative to any other spectrum that can be used for mobile services.

102 As a result of their extensive and exclusive access to sub-1GHz holdings, the original incumbent operators – Vodafone and O2 – have always enjoyed an advantage in this regard but one limited to voice and text services.

103 In terms of geographic coverage, the advantage can best be demonstrated in terms of the size of the cells required for different bands. Table 3 shows how this varies.

Table 3: Estimated cell radii for different mobile spectrum bands.



Source: Analysys Mason.

104 Although it varies by geography and is affected by other factors, it will be apparent that the radius of a 800/900MHz cell can be up to approximately twice that of an 1800MHz or 2.1GHz cell. Hence the cell area of a 800/900MHz cell can be up to four times the cell area of an 1800MHz or 2.1GHz cell. Therefore, where the number of cell sites is driven by coverage rather than capacity requirements, an operator with 800/900MHz could make do with approximately a quarter the number of cell sites of an operator without access to such spectrum.

105 There has, of course, been extensive discussion in previous consultation papers and responses about the precise extent of the differential in numbers. What is clear and beyond doubt is that there is a substantial advantage in terms of cells required for an operator with 800/900MHz compared to one without such access.

106 The coverage differential arising from uneven spectrum holdings will, in the absence of other measures, translate into a substantial competitive advantage for low spectrum holders over other operators, as it results in substantial network cost savings compared to those network operators who do not have low frequency spectrum. Such operators will need to recover these costs elsewhere, whether by failing to invest in improved technology, products or services or by charging higher prices. In turn, this reduces the competitive constraint on operators with low frequency who become less incentivised to reduce prices and improve services.

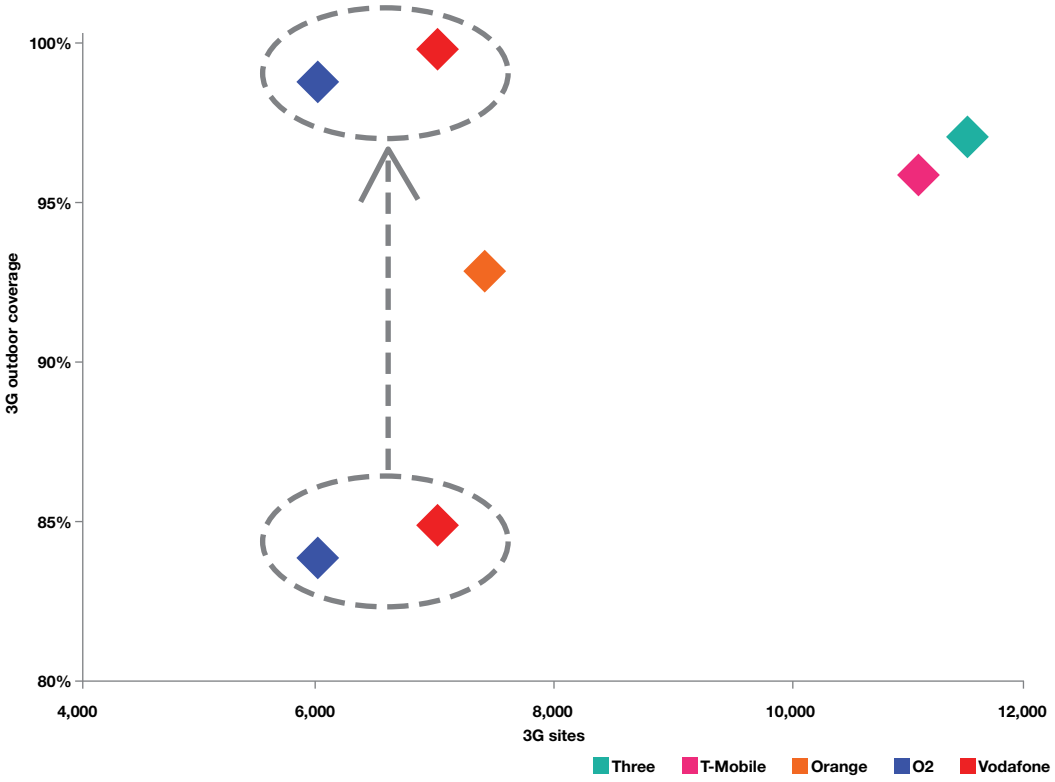
b. Outdoor population coverage.

107 900MHz liberalisation allows O2 and Vodafone to leverage their existing voice and text coverage advantage into the provision of mobile data services, the key growth area of the future.

108 Simply put, this means that O2 and Vodafone can use their current site foot print to deploy 900MHz spectrum, and by so doing they can provide services to a wider geographic area. O2 and Vodafone already claim that they provide 99% 2G voice coverage using 900MHz spectrum. It follows then, that by simply deploying UMTS at 900MHz on their existing sites they can move from 85% 3G outdoor coverage (in the case of O2) to over 99%.

109 Figure 3 demonstrates this effect. Each receives a dramatic 3G population coverage benefit as a result of 900MHz liberalisation. This increased population coverage significantly off-sets (and in fact rewards) O2 and Vodafone's under-investment in their 3G networks to date, especially compared to Three and T-Mobile (who built the largest UK 3G network through their joint venture Mobile Broadband Network Ltd (MBNL)).

Figure 3: Impact of 900/1800MHz liberalisation on 3G outdoor population coverage.



Source: Enders Analysis (2010).

c. In-building penetration.

110 Another consequence of the superior propagation characteristics of low frequency spectrum is that it offers significant advantages over higher frequencies in terms of in-building penetration.

111 Accessing mobile data in-building is a vital element of the modern and future mobile market and will be an increasingly important differentiator between mobile providers. Mobile data services are predominantly and increasingly used in-doors, and an ability to provide signal to users in less accessible locations, such as in basements or deep inside buildings, will be a significant competitive advantage.

112 In addition to being extremely important for the consumer market, reliable in-building access to mobile data services is a key factor in appealing to business users and to wholesale customers.

113 Now that O2 and Vodafone are able to exploit the superior penetration qualities of their 900MHz holdings for mobile data services, they have an additional advantage in this respect.

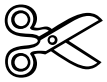
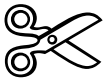
114 

Figure 4: Simulated increase in 3G indoor population resulting from 900/1800MHz liberalisation.



Source: Three (confidential).

d. Network perception.

115 Prior to liberalisation, O2 and Vodafone already had an existing geographic coverage, population coverage, and in-building coverage advantage for text and voice services by virtue of their 2G use of 900MHz spectrum. This resulted in a consumer perception that O2 and Vodafone have better networks because customers are more often in coverage to make calls and suffer fewer dropped calls, particularly inside buildings.

116 This is because the indoor propagation characteristics of the low frequency spectrum held by Vodafone and O2 create the perception that their network coverage is superior even though this coverage can only currently provide 2G services in most areas. This distorting impact of low frequency spectrum propagation will be further enhanced as O2's and Vodafone's roll out of 3G at low frequency gathers pace. Something Three and EE are unable to respond to at this time due to liberalisation.

117 If low frequency spectrum had been reallocated as in the majority of European countries, there would not be a risk that this distorted perception of 3G network quality could persist into 4G and all future markets. However 900MHz liberalisation risks allowing O2 and Vodafone to build unfairly on their positive consumer perceptions for voice and text in the growing market for mobile data.

e. Data speeds

118 Next generation technologies such as LTE offer higher download speeds the wider the bandwidth over which they are deployed (up to a current maximum of 2x20MHz). For a network deployed over 2x15MHz, the theoretical maximum download speed amounts to some 100Mbps for LTE networks which is considerably higher than could be provided using a 2x5MHz block.

119 Vodafone and O2 each have 2x17.4MHz of 900MHz spectrum. This would allow them to deploy LTE networks over up to 2x15MHz bandwidths thus providing high download speeds which are attractive to customers and which may not be possible for other operators.

Conclusions on 900MHz liberalisation advantages

120 Two out of four operators in the competitive UK mobile market have been given preferential 3G access to the only low frequency spectrum currently available. Moreover, they have access to contiguous[33] bandwidths of up to 2x17.4MHz, ideal for the deployment of high speed next generation technologies.

32 Three believes that O2 and Vodafone can quickly shift their 2G traffic into 2.4MHz of 900MHz spectrum, their 5MHz of 1800MHz spectrum and/or move more of it across to their 3G networks.

33 Three acknowledges that the spectrum is interleaved at present but this could be remedied quickly with co-operation between O2 and Vodafone.

121 Three and EE obtained no low frequency spectrum as a result of the liberalisation decision. Three will quickly become uncompetitive unless the resulting disadvantage is swiftly and effectively addressed.

2.3. Everything Everywhere has received a substantial capacity and speed benefit from 1800MHz liberalisation.

122 The most obvious benefit which EE receives from 1800MHz liberalisation is a huge capacity uplift. The importance of capacity is discussed further below.

123 In addition, it is important to note that EE now has a contiguous bandwidth of 2x45MHz at 1800MHz. As noted above, contiguous bandwidths provide the opportunity for increased data speeds. EE can easily deploy 2x20MHz LTE at 1800MHz and obtain speeds which are 4 times greater than using 2x5MHz of spectrum. Further, although 2x20MHz is the current maximum bandwidth to gain a speed advantage, it is possible that this will change as technology evolves and Everything Everywhere may gain even greater (and possibly unmatchable) speed advantages which are required to support future data services.

2.4. Unequal spectrum holdings have a direct impact on the capacity of an operator's network, which distorts the market further.

124 As widely recognised in the Consultation, spectrum is a critical capacity constraint for mobile operators. There is a direct correlation between the amount and type of spectrum available to an operator and the number of customers that its network can support. Ofcom recognises the importance of this relationship throughout the Consultation document. For example:

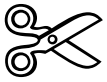
- *"Combination of low and high frequency spectrum creates the potential for next generation mobile broadband services to be widely available across the UK, while at the same time having the capacity to cope with significant demand, even in urban centres."*[34]
- *"The quality of the network and spectrum used by the national wholesaler determines: […among other things] capacity, i.e. the number of users that a network can support."*[35]

34 Consultation, para. 1.6.
35 Consultation, para. 5.31.

- *"The spectrum portfolio held by a national wholesaler can have a big influence over the quality of the services that can be delivered, and the number of people those services can be delivered to."*[36]
- *"In theory, deploying more sites could be used to add capacity instead of a greater quantity of spectrum. However, the higher the demand, the more sites would be required to match capacity and the less feasible it would be, both in terms of practicality and financial viability. We therefore consider that a national wholesaler's spectrum portfolio will have a significant influence over the capacity as well as the quality of service it can offer. […] if its spectrum portfolio is small, it may have limited capacity."*[37]

125 Three agrees that there is a limit to the extent that a network's capacity can be improved by an operator increasing the number of sites deployed. With limited spectrum, there will be a correspondingly finite limit to the number of customers that can feasibly be supported by a network, without it resorting to impractical or economically unsustainable measures.

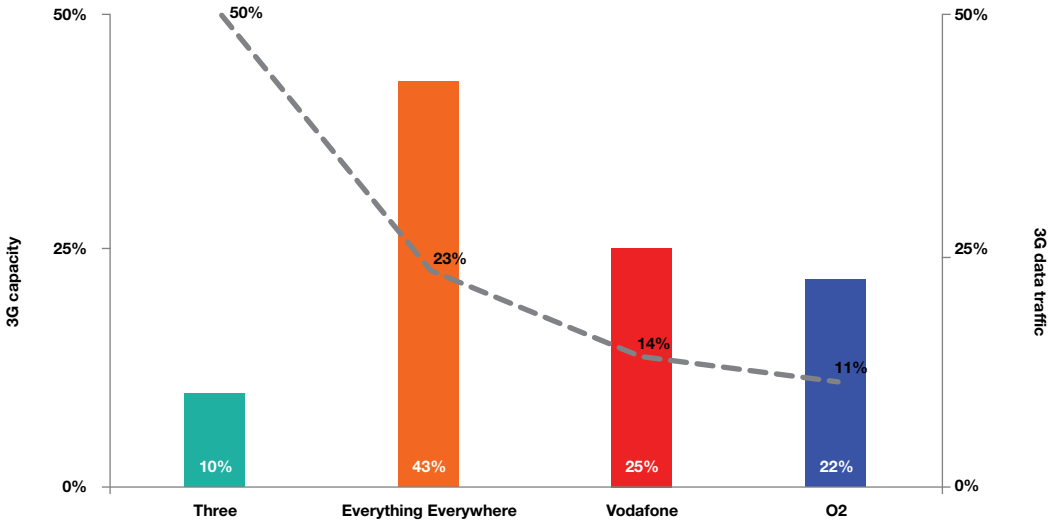
126 Hence, 900/1800MHz liberalisation, which has led to significant imbalances in mobile spectrum capacity – with one operator holding just 10% of total capacity and another operator holding almost 50% of total spectrum capacity – will undoubtedly lead to a competitive imbalance in terms of the market shares that different operators can ultimately serve.

127 

128 Figure 5 illustrates the relationship between current (post liberalisation) spectrum holdings and mobile data traffic between the four UK national wholesale operators.

36 Consultation, para. 5.36.
37 Consultation, para. 5.37.
38 Enders Analysis 2010

Figure 5: 3G spectrum capacity and 3G spectrum traffic.



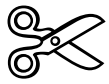
Source: Enders Analysis (2010), Ofcom.

129 It can be seen that Three has adopted a more aggressive data strategy than its competitors by electing to provide consumers with more favourable data offers. Despite this, Three was the only operator that did not receive additional capacity in the liberalisation process.

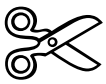
130 [redacted]

131 [redacted]

Figure 6: Three site congestion forecast with current spectrum holdings.



Source: Three.

132 

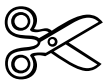
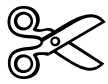
133 

Figure 7: Feasibility of network solutions using existing 2.1GHz spectrum.



Source: Three.

134 As discussed in more detail in Section [3.5], below, economic theory indicates that unequal holdings of spectrum tend to distort competition. This is because if certain firms become capacity constrained, due to lower amounts of essential inputs, while other firms do not, then effective competition occurs only between those firms that are not capacity constrained.

135 As demand rises, further firms may become capacity constrained and competition becomes further limited between the firms with available spare capacity. In contrast, competition would be maximised if all firms held equal shares of the essential input, as this would reduce the likelihood of a subset of firms becoming capacity constrained and competition thereby being limited to the remaining firms. See Annex 3 below for detailed analysis.

136 The capacity distortions arising from spectrum liberalisation means that all other things being equal (including network size and total data traffic), Three will now become capacity constrained years before its competitors.

137 [redacted]

Figure 8: Estimated UK national wholesale mobile operator capacity limits with current spectrum holdings.

[redacted]

138 [redacted]

139 [redacted]

2.5. Distortion of competition is already occurring and should be addressed by the Combined Auction.

140 As a result of the ability to provide mobile data services using either superior low frequency spectrum (as in the case of O2 and Vodafone) or extensive spectrum holdings (as in the case of EE), it is clear that, absent further measures, 900/1800MHz liberalisation in the hands of the existing licensees will entrench and aggravate existing disadvantages caused by uneven spectrum holdings and lead to on-going distortion of competition.

141 Indeed, such a distortion of competition is already occurring, as at least one of the holders of low frequency spectrum has launched new 3G services using 900MHz within a very short space of time following 900/1800MHz liberalisation. This has allowed the operator, O2, to gain, at minimum, a significant first-mover advantage over other operators for such services. It is notable that O2 has launched its 900MHz 3G services in less than 2 months from liberalisation even though it previously contended in submissions to Ofcom that it would take a considerably longer period of time to clear and make use of the spectrum, which Ofcom appeared to rely on in its advice to Government that liberalisation of 2G spectrum was not likely to distort competition at least in the short term. Ofcom should bear this in mind when considering the assertions that the other mobile operators may make about future behaviour and development of the market.

142 Moreover, it has been widely publicised that O2 have moved quickly to roll out 3G services using 900MHz spectrum in a number of major cities – including London. An industry analyst has commented that *"O2 has moved quickly as the benefits of reusing 900MHz is that they don't have to build out an entire 3G network on new base stations but can just make a few tweaks*

to equipment at existing sites […]This means most customers won't have to upgrade their handsets either to benefit from the improvement as most new Smartphone devices have the ability to access data on 900MHz."[39]

143 Absent the timely availability of new spectrum, 900/1800MHz liberalisation will cause further distortion of competition. Merely making new low frequency spectrum available is not enough, however, given the amount of 900MHz spectrum held by O2 and Vodafone and their incentives to acquire more low frequency spectrum. Three and EE would each need to acquire half of the 800MHz spectrum available to even get close to having similar low frequency capacity to O2 and Vodafone.

144 Ofcom is obliged as a matter of law to form a view about the distortion to competition that has been caused and could continue to be caused by 900/1800MHz liberalisation and then to apply proportionate measures to address that distortion and promote competition. Absent such regulatory measures, Three (at least) will struggle to get any 800MHz spectrum (let alone half of the total available), because existing larger operators have strong incentives to entrench and further consolidate the existing uneven spectrum holdings. This reflects the large benefits to the existing larger operators from reducing or limiting competition in future mobile markets. Section [4] below explains the specific reasons for this.

145 For further analysis of the impact of 900/1800MHz liberalisation on competition, please also see Three's response to Ofcom's proposed variation of 900MHz and 1800MHz mobile spectrum licences and previous consultation responses[40].

39 Read more: http://www.v3.co.uk/v3-uk/news/2035339/o2-improved-3g-network-london#ixzz1O1zoQidt; Read more: http://www.v3.co.uk/v3-uk/news/2035339/o2-improved-3g-network-london#ixzz1O1zwObhD

40 "Three response to Ofcom's proposed variation of 900MHz and 1800MHz mobile spectrum licences", 29 November 2010.

3. Ofcom is right to pursue a policy objective of retaining a minimum of four viable national wholesale mobile operators.

146 *Three fully supports Ofcom's provisional conclusion that there would be a risk to wholesale competition in the UK mobile market if fewer than four credible national wholesalers are active in the market following the Combined Auction.*

147 *However, for Ofcom's conclusions to have any meaningful and substantive effect each of those wholesalers must be at least theoretically viable beyond the short term – if that cannot be demonstrated now, Ofcom's conclusions will not be supported by a proper analysis of all relevant considerations and will fail to satisfy Ofcom's legal duty to promote competition and efficient use of spectrum.*

148 *In this section Three provides further support for Ofcom's conclusions and develops that analysis by considering the requirements for sustainable wholesale competition between four national operators beyond the short term. Three focuses particularly on the extent to which:*

- *cross-country analysis and economic theory both demonstrate that mobile markets with a minimum of four players and/or effective 3G entry dramatically increase competition and make a material difference to mobile prices, investment and innovation, while also providing wider economic and social benefits;*
- *the benefits from a competitive market will be felt only if such competition is sustainable; and*
- *economic theory shows that maximisation of competition and efficient use of spectrum would be best achieved through the equalisation of spectrum between operators.*

3.1. The benefits of a four player market.

149 The experience of 3G licensing in Western Europe during the last ten years provides strong evidence of the benefits to consumers of markets with a minimum of four players, particularly where there has been sustainable market entry by a new 3G operator. This experience reflects the theoretical economic models which support a four rather than three player market. Three also believes that a four player market offers wider social and economic benefits that would not be secured in a three player market.

a. Cross-country analysis demonstrates that 3G new entry has a positive effect on prices and improves the quality of services.

150 Ofcom's policy objective of ensuring that there are at least four credible national wholesalers necessarily implies that at least one of those national wholesalers must be either the 3G new entrant in 2000 (i.e. Three) or a new entrant today. Three considers that this is an important feature of Ofcom's proposal and one which requires greater consideration. The benefits of new entry (if sustainable) are considerable and provide strong support for Ofcom's proposed policy objective.

151 In 1999, the UK took the lead in transforming its mobile communications market, announcing that competition was the key to the future of next generation mobile phones and seeking to encourage market entry by new 3G operators:

> *"Increased competition in the mobile telecommunications market is expected to lead to significant benefits for consumers, including lower prices and the faster rollout of more innovative services."*[41]

152 Twelve years later, the UK's belief in the power of increased competition has been vindicated. The UK – among a small number of other Western European economies – now benefits from materially lower prices and greater penetration of new and innovative mobile communications services.

153 Where 3G market entry has been successful, the subsequent revolution in 3G mobile communications has clearly demonstrated the benefits of creating effective and sustainable competition.

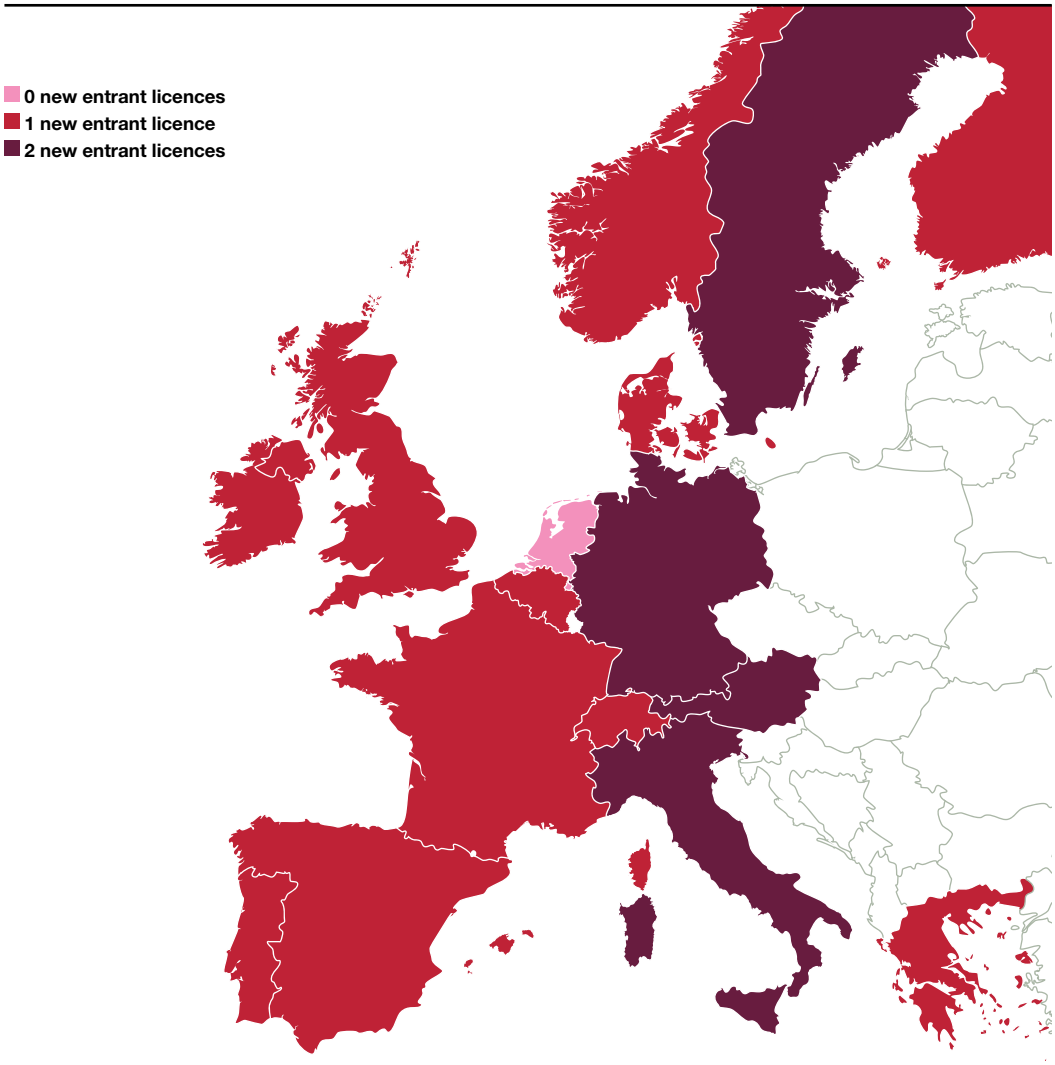
154 In contrast, many other large Western European economies have either not tried to secure, or have failed to support, 3G market entry and thereby create effective or sustainable competition in mobile communications services. In those countries this has generally resulted in much higher prices and lower availability of new and innovative mobile services.

41 "Mobile Phones – The Next Generation – Competition the Key to the Future", Government Press Notice, 9 May 1999.

155 Figure 9 below outlines European governments' attempts to increase competition in mobile communications with the introduction of 3G technology at the start of the 2000s. Namely, of the 16 main Western European countries[42]:

- 11 countries decided to offer one new entrant 3G licence;
- four countries decided to offer two new entrant 3G licences; and
- only one country decided to offer no new entrant 3G licences.

Figure 9: Western Europe new entrant 3G licences.



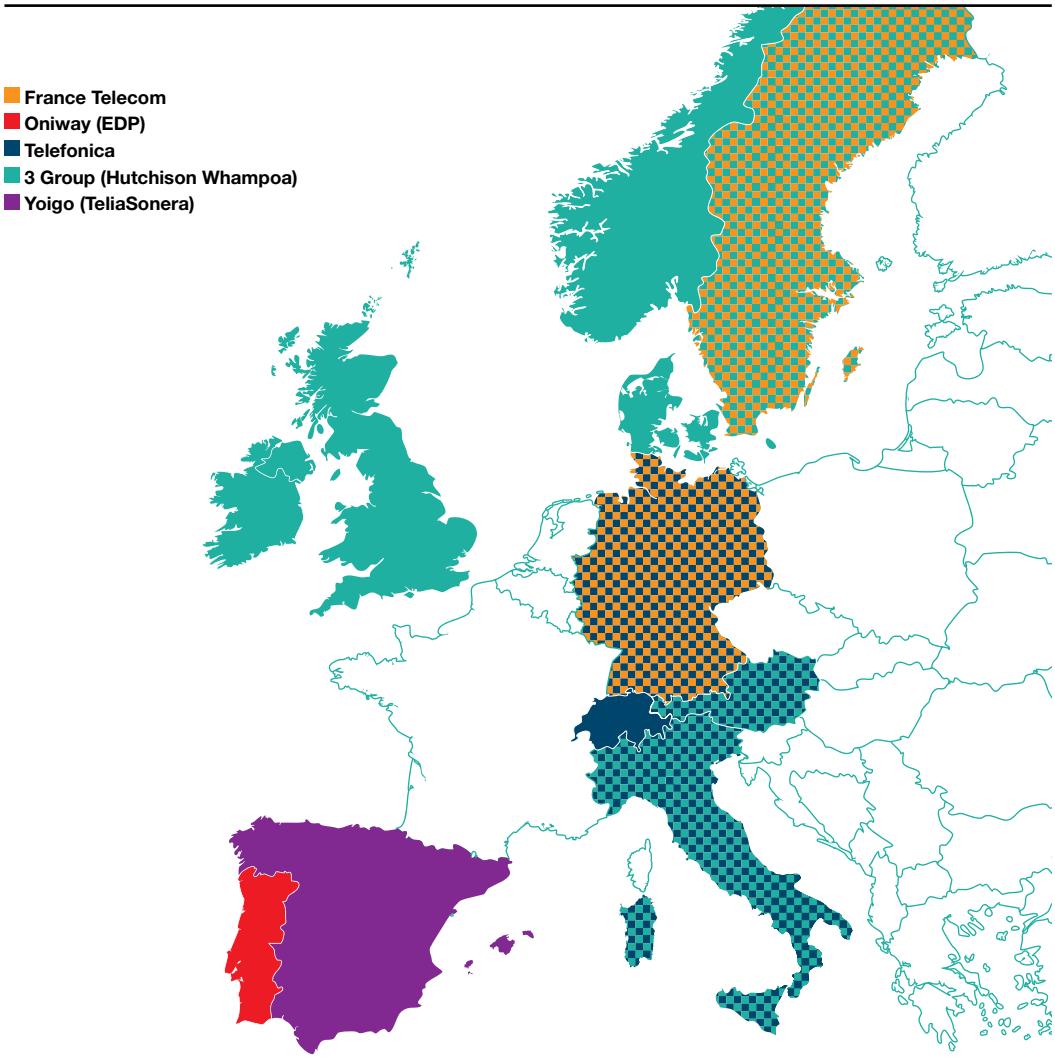
Source: Three research.

42 The 15 members of the European Union at the time, excluding Luxembourg, plus Norway and Switzerland.

156 Furthermore, Figure 10 below shows the telecoms operators that actually acquired 3G new entrant licences in each country, namely:

- 3 Group (Hutchison Whampoa) – in Austria, Denmark, Ireland, Italy, Norway, Sweden and UK;
- France Telecom – in Germany and Sweden;
- Oniway (EDP) – in Portugal;
- Telefónica – in Austria, Germany, Italy and Switzerland; and
- Yoigo (TeliaSonera) – in Spain.

Figure 10: Western European new 3G entrants.

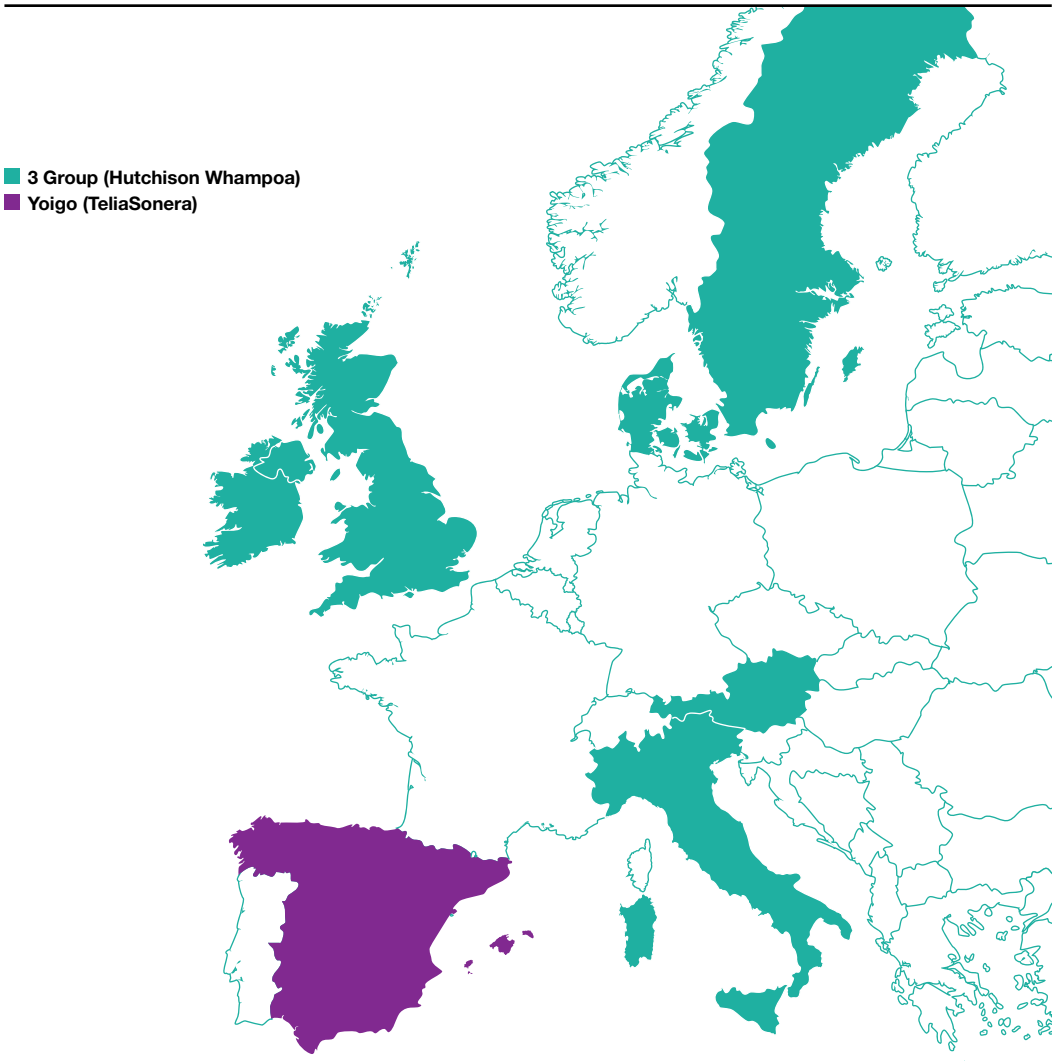


Source: Three UK research.

157 However, Figure 11 below shows the 3G entrants that are now remaining in the market after ten years, namely:

- 3 Group (Hutchison Whampoa) – Austria, Denmark, Ireland, Italy, Sweden and UK; and
- Yoigo (TeliaSonera) – Spain.

Figure 11: Western European 3G entrants remaining in 2011.



Source: Three UK research.

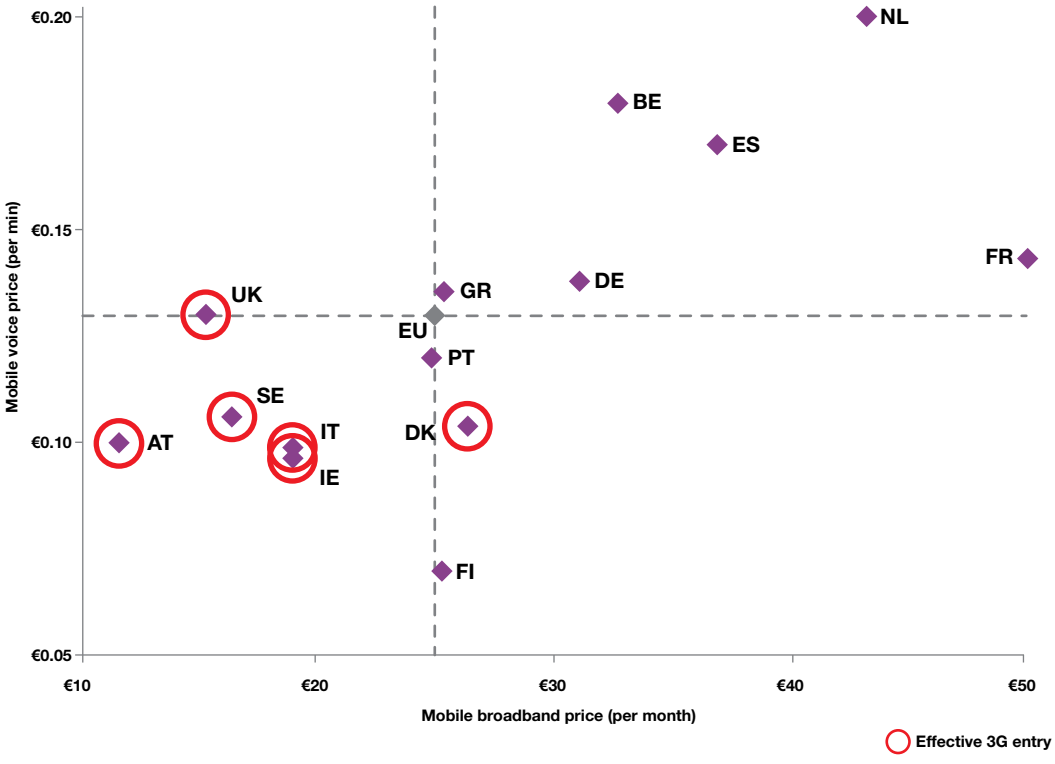
158 All the other new 3G entrants either:

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

159 As a result, a clear divide can be seen between countries that managed to attract and sustain the presence of a 3G entrant and those that did not.

160 In particular, Figure 12 below shows the current level of pricing for mobile voice and mobile broadband services across each Western European country[43] – which demonstrates that mobile voice and mobile broadband prices are materially lower than the EU average in the countries that have seen effective 3G market entry, circled in red[44]. Moreover, as discussed further at subsection [3.1(b)], below, the countries that have seen effective 3G entrants are also all of the countries that benefit from four operators competing in their mobile markets[45].

Figure 12: Mobile voice and broadband pricing in Western Europe.



Source: Berg Insight, European Commission.

43 Comparable data not available for Norway or Switzerland.
44 Namely, Austria, Denmark, Ireland, Italy, Sweden and the UK. Not including Spain, as the 3G entrant in Spain, Yoigo, only launched services in 2007 and has not yet had a material impact on the Spanish mobile market.
45 The exceptions being Spain (which is a four-operator market but where the new 3G entrant only recently launched services) and Germany (where all the four operators are 2G incumbents, the two new 3G entrants having previously exited).

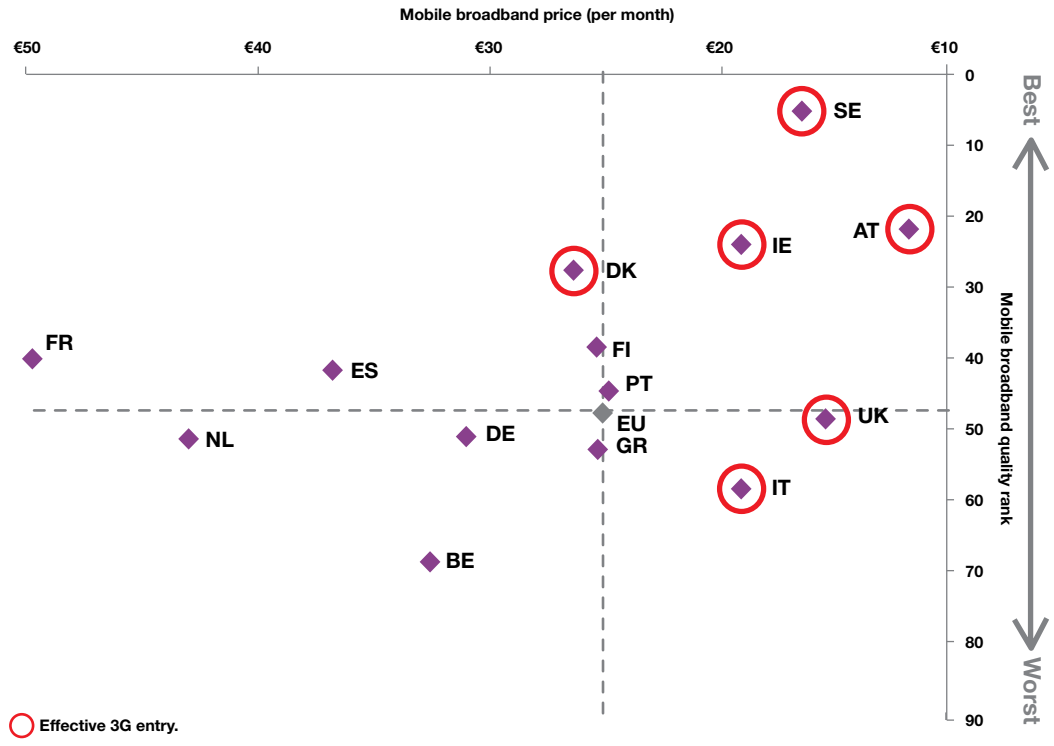
161 In the four-operator countries identified in red, consumers have on average benefited from 19% lower mobile voice prices and 28% lower mobile broadband prices than the EU average – whereas prices in almost every other Western European country remain above the EU average.

162 In the UK, mobile broadband prices are 39% below the EU average.[46]

163 In addition to lower prices for consumers, effective competition between four or more national wholesalers has also led to higher quality mobile networks and greater penetration of new and innovative products and services.

164 In particular, Figure 13 below shows the relationship between mobile broadband price and mobile broadband network quality across Western European countries. Once again, it is possible to identify a strong relationship between increased competition through 3G market entry, on the one hand, and lower prices and higher quality, on the other hand.

Figure 13: Western European mobile broadband price and network quality.



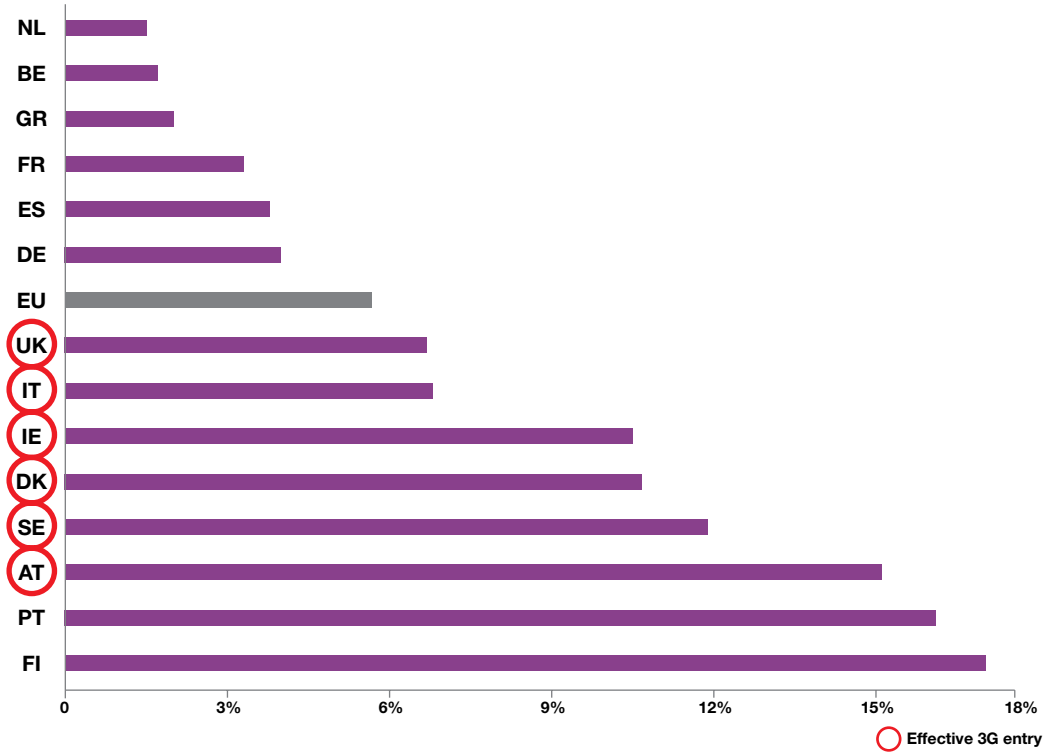
Source: ArcChart, Berg Insight.

46 Unfortunately, in contrast, UK mobile voice prices are almost identical to the EU average. This difference is primarily due to high mobile termination rates (MTRs) in the UK, which Ofcom has recently concluded limit competition. Following Ofcom's decision to reduce MTRs by 80% over the next four years, UK mobile voice prices are expected to fall considerably. See "Wholesale mobile voice call termination statement,", Ofcom, March 2011.

165 In addition, Figure 14 below shows the current level of mobile broadband penetration in each country – showing that mobile broadband penetration is significantly higher than the EU average in the same countries, identified in red, that have had sustainable 3G market entry.

166 Consumers have benefited from greater penetration of mobile broadband services – on average 81% greater than the EU average – whereas elsewhere, mobile broadband penetration has typically been much lower than the EU average.

Figure 14: Mobile broadband penetration in Western Europe.



Source: European Commission.

167 See Annex [2] for evidence on innovation in new products and services.

168 In each country, it has typically been the 3G market entrants that have led the market on geographic expansion, network quality, innovation in new services and lower pricing. Moreover, in its recent MTR decision, Ofcom found that lower prices and profitability resulting from lower MTRs was unlikely to affect future investment. In particular, Ofcom found that greater competition was likely to stimulate greater innovation and investment.

169 The impact of Three as the 3G market entrant in the UK has been widely recognised, including by the European Commission, which acknowledged in its decision on the merger between Orange and T-Mobile that, *"3UK is considered by several market players as an important competitive force in the UK market and to be the most innovative MNO in the market. It has played a key role in driving innovation, particularly in the data segment, and lower prices for consumers"*[47].

170 Many industry analysts share the same conclusion, for example:

> *"Interestingly data pricing in Germany is c. 2x higher than that in the UK at this point in time, reflecting primarily the absence of a Hutchison subsidiary, in our view.*
>
> *We believe there are a number of reasons for [the difference between pricing in different markets]. Mainly they have to do with the presence of Hutchison and with how supportive regulators are towards smaller, potentially disruptive, players."*[48]
>
> *"In markets where mobile broadband is priced at a clear discount vs. fixed broadband (for roughly similar performance), the take-up is high. There is a race for acquisition of mobile broadband customers. In [such] markets, the competitive landscape has these characteristics:*
> - *at least four MNOs fighting for voice customers for several years and, more recently, mobile broadband customers;*
> - *the smallest and latest MNO entrant usually holds at least 5% market share; and*
> - *3 (Hutchison) is in the market. As a late entrant in most markets, and with low penetration in voice, 3 is now betting significantly on data. Consequently, 3's presence has typically heightened competition, triggering retaliation from other MNOs in a race to acquire customers. The result: Very fast price erosion on mobile broadband."*[49]

171 It is therefore critical that the Combined Auction design does not undermine or reverse the merger commitments put in place to protect Three's important role in the mobile market, by putting Three (or a fourth 3G entrant that would fulfil a similar role to Three) at risk as a competitive force in the UK mobile market.

47 Case No COMP/M.5650 – T-Mobile/ Orange, para. 107
48 "US vs. Europe", JP Morgan Cazenove, Europe Equity Research, 2 February 2011.
49 "Mobile Broadband Business Designs: Operators Under Cost Pressure Are at Crossroads", Oliver Wyman (2009).

b. Cross-country analysis shows that a four player market will reduce prices for consumers and increase the quality of services.

172 As discussed at Subsection [3.1(a)], above, the countries with a strong connection between lower prices for mobile services and higher quality of those services, are countries with 3G market entrants. However, they are also all countries that benefit from four operators competing in their mobile markets.

173 By comparison, it is noteworthy that outlying countries in terms of higher pricing and lower quality of services, such as France, the Netherlands and Belgium, are generally jurisdictions in which only three operators compete because they were unable to attract 3G entrants (i.e. Belgium and France[50]), or at the time did not consider it necessary to increase competition (i.e. the Netherlands[51]).

174 In summary:

- Consumers in countries that have managed to attract 3G entrants and sustain a market in which four or more national wholesalers compete (such as Sweden, Austria and Ireland), generally benefit from materially lower than average mobile voice and mobile broadband pricing, while simultaneously experiencing substantially higher than average mobile broadband quality and penetration; whereas
- Consumers in countries that did not attract 3G entrants and have fewer than four national wholesalers competing in their markets (such as Belgium, France and the Netherlands), generally suffer from materially higher than average mobile voice and mobile broadband pricing, while simultaneously experiencing substantially lower than average mobile broadband quality and penetration. In particular, the Netherlands has the highest level of mobile voice prices; the second highest level of mobile broadband prices and lowest level of mobile broadband penetration in Western Europe (see figures above)[52].

175 The UK is in the fortunate position in which it currently has a mobile market with four active national wholesalers, one of which is a 3G market entrant. From the evidence available, this would appear to be the optimal competitive situation, to the benefit of UK consumers.

50 Both of which have subsequently tried again to attract 3G new entrants. A new operator, Free, is about to launch in France but will not yet have had any impact on the data used in this response.
51 See European Commission 3G Report, Chapter 2.
52 The Netherlands has now belatedly attracted two new mobile entrants in 2010.

176 Although Ofcom is rightly indifferent as to the identity of any particular national wholesalers that would be in the market following the Combined Auction, Three believes Ofcom has correctly concluded that ultimately reaching a position with fewer than four competitors in the market would be a potentially serious detriment to consumers and should be avoided.

c. The experience that a minimum of four national wholesale mobile operators make a material difference to mobile prices, investment and innovation is supported by theoretical economic models.

177 In addition to the experiential evidence discussed at sections [3.1(a)] and [(b)], above, the conclusions of a wide class of economic models support the conclusion that reducing the number of competitors in a market from four to three reduces output and increases prices, leading to loss of consumer welfare.

178 Table 4 below summarises the results of these models, showing that the impact on prices of a reduction in competitors from four-to-three could vary between 0% and 33% under standard assumptions. The possibility of a 0% impact should nevertheless be disregarded, as the national wholesale mobile operator market is unlikely to be characterised as "Homogenous Bertrand" competition, as this represents the extreme case of an industry without supplier capacity constraints or customer switching costs.

Table 4: Impact of a four-to-three reduction in competition on prices.

		market price impact (%)	market quantity impact (%)
Cournot	homogenous	+25%	–6%
	differentiated	+17%	–13%
Bertrand	homogenous	0%	0%
	differentiated	+25%	–30%
Stackelberg	homogenous	+33%	–5%

Source: NERA Economic Consulting.

179 Annex [3] below describes each of these theoretical models further.

d. The implied consumer and economic benefits of a four player competitive national wholesale market are considerable.

180 As highlighted above, the benefits to consumers of effective competition in mobile communications – through 3G entry and, by extension, the existence of a market incorporating four competitors – are extremely high. Three believes that the wider economic benefits are at least as great.

181 Table 5 below shows the estimated benefit to the UK economy that 3G entry has generated – of up to hundreds of billions of pounds sterling in present value terms, as:

- even on conservative assumptions, namely that the competitive benefits of 3G entry are confined to the mobile market only, that there are no wider economic "multiplier" effects and that 50% of lower prices are reflected in lower profits, the UK economic benefits still amount to 0.1% of GDP or approximately £40bn in UK present value terms; and
- stronger assumptions, namely that the benefits of competition in the mobile communications market also result in lower prices in the wider communications market, that there are reasonable wider economic multiplier effects on the UK economy and that lower prices are reflected in greater efficiency, result in economic benefits of 0.7% of GDP or £290bn in UK present value terms.

Table 5: UK economic benefits of effective mobile 3G entry.

	EU average consumer prices	Average prices in countries with effective 3G entrants[53]	Consumer benefit of 3G entrants[54]	UK annual consumer benefits	UK GDP benefit[55]	UK present value benefit[56]
Mobile voice	€12.8c/min	€10.6c/min	19% lower			
Mobile broadband	€25.0/ month	€17.9/ month	28% lower			
Total			**20-22% lower[57]**	**£3.0-6.7bn[58]**	**£1.5-10.0bn**	**£40-290bn**
					0.1%-0.7%	

Source: Berg Insight, European Commission, Ofcom, Office for National Statistics, Ovum, Three UK.

182 The above calculation assumes that a large proportion of benefits to consumers translate directly into wider economic benefits, namely, that benefits to consumers are not simply a transfer from firms, in lower profits, to consumers, in lower prices. Three considers that this is realistic, as competition is not merely expected to result in lower prices (i.e. "static competition") but to drive greater efficiency and innovation (i.e. "dynamic competition").

183 Competition also results in a reduction of "super-normal" profit and the risk of such profits. This necessarily translates into an increase in economic welfare. As discussed further, while competition in the UK mobile market has reduced super-normal profits, Three believes that long-run profitability of the market is still above the cost of capital and not at unsustainably low levels, as claimed by some mobile operator groups. See Section [3.3], below, for further discussion of the profit potential of the UK mobile market.

53 Austria, Denmark, Ireland, Italy, Sweden and UK.
54 Equal to the reduced cost of services to UK consumers in proportion to the total UK market for mobile communications or wider telecoms services. Source: "Communications Market Report", Ofcom, 2010.
55 Includes economic multiplier of 1-1.5. For example, see "The Impact of the US Wireless Telecom Industry on the US Economy", Ovum, 2005. Also includes efficiency factor of 50%-100%, representing the share of lower consumer prices reflected in GDP benefits (rather than just lower firm profits).
56 Equal to UK annual GDP benefit discounted at a real long-term social discount rate of 3.5% (see "The Green Book", HM Treasury).
57 Range reflects whether voice and broadband are weighted by estimated UK mobile voice to mobile broadband revenue or total UK voice to UK broadband revenue (source: Ofcom, Three UK).
58 Range reflects whether just UK mobile communications services included or wider UK communications services.

3.2. The benefits from a competitive market will only be felt if such competition is sustainable.

184 As discussed above, attracting new 3G entrants and encouraging the presence of a fourth national wholesaler on any given market is highly likely to benefit consumers and provide wider social and economic benefits. However, this will only be true in situations where such competition is sustainable.

185 Figures 9, 10 and 11 (three Europe maps), above, identify countries that failed to attract or sustain new 3G entrants.

186 The example of Germany is instructive. Germany initially attracted two new 3G entrants, France Telecom and Telefónica. However, they both subsequently exited the market for stated financial reasons. Three understands this to have largely been as a result of a regulatory environment that proved unfavourable towards new entrant mobile operators.

187 Germany has experienced higher prices and lower levels of penetration than countries that managed to sustain their 3G new entrants (see figures 12, 13 and 14 [mobile pricing, broadband pricing/quality and broadband penetration]). However, Germany has not suffered the even higher costs and lower penetration experienced by countries such as Belgium, France and the Netherlands, which may be explained in part by the fact that it has four competitors despite losing its 3G entrants (all of the remaining competitors in Germany were incumbents at the time of the 3G award).

188 In summary, more than half of the new 3G entrants in Western Europe have subsequently exited their respective markets, mainly due to regulatory environments that were unfavourable toward sustainable new entrant competition in the mobile communications market, or because the relevant markets may not have been able to sustain them financially.

189 As Ofcom recognises, it is only possible to serve a certain market share if an operator has a corresponding holding of spectrum, as spectrum represents a finite limit on an operator's service capacity.

190 For the reasons explained below, that market share must reach a certain level (approximately 20%) for an operator to be viable over the long run.

a. Market share is key for national wholesale mobile operators because of their large fixed costs.

191 Market share is important in the mobile market because national wholesale mobile operators are faced with large fixed costs – which are independent of market share – chiefly the cost of building and running a national wholesale network.

192 A recent Enders Analysis study[59] shows that for a representative UK operator (with 25% market share) fixed costs represent 35% of its service revenue and 40% of its total costs (see Table below).

Table 6: Representative UK mobile network operator cost structure.

Cost element	% of service revenue	Nature of cost
Interconnect	20-25%	Variable
Network operating cost	10%	Mostly fixed
Subscriber acquisition costs (SACs)/ Subscriber retention costs (SRCs)	15-20%	Mostly variable
Customer service/billing	10%	Mostly variable
Advertising	2-3%	Fixed
Selling, general and administration costs	15%	Mostly fixed
Network capital expenditure/ depreciation and amortisation	8%	Mostly fixed
Total cost	80-91%	
Earnings before interest and tax (EBIT) margin	9-20%	
Earnings before interest, tax, depreciation and amortisation (EBITDA) margin	17-28%	

Source: Enders Analysis.

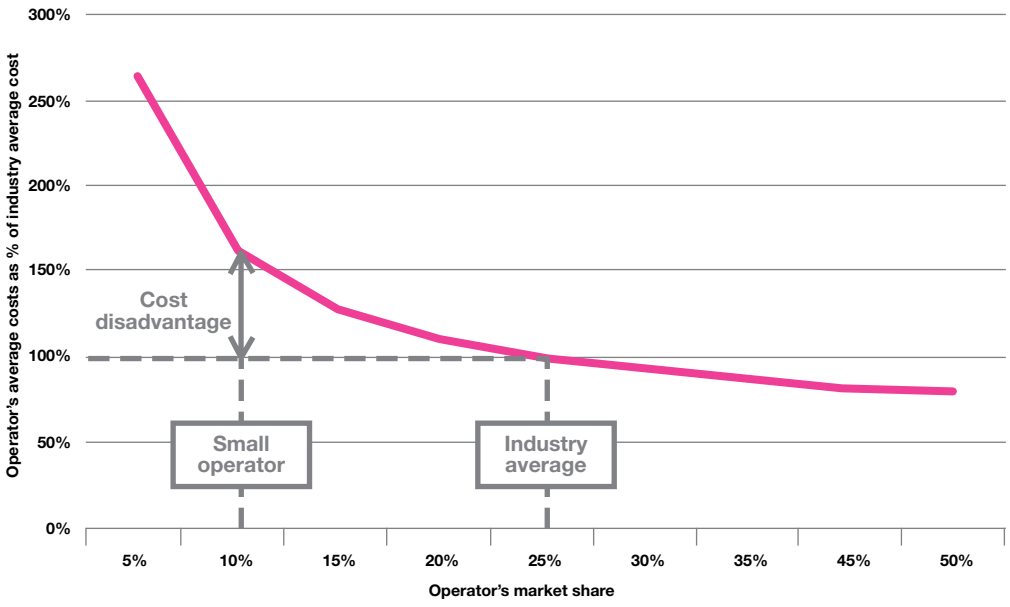
193 Hence, for a representative industry operator, this means that:
- costs representing 35-36% of revenue are mostly fixed; and
- costs representing 45-55% of revenue are mostly variable.

59 "T-Mobile and Orange in the UK: creating a synergy champion", Enders Analysis, September 2009

194 Given that fixed costs have to be incurred by any national wholesale operator irrespective of their size, operators with small market share experience a clear cost disadvantage. Figure 15 therefore shows how the average unit cost of an operator (in relation to the industry average cost) varies with market share. For example, on the basis of the above relationship between fixed and variable costs for representative mobile operators:

- an operator with 10% market share would have an average unit cost 62% higher than the industry average;
- while an operator with 35% market share would have an average unit cost 12% lower than the industry average.

Figure 15: Relationship between national wholesale mobile operator average cost and market share.



Source: Three's analysis based on Enders study.

195 Clearly, a minimum market share is needed for an operator merely to break even. On the basis of the above fixed and variable cost estimates, an operator would therefore need a minimum market share of 16-20% just to break even, i.e. to make zero EBIT.

196 However, it is not sufficient merely to break even. An operator should be able to recoup its investment or the investment would not be made. On the basis of the above fixed and variable costs, an operator would need a minimum market share of 18-22% to make a return on capital employed (ROCE) equal to Ofcom's estimate of the mobile wholesale

industry weighted-average cost of capital (WACC) of 6%[60]. This would equate to an EBIT margin of 5-6% and EBITDA margin of 13-14%, a long way below UK and European mobile wholesale industry averages.

197 Ofcom's MTR statement in 2011 suggested that the minimum efficient scale for a four-player market is actually 25%, as any operator with share less than 25% would be unable to achieve normal profitability. Three nevertheless believes (notwithstanding the views expressed by Ofcom in its MTR statement 2011) that the UK national wholesale mobile market is characterised by relatively high levels of profitability and that an operator with a 20% market share (or a particularly efficient operator) should be able to achieve sustainable profitability.

198 This conclusion is also consistent with the European Commission's and UK Competition Commission's analysis of the efficient scale of operators for the purpose of regulating mobile termination rates:

> *"To determine the minimum efficient scale for the purposes of the [mobile termination rate] cost model, and taking account of market share developments in a number of EU Member States, the recommended approach is to set that scale at 20% market share.*
>
> *When setting the appropriate efficient scale, it is important to mimic a competitive outcome and provide appropriate incentives for efficiency. The Competition Commission in the UK in the context of its 2003 review of the UK market concluded that once a mobile network operator has captured 20%–25% of the market volume, there are only very limited remaining economies of scale.*
>
> *As indicated by the Competition Commission, a mobile operator with a lower than average market share has the opportunity to capture at least an average share of the market over time. It may similarly be expected that mobile operators, having entered the market, would strive to maximise efficiency and revenues and thus be in a position to achieve at least a minimum market share of 20%."*[61]

60 This calculation assumes an average network asset life of ten years and straight-line depreciation. Therefore, in steady state, total capital employed is equal to ongoing capital expenditure (8% of service revenue) multiplied ten. This is still a highly conservative assumption, as it disregards capita employed in business start-up costs and spectrum.

61 "COMMISSION STAFF WORKING DOCUMENT accompanying the COMMISSION RECOMMENDATION on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU", European Commission, 2009.

b. Cross-country market share evidence also indicates that the minimum sustainable market share of a national wholesale mobile operator is 20%.

199 International evidence indicates that 20% market revenue share is the minimum sustainable scale for a national wholesale mobile operator. This is because operators below this scale across Western Europe have either exited or needed to grow to remain in the market, namely:

- all the Western European national wholesale mobile operators that have exited the market since 2001 had market shares less than 20%;
- the majority of operators in Western Europe have stable market shares considerably in excess of 20%; and
- operators with market shares less than 20% are either growing quickly (i.e. are seen as "challengers") or declining (i.e. seen at risk of exit).

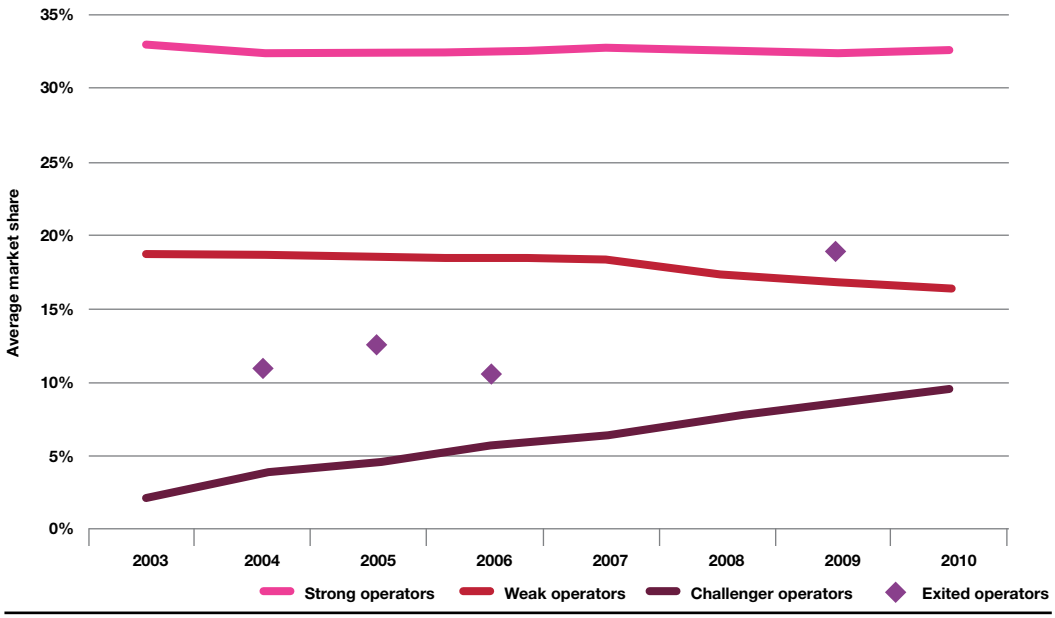
200 Figure 16 below illustrates the average markets shares of each of the above categories of operators, showing that:

- strong operators in Western Europe (i.e. operators with stable market shares) have average market shares of 33%;
- weak operators (i.e. operators with falling market shares) currently have average market shares of 17% and falling slowly[62];
- exited operators (i.e. operators that have now exited the market) have average market shares consistently less than 20%; and
- challenger operators (i.e. operator with growing market shares) have average market shares of 10% and rising rapidly[63].

62 The chief "weak" operators (which are seen at risk of exit) are currently: Orange Austria; Orange Switzerland; and Wind Greece.

63 The chief "challenger" operators are currently: the 3 Group (Austria, Denmark, Ireland, Italy, Sweden, UK); E-Plus (Germany); O2 Germany; Optimus (Portugal); Network Norway; Wind Italy; and Yoigo (Spain).

Figure 16: Western European average mobile wholesale operator market shares.



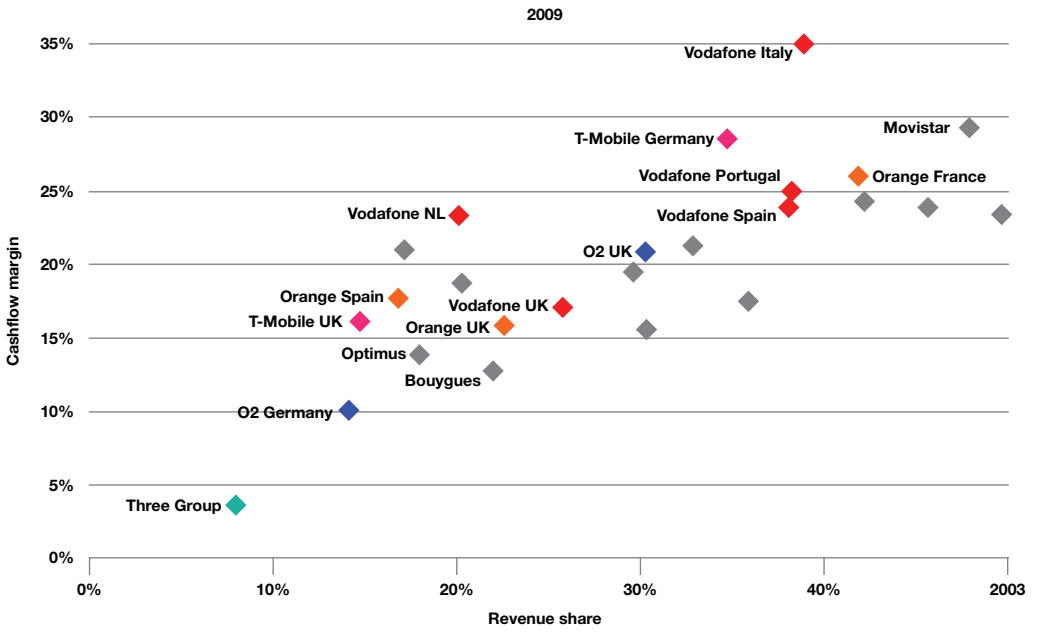
Source: Analysys Mason.

201 Annex [7] shows the market shares of all national wholesale mobile operators in Western Europe between 2003 and 2010.

c. *Cross-country financial evidence also indicates that the minimum sustainable market share of a national wholesale mobile operator is 20%.*

202 A cross-country comparison of operators' profitability across Western Europe demonstrates that operators' profitability strongly correlates with their market share (due to economies of scale discussed above). Most operators with market shares in excess of 20% achieve cash flow margins – approximately equivalent to EBIT margins – of 10% or more. In contrast, operators with less that 20% market share, have lower cash flow margins . Fig. 17 below illustrates this

Figure 17: Western European national wholesale mobile operator cash flow margin and market share.



Source: Wireless Intelligence, 2009.

3.3 Equalisation of spectrum between operators.

203 Even if an operator can obtain enough spectrum to achieve minimum viable scale and cover its fixed costs, it still may not be able to exert its full potential competitive pressure on other providers. If an operator were to hold a comparatively small amount of spectrum, that amount might put a binding cap on its output.

204 As a consequence of such a capacity constraint, the remaining "unconstrained" operators would find themselves in the position of competing only among themselves (see Section [2.3] above).

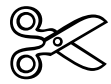
205 Correspondingly, operators with larger holdings of spectrum will have a tendency to hoard their spectrum, resulting in higher prices to consumers. Indeed, in any industry where there are scarce valuable inputs, maximising competition is achieved by equalising those scarce inputs between market players.

206 Annex 3 by NERA Economic Consulting below describes the economic theory and conditions under which this conclusion applies.

207 Some EU Member States, such as Finland[64], have specifically recognised that unequal mobile spectrum holdings will tend to limit competition between national wholesale mobile operators and have thereby actively sought to equalise spectrum holdings between operators for the benefit of consumers.

208 While it may not be possible to achieve exact equalisation of low frequency and high spectrum across all existing national wholesale operators without redistribution of existing spectrum, it would be possible to achieve approximately equal holdings following the spectrum award.

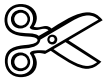
Table 7: Possible approximately equal UK mobile spectrum allocation.



209 Figure 18 shows the same overall spectrum holdings.

64 Source: Cullen International (FICORA decision 958/700/2007 of Oct. 31, 2007; FICORA radio spectrum report of May 12, 2010).

Figure 18: Possible approximately equal UK mobile spectrum allocation.

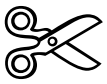


Source: Three.

210 In conclusion, although the minimum spectrum portfolios proposed by Ofcom could possibly support four competitors, Three does not believe that all four of those competitors would necessarily be "credible" or sustainable. The current proposals are likely to deliver an outcome in which spectrum is so unevenly distributed as to inhibit competition and constrain the ability of certain operators to achieve a sustainable market share. Three therefore urges Ofcom to adopt the proposals which are put forward in Section [4] below which Three believes will secure Ofcom's policy goal of a sustainable four player market with all of the benefits that flow from that outcome.

4. 800MHz in blocks of less than 10MHz is insufficient to support a national wholesale operator and will lead to spectrum inefficiency.

211-246



5. Proposed amendments to auction design measures – spectrum.

247 ***Three supports Ofcom's structural approach of including both minimum spectrum portfolios and total spectrum caps into the auction design. Three considers, however, that the size and composition of the minimum spectrum portfolios should be adjusted in order to reflect: (i) the legal obligation to redress liberalisation distortion; (ii) the need to ensure that all four national wholesalers are viable. Ofcom should also consider the benefit of equalising key mobile inputs (such as spectrum). The overall spectrum caps should also be reduced.***

248 An entirely unconstrained auction would present a substantial risk that the liberalisation distortion would be perpetuated and the four player market would fail. This is because the other national wholesale operators have strong incentives to reduce future competition – they would receive a substantial financial benefit if Three ceased to fulfil its current role as a maverick and a competitive constraint on prices in the market. Three's exposure to such marginalisation or foreclosure has been largely caused administratively by the decision to liberalise all 900MHz and 1800MHz spectrum in the hands of the incumbent operators because this decision has put Three in the position of having insufficient spectrum holdings relative to competitors. Even if Three's competitors did not actively increase their bids in an attempt to marginalise or foreclose Three, differing valuations risk leading to the same result.

249 Further information regarding the reasons that an unconstrained auction is not appropriate are set out in Annex [5].

5.1. Determining auction design measures for spectrum.

250 2G liberalisation creates a significant competitive distortion which will not be remedied unless effective auction design measures are adopted which address the issues identified in Sections 1, 2, 3 and 4 above. Similar measures are also required to achieve Ofcom's policy objectives and legal duties to promote competition generally, namely to ensure there are at least four national wholesalers with a "minimum spectrum portfolio" sufficient to provide high quality data services in the future[70].

251 In seeking to ensure that Ofcom complies with its legal obligations and achieves its policy objectives, Three considers that Ofcom should apply three tests:

70 Consultation, para.1.13, 1.16.

1. will the Combined Auction remedy the competitive distortion arising from liberalisation (both the grant to O2 and Vodafone of preferential access to low frequency spectrum and the creation of disparity in total capacity)?
2. will the spectrum awarded under the Combined Auction ensure that at least four national wholesale operators are credible and sustainable competitors?
3. will the Combined Auction avoid spectrum being a source of competitive distortion in the future?

252 Three strongly supports the idea of a "minimum spectrum portfolio". Three is concerned, however, that Ofcom's current proposals do not satisfy any of the tests outlined above and will therefore not meet Ofcom's legal obligations or achieve its policy objectives.

253 In the remainder of this section, Three first discusses Ofcom's current "minimum spectrum portfolio" proposals and highlights some issues associated with this approach. Three then considers minimum spectrum portfolios against the three tests outlined above.

5.2. Ofcom's approach to "minimum spectrum portfolios".

(a) Minimum spectrum packages should support a credible provider of high quality data services.

254 Ofcom states that it is proposing to ensure that after the Combined Auction, subject to demand, there should be "at least four holders of a minimum spectrum portfolio that mean they are credibly capable of providing high quality data services in the future" – and that to be a credible national wholesaler an operator is likely to need at least as much spectrum as one of the following minimum spectrum portfolios[71]:

a) 2x5MHz of sub-1GHz spectrum and 2x20MHz of 2.6GHz spectrum; or
b) 2x5MHz of sub-1GHz spectrum and 2x15MHz of 1800MHz spectrum; or
c) 2x10MHz of sub-1GHz spectrum and 2x15MHz of 2.6GHz spectrum; or
d) 2x10MHz of sub-1GHz spectrum and 2x10MHz of 1800MHz spectrum; or
e) 2x15MHz of sub-1GHz spectrum.

71 Consultation, para. 1.16.

255 However, while the Consultation invites views from stakeholders (an opportunity that Three welcomes), Ofcom does not directly explain how it formulated these "minimum spectrum portfolios", why it considers these capable of supporting a national wholesaler of high speed data services and how such packages would fulfil Ofcom's legal obligations in relation to redressing spectrum liberalisation or would secure Ofcom's policy objectives.

256 Instead, the Consultation limits itself to stating that:

- *"there is some uncertainty over what is likely to be the minimum spectrum portfolio necessary to be a credible national wholesaler and in particular whether the holding of 2 x 5 MHz of sub-1GHz spectrum combined with higher frequency holdings is likely to be sufficient"*[72]*; and*
- *"a multi-frequency network with 2x5 MHz of sub-1 GHz spectrum and a certain amount of above-1 GHz spectrum can go a long way towards matching the coverage and maximum speed deliverable by a network with only sub-1 GHz spectrum using the same number of sites […but] such multi-frequency networks will not be able to serve the same number of customers as a sub-1GHz only network with a similar amount of spectrum and number of sites, and so will have a lower capacity"*[73]*.*

257 Three infers from Ofcom's minimum spectrum portfolio proposals (though it is not expressly stated) that the minimum spectrum portfolios are intended to be broadly technically equivalent to 2x15MHz of sub-1GHz spectrum. Portfolio (e) contains solely 2x15MHz of 800MHz spectrum. The other portfolios contain less than 2x15MHz of 800MHz but also contain additional 1800MHz or 2600MHz spectrum, seemingly to compensate for the smaller block of low frequency spectrum. This conclusion that the packages are intended to provide equivalent technical benefit is supported by the fact that the current proposal does not permit bidders to select between the packages.

(b) Ofcom's minimum spectrum portfolios are not equivalent.

258 Three's analysis has shown that the technical properties of the various spectrum portfolios proposed by Ofcom are not substantially equivalent (in the sense of being capable of delivering an equivalent quality and scale of data service).

72 Consultation, para. 5.75.
73 Consultation, para. 5.76.

259 As outlined above at Section 4 above, a spectrum package with only 2x5MHz of 800MHz will create substantial technical difficulties compared to a package with 2x10MHz of 800MHz and will lead, in the relatively short term, to an absolute constraint on capacity and speed in a multi-frequency network. Further, a spectrum package with 2x10MHz of 800MHz will not provide a similar level of technical benefit compared to a package with 2x15MHz of 800MHz.

260 Three has provided a technical review of the differences between the spectrum packages at Paragraph 4 of Annex 4.

261 The fact that these spectrum portfolios provide a wide range of technical benefits can also be inferred from reserve price valuations associated with the various packages, which (using any of the four approaches considered in the Consultation) yield substantially different values for the different packages. As shown in Table 9 below, there is a great disparity of valuation between each package (whichever method is adopted)[74].

Table 9: Comparison of Ofcom's proposed minimum spectrum portfolios.

MSP	800MHz	1800MHz	2.6GHz	Estimated Market Value[75]	Total Eligibility Points[76]	Ascending -Auction Reserve[77]	Spectrum -Floor Reserve[78]
a)	2x5MHz	2x15MHz		£391m	45	£45m	£260m
b)	2x5MHz		2x20MHz	£421m	50	£50m	£280m
c)	2x10MHz	2x10MHz		£661m	70	£70m	£440m
d)	2x10MHz		2x15MHz	£691m	75	£75m	£460m
e)	2x15MHz			£900m	90	£90m	£600m

Source: Ofcom Consultation.

74 Table 8.1 of the Consultation reports prices, adjusted for population, from other European spectrum auctions which average £300 million per 2x5 MHz block of sub-1GHz spectrum and which average £30.33 million per 2x5 MHz block of 2.6 GHz spectrum. In our computations above, we use the values of 2.6 GHz spectrum for the same quantity of 1800MHz spectrum.
75 Estimated market values, based on results of other European spectrum auctions, adjusted for population – See Consultation ¶8.104 and Table 8.1.
76 Eligibility points – See Consultation ¶8.105.
77 Ascending-auction reserve prices – See Consultation ¶8.106 – 8.115 and Table 8.2.
78 Spectrum-floor reserve prices – See Consultation ¶8.116 – 8.122.

5.3. Will the Combined Auction remedy the competitive distortion arising from O2 and Vodafone's preferential access to low frequency spectrum?

(a) 2x15MHz of low frequency spectrum equivalence is required.

262 The key issue in responding to this question will be whether the "minimum spectrum portfolios" are framed in such a way as to provide competitors who did not benefit from the low-frequency windfall, following 900MHz liberalisation, enough spectrum to address the advantages that their competitors received.

263 As discussed at Section 1, Ofcom is required to take appropriate and proportionate measures to redress the distortion caused by 2G spectrum liberalisation in the hands of the incumbents. Section 2 outlined the likely nature of this distortion. Section 4 also sets out the substantial disadvantages which operators without wide bandwidths of low frequency are likely to incur in seeking to provide quality high speed data services in the future.

264 Three considers that any meaningful effort to redress low frequency spectrum distortion must start from the premise that each non-benefiting operator should be entitled to 2x15MHz of low frequency spectrum (or equivalent).

265 It is likely that O2 and Vodafone would argue that 2x15MHz overstates their own ability to use 900MHz spectrum for 3G or next generation technologies. No doubt they would submit that substantial parts of their 900MHz spectrum will be allocated to 2G customers for the foreseeable future and accordingly, the distortion should only be measured against a small portion of their 900MHz spectrum holdings. Three disagrees. O2 and Vodafone have strenuously argued about the time and cost of clearance of 900MHz spectrum for many years, and yet within two months of liberalisation O2 was able to clear and launch 2x5MHz of 900MHz for 3G use. Three estimates that the current customer bases of O2 and Vodafone could be supported on 2x7.5MHz of spectrum if this spectrum was used efficiently. Further, customers could be transitioned from 900MHz spectrum across to the 2x5.8MHz of 1800MHz spectrum which O2 and Vodafone also hold and accordingly only 2.5MHz of 900MHz spectrum would be required for their legacy 2G customers Furthermore, 2G customer bases are likely to rapidly decline as UK customers move ever more quickly across to smartphones.

266 Annex 4 sets out further information regarding Three's view on 900MHz spectrum clearance and the decline in 2G customer numbers.

267 Three therefore supports Ofcom's apparent approach of considering equivalence to 2x15MHz of low frequency spectrum, although Three would encourage Ofcom to make the link to low frequency spectrum liberalisation more explicit.

(b) Amendments to minimum spectrum portfolios are required to redress the distortion from O2 and Vodafone's preferential access to low frequency spectrum.

268 The nature of the spectrum holdings which can provide 2x15MHz low frequency equivalence must then be considered. Ofcom has proposed various multi-frequency spectrum portfolios

269 As discussed at Section 4 above, the substantial propagation characteristics of 900MHz spectrum cannot be matched by a combination of spectrum which contains only 2x5MHz of 800MHz spectrum. Three therefore considers that it would not be an appropriate or proportionate decision of Ofcom to implement an auction design which does not guarantee other operators at least 2x10MHz of 800MHz spectrum.

270 Accordingly, Three submits that spectrum portfolios (a) and (b) should be removed from the minimum spectrum portfolios due to the substantial disparity in their technical equivalence – they would not enable a national wholesaler to provide a credible high quality data service on a sustainable basis.

271 However it is important to understand that even if the portfolios are adjusted to reflect a minimum of 2x10MHz at 800MHz this will still only partially redress the low frequency distortion. In practice, holders of 2x10MHz of 800MHz spectrum will still be disadvantaged compared to O2 and Vodafone (particularly if they did not obtain wide bandwidths of other liberalised spectrum) because:

(a) 2x15MHz of low frequency spectrum can deliver far higher data speeds than 2x10MHz of low frequency spectrum[79]; and

(b) 2x15MHz of low frequency can be leveraged to provide optimum spectral efficiency with wider bandwidths of high frequency

79 cell capacity is 6.29Mbps higher with 2x15MHz

spectrum than 10MHz, thus facilitating greater total network capacity (see Section 4 and Annex 4 for a discussion of the challenges in load balancing networks.

272 Hence the only way to fully address the competitive distortion of 900MHz liberalisation without re-distributing the 900MHz spectrum would be to ensure that the operators who did not benefit from such liberalisation receive 2x15MHz of 800MHz spectrum in the Combined Auction. This is the fair outcome.

5.4. Will the Combined Auction redress the capacity distortion caused by 900MHz and 1800MHz liberalisation?

273 As outlined in Section 2, the liberalisation of 1800MHz (and 900MHz) spectrum in the hands of the incumbents has provided a massive capacity uplift to Everything Everywhere, (and also to Vodafone and O2) in a market which is likely to become increasingly reliant upon capacity in order to attract and retain customers. This provides Everything Everywhere, Vodafone and O2 with a substantial commercial advantage in terms of capacity.

274 In order to redress this capacity distortion, the Combined Auction must ensure that a fourth operator is guaranteed additional spectrum. There are a number of mechanisms which Ofcom could impose – but at a minimum it should ensure that a fourth operator has enough spectral capacity to act as a viable competitor to those operators (Everything Everywhere, Vodafone and O2) who have been the beneficiaries of spectrum liberalisation having regard to the relative holdings of 3G capable spectrum before liberalisation.

275 In section 5.5 (b) below, we have identified that, for Three, to be a viable competitor would mean that Three is able to achieve 20% of the total spectrum and 20% of low frequency spectrum. This is consistent with the fact that Three held 25% of 3G capable spectrum before liberalisation and that the operator holding the smallest amount of 3G capable spectrum still had 18% of it (i.e. 2x10MHz FDD and 5MHz TDD) – as well as 2G spectrum that acted as a substitute for voice calls, at least.

276 Therefore we propose that, at a minimum, at least four operators should be guaranteed the ability to acquire a minimum of 20% of total spectrum and 20% of low frequency spectrum – to redress the capacity distortion

caused by 1800MHz (and 900MHz) liberalisation. This would be in addition to the need for total spectrum caps and revised annual licence fees (ALFs).

5.5. Will the spectrum awarded under the Combined Auction ensure that at least four national wholesale operators are credible and sustainable competitors?

(a) Current minimum spectrum portfolios do not provide sufficient spectrum to support the minimum efficiency scale.

277 As set out in Section [3], it is critical that each national wholesale operator is capable reaching and sustaining a financially viable market share. This minimum size is approximately 20%.

278 As spectrum holdings form a constraint on the market share that an operator can achieve (and may also impact the markets that a competitor may operate in) it is important that the Combined Auction results in four national wholesalers obtaining spectrum holdings which are capable of supporting a level of customers and data traffic that can yield around 20% of market revenues.

(b) Amendments to the proposed "minimum spectrum portfolios" would be required to ensure four credible competitors have a sustainable market share.

279 It is generally understood that it is not possible to serve a given market share of the wholesale mobile market in the medium or long term without a substantially similar share of mobile spectrum, though there may be short term periods where this is possible. This link between spectrum capacity and maximum market share is generally understood. Both the European Commission and the Office of Fair Trading recognised the importance of spectrum in maintaining a competitive market, during the merger approval process for the Orange/T-Mobile merger.

280 Designing "minimum spectrum portfolio" rules that will secure that outcome will involve careful consideration of each existing wholesale network operator's particular circumstances. For example, to ensure that Three is able to achieve 20% of total spectrum and 20% of low

frequency spectrum would require the minimum spectrum portfolios to be increased to at least:

- 2x15MHz of 800MHz spectrum; plus
- 2x20MHz of 1800MHz and/or 2.6GHz spectrum.

281 Achieving the same outcome for the other wholesale network operators could be done in a number of relatively straightforward ways and Three does not presume to make suggestions on their behalf here. However, Three does note that in the case of Everything Everywhere, which already has total spectrum holdings well over 20%, the rules might require it to relinquish high frequency spectrum on a 1:1 basis to the extent that it wishes to guarantee its ability to acquire low frequency spectrum. That approach would address one criticism that has been made of minimum spectrum portfolios which is that they guarantee Everything Everywhere an incremental gain on its already superior spectrum holdings.

5.6. Will the Combined Auction avoid spectrum being a source of competitive distortion in the future?

(a) Equality of spectrum inputs.

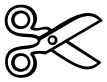
282 As outlined in Section [3.a], the simplest and most equitable principle for ensuring that four credible competitors are capable of operating in the UK market on a long term basis and that spectrum does not distort competition in the future is to ensure that the inputs which are capable of limiting market share are split equally between them. To achieve this, all four successful bidders should have 25% of all spectrum, with an even distribution of types of spectrum. In particular, both low frequency spectrum and total spectrum should be equally distributed.

(b) Spectrum caps.

283 As discussed in Section [3] above, widely varying amounts of spectrum will tend ultimately to reduce competition to the extent that it becomes constrained by the availability of spectrum. Further, as outlined at Annex 5, there is a strong incentive for operators to acquire a level of spectrum holdings which may marginalise or foreclose their competitors, undermining their ability to compete sustainably in the future. The risk of this occurring is exacerbated by the liberalisation decision, which has resulted in substantially uneven spectrum holdings going into the spectrum auction.

284 Ofcom, has proposed a spectrum cap to address the risk of one operator acquiring a level of spectrum which would distort competition and encourage spectrum hoarding. Three supports the imposition of such a spectrum cap. This cap is currently proposed to be 105MHz (Option 1), although an alternative of 120MHz (Option 2) is also included in the Consultation.

285 Three does not consider that the current cap of 2x105MHz proposed by Ofcom will protect effectively against strategic bidding being employed to reduce competition. The proposed cap represents 37% of total post-auction UK paired spectrum. This is higher than the largest spectrum holdings of any operator prior to the 2G liberalisation, even after the merger of Orange and T-Mobile. EE's total spectrum holdings for paired UK spectrum available for 3G use before the spectrum liberalisation decision was 2x20MHz which equated to 33% of total 3G spectrum holdings in the UK (being 2x20MHz of a total of 2x59MHz of 2100MHz spectrum).

286 

287 At this point, EE would be the only operator capable of offering high data bundles or entering new data-hungry markets. In contrast, other operators would cease aggressively to price consumer or wholesale offerings or to seek to enter into new markets. This is likely to mean that consumers experience no competition at all, meaning much higher prices and much less competitive product and service offerings. Such a situation could persist for a considerable period. It would also make it less likely that all of the other three national wholesalers would

successfully acquire enough spectrum to reach the minimum efficient scale (discussed above in Section [3] of this response).

288 Three therefore recommends that the overall cap be reduced from 2x105MHz. As outlined at Section [3] above, Three considers that substantially equal spectrum holdings (at both low frequency and total capacity) would be the best way to secure optimum competition in the UK market.

289 If this is not adopted then Three proposes a reduction in the cap to 2x95MHz at the highest (or 33% of total paired spectrum) would prevent even further distortion of the market. This would still permit EE to obtain an additional 2x30MHz in the auction.

290 Three strongly objects to a cap of 2x120MHz, which would equate to 42% of total paired spectrum. Not only would this cap further exacerbate the issues discussed above, it also makes it more likely that one of the national wholesale operators will fail to reach the minimum efficient scale and will exit the market. Even if market exit did not occur, the other operators would inevitably reach a spectrum capacity constraint preventing effective competition.

6. Three supports the national coverage obligation provided that 2x10MHz of 800MHz spectrum is available in minimum spectrum portfolios.

291 ***This section outlines Three's support of the national coverage obligation and its view that the data speeds for this obligation can only be provided using 2x10MHz of 800MHz spectrum. Further, in certain circumstances the obligation could be extend from 96% indoor population coverage up to 97-99%.***

292 Three supports the Government's policy objective of near-universal high speed data services across the United Kingdom using 800MHz spectrum.

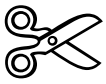
293 The Government's stated objective, and that contained in the Consultation is to delivery 95% indoor population coverage at 2Mbps with 90% probability in a lightly loaded cell. Three also agrees with Ofcom's proposal that the relevant 800MHz block should be in the centre of the 800MHz band so as to be substantially interference-free and should be one of the blocks which are available for inclusion in the Minimum Spectrum Packages.

6.1 2x10MHz of 800MHz spectrum is required to deliver the required data speeds.

294 While the 800MHz spectrum has the necessary properties to deliver 95% indoor population coverage, Three's technical analysis demonstrates that a 2x5MHz block of 800MHz is likely to achieve only 1Mbps, even in a lightly loaded cell. Rather, Three's analysis shows that a 90% probability of 2Mbps could be achieved using 2x10MHz of contiguous 800MHz spectrum.

295 See Annex [4] for the full technical analysis.

6.2 A more ambitious coverage obligation could be attached to a 2x10MHz block of 800MHz spectrum.

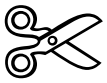
296 

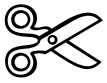
a. 95% Indoor coverage with a 90% probability of 2Mbps.

297 Three would support the current proposed coverage obligation (providing 95% indoor population coverage at 2Mbps on a lightly loaded cell) if the Minimum Spectrum Portfolio were increased to 2x10MHz of contiguous 800MHz.

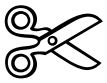
b. 96% – 97% Indoor coverage with a 90% probability of 2Mbps is possible.

298 Using 2x10MHz contiguous 800MHz spectrum a 96-97% population coverage target could be achieved without effect on auction prices for the relevant block(s).

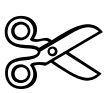
299 

300 

c. 97% – 98% Indoor coverage with a 90% probability of 2Mbps could be achieved.

301 

d. 98%-99% Indoor coverage with a 90% probability of 2Mbps could even be achieved.

302 

303 More detailed analysis is required for coverage obligations beyond 97%.

6.3 The coverage obligation should only be attached to one lot of 2x10MHz 800MHz spectrum.

304 A more efficient outcome to the auction may be achieved by attaching the coverage obligation only to 1 lot of 2x10MHz 800MHz spectrum in the reserved spectrum portfolios. If Ofcom implements Three's recommendations in respect of the inclusion of only 10MHz 800MHz blocks in the Minimum Spectrum Portfolios, then there is likely to be positive competitive tension for the unencumbered 10MHz block of 800MHz spectrum.

7. Other changes to the auction design are needed – reserve prices, bidder choice and integration of the spectrum floor.

305 ***As presently designed, the Combined Auction will not necessarily secure Ofcom's policy goal of ensuring that a minimum of four national wholesale operators gain access to enough spectrum of the right kind. In this section Three explains how changes to the approach proposed as to reserve prices, bidder choice and the integration of the spectrum floor into the principal stage of the auction are required to ensure that the auction delivers Ofcom's policy objectives without unintended consequences and performs as intended.***

306 Ofcom rightly concludes that the auction must be designed to ensure that a minimum of four national wholesale operators gain access to enough spectrum of the right kind. However, in addition to the issues discussed above, several aspects of the current auction design may prevent this outcome from occurring.

307 A combination of the imposition of 'dual reserve prices' and the absence of 'bidder choice' afforded to any party seeking to become a guaranteed spectrum winner may lead to a number of unintended consequences, which could frustrate the policy behind the auction design. In particular it is possible that:

- fewer than two bidders may find it worthwhile to opt in to compete for the spectrum floor, creating the distinct risk that there will not be four winners who meet the minimum requirements identified by Ofcom for a national wholesale operator; and
- any new entrants and small operators that do opt in to compete for the spectrum floor may end up paying significantly more for spectrum than the incumbents.

308 In light of the risk of these unintended consequences, Three proposes the following modifications:

- uniform reserve prices that apply equally to incumbents and entrants; and
- 'bidder choice': permitting bidders to opt in to the spectrum floor by submitting bids only for packages corresponding to their preferred choice from among the minimum spectrum portfolios, subject to the requirement that their choice is 'generalisable'[80].

309 Three considers that these modifications can be introduced without undermining Ofcom's stated aims. Three notes in particular that an

80 A menu of choices is 'generalisable" if there is sufficient spectrum so that two opt-in bidders (if present) who are limited to this menu can both win.

apparent concern for Ofcom is the risk that national wholesale operators will leverage the spectrum floor, to force an award of a much larger package at a reduced price. As discussed at Subsection [7.4] below, Three's proposal for increasing "bidder choice" would still protect against this risk, while allowing opt-in bidders the flexibility to be competitive in the auction.

310 Finally, at Subsection [7.5], Three discusses the implications of the spectrum floor not being fully integrated into the design of the principal stage of the auction, and sets out proposals for how the design could be amended to ensure that it functions as intended.

7.1 Dual reserve prices are unjustified and unfair.

311 The Consultation presents three basic rationales for the proposed reserve prices. Three suggests that each of these three rationales should lead the reserve prices applicable to entrants (if different at all from the reserve prices applicable to incumbents) to be lower, not higher.

312 – **Strategic demand reduction[81].**
In uniform-price auctions, bidders have strategic incentives to reduce their quantities demanded on marginal units in order to pay lower prices on infra-marginal units — the standard monopoly incentive.[82] In such situations, reserve prices can be an effective approach for mitigating demand reduction[83], provided that they are targeted against the bidders that would be most likely to engage in such practices. However, in the context of the current auction, Three considers that the structure of the dual reserve prices targets the wrong bidders. It should be observed that large bidders have an unambiguously greater incentive for demand reduction than small bidders. Furthermore, for an opt-in bidder, demand reduction below the spectrum floor is impossible — it is a *minimum* spectrum portfolio. Moreover, to the extent that the combinatorial clock auction induces "Vickrey" prices, there is no demand reduction incentive. Our conclusion is that, to the extent that the rationale for reserve prices is strategic demand reduction, if anything the reserve price for entrants should be lower than for incumbents.

81 Consultation, para. 8.108.
82 L. Ausubel and P. Cramton (2002), "Demand Reduction and Inefficiency in Multi-Unit Auctions," (http://www.ausubel.com/auction-papers/demand-reduction-r.pdf).
83 See P. Cramton (2004), "Simultaneous Ascending Auctions," p. 13 (http://www.cramton.umd.edu/papers2000-2004/cramton-simultaneous-ascending-auction.pdf) and P. Klemperer (2001), "What really matters in auction design," p. 8 (http://www.nuff.ox.ac.uk/users/klemperer/papers.html).

313 – **"To maximise the probability that the winners are willing and able to invest in the spectrum and its use"[84].**
Theoretically, incumbents have at least as much incentive as entrants (and greater capability) to purchase licences and hold them fallow, as incumbents have greater access to capital and more to gain from erecting entry barriers. Empirically, it has been the entrants in the UK market that have used their spectrum to provide more innovative services and have engaged in greater build out than incumbents. Furthermore, to the extent that one believes higher spectrum prices leave fewer resources for build-out, charging higher prices to entrants, which are likely to have more constrained resources, operates at cross-purposes to the spectrum floor. As such, our conclusion is that, to the extent that the rationale for reserve prices is concern that spectrum winners will not invest adequately in their networks, if anything the reserve price for entrants should be lower than for incumbents.

314 – **"There may also be some efficiency reasons to support higher reserve prices in respect of certain lots. … As we require four winners to meet these essential requirements following the auction, competition for these lots may be weak or non-existent"[85].**
In the Consultation's dual reserve discussion, an overly narrow notion of "efficiency" is being taken: namely, maximising the sum of the private values of the winners. Elsewhere, in proposing the spectrum floor, the Consultation recognises that one must look to a broader notion of "efficiency", which includes the market structure and the resulting consumer surplus. There is evidence of an enormous consumer surplus generated by having a fourth major player in the market, which is ignored by the narrow approach to efficiency adopted by Ofcom in this context. Furthermore, there are external considerations that may artificially inflate the private value of spectrum for incumbents over entrants and skew perception of the most efficient use of such spectrum (for example, the benefits to incumbents of erecting entry barriers, as discussed above). There is a risk that focusing too hard on achieving the narrower concept of efficiency, may risk sacrificing the wider one. Setting dual reserve prices that are higher for entrants than incumbents creates the distinct risk that fewer than two bidders will opt in to the spectrum floor and that there will not be four winners who meet the minimum requirements identified by Ofcom for a national wholesale provider.

84 Consultation, para. 8.118.
85 Consultation, para. 8.116.

315 As a general point, one should also observe that in the Consultation's dual reserve approach, there is a substantial probability that higher prices will be charged to entrants than to incumbents. Three notes that the spectrum floor reserve prices are proposed to be based on an ex ante estimate of likely value of the spectrum. Consequently, the spectrum floor reserve prices will sometimes exceed the ex post value of the spectrum. In all scenarios in which it is consequential that the ascending auction reserve prices are lower than the spectrum floor reserve prices, the final outcome will result in entrants paying more than incumbents. Finally, as best Three's team can determine, the Consultation's proposed linear reference price procedure[86] assumes that there is a single, uniform reserve price applicable to each category of lot. For all of these reasons, we conclude that dual reserve prices should be replaced by uniform reserve prices.

316 In Annex 9 [Analysis of dual reserve pricing], we provide a detailed discussion of the issues surrounding the reserve prices.

7.2 Absence of bidder choice undermines the ongoing competitiveness of opt-in bidders.

317 In the auction rules as currently proposed, bidders opting in to compete for the spectrum floor are required to submit bids for each and every one of the minimum spectrum portfolios. Under this proposal, opt-in bidders have very little control over the portfolios that they will be awarded.

318 In combination with a high reserve price applicable to the minimum spectrum portfolio, this approach may lead to the following unintended consequences:

- If the applicable reserve price is lower than incumbents' bids, entrants are awarded minimum spectrum portfolios that are of least interest to incumbents;
- Alternatively, if reserve prices for entrants are higher than incumbents' bids (a distinct possibility under dual reserve prices), entrants are awarded the most overpriced minimum spectrum portfolios.

319 In both cases, entrants suffer from a severe adverse selection problem and risk being allocated the least suitable of the five minimum spectrum

86 Consultation, para. A10.20-A10.25

portfolios. Therefore, the predicted effect of the requirement to bid on all five minimum spectrum portfolios is to harm competition in the national wholesale market and to reduce consumer surplus.

7.3 The combination of a high reserve price applicable to the minimum spectrum portfolio and a lack of 'bidder choice' may lead to non-participation in the spectrum floor.

320 The Consultation is evidently quite concerned about the risk of weak competition for the spectrum floor. While weak competition is a valid concern in almost any auction, Three considers that Ofcom's proposals to address that problem may instead exacerbate it.

321 The adverse selection problem arising from high reserve prices applicable to the minimum spectrum portfolios, and the lack of bidder choice over the type of spectrum they are bidding for, may be a serious disincentive to entrants opting in to the spectrum floor, further reducing competition. As a result, there is a real risk that fewer than two bidders may opt in to the spectrum floor, and that fewer than two entrants may acquire sufficient spectrum to be credible national wholesalers. If this happens, Ofcom would fail to achieve its objective of maintaining a four-player market.

322 In order to avoid these unintended consequences, Ofcom should introduce uniform reserve prices and allow opt-in bidders to choose their preferred minimum spectrum portfolio. This would encourage bidders to opt in to the spectrum floor and would provide operators with greater control over the amount and type of spectrum they acquire, eliminating the adverse selection problem and increasing the likelihood of attaining the goal of four national wholesale competitors.

323 Three is encouraged by indications that Ofcom may be considering the use of uniform reserve prices to avoid such unintended consequences. At the bidder session of 19 May 2011, Ofcom stated that it was *"not intended that winners of guaranteed spectrum should end up paying a price that is higher than the auction price for non-guaranteed spectrum."* Ofcom also stated that the *"intention was to ensure that bidders for guaranteed spectrum face an appropriate price for that spectrum even if demand to win an MSP is weak (to mitigate risk of inefficient auction outcome), not to extract any particular price."*[87] We note that this

87 Each of the quoted sentences is taken from slide 25 of the bidder session presentation of 19 May 2011.

argument does not support higher reserve prices for entrants than for incumbents—the dual reserve price cannot affect the auction outcome unless it causes the auction to end with fewer than four national wholesale operators with minimum spectrum portfolios.

324 Ofcom also apparently recognises that the pricing indicated in the Consultation becomes incoherent when dual reserve prices are introduced. Ofcom acknowledged: "We are considering auction design implications of this option—potentially complex."[88] The notion that it is unclear how to implement pricing with dual reserve prices is tacitly supported by the fact that the mock auction rules of 27 May 2011 utilised uniform reserve prices.[89] Three is hopeful that the final auction rules, too, will have uniform reserve prices that apply equally to incumbents and to entrants.

325 However, while Three considers that the introduction of uniform reserve prices would be a positive step, they will not achieve a four-player market in and of themselves. As discussed above, they should be supported by increased flexibility for an opt-in bidder in choosing the portfolios to bid for. As discussed at Subsection [7.4,] below, Three considers that desirable 'bidder choice' could be achieved without creating the leverage problem that apparently concerns Ofcom.

7.4 Entrants can be allowed 'bidder choice' without creating a leverage problem.

326 Three proposes modifying the procedures for opting in, so as to accommodate as much bidder choice as is consistent with satisfying all of Ofcom's objectives for the spectrum floor. Our proposal would provide entrants with much greater control over their destinies in the auction—and without creating the leverage problem that Ofcom seeks to avoid.

327 We begin by describing the leverage problem. Under the competitive measures proposed for the auction, if two or more bidders opt in to compete for the spectrum floor, then Ofcom will only consider solutions to the winner determination problem in which at least two opt-in bidders receive spectrum awards that include a minimum spectrum portfolio. In implementing such a procedure, Ofcom must guard against an entrant 'leveraging' the spectrum floor to force winning a much larger package.

88 Slide 25 of the bidder session presentation of 19 May 2011.
89 See Table 1 of "Rules for mock auctions of 800MHz and 2.6GHz spectrum", dated 25 May 2011.

328 For example, suppose that the minimum spectrum portfolio comprised 2x10MHz of 800MHz spectrum and 2x15MHz of 2.6GHz spectrum and suppose that a given entrant submitted bids only for 2x15MHz of 800MHz spectrum and 2x40MHz of 2.6GHz spectrum. Then Ofcom might only be able to satisfy the constraint of allocating two entrants the minimum spectrum portfolio by awarding the given entrant its package of 2x15MHz of 800MHz spectrum and 2x40MHz of 2.6GHz spectrum (double the spectrum of the minimum spectrum portfolio). We refer to this as the *leverage problem*.

329 Ofcom's rationale for requiring a spectrum-floor bidder with no initial holdings to submit bids for each and every one of the minimum spectrum portfolios is to avoid the leverage problem. The Consultation states: "Requiring reserve price bids from those who wish to compete to benefit from the spectrum reservation addresses the risk that bidders may leverage the competition constraint to win additional spectrum cheaply."[90] Indeed, with this requirement, a spectrum-floor bidder may win a minimum spectrum portfolio at a discounted price, but it will pay full market price for any incremental spectrum above and beyond that portfolio.

330 However, Ofcom could equally avoid the leverage problem while imposing a less onerous requirement on entrants. Three proposes 'bidder choice': permitting bidders to opt in to the spectrum floor by submitting bids only for packages corresponding to their preferred choice from among the MSPs. More precisely, our proposal would work as follows:

1. A bidder's pre-existing holdings are credited toward each of the five MSPs to obtain five incremental portfolios [this step is the same as in the Consultation];

2. The bidder's minimum incremental portfolios are found by deleting any incremental portfolios that are strict supersets of any of the other incremental portfolios [this step is also the same as in the Consultation]; and

3. To the extent that there is more than one minimum incremental portfolio for the bidder, the bidder opts in by selecting at least one minimum incremental portfolio and by placing all package bids (at the reserve price) associated with the selected portfolio. The bidder is also free, but not required, to place reserve bids for any of the other minimum incremental portfolios.

90 Consultation, para. 9.72.

331 One other constraint is placed on the opt-in bidder's choice. The menu of choices is required to be 'generalisable' in the sense that there is sufficient spectrum so that two opt-in bidders (if present) who are limited to this menu can both win.[91] As a practical matter, if there are two opt-in bidders with no relevant prior holdings, this constraint limits them to a choice of portfolio b) or d).[92] However, if there is only one opt-in bidder, then it is free to select any of the five MSPs.

332 Bidder choice, as we have proposed it, equally avoids the leverage problem. With bidder choice, a spectrum-floor bidder may win its selected MSP at a discounted price, but it will pay full market price for any incremental spectrum above and beyond this MSP. There is no way for a spectrum-floor bidder to 'leverage' the spectrum floor by obtaining any discount on incremental spectrum above and beyond an MSP.

333 In Annex 8 [Accommodating bidder choice within the spectrum floor], we provide a detailed description and analysis of our 'bidder choice' proposal.

7.5 The spectrum floor is only incompletely integrated into the design of the combinatorial clock auction, requiring several technical design changes.

334 The recent introduction of the combinatorial clock auction format into practice has been one of the notable successes of Ofcom's spectrum auction program. This innovative auction format has performed well in the UK's L-band and 10 to 40 GHz auctions. Together with its subsequent adoption in Austria, Denmark and the Netherlands—and its consideration for adoption in many other countries—the combinatorial clock auction format has been established as the successor to the simultaneous multiple round (SMR) auction as international best practice for conducting spectrum auctions,

335 One especially valuable facet of the combinatorial clock auction format is that it enables the spectrum regulator to implement competitive measures

91 The approach that we develop is that an opt-in bidder should be able to limit itself to choosing a single portfolio from among the minimum spectrum portfolios a), b), c), d) and e). However, in order for this approach to be consistent with ensuring at least four national wholesale operators with minimum spectrum portfolios, the menu must be 'generalisable' in the sense that there is sufficient spectrum so that two opt-in bidders (if present) can both win.

92 For example, to satisfy two opt-in bidders who each select portfolio d), 2x20MHz of 800MHz spectrum and 2x30MHz of 2.6 GHz spectrum are required, whereas there are 2x20MHz of 800MHz spectrum and at least 2x60 MHz of 2.6 GHz spectrum eligible for minimum spectrum portfolios. Two opt-in bidders can also be accommodated if each selects portfolio b), or if one selects portfolio b) and one selects portfolio d). However, if two opt-in bidders each select portfolio e), they cannot both be accommodated with the spectrum that is allowed to be used in MSPs.

based on aggregate constraints. Within the traditional SMR auction format, competitive measures are limited to using unilateral constraints—such as spectrum caps and spectrum set-asides. By way of contrast, the combinatorial clock auction format opens possibilities for defining joint conditions such as "the auction outcome must result in at least four operators possessing sufficient spectrum to be credible national wholesale competitors." The spectrum floor proposed for the Combined Auction is the first instance of a regulator employing an aggregate constraint in a clever way to ensure a specific competition goal.

336 Generally speaking, the auction proposed for the 800MHz and 2.6GHz spectrum is well designed and well suited to the objective of obtaining a four-firm national wholesale market. However, the proposed spectrum floor is only incompletely integrated into the design of the combinatorial clock auction, and some technical changes are needed in order for the auction to perform as intended. This section will summarise the weaknesses of the currently proposed design and will describe how our suggested modifications will remedy these defects.

337 The principal stage of a well-functioning combinatorial clock auction should satisfy six important criteria that contribute to efficiency:

1. **Feedback on the relevant aggregate demand:** After each primary bid round, bidders are informed of the relevant aggregate demand;
2. **Price discovery:** The "clearing" of the primary bid rounds should communicate to bidders that all sources of demand can be accommodated;
3. **Flexibility of bidding:** Bidders, including those who opt in to the spectrum floor, should be able to bid for their most preferred package in each primary bid round;
4. **Avoidance of manipulative bids and collusive behaviour:** Bidders, including those who opt in to the spectrum floor, should be precluded from placing manipulative 'infeasible' bids. All bidders should be deprived of information whose primary use would be to facilitate collusion;
5. **Minimisation of uncertainty in the supplementary bids round:** Provisional winners of spectrum at the end of the primary bid rounds should have clear routes on how to retain these packages in the supplementary bids round; and
6. **Minimisation of the effects of budget constraints:** The auction process should minimise the adverse consequences of budget constraints, which may lead to spectrum being allocated to the bidders with the highest budgets, instead of the bidders with the highest values.

338 The Consultation's proposal scores poorly on five of these six criteria. The aggregate measure of demand reported after each primary bid round may conceal 'hidden' demand attributable to spectrum-floor bidders. The primary bid rounds may 'clear' before all sources of demand can be accommodated. Bidders, especially those who opt in to the spectrum floor, have the ability to place manipulative 'infeasible' bids. Provisional winners of spectrum at the end of the primary bid rounds lack any clear recipe for retaining their winnings in the supplementary bid rounds. And entrants who opt in to the spectrum floor may be required to top up their deposits on minimum spectrum portfolios even after only two opt-in bidders remain (and so the eventual price of the MSP has stopped increasing), causing their budget constraints to bind and inducing inefficient outcomes. Only bidder flexibility is good (indeed, through infeasible bids, bidder flexibility may be excessive).

339 Fortunately, there are effective ways to complete the integration of the spectrum floor with the information policy, bidding and clearing in the principal stage of the auction. Three proposes five changes to the auction design, in order to resolve these issues:

1. **Augmented information policy:** The measure of aggregate demand disclosed should reflect the up to 2x50 MHz of 'hidden demand' that may be present from opt in bidders [as discussed in more detail in annex [6]. In addition, Ofcom should disclose, after each round, the number of opt-in bidders who have maintained at least the minimum number of eligibility points associated with a minimum spectrum portfolio.
2. **New condition regarding supplementary bids and the spectrum floor:** Bidders who drop out of contention for a minimum spectrum portfolio in the primary bid rounds should not be able to return into contention to be a guaranteed spectrum winner in the supplementary bids round.
3. **New feasibility constraint on bids:** Bidders should not be permitted to submit bids that are demonstrably 'infeasible' in light of the spectrum floor. For example, once it has been disclosed that at most two opt-in bidders remain as potential spectrum floor winners, the remaining opt-in bidders should be prohibited from submitting bids for nonempty packages that do not include a minimum spectrum portfolio.
4. **Revised clearing condition for primary bid rounds:** The primary bid rounds should continue until the measure of aggregate demand, including the up to 2x50 MHz of 'hidden' demand of spectrum floor

bidders, is no greater than supply for every category of spectrum.

5. **Capping of financial deposits after only two opt-in bidders remain:** Once the number of opt-in bidders has dropped to two, the remaining opt-in bidders should be required only to increase their deposits in relation to the increases in prices for the incremental spectrum that they demand (above and beyond the minimum spectrum portfolio).

340 These five proposed changes work together in their operation. For example, the capping of financial deposits necessitates disclosing to opt-in bidders that only two opt-in bidders remain. Similarly, it would be problematic to ban 'infeasible' bids unless sufficient information was disclosed to indicate that these bids had become infeasible. It would also be problematic to base infeasibility on an opt-in bidder's reduction in eligibility below the minimum spectrum portfolio, unless this reduction precluded the opt-in bidder from becoming a guaranteed spectrum winner in the supplementary bids round. Finally, the revised measure of aggregate demand that we propose to be disclosed after each round is exactly the same measure of aggregate demand that we propose to be incorporated into the revised clearing condition.

341 These changes proposed to the auction design will help to assure that the six important criteria listed above are satisfied by the principal stage of the combinatorial clock auction. By doing so, these changes will help to ensure an efficient auction outcome in which a minimum of four effective national wholesale operators emerge. Moreover, we propose a way to accomplish these objectives without disclosing any additional information whose primary use to bidders would be to facilitate collusion.

342 In Annex 6. [Reconciling information policy, bidding and clearing in the primary bid rounds with the spectrum floor], we provide a detailed analysis of the gaps in the consultation's proposal and a detailed description of our proposed changes.

8. Maintaining the link between auction prices and liberalised spectrum remains critical.

343 ***Three supports the linkage suggested by Ofcom (800MHz prices for 900MHz and the average of 800MHz and 2.6GHz prices for 1800MHz) but the annual licence fees for 900MHz spectrum also need to reflect the first mover advantages associated with earlier availability of the liberalised spectrum and other commercial advantages it carries over 800MHz spectrum. If this is not achieved an unlawful state aid will be conferred on the beneficiaries of the liberalisation decision.***

344 The Consultation states that, as required by the Government's Direction, the annual licence fees for 900MHz and 1800MHz should be reset to reflect the full market value of these frequencies, and that the bids in the auction are likely to provide the most reliable source of information on these values.

345 Three agrees with Ofcom that bids in the auction should provide the relevant basis for setting annual licences fees for 900MHz and 1800MHz spectrum. Three also agrees with Ofcom that if the auction is not sufficiently competitive, information from other auctions for similar or the same spectrum in other countries should be used as the next best alternative, e.g. recent auctions in Germany and Hong Kong.

346 While Three supports Ofcom in establishing the link between the value of 900MHz spectrum and the auction price of 800MHz spectrum, this link should not be one-to-one. The annual licence fees for 900MHz spectrum must reflect the considerable additional value of 900MHz over and above 800MHz spectrum, in particular due to the much earlier availability of 900MHz and other commercial advantages compared to 800MHz and 2.6GHz spectrum.

347 In the Consultation, Ofcom considers several potential sources of value difference between 800MHz and 900MHz spectrum and concludes that none of these differences are material. Consequently, Ofcom proposes to use an average price per MHz across the three lot categories of 800MHz spectrum (those that counts towards the minimum spectrum floors) as an estimate of the full market value of 900 MHz spectrum (A11.22).

348 Three disagrees with this approach. In particular, the 900MHz spectrum is significantly more valuable in the short and medium term due to: (i) earlier availability, (ii) lack of legacy problems (such as in-band and adjacent band compatibility constraints) and (iii) earlier availability of handsets. Indeed, UMTS/HSPA900 devices are available today, well ahead of LTE800

devices. For example, the GSM Suppliers Association reports[93] that there are currently 618 HSPA900 devices available, compared with 98 LTE devices (mostly dongles operating in the 2.6GHz band).

349 Given that performance of HSPA+ is comparable to that of LTE, as shown in Table 10 below, we expect that operators with 900MHz spectrum would deploy HSPA+ and enjoy commercial advantages over LTE800 operators in the short and medium term (up to 5-10 years)[94], i.e. they will be able to grow their market share faster.

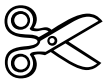
Table 10: Peak Downlink comparison of data rates between HSPA+ and LTE.

Technology	MIMO usage	Carrier size (MHz)	Peak downink data rates (Mbit/s)
HSPA+	Single stream	5	21
LTE	Single stream	5	22
HSPA+	MIMO (2x2)	5	42
LTE	MIMO (2x2)	5	43
HSPA+	Single stream	10	42
LTE	Single stream	10	43
HSPA+	MIMO (2x2)	10	84
LTE	MIMO (2x2)	10	86

Source: Analysys Mason.

93 GSA, "Fact sheet: GSM/3G/WCDMA-HSPA, HSPA+ and LTE", 15 May 2011
94 Although both LTE800 and HSPA900 devices are expected to available by 2013, the penetration of HSPA devices is expected to remain above that of LTE devices until 2022

Figure 25: Illustration of the value of earlier device availability.



Source: Analysys Mason.

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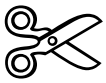
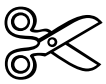


Figure 26: Incremental value of 900MHz spectrum.



Source: Analysys Mason.

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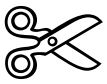
351 

352 Our analysis is indicative only. HSPA+ operators may enjoy other commercial advantages over and above the market share increase, e.g. reduced churn, reduced subscriber acquisition costs, higher average revenue per user (ARPU), etc. Ofcom needs to undertake a more detailed modelling of potential advantages of 900MHz spectrum in order to estimate an appropriate uplift in price.

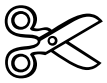
353 While we recognise that the timing advantages for 1800MHz spectrum are not as significant as for 900MHz, there is still expected to be a time advantage for LTE1800 deployment over LTE800 and LTE2600. Given the likely absence of 1800MHz in the auction, the 1800MHz value will fall between 800MHz and 2600MHz and should be linked to these prices.

354 The analysis referred to above is necessary to ensure that a significant state aid is not conferred upon the beneficiaries of the liberalisation decision.

Annex 1: Response to Consultation questions.

355 **Mobile spectrum bands.**

Question 4.1: *What use, if any, would you make of the top 2x10MHz of the 800MHz band in the second half of 2012 if it were available for use? What would be the benefits for citizen and consumers of such availability?*

356 

357 Such availability will offer the following benefits to citizens and consumers:

- greater peak and average mobile data speeds than current technologies;
- lower latency mobile data than current technology, allowing for example, faster web browsing, gaming and use of VoIP services;
- significantly greater indoor and geographic coverage than Three's currently available spectrum; and
- additional user capacity on top of currently available spectrum.

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

358 If Ofcom were to introduce shared access low-power licences, then the technical licence conditions must ensure minimal interference between low-power and high-power use.

Competition assessment and future mobile markets.

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

359 Three strongly agrees with this statement and has made some detailed recommendations in this respect in the main body of the response document.

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

360 Three strongly agrees with this statement and has made some detailed recommendations this respect in the main body the response document.

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

361 No, Three does not agree that there is a risk in this regard that would justify any intervention by Ofcom.

362 As Ofcom recognises itself, the benefits of a 2.6GHz low-power reservation are unclear[96], whereas, the opportunity cost of any such low-power reservation is clear and high. In light of the fact that there are means available (and currently being used) to achieve the same aim as a reservation, Three does not believe that Ofcom would be justified in exposing the market to such an opportunity cost.

363 Firstly, Three agrees with Ofcom that the benefits of sub-national RAN services are unclear. The closest equivalent services currently are those that use the DECT guard band. We understand that this spectrum band is significantly less utilised than the neighbouring GSM band.

364 Existing evidence does not suggest that there is actually a need to introduce measures to promote competition in order for sub-national RAN to develop.

365 For example we estimate there are between 10,000 and 30,000 public WiFi hotspots in the UK[97]. WiFi is becoming a common feature in smartphones and is standard in laptops. Therefore, consumer access to sub-national RANs is already commonplace.

96 Consultation, para. 4.48
97 Quote from Owen Geddes, chief executive of Freerunner to the Financial Times (http://www.ft.com/cms/s/0/8e4faa12-f73d-11de-9fb5-00144feab49a.html#axzz1KpMAYni2)

366 Furthermore other licensed spectrum suitable for such services is either available now in the secondary market or potentially available in the future, such as:
- L-Band (available in secondary market) – being used for mobile services by LightSquared in the USA;
- spectrum around 3.5GHz (available in secondary market) – this high frequency spectrum is ideal for low-power use; and
- The MoD is likely to release potentially suitable spectrum in the coming years.

367 However, national mobile operators, on the other hand, have a clear and immediate benefit from access to 2.6GHz spectrum, namely:
- mobile data traffic is growing exponentially and additional spectrum capacity is required in order to meet clear and demonstrated consumer demand;
- both end user and network equipment is available today to meet this demand; and
- the 2.6GHz band has been/is to be awarded for high-power use across Europe – any deviation from this approach would be specific to the UK.

368 The results of previous European 2.6GHz auctions suggest that the 2.6GHz FDD spectrum is of high value. Prices have been up to EUR0.18/MHz/pop – over GBP450 million for a 2×20MHz block when scaled to the UK.

369 In contrast, the opportunity cost for a reservation is very different to that for the DECT guard band:
- the DECT guard band was limited to low-power use;
- there was no obvious higher value alternative use (including high-power mobile use); and
- therefore, the opportunity cost of a reservation was very low.

370 Overall, Three considers that the benefits of sub-national RAN operators are not sufficiently well-defined and quantified in order to warrant intervention by Ofcom and spectrum reservation in the 2.6GHz band.

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

371 Three strongly agrees with this analysis and provides additional supporting evidence to Ofcom's conclusions in the main body of the response document.

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

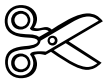
372 Three agrees that there should be specific measures to ensure that there are at least four holders of minimum spectrum portfolios. However our analysis shows that the current proposals are insufficient to address both the competitive distortion created by 2G liberalisation and to enable an operator to be a credible competitor in the future market.

373 Three's detailed recommendations in this respect are set out in the main body of the main response document.

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

374 Three agrees with this conclusion – provided that Ofcom continues to actively support the principle of ensuring 4 national wholesale operators.

375 As detailed in the main response document – Three believes that market consolidation to 3 competitors is likely to increase the risk that these incumbent operators will seek to capitalise their dominant position in both consumer and wholesale markets.

376 

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

377 No. As discussed in our response to question 5.3, Three does not consider that there is sufficient justification for Ofcom to intervene to assist low-power use of 2.6GHz spectrum at all.

378 However, if Ofcom determines that such measures should be introduced, then Ofcom is correct to identify that care must be taken to ensure that those measure do not distort the auction or prevent the most efficient use of spectrum.

379 There may be an argument for low-power users' bids being aggregated to allow direct competition with high-power national users, provided that this is done appropriately and not in a manner that would inflate low-power users' bids by misrepresenting the actual use that would be made of the spectrum following completion of the auction. In this way, spectrum would go to low-powered users if they are the bidders who value it the most, which would be a proportionate response, given the unclear benefits to be obtained from low-power use over the 2.6GHz spectrum.

380 In light of the high opportunity cost in preventing high-power users access to 2.6GHz spectrum, Three would not support any blocks of spectrum being reserved, either in whole or in part, for low-power use. If any reservation is included in the auction, it should be as limited as possible and, in any case, Three agrees that it would not be appropriate or proportionate to reserve 2x20MHz 2.6GHz spectrum.

Mobile coverage and related issues.

Question 6.1: *Do you have any comments on the proposal to include in one of the 800MHz licences an obligation to serve by the end of 2017 an area in which 95% of the UK population lives, while providing a sustained downlink speed of 2Mbps with a 90% probability of indoor reception? Do you think there is another way of specifying a coverage obligation that would be preferable?*

381 Three agrees with a coverage obligation being imposed as part of a block of the spectrum award, provided that the relevant block is able to support such an obligation. See section (6) of the main response document for further discussion of this point.

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

382 As discussed in relation to question 6.1, above, and in section (6) of the main response document, Three supports the imposition of national coverage obligations, provided that the spectrum to which the obligations are attached would realistically allow the relevant operator to comply with them. On this basis, Three is open to discussing solutions to more specific geographic coverage issues as part of the continuing debate on the government's policy of near universal high speed data services.

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

383 Three does not believe that an additional coverage obligation on roads is needed as roads are already well covered by HSDPA networks. Therefore, if any additional coverage obligations on roads are imposed, they should be spectrum and technology neutral (LTE and HSDPA).

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

384 We agree with Ofcom's proposal not to use the combined award to address existing not-spots.

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

385 Three agrees with Ofcom's proposal not to impose "use it or sell it" obligations. However, Three does not agree that there is a need for additional powers of revocation during the initial term of the licences.

386 If Ofcom achieves its objectives for the current auction, the UK will benefit from a market in which four credible wholesale mobile operators will be able to compete effectively. With increased competition and four operators with the necessary spectrum to provide comprehensive mobile data services, it will be much more likely that the Government will be able to find a partner to meet its future objectives without having to resort to expropriating spectrum.

387 Therefore, rather than seeking to intervene with specific powers of revocation, which would be difficult to implement appropriately and proportionately and would necessarily bring with them a risk of chilling investment incentives (as Ofcom correctly identifies), Ofcom should use its discretion to design the current auction in a way that will ensure competition that is as robust as possible and the presence of four credible operators with the technical capabilities to assist with the Government's future objectives, whatever the geographic scope.

388 However, Three does share Ofcom's concerns that operators may seek to acquire spectrum with a view to hoarding it rather than using it to provide services. As outlined in the main response document and annex (5), there are strong incentives for other operators to seek to obtain more spectrum than they require to provide services, in order to foreclose Three or to erode Three's ability to compete in new markets by ensuring that it does not obtain sufficient spectrum in the auction. Such operators would have the same incentive in relation to efforts by any new entrant to acquire spectrum.

389 To this end, Three considers that the most beneficial options for addressing the risk of spectrum hoarding and improving spectrum efficiency through robust competition, are to increase the minimum spectrum packages and lower the overall spectrum cap to 2x95MHz as proposed in the main response document. This proposal would ensure that spectrum resources are more fairly distributed and is more likely to promote competition at a network level to encourage the provision of high quality network services and broad geographic coverage. When coupled with the coverage obligation at 800MHz , these measures would also deliver substantial benefits to UK consumers and citizens.

390 If such measures are not adopted, then additional measures may be appropriate.

391 As mentioned above, Three supports Ofcom's well-founded concerns over the difficulties of imposing a "use it or lose it" obligation as discussed at paragraph 6.53 of the Consultation, and would not consider such a measure to be appropriate.

392 If a revocation right of the type suggested by Ofcom in paragraph 6.54 of the Consultation were to be adopted, the terms and restrictions would need to be specified in advance with sufficient detail and clarity to provide investment certainty to successful bidders. Three considers that the conditions for use of any additional revocation rights (as set out at paragraph 6.54 of the Consultation) would be the bare minimum required to protect against the right being improperly triggered, although further protection around the meaning of "appropriate funding" would be necessary. Furthermore, Three considers that it is likely to be necessary to compensate a licence-holder appropriately for any loss of spectrum in such circumstances (although Three recognises that lower compensation may be appropriate if the spectrum was being hoarded).

393 Importantly, any additional revocation right should be applied not only to newly auctioned spectrum, but also to any liberalised spectrum, in order to ensure that those operators who are most likely to hoard spectrum (being the large incumbent operators who have benefited from liberalisation), do not gain an undue advantage and benefit from preferential licence conditions.

394 It may also be appropriate to impose an obligation to deploy the spectrum within an appropriate timeframe or be able to demonstrate a clear intention to deploy the spectrum in the future with a clear timed

plan to support it. To avoid an unfair advantage being given to the incumbent operators such an obligation would need to be imposed on both auctioned and liberalised spectrum .

Non-technical licence conditions for 800MHz and 2.6GHz.

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

395 Three does not have any comments in relation to the proposed duration of the initial term, other than to agree with Ofcom's conclusion, as there is no reason to believe that a term shorter than 20 years would be appropriate. Indeed, a shorter term would be more likely to have the adverse impact on network investment decisions identified by Ofcom.

396 Nor does Three have any specific comments in relation to the proposal that licence holders would be required to pay licence fees at the end of this initial term, provided that the consultation with the licence holders and other stakeholders on the mechanism to be used to set licence fees for auctioned spectrum takes place well in advance of the date on which they become payable.

397 In relation to revocation rights, Three refers to its comments above in relation to Question 6.5.

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

398 Yes. It is important that all liberalised and auctioned spectrum is subject to the same terms in relation to spectrum trading and should include a competition check. Three supports the proposal that 800MHz and 2.6GHz spectrum should be tradable on the same terms as 900MHz and 1800Mhz spectrum.

399 We also agree with the proposal not to allow transfers that would increase the number of 2.6GHz low power licensees (if any).

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

400 Three is of the opinion that the request for information about equipment, use of frequencies and network roll out does not go much further than information already provided under existing arrangements. However, it would not be reasonable to compel the provision of information intended to be made available in the public domain where a wholesale mobile operator reasonably considers such information to be commercially sensitive. Operators must have recourse to make strong representations in this respect if required.

Spectrum packaging proposals for the 800MHz and 2.6GHz award.

Question 8.1: *Do you agree with the way in which we are taking account of the main factors relevant to spectrum packaging and why?*

401 Yes.

Question 8.2: *Are there other factors that we should consider to develop our approach to packaging? If so which ones and why?*

402 We are not aware of any other factors that Ofcom has not already addressed.

Question 8.3: *Do you agree with our packaging proposals for the 800MHz band? Please give reasons for your answer.*

403 Yes. Three agrees with Ofcom's proposal to package spectrum in 2x5MHz blocks as it provides flexibility in terms of the amount of spectrum that can be acquired (e.g. 2x15MHz).

404 Three agrees in principle with Ofcom's proposal to split 6 lots of 800MHz spectrum into several types of generic lots based on their location within the band (and potential interference) and imposed coverage obligation.

405 The main modification we propose is that the minimum spectrum packages should include 2 blocks of 2x5MHz each, i.e. 2x10MHz. One of these packages should include a coverage obligation (as discussed at section (6) of the main response document, Three believes that the coverage obligation can only realistically be achieved if the relevant operator has access to 2x10MHz 800MHz).

406 Assuming that the package with the coverage obligation would be available for bidding by any auction participant – there also needs to be another 2 lots of 2x5Mhz – i.e. 2x10Mhz of 800MHz available to those eligible for the spectrum floors. This is supported by the detailed arguments made in this response document regarding addressing liberalisation, promoting competition and ensuring that smaller bidders are able to be credible competitors.

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

407 Three considers that Ofcom should have required relinquishment of 900MHz spectrum. However, since no such requirement was made, it will be unlikely to make a difference whether Ofcom allows relinquishment of 900MHz in the current auction or not, as the holders of the valuable 900MHz spectrum are unlikely to relinquish 900MHz spectrum voluntarily.

408 As referred to in Three's previous response on [spectrum liberalisation], Three did not support liberalisation in the hands of the incumbents as it provided them with a substantial commercial advantage. The same commercial advantage renders it academic whether Ofcom allows relinquishment of 900MHz spectrum or not.

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

409 As discussed above in relation to the 900MHz band and question 8.4, Three considers that the 900MHz/1800MHz liberalisation should have been accompanied by a requirement for the beneficiaries to relinquish some spectrum.

410 As a result of liberalisation (and even after the spectrum divestment required following the Orange/T-Mobile merger) EE benefits from a large swathe of contiguous 1800MHz spectrum with significant capacity and download speed advantages. Since EE will have the buying power to acquire a potentially significant amount of additional spectrum in the current auction (especially if the spectrum caps are maintained at the high level currently proposed), it is also unlikely to make any difference whether Ofcom does or does not allow relinquishment of 1800MHz spectrum.

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

411 Three agrees with Ofcom's proposals not to permit relinquishment of 2.1GHz spectrum into the current auction. In practice, Three considers that there is unlikely to be any commercial appetite to relinquish such spectrum.

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

412 We agree with Ofcom's proposal of a fixed band plan which is consistent with relevant technical standards for this band.

413 We note, however, that the proposed lot size of 2x10MHz is inconsistent with proposed minimum spectrum portfolio d), which includes 2x10MHz of 800 MHz spectrum and 2x15 MHz of 2.6GHz spectrum. If 2.6GHz spectrum is packaged in 2x10MHz lots, this option is clearly not feasible. Therefore Three's view is that FDD spectrum in the 2.6GHz band should be packaged in 2x5MHz lots as it would allow greater flexibility, e.g. to acquire 2x15MHz blocks of spectrum which otherwise would not be feasible.

414 With respect to the unpaired 2.6GHz TDD spectrum, we would recommend to split it into two lots (with 5MHz guard band in between). This approach has been used in a number of countries, including Germany and Austria. This would give operators more choice in terms of spectrum portfolios and will allow more operators to acquire both paired and unpaired spectrum in the 2.6GHz band.

415 With respect to low-power users, as explained earlier (see our response to question 5.1), Three considers that option a) – designing the award in order to let concurrent low-power users compete with high-power users – is the most appropriate. We strongly disagree with option b), which allocates 2x10MHz of spectrum for high power use with low-power use as an underlay, because of the high risk of interference. We also disagree with option c) – reserving 2x10MHz for concurrent low-power use only. As explained in response to question 5.3, the benefits of reserving spectrum for low-power use are uncertain, while the opportunity costs are certain and high.

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

416 See annex 10 which sets out Three's position.

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

417 See section (7) of the main response document and annex 9 which set out Three's position.

Auction design and rules proposals for the combined award.

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

418 See section (7) of this response document.

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

419 See section (7) of this response document.

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

420 Three agrees that deposits should be set at a level that deters invalid bids and unsold spectrum.

421 Under the current rules governing eligibility for spectrum floors and the associated reserve prices Three or another new entrant would be required to place a deposit of £600million in order to be eligible to win one the minimum spectrum portfolios (2x15MHz @ £200million per 2x5Mhz lot of 800MHz spectrum).

422 Having this sum "on risk" even for a short time would cause a material disadvantage to Three or any new entrant compared to the significantly lower sum initially placed "on risk" by competitors in the open auction.

423 With this in mind we refer to our detailed comments on the design of the auction set out in section (7) of the response document.

424 In particular the ability for bidders to select the minimum spectrum portfolio most suitable for them and a more uniform approach to reserve prices would address some of our current concerns with the payment of deposits.

425 Additionally Ofcom has set the objective of making entry to the auction simple and relatively low cost for bidders and, we assume, this is specifically aimed at attracting smaller bidders and new entrants.

426 This objective is more likely to be met if Ofcom considers that smaller bidders and new entrants may be constrained in the amount of deposit that they can raise (especially given the potential cost associated with accessing large capital sums).

427 With this in mind Three is of the opinion that it would very helpful to smaller bidders if additional information was provided that enabled them to recognise the point at which they do not need to increase the amount of deposit or the size of a bid to win.

428 This may be achieved by providing information to bidders, who have opted into the minimum spectrum portfolios, which enables them to see the number of opted in bidders that have maintained their eligibility in the current round.

429 As prices ascend, the formula for the amount of deposit required of a bidder who has opted into the minimum spectrum portfolios should to be relaxed when the number of opt-in bidders has dropped to two. At that point, the opt-in bidder's payment for the minimum spectrum portfolio should stop rising, and so the deposit payable should also stop rising.

430 A more detailed review of the Information policy and Three's recommendations can be seen at annex [6] of the consultation response.

Revising annual licence fees for 900MHz and 1800MHz.

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

431 See section (8) of the consultation response.

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

432 See section (8) of the consultation response.

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

433 In relation to converting upfront lump-sum payments to annual payments, there is no particular justification for using a „constant real terms" annuity price for 900MHz spectrum, particularly given the argument that the difference in value arises in the first ten years. It is likely to be more appropriate to use a glide path similar to that suggested by the incremental value chart (please see section 8 of the consultation).

Annex 2: Impact of competition on network quality and product innovation.

Network quality.

434 The price benefits to consumers in the UK and other four-player markets in Europe are not delivered at the expense of worse quality. Below, we provide evidence from various source that demonstrate this point.

435 ✂

436 ✂

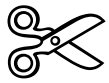
Figure 27: 3G service availability: UK vs. Global.

✂

Source: Nokia Siemens Networks (confidential).

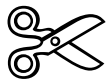
98 ✂
99 ✂

Figure 28: Voice performance: UK vs. Global.



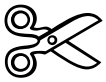
Source: Nokia Siemens Networks (confidential).

Figure 29: Access to high speed data connection (download): UK vs. Global.



Source: Nokia Siemens Networks (confidential).

Figure 30: Access to high speed data connection (upload): UK vs. Global.



Source: Nokia Siemens Networks (confidential).

437 **2.** The ArcChart research "European Carrier Mobile Broadband Network Performance"[100] also shows that countries with 4 operators have, on average, better network quality than countries with 3 operators (see Table below).

Table 11: Average mobile data quality ranking – European markets.

No. Competitors	Average Quality Ranking (Out of 94, 1 = best quality)
3	52
4	43

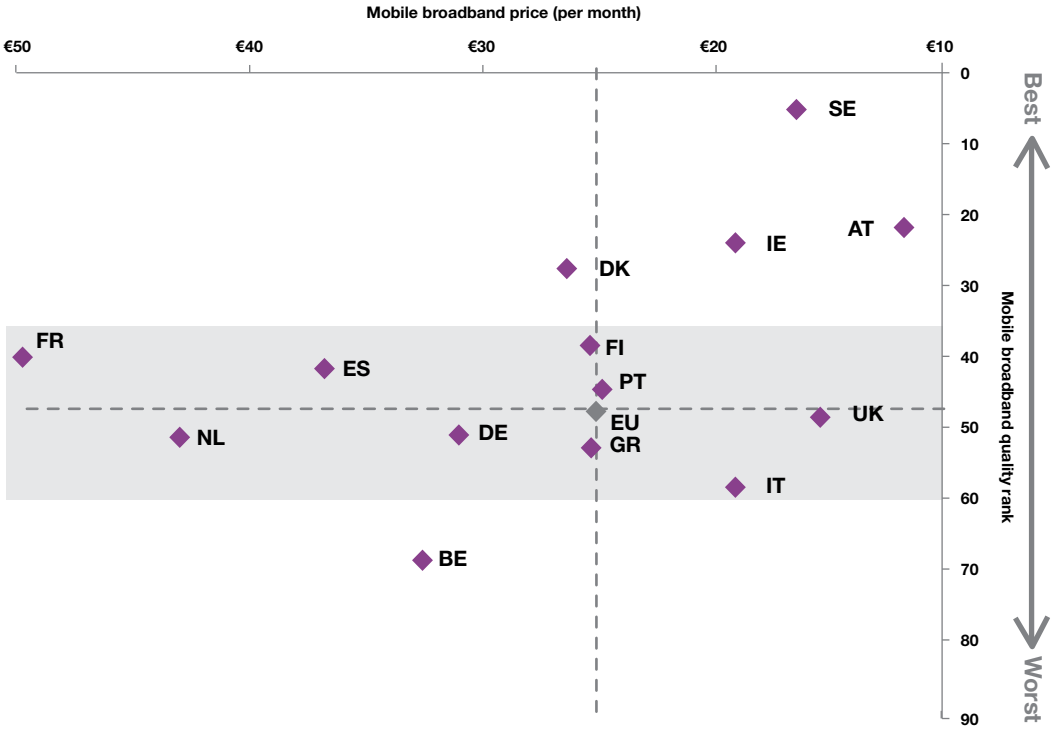
Source: ArcChart.

100 The ArcChart study is based on data speed and latency measurements collected using a speed test smartphone app. This report focuses on European operators and ArcChart has estimated averages for download speed, upload speed, latency and overall network quality for 94 carriers in 28 European countries. Operators are ranked between 1 and 94, with '1' indicating highest overall network quality. http://www.arcchart.com/reports/european-carrier-mobile-broadband-network-performance.asp

438 More generally, network quality correlates negatively with price, i.e. countries with lower MBB prices have, on average, better quality (see Figure below).

439 Average network quality in the UK is comparable to the EU average, while prices in the UK are lower than the EU average, suggesting that these consumer benefits are not delivered at the expense of quality.

Figure 31: Mobile Data price vs. quality.



Source: ArcChart.

440 Moreover, it is worth noting that there is a significant dispersion of quality across the UK network. Three has the highest rank (14), while Orange and T-mobile are considerably lower than the EU average – 72 and 78 respectively.

Table 12: UK Mobile data quality ranking.

Operator	Ranking (Out of 94)
Three.co.uk	14
O2	39
vodafone	40
T-Mobile	72
orange	78

Source: ArcChart.

441 The ArcChart data also shows that Three group has the best quality among all operator groups in the EU.

Table 13: EU mobile data quality ranking.

Group	Ranking (Out of 94)
Three.co.uk	24
TeliaSonera	32
vodafone	37
T-Mobile	45
orange	49
Telefonica	52

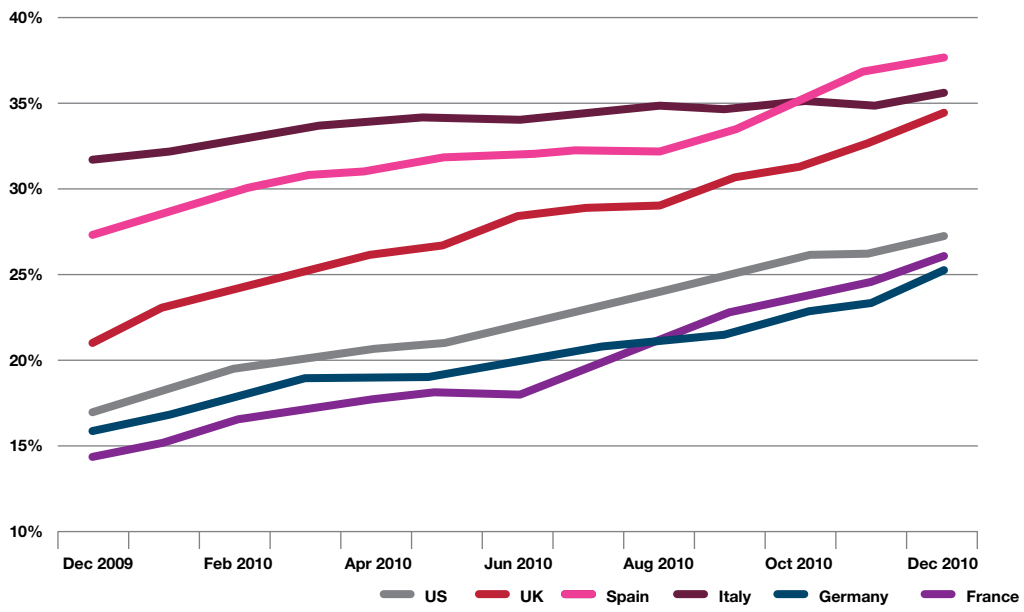
Source: ArcChart.

Products and Services.

442 Consumers in the UK enjoy a range of mobile products and services which is as good or better than in other major mobile markets. For example, the UK is ranked high in (i) smartphone penetration, (ii) overall mobile Internet usage and (iii) browser and application usage.

443 – As Figure below shows, the UK has high smartphone adoption rate – higher than in the US, Germany and France

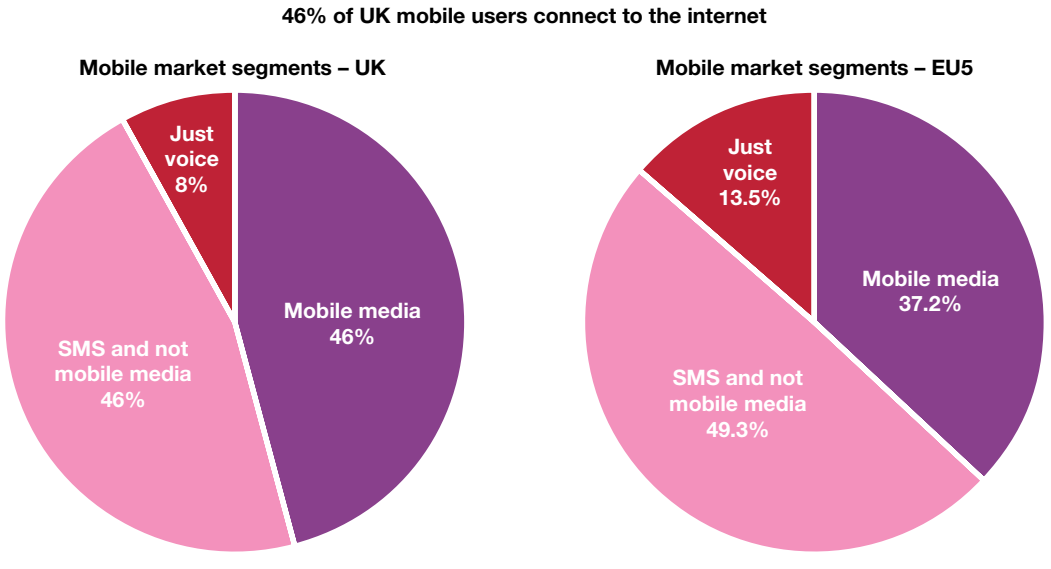
Figure 32: Smartphone adoption by market.



Source: comScore MobiLens.

444 – 46% of UK mobile users connect to the Internet vs. 37.2% in the EU5 countries.

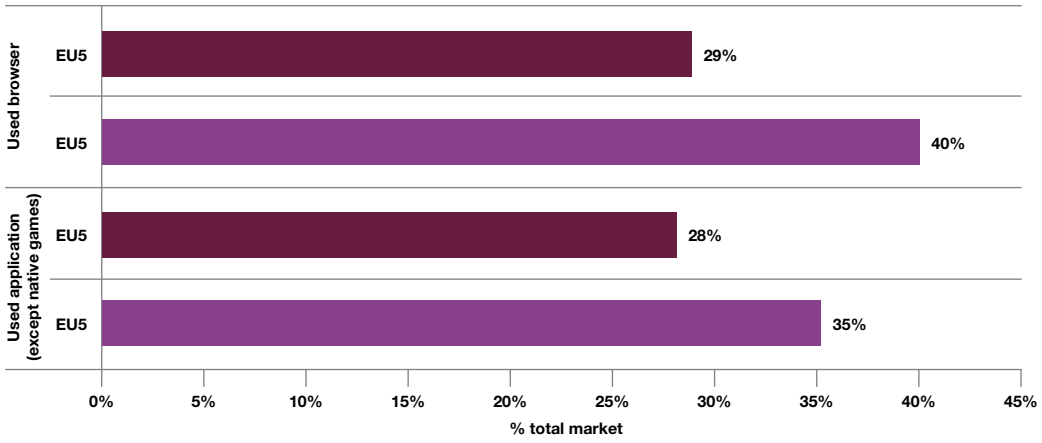
Figure 33: Shift in mobile market segments.



Source: comScore.

445 – 40% customers in the UK use browsers and 35% use applications on their phone (versus 29% and 28% in the EU5 countries respectively).

Figure 34: Browser and application usage EU5 vs UK.



Source: comScore MobiLens.

446 The UK was first country in Europe to launch Skype (2006), Google Maps (in April 2010 vs. June 2010 in rest of Europe) and Spotify (October 2009).

447 Our competitors admit that the UK market is a trend-setter for the rest of Europe:

> "The UK is of particular importance…because it is the market in which Telefónica Europe's trends emerge first, offering useful guidance for the rest of the portfolio." Interview with Matthew Key, CEO of Telefónica Europe (5th February 2010)

Annex 3: Spectrum allocation and competition.

This annex has been prepared by NERA Economic Consulting.

Introduction.

448 Ofcom is concerned that, without policy intervention into the 4G spectrum auction, Hutchison 3G ("Three") may not obtain sufficient (or any) spectrum to remain a viable and effective fourth player in the UK mobile telephony and data market.

449 In this paper we provide some economic analysis of a number of issues that shed light on Ofcom's analysis and conclusions.

3-firm markets are less competitive than 4-firm markets.[101]

450 If Three were unable to secure enough spectrum to achieve minimum viable scale, it would be forced to exit the market in due course, leaving a 3-firm market to serve UK mobile telephony and data customers.

451 This then raises the question of whether 3-firm markets are less competitive than 4-firm markets. To summarise our conclusions, this is the case in a wide range of models, but there do exist certain specialised models and sets of assumptions where it is not the case. Two exceptions are (i) one-shot (Bertrand) price competition between wholly undifferentiated homogenous products (in the absence of capacity constraints) and (ii) ultra-free entry "contestable market" models, but neither of these appears to be a plausible representation of the UK mobile telephony and data market.

452 Accordingly, in the event of exit by Three, there is a real risk that UK consumers would face the detriments associated with moving from a 4-firm market to a 3-firm market.

4-firm markets with a capacity-constrained firm are less competitive than 4-firm markets where no firm is capacity-constrained.

453 Even if Three could obtain enough spectrum to achieve minimum viable scale and cover its fixed costs (and therefore remain active in the market), it might still not be able to exert its full potential competitive pressure on the other providers.

101 Appendix I discusses these matters in more detail.

454 If Three were allocated a "comparatively small" amount of spectrum in the auction, that amount might put a binding cap on its output.

455 As a consequence of such a capacity constraint, the remaining "unconstrained" players would find themselves in the position of residual-demand oligopolists in a 3-firm market.[102]

456 Given Three's inability to expand output to (partially) offset an output restriction by the residual-demand oligopolists, they would find it profitable to reduce market output below the level that would result in a situation where the fourth player is not so constrained.

Transferring spectrum from unconstrained providers to capacity-constrained providers increases output and lowers prices.

457 A transfer of spectrum from an unconstrained provider, i.e. a firm that has spare capacity which it is not using, to a capacity-constrained provider, i.e. a firm that would like to produce more but for its insufficient capacity, will increase output and lower prices.

458 Taking away capacity from a firm which is not using it cannot, ceteris paribus, result in lower output.

459 Giving capacity to a firm with a binding capacity constraint will lead to higher output by that firm.

460 The output expansion by the previously capacity-constrained firm may trigger output restrictions by other providers but those reactions will normally be "partial", i.e. the output restrictions will not fully offset the output expansion, so that the net change in output remains positive.

461 To illustrate the point, assume a 4-firm Cournot oligopoly with homogenous goods, zero marginal cost, and market demand given by P=125-Q. Each firm is allocated an amount of spectrum, and cannot produce a quantity of output greater than its allocation. If 45, 25, 25, and 5 units of spectrum are allocated to the four firms respectively, the market price is 35 and market output is 90, comprising 35, 25, 25, and 5 units by the four firms (i.e. three firms are producing at full capacity, and the fourth firm is hoarding 10 of its 45 units of capacity). Reallocating 20

102 If, in addition to Three, another player were also facing a binding capacity constraint, the remaining "unconstrained" providers would be residual-demand duopolists. In the event of three capacity-constrained firms, the remaining provider would be a residual-demand monopolist.

units so as to achieve a capacity allocation of 25 units for each firm leads to a price reduction from 35 to 25 and an expansion in market output from 90 to 100 (which is the maximum achievable output level in this illustration, even with infinite capacity).[103]

462 In this sort of situation, a spectrum allocation in which some firms left capacity underutilised whilst other were capacity constrained would be inefficient and against the interests of UK mobile customers.

Unconstrained providers' profits are higher if one or more of their rivals are capacity-constrained, relative to their profits in an unconstrained 4-firm market.

463 Unconstrained firms benefit from capacity constraints on their competitors, given that such constraints allow them to raise prices without fear of losing demand to the (capacity-constrained) rivals.[104]

464 Accordingly, an unconstrained firm will be prepared to pay for capacity – i.e. spectrum in the present case – that they do not intend to use, if obtaining that capacity denies it to rivals – such as potentially Three – that would have used it. This willingness to pay for "excess" capacity does not reflect any intrinsic valuation, but derives entirely from the strategic incentive to marginalise or exclude a rival.

Firms can find it profitable to outbid their rivals so as to render them capacity-constrained or induce them to exit or not enter.

465 The sum of the above strategic benefit – from marginalising/excluding a given rival by denying it sufficient capacity – across the remaining players generally outweighs the intrinsic valuation of the capacity by that rival. Accordingly, in many cases there will be a collective incentive to outbid and thus marginalise or exclude the rival.

466 There are also likely to exist scenarios where the strategic benefit – from marginalising or excluding a given rival by denying it sufficient capacity – accruing to a single player will outweigh the intrinsic valuation of the capacity by that rival, e.g. when the rival's offering is a particularly close substitute to that player's products and differentiated from other firms'

103 A more expansive treatment of this illustrative model is provided at Appendix II.
104 Firms of course benefit even more if insufficient access to capacity forces their rivals to exit the market altogether.

products, where competition in a 4-firm market leaves the rival earning "zero" profits after fixed costs are taken into account, or where there is a residual monopolist. Accordingly, in some cases there will be a private incentive to outbid and thus marginalise/exclude the rival.

Ofcom's proposed intervention into the spectrum auction would be likely to improve competition and benefit UK mobile telephony and data customers.

467 The analysis above is consistent with the views of the European Commission (EC) and the Office of Fair Trading (OFT) in their appraisal of the T-Mobile/Orange merger, where the EC required remedies to prevent foreclosing behaviour on the part of the merged entity (now Everything Everywhere) against Three, hence fearing that the market might otherwise be reduced to three firms only.[105,106] The EC also required a divestment of spectrum by the merged entity due to concerns that it would otherwise be the only provider with sufficient spectrum to introduce 4G services (at the best possible speeds with full coverage) in the near future.[107]

468 Ofcom's proposed intervention of spectrum caps and spectrum floors would alleviate the concern that the auction may result in a distribution of spectrum that reduces competition:

- spectrum caps reduce the scope for hoarding large amounts of capacity; and
- spectrum floors reduce the scope for denying rivals sufficient capacity.

469 It is impossible to be certain that spectrum caps and/or floors are necessary to ensure pro-competitive spectrum allocations. Yet, even if the caps and/or floors have no effect and pro-competitive allocations would occur in any event, their introduction should not distort those allocations.[108]

105 For the EC's conclusions on Three's position, see paras 105, 108 and 109 of the T-Mobile/Orange merger decision (M.5650).
106 The EC notes that "the competitive concern does not only rest on the possibility of eliminating 3UK as a competitive force, but also on the risk that its position in the market might be severely compromised" (see para.104 of the T-Mobile/Orange merger decision (M.5650))
107 For the conclusion on concentration of spectrum in the 1800MHz band see paras 120-121 and 138 of the T-Mobile/Orange merger decision (M.5650).
108 We note the possibility that if some users make more efficient use of a unit of spectrum than others, then allocations may have efficiency implications as well as competition implications. A complete analysis of market impacts would need to take these into account.

Appendix I: Impact on Competition of Moving from 4 to 3 Firms.

470 This Appendix provides an overview of the economic literature on oligopoly and the inferences that can be drawn from the literature on whether reducing the number of firms in a market is likely to reduce competition.

471 Non-collusive oligopoly models can, in broad terms, be categorised according to (i) whether firms compete by setting quantities ("Cournot") or prices ("Bertrand") and (ii) whether the products being supplied are homogenous or differentiated. Combining these two dimensions gives rise to four general classes of models, which we briefly discuss in turn.

472 To make the analysis more tractable, we have employed the following assumptions (which are also often used in textbooks and the literature):

a) demand is linear, given by:

i) Homogenous goods: $P = a - b*Q$ for the entire market;

ii) Differentiated goods: $p_i = a - b*(s*Q + (1 - s)*q_i)$ for each firm i;[109]

b) all firms have the same constant marginal cost c;

c) there are no fixed costs; and

d) there is no new entry.

473 In relation to the above models we obtain the following results for the impact of reducing the number of firms from n to (n-1):

a) For Cournot with homogenous goods:

i) price increases by an amount equal to $\frac{a - c}{n*(n + 1)}$;

ii) quantity falls by $\frac{a - c}{b*n*(n + 1)}$;

b) For Cournot with differentiated goods:

i) price increases by an amount equal to $\frac{s*(a - c)}{(2 + (n - 1) * s) * (2 + (n - 2) * s)}$;

109 Parameter s is a measure of substitutability of different varieties. If s=0, the varieties are independent, as s increases, the varieties become closer substitutes and when s=1, varieties are perfect substitutes.

ii) quantity falls by $\frac{(s-2)*(a-c)}{b*(2+(n-1)*s)*(2+(n-2)*s)}$;

c) For Bertrand with homogenous goods, there is no price and no quantity impact;

d) For Bertrand with differentiated goods:

i) price increases by an amount equal to $\frac{s*(1-s)*(a-c)}{(2+(n-3)*s)*(2+(n-4)*s)}$;

ii) quantity falls by:

$$\left(\frac{n*(1+(n-2)*s)}{2+(n-3)*s} - \frac{(n-1)*(1+(n-3)*s)}{2+(n-4)*s}\right) * \frac{a-c}{(1+s)*b}.$$

474 In addition to the above, we reviewed Stackelberg models with homogenous products where one or more "leaders" set their quantity before one or more "followers" set theirs. On the basis of the same specifications as set out at para.25 above, and assuming a single leader, the impact of moving from n to (n-1) firms, by removing one of the followers, is given by:

a) price increases by an amount equal to $\frac{a-c}{2*n*(n-1)}$;

b) quantity falls by $\frac{a-c}{2*b*n*(n-1)}$;

475 For illustrative purposes, the table below gives these results (in percentage terms) on the basis of the following parameters: n=4 (i.e. we look at the impact of moving from 4 to 3 firms); a=1; b=1; c=0; and s=0.5. We include these illustrations solely for expositional clarity, and the numbers should therefore not be interpreted as a realistic calibration.

Table 14: Illustrative Example of Impact of Moving from 4 to 3 Firms.

		market price impact (%)	market quantity impact (%)
Cournot	homogenous	+25%	–6.25%
	differentiated	+16.67%	–12.5%
Bertrand	homogenous	0%	0%
	differentiated	+25%	–29.69%
Stackelberg	homogenous	+33%	–4.76%

Source: NERA Economic Consulting.

476 As illustrated above, the standard IO models offer the following predictions on the impact on market performance of reducing the number of firms in the market:

a) Going from 4 to 3 directionally reduces output and increases price[110] in a wide class of models[111].

b) The magnitude of the impact of going from 4 to 3 is naturally parameter dependent, and if there are efficiencies affecting marginal costs to be gained in a 3-firm market, the directional predictions in most models could in principle be reversed.

c) There are some models – e.g. Bertrand with homogenous goods – where 4-to-3 has no effect, since the presence of two firms alone is sufficient to result in marginal cost pricing.

477 The above summary is not exhaustive and therefore does not reflect all models in the economic literature. In particular, there are models where the number of firms may have an impact on competition, but will not always do so (e.g. due to a multiplicity of equilibria). There even exist specifications where 4-to-3 can reduce price: for example, equilibrium market price could increase with the number of firms in a Cournot homogenous good model with sufficiently strong increasing returns to scale in production[112].

478 We consider it unlikely that the market is characterised by Bertrand with homogeneous goods, as we understand that for parts of the past decade MNOs have earned sizeable gross margins (while not being constrained by capacity).

479 In respect of tacit collusion models, it may be the case that the number of firms makes no difference to whether a collusive outcome is sustainable: it may be the case that tacit collusion is not sustainable if there are only three firms or it may be the case that tacit collusion is sustainable with four firms as well as three. More generally, the multiplicity of equilibria in tacit collusion models makes clear directional predictions difficult to reach. As a general remark, a reduction in the number of firms from four to three may make it more likely that sustainable collusion would occur, but it is not possible to reach stronger conclusions than that without very detailed and complex empirical analysis.

110 In many models the scale of the impact on prices of the number of firms is predicted to be greater the smaller is the number of firms to start with. In these models, going from 4 to 3 will have a greater impact than going from 5 to 4. For example, in quantity and in price setting models with linear demand, the price-cost margin is typically of order 1/n, where n is the total number of firms.

111 Under appropriate regularity conditions, prices tend to decrease with the number of competitors in various simultaneous move and sequential quantity setting models and price setting models with differentiated products as well as in various multistage games.

112 In general, the conditions for the 'perverse' Cournot behaviour are restrictive, requiring either that marginal costs decrease as output expands or that marginal revenue of a given firm increases as the output of all other firms rises (i.e., the Hahn-Novshek stability condition is violated).

480 Accordingly, our view is that the standard IO literature on non-collusive oligopoly provides strong support for the conclusion that a reduction in the number of firms will have the directional effect of reducing competition (unless there are efficiency gains for marginal costs that outweigh the effect of the reduction in the number of firms), although by what magnitude we cannot say on the basis of the analysis here. As regards tacit collusion frameworks, the directional predictions are probabilistic.

Appendix II: Cournot Model with Scarce Inputs.

481 Textbook models of Cournot assume that firms have the ability to produce their equilibrium output (see Appendix I). However, this is not necessarily valid in worlds (such as the one at hand) where a critical input is in scarce supply. Accordingly, this Appendix considers a framework of 4-firm Cournot competition with the possibility of capacity constraints.

482 The basic results under this setting are as follows:

a) If Three is capacity constrained, but one (or more) of the other firms have spare capacity ("capacity unconstrained firm(s)"), then market output (and customer benefits) could be increased if spectrum were reallocated from a capacity unconstrained firm to Three or to another capacity constrained firm;

b) This result does not rely on Three exiting the market. Accordingly the framework used here provides one illustration of how spectrum allocations may impact on competition by marginalising (rather than totally excluding) one (or more) competitors.

c) We note that in our framework it will not always be the case that reallocations of spectrum increase competition. If either all firms have sufficient capacity or all firms are capacity constrained, re-allocation of spectrum cannot increase (and might in fact lower) market output.[113]

483 Our setting is stylized on a number of counts. For simplicity we assume that a unit of mobile output requires a constant amount of spectrum input, whereas in practice the contribution of spectrum to delivery of wholesale mobile services will be more complex. However, we believe that the basic insights here would also be likely to apply if the setting were extended to attempt to take these complexities into account.

113 We note the possibility that if some users make more efficient use of a unit of spectrum than others, then allocations may have efficiency implications as well as competition implications. A complete analysis of market impacts would need to take these into account.

Basic framework.

484 We assume that the firms in our market interact by choosing quantity as their strategic variable (i.e. we use a Cournot[114] framework), and that firms individually or collectively may face capacity constraints (arising from lack of spectrum) such that they are not able to supply their (capacity unconstrained) Cournot output.

485 The model parameters are assumed to be as follows:[115]

a) the market inverse demand is given by P=125-Q;
b) the product being supplied is fully homogenous;
c) there are four firms;
d) marginal cost is zero for all firms;
e) there are no fixed costs;[116]
f) firms cannot produce more units of output than they have units of spectrum.[117]

486 In this setting, if there were no capacity constraints the Cournot equilibrium would be that each firm produces qi=25 and the aggregate market output would be Q=100, with price P=25.

Introducing spectrum scarcity.

487 Now we consider the impact of placing limits on the spectrum held by each individual firm. We provide below several illustrative scenarios in which the four firms have different endowments of spectrum, and analyse the implications for individual firm outputs and aggregate market output.

488 In each case we report the absolute spectrum caps and the equilibrium outputs.

114 The assumption of Cournot is made for analytical tractability and simplicity, in order to focus on the role of capacity constraints. We recognise that there may be arguments for characterising mobile markets as differentiated Bertrand (with capacity constraints applying in similar circumstances). However, we believe that the essential intuitions and directional conclusions of the analysis under Cournot would broadly apply if a differentiated Bertrand framework were explicitly modelled.
115 The figures are purely illustrative and are intended to clarify the presentation of the analytical insights.
116 The assumption of no fixed costs is conservative as regards the theory of harm. With positive fixed costs, the smallest firm is more likely to exit the market.
117 This essentially assumes fixed proportions between spectrum and other factor inputs in the production function.

Table 15: Spectrum allocations and market output.

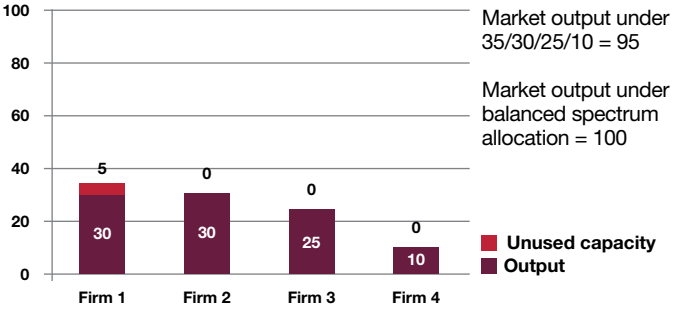
	Total Spectrum	Spectrum Allocation	Firm Outputs	Market Output	Comment
Base	Unlimited spectrum	Unlimited spectrum	25/25/25/25	100.0	Cournot output without capacity constraints
Example 1	100	35/30/25/10	30/30/25/10	95.0	Although the aggregate amount of spectrum (100) equals the unconstrained Cournot market output, the asymmetry in the distribution of spectrum results in lower market output. The largest firm sets its output as a monopolist of residual demand after the other firms have "sold out" their spectrum allocations. Under a symmetric allocation of the 100 units of spectrum (i.e. 25/25/25/25) market output would increase from 95 to 100.
Example 2	100	50/25/20/5	37.5/25/20/5	87.5	Adopting an even more asymmetric distribution of the 100 units of spectrum results in an even lower market output. Reallocating the largest firm's spectrum to rivals (though it need not be to the smallest rival) to achieve a more symmetric allocation would increase output.
Example 3	100	30/30/25/15	28.3/28.3/25/15	96.7	In this example the 100 units of spectrum are distributed such that two firms face capacity constraints and two firms are unconstrained. The unconstrained firms set their output as a Cournot duopoly of the residual demand left after the other firms have "sold out" their spectrum allocations. Reallocating spectrum away from the unconstrained and towards the constrained firms to achieve a more symmetric allocation would increase output.
Example 4	100	30/30/30/10	28.8/28.8/28.8/10	96.3	Only one firm is capacity constrained in this example, and the three others set their output as a 3-firm Cournot oligopoly of the residual demand left after the capacity constrained firm has "sold out" its spectrum allocation. Reallocating spectrum away from the unconstrained firms towards the constrained firm to achieve a more symmetric allocation would increase output.
Example 5	100	43/25/22/10	34/25/22/10	91	Only one firm is unconstrained. This firm is a residual monopolist and reallocating spectrum from this firm to any of its rivals to achieve a more symmetric allocation would increase market output.
Example 6	50	17.5/15/12.5/5	17.5/15/12.5/5	50.0	If the aggregate amount of spectrum available is very low (e.g. here it is 50 and therefore lower than the unconstrained monopoly output of 62.5), all firms produce the maximum allowed by their spectrum endowment, and the distribution of the available spectrum makes no difference to market output.
Example 7	200	100/40/35/25	25/25/25/25	100	Although the spectrum is allocated unevenly in this example, all firms are able to produce the unconstrained Cournot output, and the unconstrained market output of 100 is reached. A reallocation of spectrum from the firm with the largest spectrum holding to the firm with the smallest spectrum holding would not result in increased output.

Source: NERA Economic Consulting.

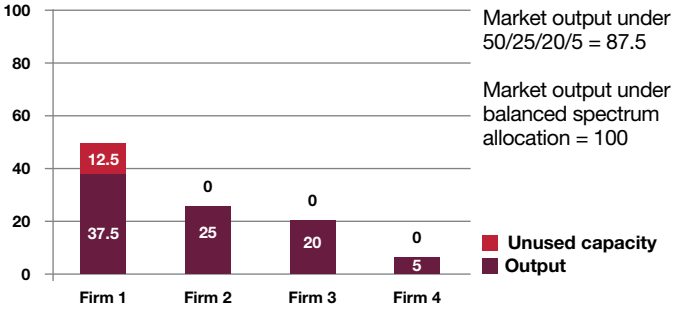
489 The examples in the Table above are illustrated graphically below.

Figure 35: Spectrum allocations and market output.

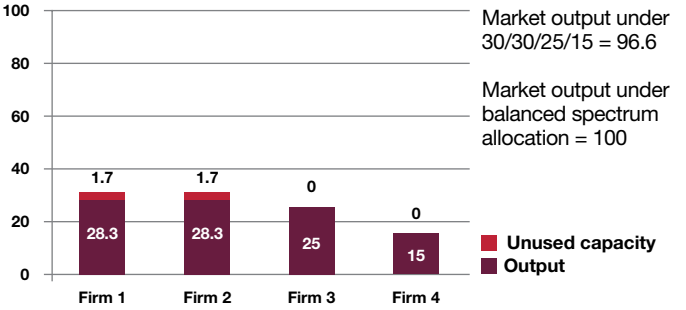
Example 1: 35/30/25/10



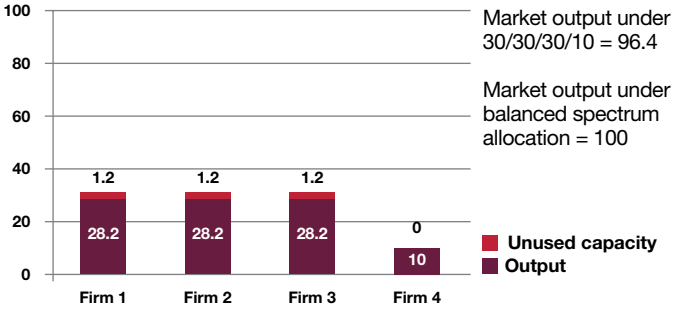
Example 2: 50/25/20/5



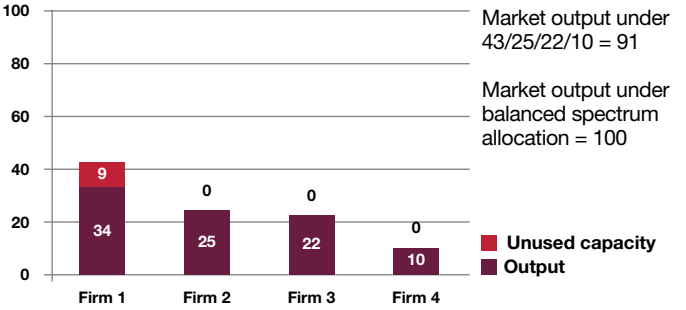
Example 3: 30/30/25/15



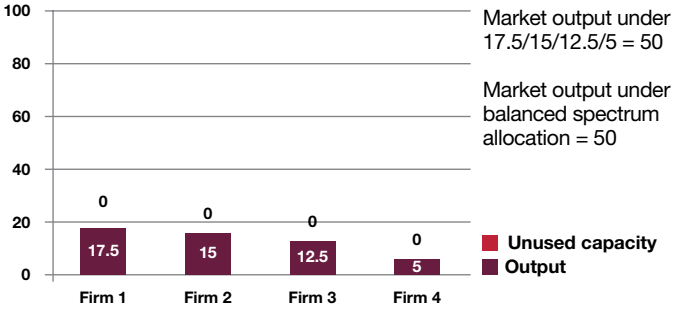
Example 4: 30/30/30/10



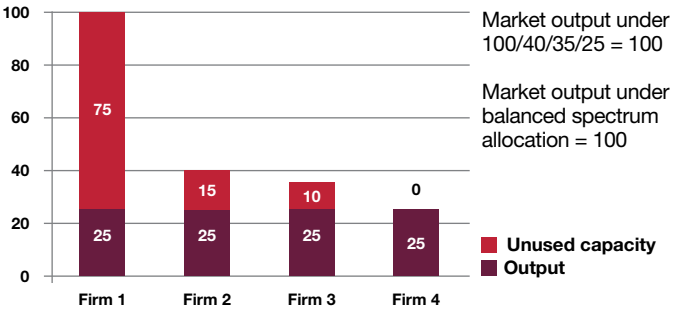
Example 5: 43/25/22/10



Example 6: 17.5/15/12.5/5



Example 7: 100/40/35/25



Source: NERA Economic Consulting.

Spectrum Capacity and Market Demand.

490 In this section we explain how, in our illustrative framework, the relationship between the capacity afforded by the available spectrum and future aggregate demand influences the competitive impact of various spectrum distributions.

a) With 'sufficiently tight' capacity, so that everybody produces at full capacity, reallocation of capacity from firms with large amounts of spectrum to firms with small amounts of spectrum will not increase market output or reduce market prices.[118]

b) With 'sufficiently abundant' capacity where all firms have so much spectrum that they do not hit any capacity constraints, reallocation of capacity from large to small again has no effect (as long as that reallocation does not lead to the introduction of any capacity constraints on the part of the large firm).[119]

c) Between these extremes, the distribution of spectrum may affect market output. For example, if initial capacity constraints happen to equal unconstrained Cournot (such that all firms are just short of being capacity constrained), then any change in the spectrum distribution will lead to lower output (since a redistribution of capacity will result in at least one firm being capacity constrained).

491 We illustrate these ranges in the figure below. This figure shows how market output changes as the aggregate amount of spectrum increases (with the market demand schedule remaining unchanged), utilising three different distributions of the available spectrum between the four firms:

a) Symmetric distribution of spectrum (in this case market output simply grows in line with the aggregate amount of spectrum until it reaches the 4-firm Cournot output of 100);

b) Where the available spectrum is distributed in the following proportions: 27.5%/27.5%/27.5%/17.5%. Note that it is the proportions of spectrum that are assumed to be fixed, not the absolute amounts. Hence if there are 100 units of spectrum available, the fourth firm gets 17.5 units. If the total amount of spectrum available is 200 units, the fourth firm gets 35 units.

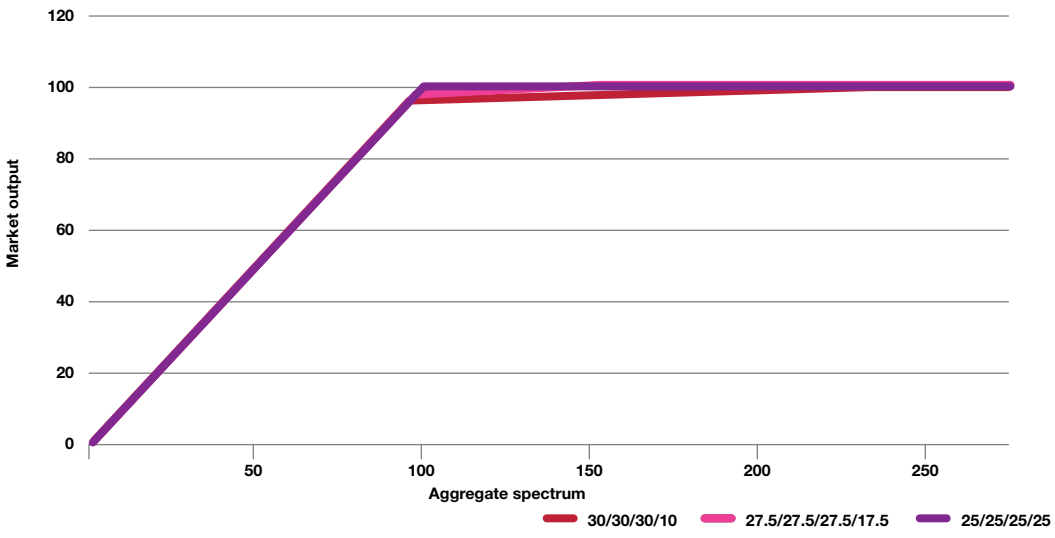
c) Where the available spectrum is distributed in the following proportions: 30%/30%/30%/10%. For example, if there are 100 units of spectrum available, the fourth firm is allocated 10 units; if there are 200 units of spectrum available, the fourth firm is allocated 20 units.

118 This scenario is consistent with some firms having capacity constraints set at substantially above the unconstrained Cournot outcome. For example spectrum allocations of e.g. 50/5/5/5 (i.e. where the first firm's capacity constraint is double its output in an unconstrained 4-firm Cournot equilibrium, but below the monopoly output) do not lead to any output restriction and shifting capacity from the large firm to the smaller ones has no effect, despite the significant asymmetry.

119 We note that under this scenario, spectrum would not be "scarce" and would have no value in our illustrative model.

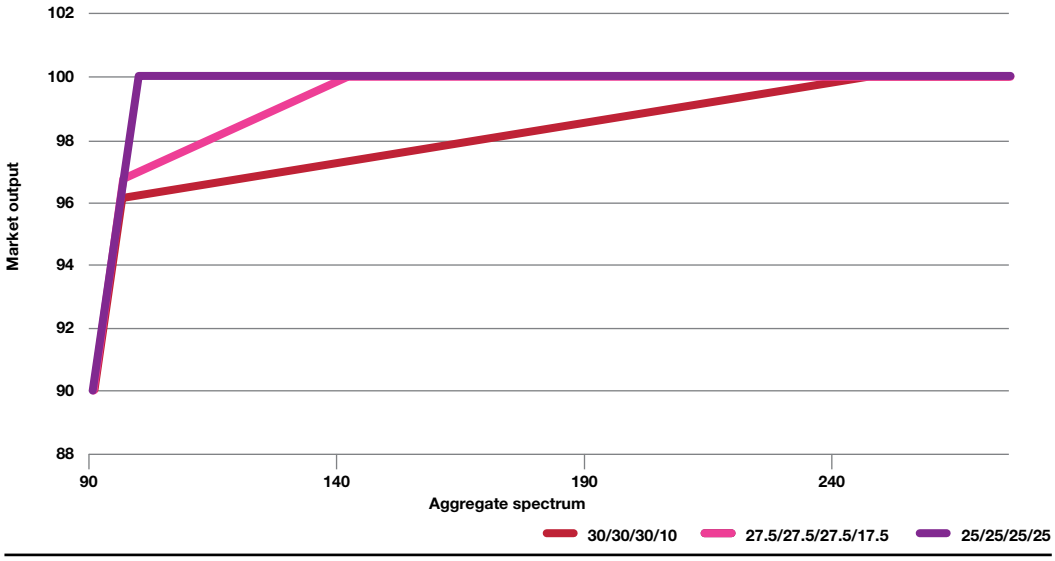
492 Figure 36 depicts the entire potentially relevant parameter range, whereas Figure 37 zooms in on the region where the three different spectrum distributions lead to divergent market output levels.

Figure 36: Aggregate Spectrum, Spectrum Distribution and Market Output (Full Parameter Range).



Source: NERA Economic Consulting.

Figure 37: Aggregate Spectrum, Spectrum Distribution and Market Output (Restricted Parameter Range).



Source: NERA Economic Consulting.

493 These diagrams illustrate the range in which market output falls short of its full potential, and how that range changes if the available spectrum is allocated in differing proportions:

a) Where only limited spectrum is available in aggregate (less than 96.15 units in this illustration), market output coincides for all three of the spectrum distributions and is simply equal to the aggregate amount of spectrum available.[120]

b) Where there is a large amount of spectrum available (250 units or more), market output equals the 4-firm unconstrained Cournot output (100) under all three spectrum distributions, and again reallocation of spectrum makes no difference.[121]

c) If spectrum is allocated in proportions of 27.5/27.5/27.5/17.5, market output could be increased if more than 17.5% of spectrum was allocated to the fourth firm, but only if the total amount of the available spectrum is between 96.67 units and 142.86 units (the point at which the smallest firm gets 25 units of spectrum and output reverts to 100, i.e. unconstrained 4-firm Cournot)

d) If spectrum is allocated in proportions of 30/30/30/10, market output could be increased if more than 10% of spectrum was allocated to the fourth firm, but only if the total amount of the available spectrum is between 96.15 units and 250 units (the point at which the smallest firm gets 25 units of spectrum and output reverts to 100; i.e. unconstrained 4-firm Cournot). This illustrates how allocating a smaller proportion of the available spectrum to the smallest firm increases the range in which spectrum re-allocation can increase market output.

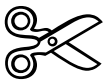
120 If an even more extreme distribution of spectrum were adopted – e.g. allocating less than 10% to the fourth player – then market output could be affected if aggregate spectrum is lower than 96.

121 If an even more extreme distribution of spectrum were adopted – e.g. allocating less than 10% to the fourth player – then market output could be affected if aggregate spectrum is greater than 250.

Annex 4: Part 1 Technical analysis.

Confidential.

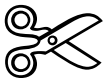
494-566



Annex 5: Future competition is likely to be damaged if bidders can bid for and acquire any amount of spectrum in an open auction.

Confidential.

567-588



126 Consultation, para. 5.2.
127 Consultation, 6.34.
128 Consultation, 6.39.

Annex 6: Reconciling information policy, bidding and clearing in the primary bid rounds with the spectrum floor.

Produced by Power Auctions LLC.

Executive Summary.

589 Following up on the successes of the combinatorial clock auction format in the L-band and 10 to 40 GHz auctions, Ofcom proposes a generally effective design for the Principal Stage of a combined 800 MHz and 2.6 GHz auction. In addition, Ofcom has proposed a novel and promising "spectrum floor" for the auction, with the objective of obtaining a four-firm national wholesale market.

590 However, the joint implementation of the Principal Stage and the spectrum floor gets some of the details wrong, potentially undermining the purposes of the Principal Stage. The Principal Stage, with the information policy as proposed,[132] is not the intended strategically simple transparent open auction; it is effectively a strategically complex, opaque sealed-bid process. Ofcom has not foreseen the crucial alterations needed to the Principal Stage so that it will work as intended in the presence of the spectrum floor.

591 We make several recommendations.

592 First, the information policy of the primary bids round should be augmented so that up to 2x50 MHz of potentially hidden demand is disclosed to bidders.

593 Second, the supplementary bids of a bidder whose eligibility in any primary bid round drops below the eligibility points needed for a spectrum floor portfolio should not be flagged as spectrum floor bids (i.e. they should not count as coming from a bidder who opted in to the spectrum floor).

594 Third, the auction rules and associated software interface should not admit bids that are infeasible in light of the spectrum floor.

595 Fourth, the clearing conditions for the primary bid rounds should be updated to permit the aggregate demand—including hidden demand associated with spectrum floor bids—to equal supply.

596 Fifth, once the number of opt-in bidders has dropped to two, the remaining opt-in bidders should only be required to increase their

132 Ofcom, "Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues" (hereafter, "Consultation"), p. 122, http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/summary/combined-award.pdf.

deposits in relation to the price increases for incremental spectrum above and beyond the minimum spectrum portfolio (MSP).

597 All of these recommendations can be implemented without introducing the information necessary for bidders to game the auction.

Characteristics of an Efficient Principal Stage.

598 The Principal Stage of a well-functioning combinatorial clock auction should have six characteristics contributing to efficiency:

599 **1. Feedback on the relevant aggregate demand.**
After each primary bid round, bidders are informed of the relevant aggregate demand. For the primary bid rounds to work as intended, bidders must know the aggregate demand. Bidders use this information to assess other bidders' values, helping to mitigate the winner's curse and encouraging bidders to bid more aggressively. The information also provides guidance in predicting the final prices, assisting bidders in assessing the relevant packages that they may afford with their limited budgets. They use the feedback to focus their valuation and budgeting efforts on relevant packages.

600 **2. Price discovery.**
The "clearing" of the primary bid rounds should convey to bidders that all sources of demand can be accommodated. The prices of the final primary bid round are intended to be indicative of the market-clearing prices; this is only the case if all sources of demand within the auction are accounted for.

601 **3. Flexibility of bidding.**
Bidders, including those who opt in to the spectrum floor, should be able to bid for their most preferred package in each primary bid round. Bidders should be able to seek large packages at low prices and to seek smaller packages at higher prices. Bidders should also have the ability to change course during the auction to bid for substitute packages depending on how prices develop (e.g. substituting into 2.6 GHz spectrum if that is comparatively cheaper than expected, or substituting into 800 MHz spectrum in the reverse scenario).

602 **4. Avoidance of manipulative bids and collusive behaviour.** Bidders, including those who opt in to the spectrum floor, should be precluded from placing manipulative "infeasible" bids. This assumption about the primary bid rounds can normally go unstated, but care must be taken to avoid introducing the opportunity for manipulative bids whenever the winner determination algorithm is altered (e.g. by imposing additional constraints).

603 All bidders should be deprived of information whose primary use would be to facilitate collusion. Information such as the disaggregated bids of individual bidders is generally not necessary to provide.

604 **5. Minimisation of uncertainty in the supplementary bids round.** Bidders who are provisional winners of spectrum at the end of the primary bid rounds should have a clear route on how to retain these packages in the supplementary bids round. Otherwise, the outcome of the auction will be overly dependent on the bidding in the supplementary bids rounds and, indeed, the principal stage may be tantamount to a sealed-bid auction.

605 An effective way for a combinatorial clock auction to minimise uncertainty in the supplementary bids round is to utilise a clearing condition for the primary bid rounds, coupled with an activity rule for the supplementary bids round, such that the following two propositions established by Peter Cramton are satisfied:[133]

Proposition 1. *If the clock stage ends with no excess supply, then the final assignment is the same as the clock assignment. The supplementary round cannot alter the clock assignment.*

Proposition 2. *If the clock stage ends with excess supply, then a winner can guarantee that it wins its clock assignment by raising its bid on its clock package by the value of the unsold lots at the final clock prices.*

606 **6. Minimisation of the effects of budget constraints.** The auction process should minimise the adverse consequences of budget constraints. In particular, in the presence of budget constraints, the auction may allocate spectrum to bidders with the highest budgets, instead of to bidders with the highest values. It should be presumed that entrants are the bidders most likely to be limited by budget constraints.

133 Cramton, Peter, "Spectrum Auction Design", 11 August 2009, p. 26, http://www.cramton.umd.edu/papers2005-2009/cramton-spectrum-auction-design.pdf.

607 Each of the above six characteristics contributes to the success of the Principal Stage. Next, we assess the Consultation's proposed Principal Stage against these six criteria. We then provide detailed recommendations for improving upon the Consultation's proposal. Finally, we assess the revised proposal according to the same criteria.

Assessment of the Consultation's Proposed Principal Stage.

Feedback on the relevant aggregate demand.

Feedback about the quantity of spectrum demanded in each category at the current price.

608 In order for common value price uncertainty to be mitigated, the relevant aggregate demand must be disclosed to bidders. Under the information policy proposed in the Consultation, bidders may only be provided with a measure of aggregate demand computed by summing the individual quantities demanded in the primary bid rounds, without taking account of spectrum floor bids. If there are one or two entrants who have dropped out of the primary bid rounds but whose spectrum floor bids may win, then there is substantial "hidden demand" and bidders may face substantial demand uncertainty.

609 Example: Suppose the bidders have the valuations from Example 1 in the May 19 Seminar:[134]

Table 24: Example.

Bidder	Package	800MHz	2.6GHz	Reserve	Max bid
A	MSP	1	2	£50m	£100m
B	MSP	1	2	£50m	£80m
C	MSP	1	2	£50m	£60m
X	Only bid	2	1	£70m	£150m
Y	Only bid	2	2	£80m	£250m
Z	Only bid	2	2	£80m	£200m

134 Ofcom, "Consultation proposals for the award of 800MHz and 2.6GHz: Spectrum packaging and auction design", 19 May 2011, slide 19, http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/slides.pdf.

610 Suppose that the aggregate demand is computed by summing the individual quantities demanded in the primary bid rounds, without taking account of spectrum floor bids, and that prices and reported demand evolve as follows:

Table 25: Example.

Round	800 MHz Price	800MHz Demand	2.6GHz Price	2.6GHz Demand
1	£30m	9	£10m	11
2	£35m	8	£15m	9
3	£40m	8	£20m	9
4	£45m	7	£25m	7
5	£50m	7	£25m	7
6	£55m	6	£25m	5

611 If in Round 2, the price for 800 MHz spectrum rises to £35m and the price for 2.6 GHz spectrum rises to £15m, bidder C will drop out of the primary bid rounds. Further, if in Round 4, the price for 800 MHz spectrum rises to £45m and the price for 2.6 GHz spectrum rises to £25m, bidder B will drop out of the primary bid rounds. After Round 4, the other bidders see an "aggregate" demand of 7 blocks for 800 MHz spectrum and an "aggregate" demand of 7 blocks for 2.6 GHz spectrum. However, there is also "hidden" demand for 2x25 MHz of spectrum, because bidder B, while eliminated from the primary bid rounds, is nevertheless guaranteed to win a spectrum floor portfolio. Finally, if in Round 6, the price for 800 MHz spectrum rises to £55m and the price for 2.6 GHz spectrum rises to £25m, bidder A will drop out of the primary bid rounds. After Round 6, the other bidders see an "aggregate" demand of 6 blocks for 800 MHz and an "aggregate" demand of 5 blocks for 2.6 GHz spectrum. Now, there is "hidden" demand for 2x50 MHz of spectrum, because bidders A and B, while eliminated from the primary bid rounds, are nevertheless each guaranteed to win a spectrum floor portfolio.

612 Thus, after Round 4, the relevant aggregate demand is 2x25 MHz higher than Ofcom proposes to disclose. After Round 6, the relevant aggregate demand is 2x50 MHz higher than Ofcom proposes to disclose. Non-spectrum-floor bidders X, Y and Z must now participate in the

supplementary bids round, unaware that they are collectively bidding for 6 blocks of 800 MHz spectrum when only 4 blocks are available, and unaware that they are collectively bidding for 5 blocks of 2.6 GHz spectrum when only 3 blocks are available. The primary bid rounds will provide minimal guidance to bidders X, Y and Z, and the supplementary bids round will effectively function as a sealed-bid auction with a great deal of uncertainty for bidders.

613 In particular, observe that bidders cannot distinguish between the above scenario and an alternate scenario where, instead, a non-spectrum-floor bidder dropped out of the auction in Round 6. In the alternate scenario, the true aggregate demand of the remaining bidders is closer to the available supply.

614 The strategic simplicity and efficiency of a well-designed combinatorial clock auction is lost if the supplementary bids round becomes a sealed-bid round with potentially substantial uncertain excess demand and inadequate supply for the remaining bidders.

Feedback about winning a minimum spectrum portfolio.

615 There is a second serious consequence of not disclosing aggregate demand. A spectrum floor bidder such as A must bid without any way of knowing if it has locked in a minimum spectrum portfolio. If bidder A faces a binding budget constraint, bidder A cannot safely bid for additional spectrum beyond its minimum spectrum portfolio. For Bidder A to have sufficient information to bid its incremental value for additional blocks while staying within its budget, Bidder A must know what it is winning. The information that bidder A has locked in a winning portfolio is being withheld from bidder A in this example, starting after Round 2. This compromises the ability of spectrum floor bidders to reach beyond minimum spectrum portfolios to compete even more aggressively in the national wholesale market.

616 Bidders require further relevant information about aggregate demand which is missing from the Consultation's proposal. For bidders to have the correct incentives during the primary bid rounds to reveal and bid their valuations, they need to know how much of their budget they have spent. Unfortunately, the proposed disclosure for the primary bid rounds does not give sufficient information to determine what price the bidder will pay.

617 If an entrant has "locked in" a minimum spectrum portfolio (by outbidding the final bid of the third spectrum floor bidder), then it has committed a substantially smaller part of its limited budget—and it has substantially more budget available to buy additional spectrum. The Consultation's proposal does not provide any way for the entrant to determine whether or not it has locked in a minimum spectrum portfolio.

618 This omission may lead to substantial budget uncertainty. For example, suppose the reserve price for 800 MHz spectrum is £30 million as provided in the examples given in the May 19 seminar[135] and suppose that prices for spectrum reach the projected[136] £200 million in the unrestricted auction, the total price uncertainty could reach more than 500% as follows:

- the entrant would have to pay £600 million if there are two other entrants that remain in the auction at this price bidding for 2x15 MHz of 800 MHz spectrum
- the entrant would only have to pay as little as £90 million if there is only one other entrant

619 A huge difference in average price paid could make it impossible for an entrant to plan sensibly to buy additional spectrum beyond a minimum spectrum portfolio.

620 Furthermore, entrants do not face strategic simplicity given this lack of relevant demand feedback. They must take on substantial exposure risk in order to "make bids for spectrum packages they value."[137] For example, under the Consultation's proposed information policy, a bidder who has a £600m budget for 2x15 MHz of 800 MHz spectrum may want to reach for a portfolio containing 2x15 MHz of 800 MHz spectrum and 2x10 MHz of 2.6 GHz. This bidder would have to guess whether the prices it faces are lower than £600m (due to the spectrum floor constraint). If the bidder guessed wrong, it could face a substantial loss and become an unhappy winner. If the bidder forgoes the opportunity to bid for something other than the spectrum floor, it could become an unhappy loser. Bidders therefore lose "flexibility over size and composition of spectrum packages."[138]

135 Ofcom, "Consultation proposals for the award of 800MHz and 2.6GHz: Spectrum packaging and auction design", 19 May 2011, slide 19, http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/slides.pdf.
136 Consultation, p. 108.
137 Consultation, p. 110.
138 Ofcom, "Award of available spectrum: 2500-2690 MHz, 2010-2025 MHz", 4 April 2008, p. 153, http://stakeholders.ofcom.org.uk/binaries/consultations/2ghzrules/statement/statement.pdf.

621 Observe that providing additional information to the entrant in this example has the opposite effect as what Ofcom is concerned about. Generally, Ofcom wishes to suppress information because providing additional information would facilitate bidders colluding by reducing their demands. However, in this example, providing additional information to an entrant would reduce the entrant's budget uncertainty and enable the entrant to increase its demand. Thus, providing the additional information would be pro-competitive.

Price discovery.

622 The Consultation's proposed procedures may result in the premature ending of the primary bid rounds with substantial excess demand, as the above example demonstrates. Price discovery in the primary bid rounds is poor. Demand must be further compressed by as much as 2x50 MHz in the supplementary bids round. The prices in the Consultation's final primary bid round are a poor guide to the prices necessary to win in the supplementary bids round, or to the market-clearing price of spectrum.

623 An asymmetric information problem is introduced by the poorly integrated proposal in the Consultation. If there are only two successful entrants who apply to participate in the auction, then an entrant knows whether or not its own bidding is included in the primary bid round aggregate demand. This improves the entrant's price discovery (but only relative to the incumbents' – its own information is still poor). Such asymmetric information further encourages incumbents to be timid in the supplementary bids round.

624 The price discovery properties of the Consultation's proposed procedures are poor.

Flexibility of bidding.

625 Bidders may place bids for any portfolio they desire in the primary bid rounds. They have somewhat less flexibility in the supplementary bids round, due to the activity rule.

626 Bidders sometimes have the ability to maintain full flexibility in the supplementary bids round by placing manipulative bids in the primary bid rounds that are infeasible (see below). These bids may have the effect of nullifying the restrictions imposed by the activity rule.

627 Flexibility of bidding is particularly important for entrants. Since entry is costly, entrants will typically want to opt in to the spectrum floor. However, entrants may find a larger package than the minimum spectrum portfolio is needed for their business plans. It is good public policy (and pro-competitive) to allow entrants the flexibility to bid for additional blocks above the spectrum floor.

628 The flexibility of bidding provided by the Consultation's proposal is good, but given the potential presence of infeasible bids, the flexibility may be excessive.

Avoidance of manipulative bids and collusive behavior.

629 Bidders have the incentive to truthfully reveal demand in well-designed primary bid rounds because it is possible for the auction to end after any round and for the bidder to win what they bid. Any bid may be a winning bid. Furthermore, with correctly functioning revealed preference rules[139], they are further restricted in what they can bid in subsequent rounds.

630 However, with a spectrum floor, some bids that could ordinarily win now become infeasible. The proposed auction rules and software interface would permit bidders to place "infeasible bids". For example, suppose that only two bidders have entered the auction who are eligible to opt in to the spectrum floor. After opting in, such an entrant is free to place bids for packages that do not contain at least one block of A2, A3 or A4. Such packages do not contain any minimum spectrum portfolio, so such bids cannot win under the circumstances. By placing such infeasible bids, entrants can avoid revealing any information in the primary bid rounds. This type of infeasible bid can be placed completely safely, with no possibility of the bid winning, if only two bidders who are eligible for spectrum floor bids are successful applicants.

631 Non-spectrum-floor bidders may also have infeasible bids available. If two or more entrants have opted in for the spectrum floor, then a bid for 3 blocks in aggregate of A2, A3 or A4 becomes infeasible.

139 Cramton, Peter, "Spectrum Auction Design", 11 August 2009, p. 18, http://www.cramton.umd.edu/papers2005-2009/cramton-spectrum-auction-design.pdf.

Minimisation of uncertainty in the supplementary bids round.

632 Bidders who are provisional winners of spectrum at the end of the primary bid rounds do not have any clear route on how to retain these packages in the supplementary bids round, under the procedures proposed in the Consultation.

633 An implicit assumption made in Peter Cramton's paper, "Spectrum Auction Design", is that the primary bid rounds end only when true excess demand ceases to exist. However, as we saw in the example above, there may be as much as 2x50 MHz of hidden demand in the final primary bid round due to spectrum floor bids. The clearing price has not been reached.

634 Without this assumption being satisfied, Cramton's Proposition 1 is therefore not satisfied: "If the clock stage ends with no excess supply, then the final assignment is the same as the clock assignment. The supplementary round cannot alter the clock assignment." Instead, the primary bid rounds may conclude, but a bidder's assignment after the supplementary bids round may be radically different from his assignment after the final primary bid round.

635 Similarly, Cramton's Proposition 2 is also not satisfied. Instead of guaranteeing a win by raising prices by a small, calculable amount, the bidders in the supplementary bids round in the example above cannot guarantee a win at all.

636 In addition to not satisfying Cramton's propositions, the procedures proposed for the supplementary bids round have several more difficult obstacles to minimising uncertainty:

- infeasible bids may distort the intended restrictions on bidding in the supplementary bids round.
- bidders are bidding in the dark about actual demand, and
- the market-clearing prices have not yet been discovered.

637 The Consultation's proposal does a poor job of minimising uncertainty in the supplementary bids round.

Minimisation of the effects of budget constraints.

638 Ofcom proposes that bidders be required to maintain deposits in proportion to their highest bids. In particular, consultation para. 9.94c) proposes: "Primary rounds deposit to be topped up at regular intervals such that bidders have on deposit a specified proportion (not required to be greater than 50%) of their highest bid." para. 9.94d) makes a similar proposal for supplementary bids.

639 It should be considered that smaller bidders and new entrants are likely to be the most constrained in the amount of deposit that they can raise (especially given the potential cost associated with accessing large capital sums). As such, there should be special concerns when smaller bidders and new entrants are required to increase their deposits without justification.

640 In situations where the number of opt-in bidders has dropped to two, the prices that the opt-in bidders will pay for their minimum spectrum portfolios (MSPs) cease to increase, even as the clock prices continue to increase. Therefore, there is no justification for requiring their deposits attributable to MSPs to be topped up. If opt-in bidders are held to the provisions of para. 9.94c) and para. 9.94d), they are likely to be unable to generate the deposit needed to bid for incremental spectrum, and they will be limited to the MSP even if their marginal value for incremental spectrum exceeds the marginal value of incumbents.

Summary.

641 Ofcom's incompletely integrated proposal scores poorly on five of the six criteria that we have identified. Only bidder flexibility is good (but, through infeasible bids, bidder flexibility may be excessive). Fortunately, there are good ways to complete the integration of the spectrum floor with the information policy, bidding and clearing in the primary bid rounds.

Our Attempt at a Reconciliation.

642 We attempt to reconcile the information policy, bidding and clearing with the spectrum floor by offering a new proposal as follows:

New auction information policy.

643 We propose that the aggregate demand be reported including provisional winning bids of bidders who have dropped out of the primary bid rounds, but are provisional winning bidders because of a spectrum floor bid. We propose that the following broader measure of aggregate demand is reported to bidders after every round for each category of demand:

$$\sum_{\substack{non\text{-}spectrum \\ floor\ bidders}} current\ clock\ bid \quad + \quad \sum_{\substack{spectrum \\ floor\ bidders}} Max\left\{\begin{matrix} current\ clock\ bid, \\ provisional\ winning\ bid \end{matrix}\right\}.$$

644 For non-spectrum-floor bidders, the standard aggregate demand calculation is reported. However, for any bidder who has opted in to the spectrum floor but whose current clock bid has dropped below the spectrum floor, the report is potentially based on their provisional winning spectrum floor bid in lieu of their current clock bid. The provisional winning bids are determined by running the winner determination algorithm, including the constraint on guaranteed minimum winners, after every round. The "Max" represents the maximum (for each category of spectrum) of the number of lots in the bidder's current clock bid and the number of lots that the bidder would provisionally win for that category taking into account both its current clock bid and its spectrum floor bids.[140] While the above notation does not fully reflect this, we intend that this replacement of the current clock bid with the provisional winning bid occur only for a bidder who has opted into the spectrum floor but whose current clock bid has dropped below the spectrum floor. Thus, the "hidden" demand associated with a spectrum floor winner will be included in this measure of excess demand. This means that an incumbent will not have as much uncertainty about how much net excess demand remains in the auction after each primary bid round.

645 To help the bidders understand whether the entrants face excess demand due to spectrum floor bids, we also propose releasing the following information after each primary bid round:

140 More technically, the "Max" is the "join" of the current bid and the provisional winning bid (i.e. the component-by-component maximum, often denoted by the mathematical symbol v, for every category of spectrum).

The number of bidders who opted in to the spectrum floor and whose eligibility points after the most recent round equalled at least 45 (the minimum number of eligibility points associated with a minimum spectrum portfolio).

646 We suggest that this information be provided to all bidders but, alternatively, it could be provided only to bidders who opted in to the spectrum floor. This information helps clarify the difficulty in knowing how much to bid at each point in the auction in order to try to win a spectrum floor portfolio without providing any information that would promote gaming such as learning another bidder's exact bids.

647 By helping both incumbents and entrants the new information policy allows them to:
- tailor the size and composition of their spectrum packages;
- reduce common value uncertainty;
- bid truthfully; and
- bid straightforwardly

648 Moreover, observe that providing entrants with information concerning the number of other spectrum-floor bidders does not create the opportunity for entrants to engage in demand reduction. Entrants have no opportunity to engage in demand reduction (i.e. strategic reduction in quantity), as the spectrum floor sets a minimum portfolio on which they can bid—they cannot bid for any smaller quantity without dropping out completely.

New condition regarding supplementary bids and the spectrum floor.

649 We propose that spectrum-floor bidders cannot drop out of contention for a minimum spectrum portfolio in the primary bid rounds, only to return into contention to be a guaranteed minimum winner in the supplementary bids round. More precisely, suppose that a bidder who has opted in to the spectrum floor in the initial primary bid round allows its eligibility points to drop below 45 (the minimum number of eligibility points associated with a minimum spectrum portfolio) in any primary bid round. Then we propose that any bids submitted by that bidder in the supplementary bids round should not be flagged as spectrum floor bids (i.e. they should not count as satisfying the constraint on the number of guaranteed minimum winners in the auction).

650 The reason for adding this constraint is that the primary bid rounds should be consequential insofar as determining which bidders win the spectrum floor. It diminishes the effectiveness of the auction if gross surprises can occur in the supplementary bids round. It diminishes the effectiveness of the auction if a third or fourth spectrum floor bidder can apparently drop out of contention in a primary bid round, only to return as a spectrum floor winner in the supplementary bids round.

New feasibility constraint on bids.

651 We propose that constraints be placed on bidders, preventing them from submitting bids that are demonstrably infeasible, during the Principal Stage. Once a point is reached where at most two opt-in bidders remain in the auction, both of these bidders will be prohibited from submitting bids that do not include a minimum spectrum portfolio. The auction software should inform the spectrum-floor bidder that such a point in the auction has been reached and it should refuse to accept such bids.

652 Bidders who have not opted in to the spectrum floor also be prohibited from bid submissions that are incompatible with a spectrum floor award. If at least one bidder has opted in to the spectrum floor:

- no non-spectrum floor bidder may place a bid for all four lots from A2, A3 and A4;
- no non-spectrum floor bidder may place a bid for three lots of A2, A3 and A4 and more than 2x50 MHz of paired 2.6 GHz spectrum.

653 If at least two bidders have opted in to the spectrum floor:

- no non-spectrum floor bidder may place a bid for three lots from A2, A3 and A4;
- no non-spectrum floor bidder may place a bid for more than 2x50 MHz of paired 2.6 GHz spectrum;
- no non-spectrum floor bidder may place a bid for two lots of A2, A3 and A4 and more than 2x30 MHz of paired 2.6 GHz spectrum;
- no bidder may place a bid for A4a and more than 2x30 MHz of paired 2.6 GHz spectrum;
- no spectrum floor bidder may place a bid for four lots from A2, A3 and A4;
- no spectrum floor bidder may place a bid for two or three lots from A2, A3 and A4 and more than 2x50 MHz of paired 2.6 GHz spectrum.

654 This list is intended to exhaust all possibilities of bids that are made infeasible by the spectrum floor constraints and the related spectrum contiguity constraints. (Note that the list of infeasible bids is somewhat different if one of the bidder opting in to the spectrum floor has the profile of existing spectrum held by Everything Everywhere or if 2x15 MHz of relinquished 1800 MHz spectrum is in the auction.) This eliminates an unintended method of gaming introduced by the Consultation's incompletely integrated proposal.

655 Observe that our proposed new feasibility constraint on bids is effectively bundled with our proposed new information policy and our proposed new condition on supplementary bids. One cannot prevent an entrant from placing bids made infeasible by the fact that the entrant is guaranteed to win the spectrum floor, without telling the entrant that it is guaranteed to win the spectrum floor.

New clearing condition for primary bid rounds.

656 We propose that the primary bid rounds continue as long as the following condition remains true for at least one category of spectrum:

$$\sum_{\substack{\text{non-spectrum}\\ \text{floor bidders}}} \text{current clock bid} \;+\; \sum_{\substack{\text{spectrum}\\ \text{floor bidders}}} Max\left\{\begin{matrix}\text{current clock bid},\\ \text{provisional winning bid}\end{matrix}\right\} > Supply.$$

657 This uses the same aggregate demand calculation as is proposed in our new information policy. As discussed above, for non-spectrum-floor bidders, the standard aggregate demand calculation is reported. However, for any bidder who has opted in to the spectrum floor but whose current clock bid has dropped below the spectrum floor, the report is potentially based on their provisional winning spectrum floor bid in lieu of their current clock bid. The provisional winning bids are determined by running the winner determination algorithm, including the constraint on guaranteed minimum winners, after every round. The "Max" represents the maximum (for each category of spectrum) of the number of lots in the bidder's current clock bid and the number of lots that the bidder would provisionally win for that category taking into account both its current clock bid and its spectrum floor bids. While the above notation does not fully reflect this, we intend that this replacement of the current clock bid with the provisional winning bid occur only for a bidder who has opted into the spectrum floor but whose current clock

bid has dropped below the spectrum floor. Thus, the primary bid rounds will not conclude until the true aggregate demand (including the "hidden" demand associated with spectrum floor winners) can be satisfied by supply.

658 The new clearing condition restores the desirable property that the bids in the final primary bid round will win the supplementary bids round if there is no excess supply at the end of the primary bid rounds. It also restores the desirable property that the winning bids from the primary bid rounds, if increased by the value of the unsold lots in the final primary bid round, can win the supplementary bids round for certain.

Limitation on financial deposits when only two opt-in bidders remain.

659 We propose that, once the number of opt-in bidders has dropped to two, the remaining opt-in bidders be required only to increase their deposits in relation to the increases in prices for incremental spectrum above and beyond the minimum spectrum portfolio (MSP). (The prices that the opt-in bidders will pay for their MSPs cease to increase, even as the clock prices continue to increase; therefore, there is no justification for requiring their deposits attributable to MSPs to be topped up.) For example, suppose that the MSP comprised 2x10MHz of 800MHz spectrum and 2x15MHz of 2.6GHz spectrum and suppose that one of the two remaining opt-in bidders continues to bid for 2x10MHz of 800MHz spectrum and 2x25MHz of 2.6GHz spectrum. Then the increase in the bidder's deposit should be based only on the price increase of the incremental 2x10MHz of 2.6GHz spectrum.

Assessment of the New Proposed Principal Stage.

660 We now assess how our attempt at reconciliation fares according to the criteria we proposed.

Feedback on the relevant aggregate demand.

661 By disclosing the "true" aggregate demand in the primary bid rounds, including any "hidden" demand from bidders who have opted in to the spectrum floor, Ofcom has provided bidders with sufficient information to know what their preferred bid is and to place the bid at an informed low risk. There is room for improvement in our exact formula for aggregate demand, but our proposal has sufficiently repaired demand disclosure to restore efficiency and incentives for aggressive bidding in the primary bid rounds.

662 Returning to our initial example:

Table 26: Example.

Round	800 MHz Price	800MHz Demand	2.6GHz Price	2.6GHz Demand
1	£30m	9	£10m	11
2	£35m	8	£15m	9
3	£40m	8	£20m	9
4	£45m	8	£25m	9
5	£50m	8	£30m	9
6	£55m	8	£35m	9
7	£60m	8	£40m	9
8	£65m	6	£45m	8
9	£65m	6	£50m	8
10	£65m	6	£55m	8
11	£65m	6	£60m	8
12	£65m	6	£65m	8
13	£65m	4	£70m	6

663 The primary bid rounds as modified disclose demand to permit the auction to clear. All bidders have a much clearer idea about which bids are relevant in the supplementary bids round.

664 Bidders A and B will learn after Round 2 that they have won spectrum floors. If Bidder A had retained eligibility, Bidder A could safely place a bid for an additional lot of 2.6 GHz spectrum and stay within its £100m budget during round 3.

665 By providing relevant feedback to all bidders about the number of bidders who have opted in to the spectrum floor that are continuing to demand a minimum spectrum portfolio in the primary bid rounds, our proposal provides bidders with additional feedback and provides them with additional flexibility.

666 Our proposal provides bidders with good feedback about the relevant aggregate demand.

Price discovery.

667 Our proposal continues the primary bid rounds until relevant excess aggregate demand is exhausted as seen in the example above. In our above example, the auction runs many more rounds. In this situation, a longer auction is highly desirable. It provides additional feedback to bidders on the relevant aggregate demand, but more importantly it helps the primary bid rounds arrive at a price that equates supply and demand, so that bidders can have sufficient price information to bid precisely in the supplementary bids round. This exhaustion of demand is the essence of the purpose of the primary bid rounds and our proposal restores this key feature. It may be possible to fine tune our primary bid round clearing condition so that the primary bid rounds end in every case where demand from all sources can be accommodated. We have provided a simple equation that provides a strict improvement on the information policy and clearing rule proposed in the Consultation. Our proposal enables price discovery to work as Ofcom had surely intended.

Flexibility of bidding.

668 Bidders, under our proposal, maintain the flexibility to place all of the feasible bids they could place under the Consultation's proposal. Given that there is no true excess demand at the end of the primary bid rounds in our proposal, bidders should find they have full flexibility to express their preferences in the supplementary bidding round as well. Furthermore, they should be better able to exercise that flexibility because they will have the relevant demand information that lets them know what they want to bid on. They will also learn from the relevant demand information the likely remaining budget they have to bid. The demand is, furthermore, undistorted by manipulative bids. All of these features of our proposal make the flexibility benefits much more valuable than the apparent flexibility under the Consultation's proposal. Flexibility is incomplete in a sealed-bid situation with little information about relevant aggregate demand. Our proposal provides useful and complete flexibility.

Avoidance of manipulative bids and collusive behaviour.

669 Our proposal protects the features proposed in the Consultation that deprive bidders of information whose primary use would be to facilitate collusion. Our proposal also curbs the inherently manipulative infeasible bids introduced as an unintended consequence into the primary bid rounds via the Consultation's incompletely integrated spectrum floor constraints.

670 By providing sufficient information to bidders, we also restore transparency and strategic simplicity, fostering the ability of bidders to meet their spectrum acquisition goals by placing straightforward bids. This further improves the perception of fairness in the auction, efficient assignment and competitive prices.

Minimisation of uncertainty in the supplementary bids round.

671 Our proposal restores the intended clear route for provisional winners of spectrum at the end of the primary bid rounds to retain these packages in the supplementary bids round. We also restore the efficiency, price discovery and transparency effects of a supplementary bids round that is held when relevant aggregate demand is exhausted. Our proposal satisfies Peter Cramton's two propositions that hold for a supplementary bids round in a well-designed Principal Stage.

672 We feel we have provided a workable fix to the Consultation's proposal that for all practical purposes minimises the uncertainty in the supplementary bids round.

Minimisation of the effects of budget constraints.

673 Our proposal eliminates the need for an opt-in bidder to increase its deposit in relation to a minimum spectrum portfolio that it is already sure to win. This reduces the tendency for entrants to lose in the auction on incremental spectrum for which it may have the highest value, but insufficient budget to submit bids. At the same time, Ofcom (and other bidders) are fully protected, as the opt-in bidder's ultimate price for the MSP has already ceased to rise.

Conclusion.

674 There are unintended consequences to implementing the Consultation's information policy, bid restrictions and clearing conditions for the primary bid rounds as proposed. Nevertheless, there is a straightforward way to restore the desirable properties of the Principal Stage without backtracking on the spectrum floor constraint. The relevant aggregate demand, including spectrum floor bids, should be disclosed. This allows bidders to mutually mitigate common value price uncertainty as intended. Not releasing the relevant aggregate demand harms price discovery, transparency and efficiency. If a bidder also has sufficient information to determine if it is winning a spectrum portfolio, this relaxes budget constraints and enables the entrant to make efficient acquisitions of additional spectrum. Gaming, under this proposal, will be reduced by limiting infeasible bids. In addition, spectrum-floor bidders will be unable to drop out of contention for a minimum spectrum portfolio in the primary bid rounds, only to return into contention to be a guaranteed minimum winner in the supplementary bids round—limiting another potential form of gaming. Finally, altering the clearing condition for the primary bid rounds permits them to continue until relevant demand meets supply and the price is discovered. The objective of our proposals is to complete the integration of the laudable spectrum floor with the existing desirable features of the primary bid rounds, so that they will work together as Ofcom has intended.

Annex 7: Western European market shares.

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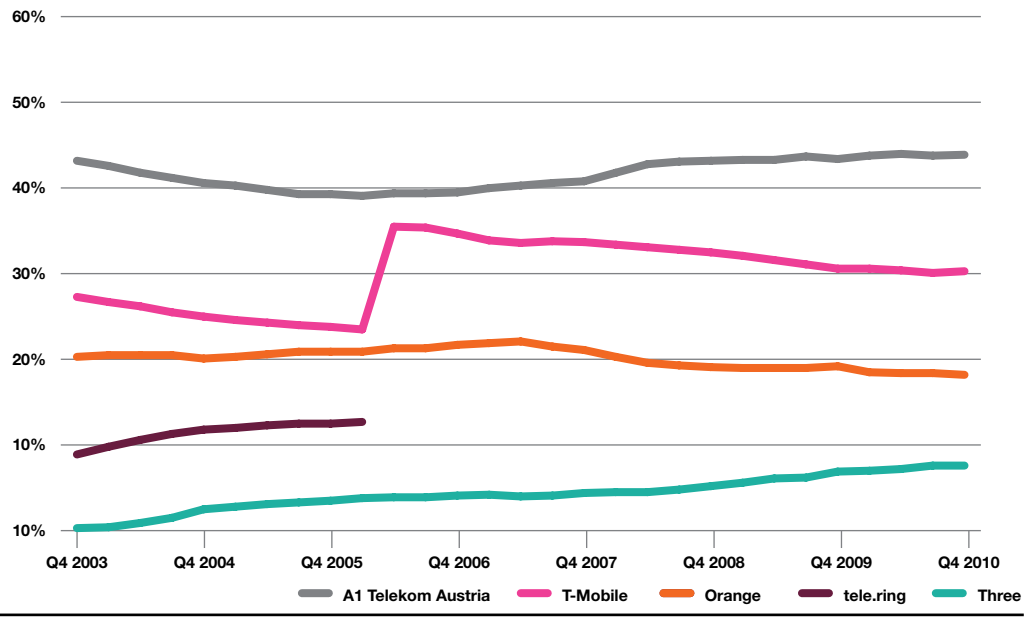
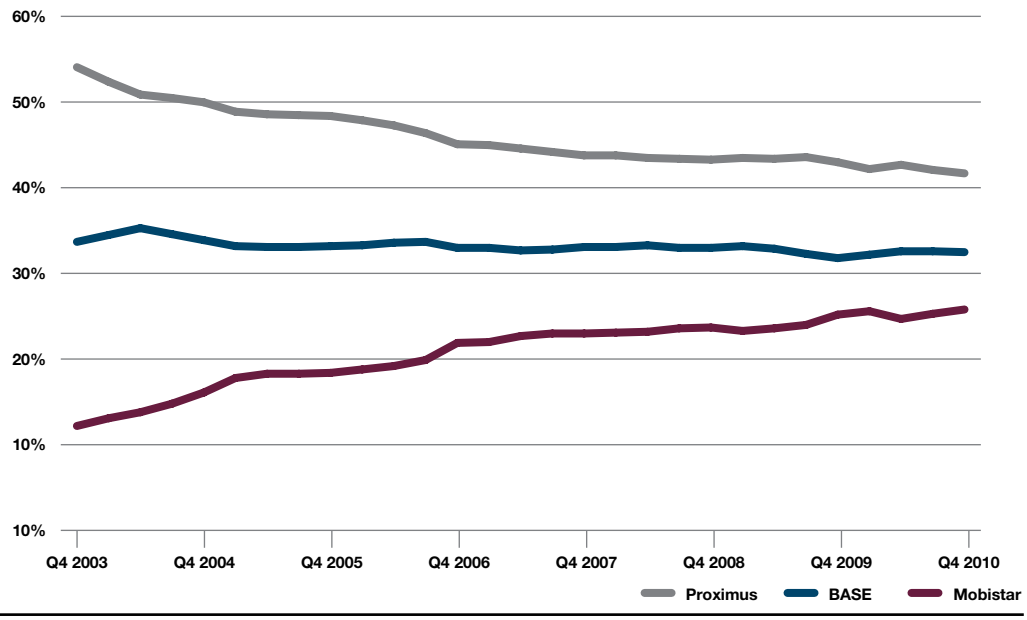
Figure 62: Development of mobile subscriber market shares in Austria.



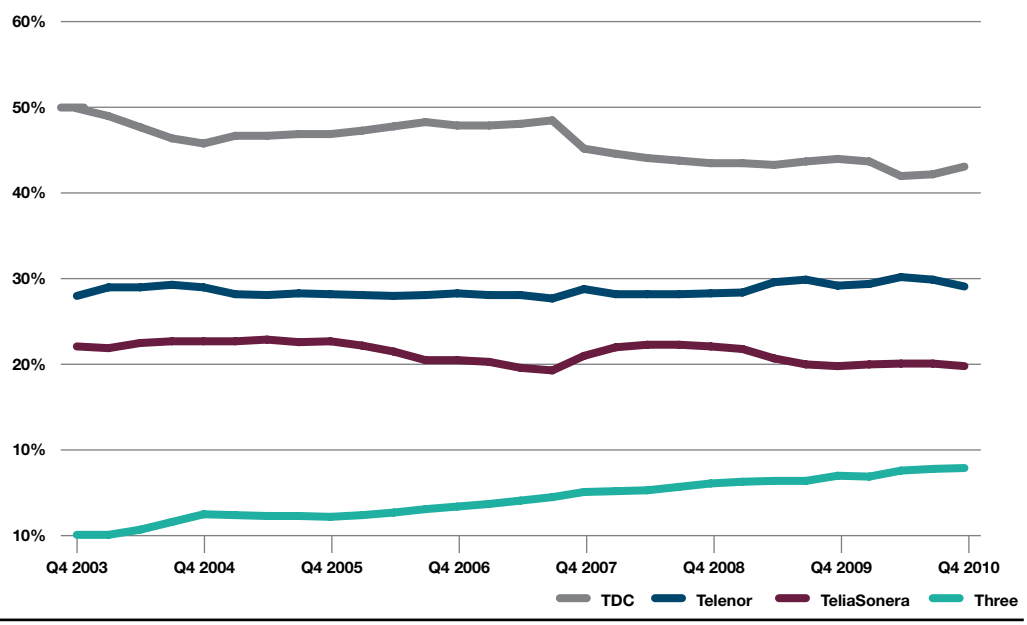
Source: Analysys Mason.

Figure 63: Development of mobile subscriber market shares in Belgium.



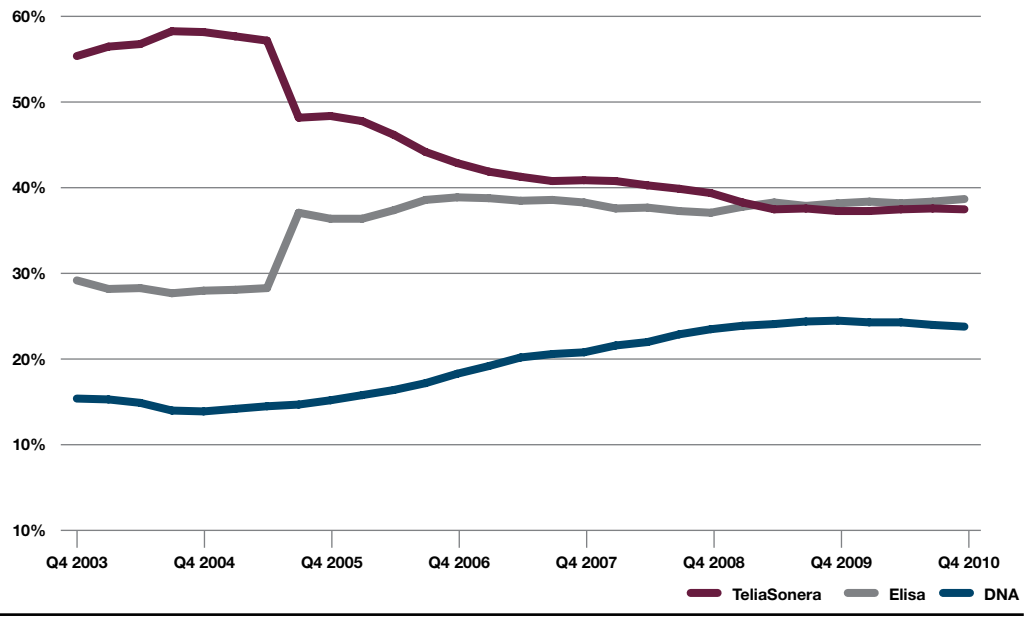
Source: Analysys Mason.

Figure 64: Development of mobile subscriber market shares in Denmark.



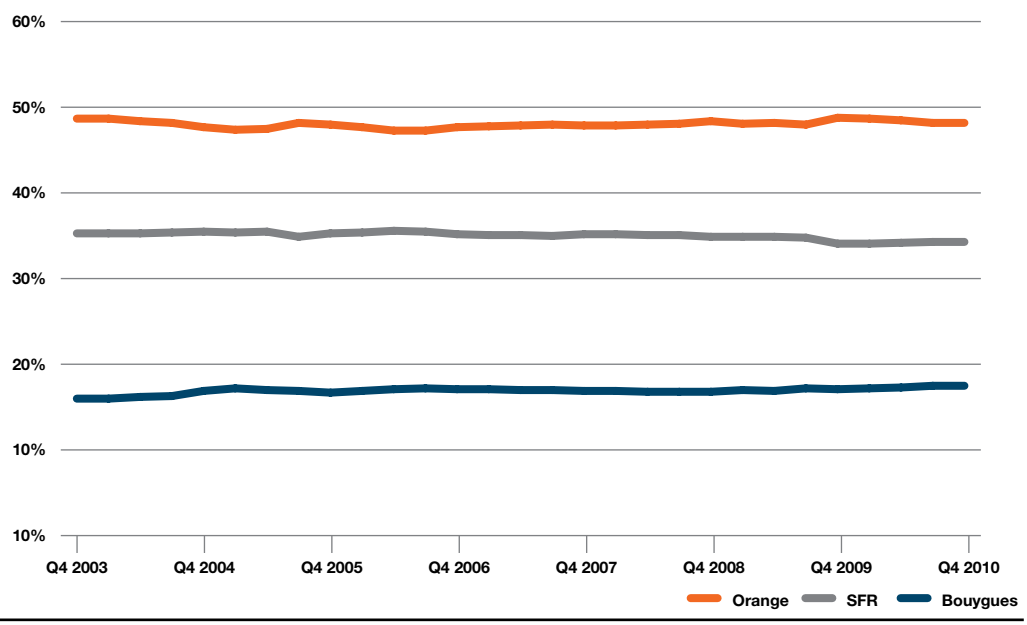
Source: Analysys Mason.

Figure 65: Development of mobile subscriber market shares in Finland.



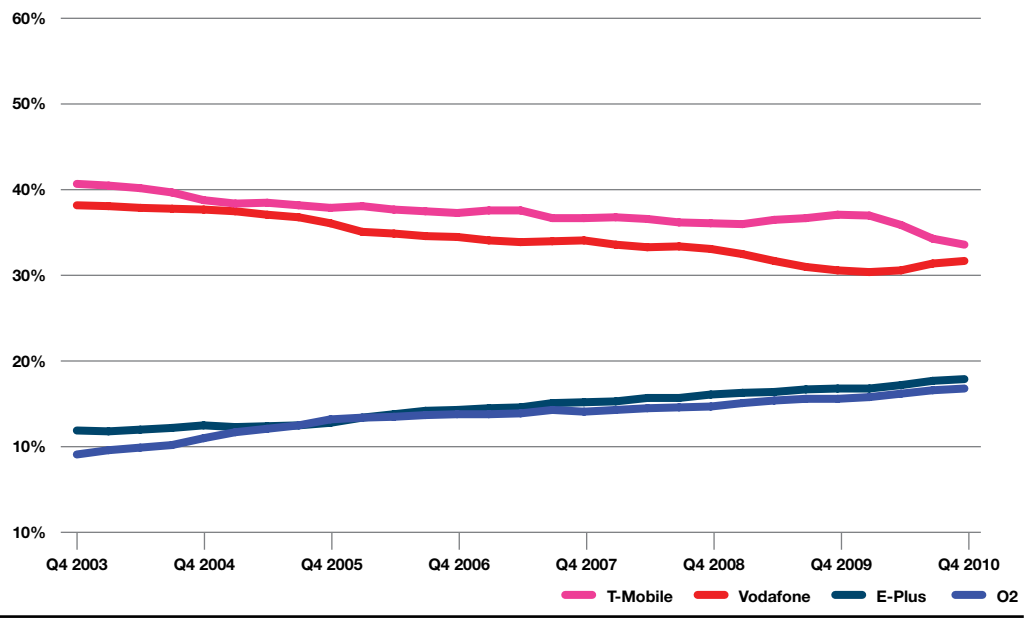
Source: Analysys Mason.

Figure 66: Development of mobile subscriber market shares in France.



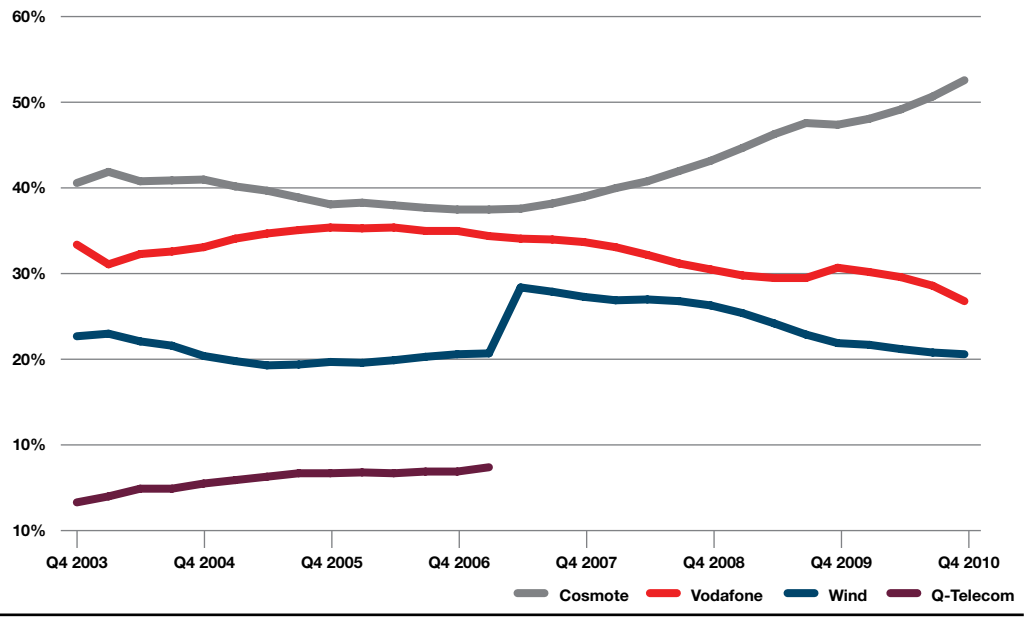
Source: Analysys Mason.

Figure 67: Development of mobile subscriber market shares in Germany.



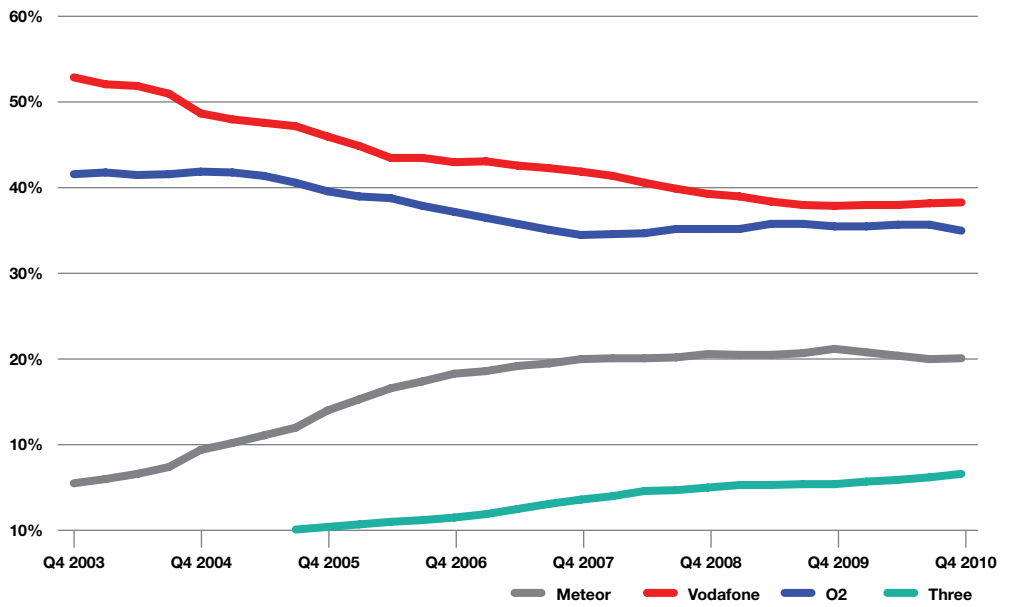
Source: Analysys Mason.

Figure 68: Development of mobile subscriber market shares in Greece.



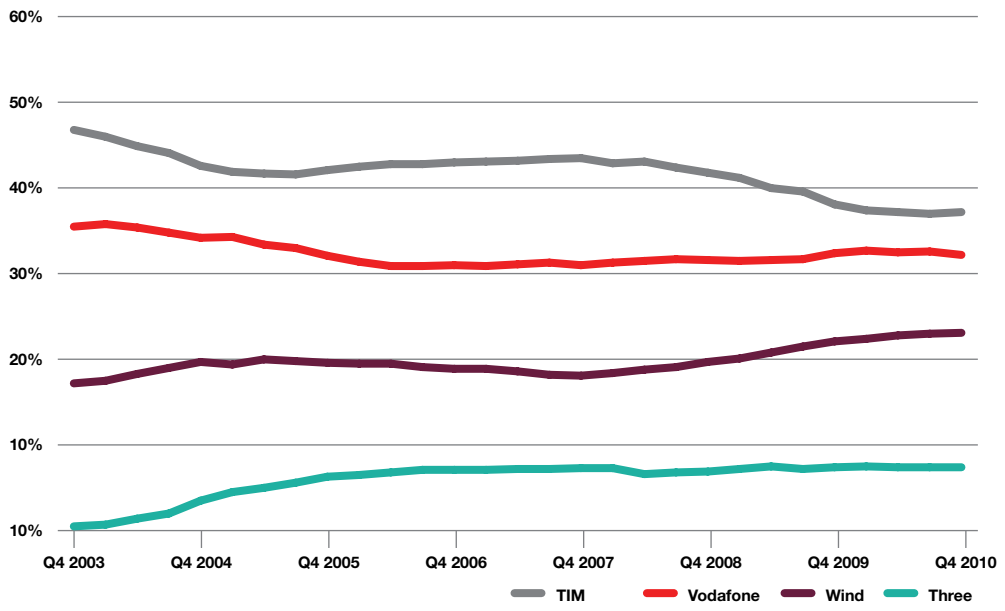
Source: Analysys Mason.

Figure 69: Development of mobile subscriber market shares in Ireland.



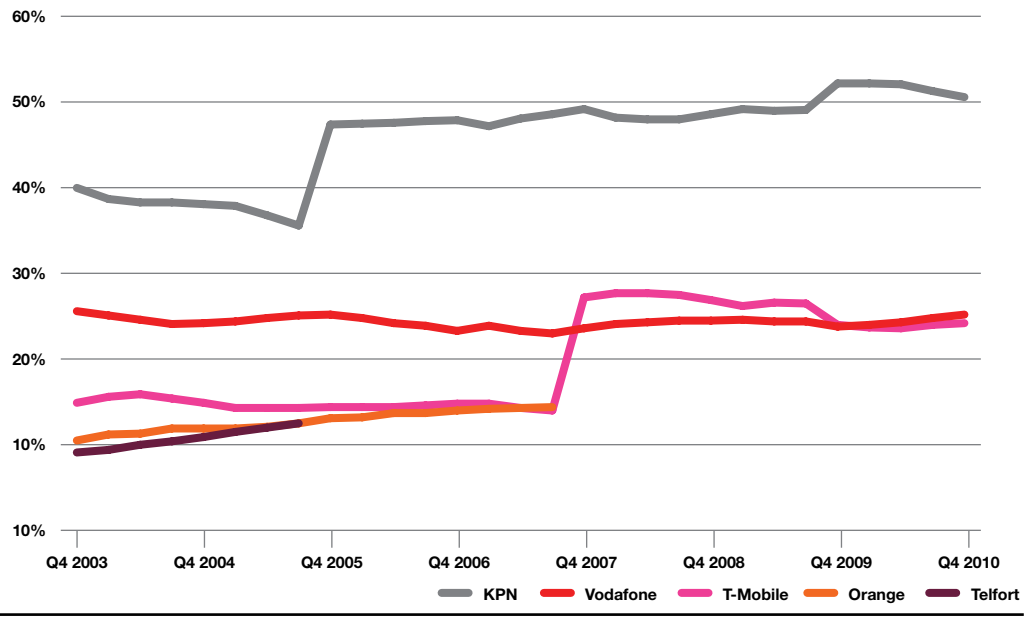
Source: Analysys Mason.

Figure 70: Development of mobile subscriber market shares in Italy.



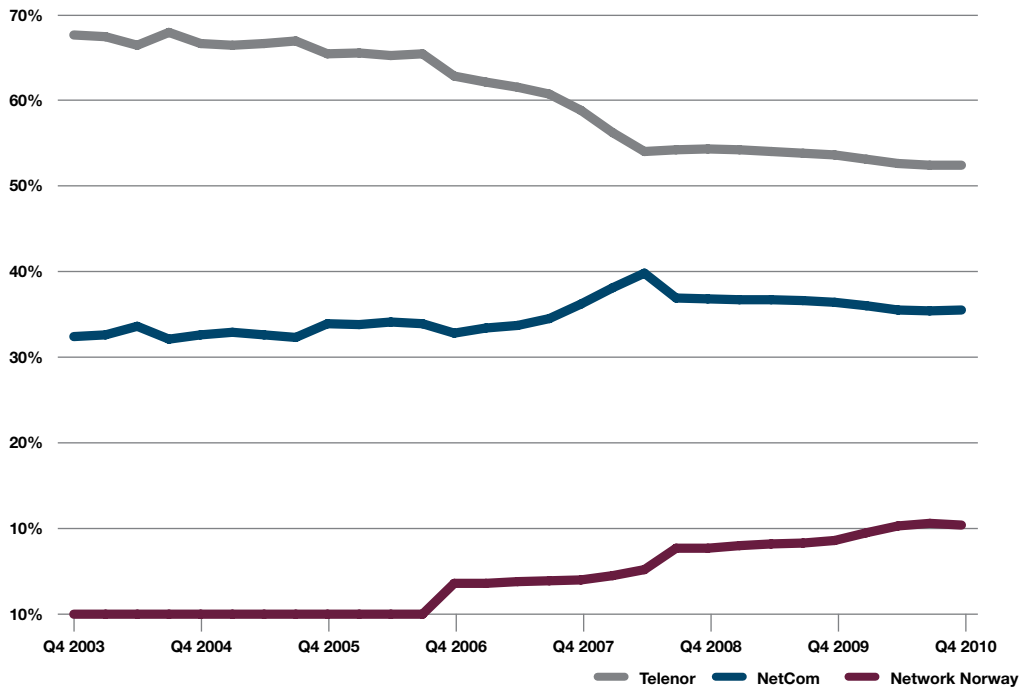
Source: Analysys Mason.

Figure 71: Development of mobile subscriber market shares in The Netherlands.



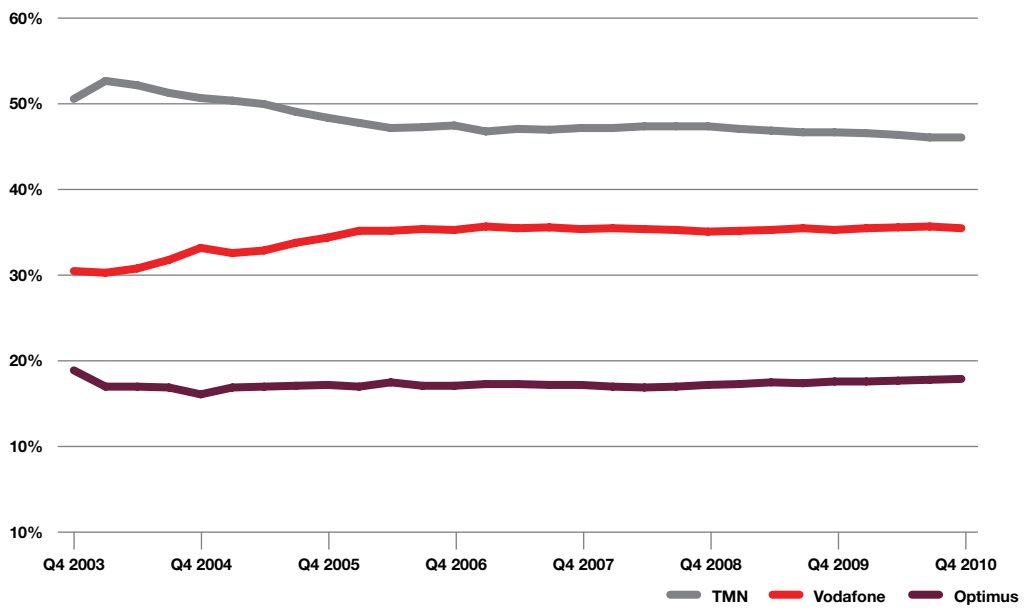
Source: Analysys Mason.

Figure 72: Development of mobile subscriber market shares in Norway.



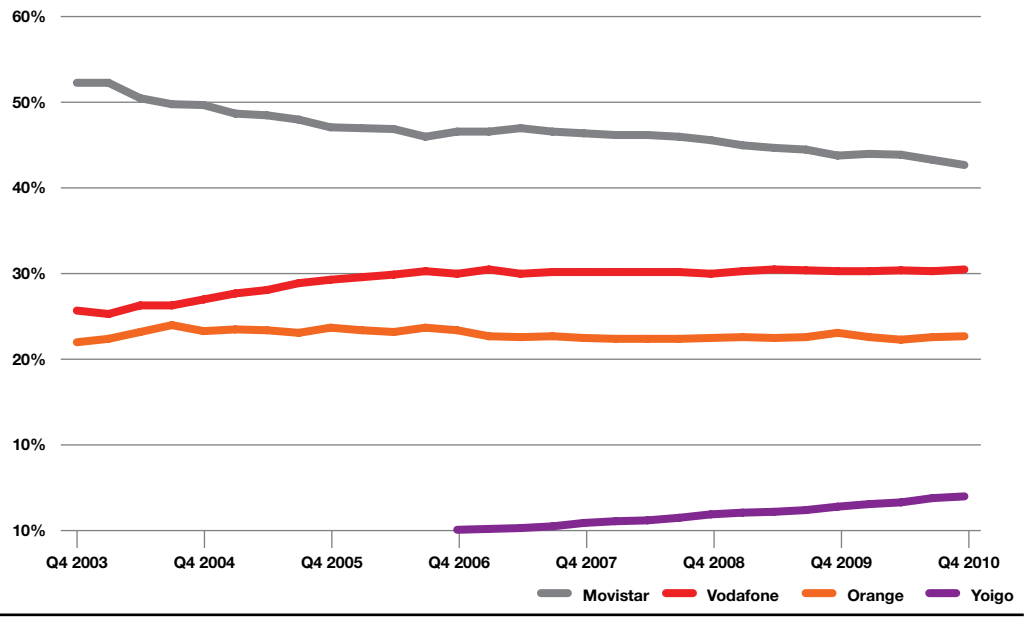
Source: Analysys Mason.

Figure 73: Development of mobile subscriber market shares in Portugal.



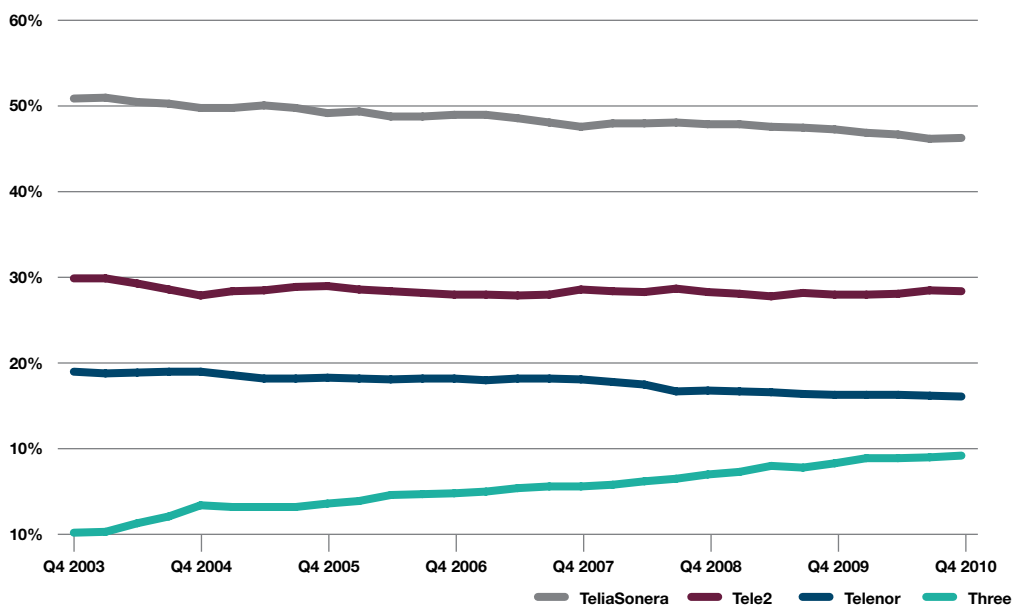
Source: Analysys Mason.

Figure 74: Development of mobile subscriber market shares in Spain.



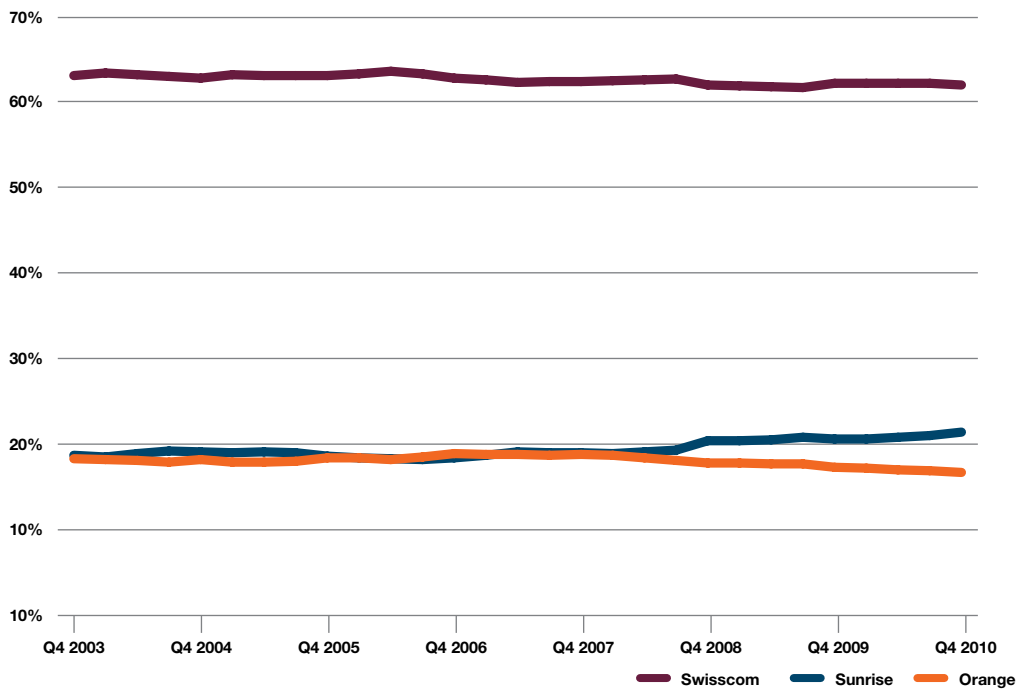
Source: Analysys Mason.

Figure 75: Development of mobile subscriber market shares in Sweden.



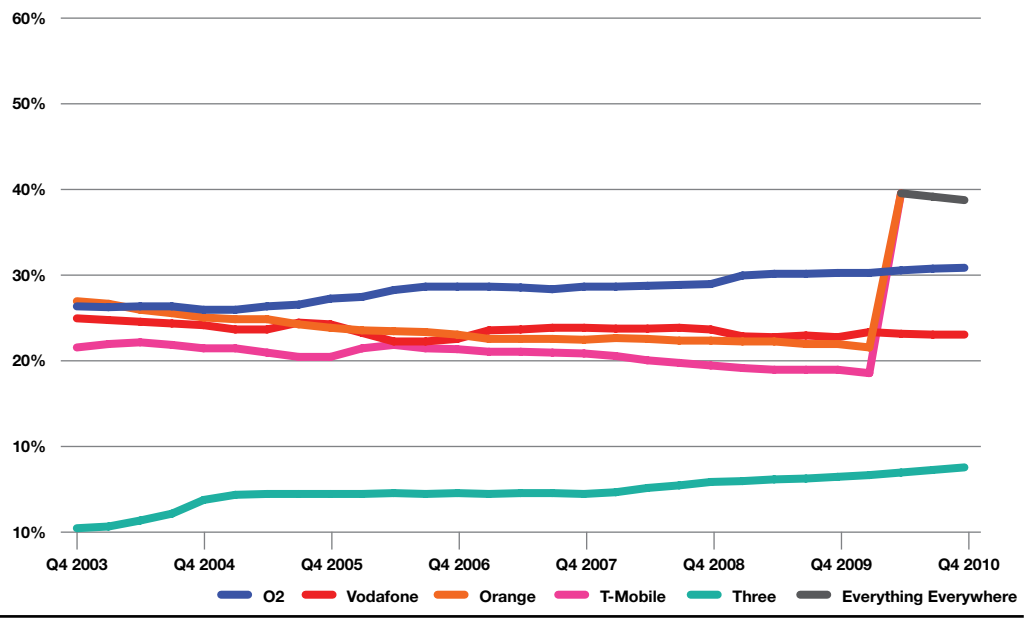
Source: Analysys Mason.

Figure 76: Development of mobile subscriber market shares in Switzerland.



Source: Analysys Mason.

Figure 77: Development of mobile subscriber market shares in the United Kingdom.



Source: Analysys Mason.

Annex 8: Accommodating bidder choice within the spectrum floor.

Produced by Power Auctions LLC.

Executive Summary.

675 Ofcom has proposed a novel "spectrum floor" in its Consultation[141] to help assure that four operators will obtain sufficient spectrum to be credible competitors in the national wholesale market. To be eligible for the spectrum floor, an operator is required to bid at the reserve price for every package associated with up to five minimum spectrum portfolios. Under this proposal, entrants have little control over their own destinies in the auction. The winners of the spectrum cap are likely to win the combinations of spectrum that are the least desirable to incumbents, and they face a severe version of the winner's curse. They also have much diminished abilities to express preferences for one minimum portfolio versus another (especially if the high dual reserve pricing proposed in the Consultation is adopted).

676 We explain in detail our understanding of how the Consultation intends the bidding for a minimum spectrum portfolio to operate, and we provide examples.

677 We then propose modifying the spectrum floor to accommodate as much bidder choice as is consistent with satisfying all of Ofcom's objectives for the spectrum floor. This provides operators with greater control over their own destinies and reduces the winner's curse, increasing the likelihood that the goal of four national wholesale competitors will be met.

678 Finally, we discuss the leverage problem that Ofcom is seeking to address by requiring an operator to bid at the reserve price for every package associated with up to five minimum spectrum portfolios. We demonstrate that the leverage problem is equally resolved by our "bidder choice" proposal.

Our Understanding of the Consultation's Proposal.

679 The Consultation proposes that spectrum be reserved in order for there to be two additional national wholesale competitors. The mechanism to achieve this is a "spectrum floor" where one of five alternative spectrum portfolios is reserved for each entrant. We applaud Ofcom's innovative policy to attain a competitive national wholesale market without imposing unduly restrictive safeguard spectrum caps. However, as we will show,

141 Ofcom, "Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues", http://stakeholders.ofcom.org.uk/binaries/ consultations/combined-award/summary/combined-award.pdf

the policy as currently proposed leaves entrant operators with too little control over their own destinies.

680 We make the following simplifying assumptions for the purpose of the analysis:

- we assume that the option to address competition concerns in Table 5.1 of the Consultation will be Option 1; and
- we assume that the inconsistency between Table 5.1 and Table 8.2[142] will be resolved by both 1800 MHz and 2.6 GHz spectrum having a lot size of 2x5 MHz.

681 Our interpretation of how the spectrum floor works under Option 1 is that bidders must place a bid for the minimum amount of spectrum to complete each of the minimum spectrum portfolios. The algorithm then selects the revenue maximising winner set subject to 4 bidders achieving at least a minimum spectrum portfolio.

682 Our interpretation of how the minimum bid is operationalized according to the Consultation is the following order:

Step 1. Each operator's prior spectrum holdings are credited toward each of the five spectrum portfolios to obtain five incremental portfolios;

Step 2. The minimum incremental portfolios are found by deleting any incremental portfolios that are strict supersets of any of the other incremental portfolios; and

Step 3. A menu comprising each distinct minimum incremental portfolio is presented to each bidder. The bidder opts in to the spectrum floor by submitting all package bids (at the reserve price) associated with all minimum incremental portfolios in the 'opt in' round.

683 The following four examples illustrate our understanding of how the spectrum floor works as currently proposed in the Consultation under Option 1 for operators with different prior holdings. In all examples, we assume that the operator has no prior holdings of 2.6 GHz spectrum, as this band has not yet been allocated.

142 In the Consultation Table 8.2 on p. 106, the lot sizes indicated for 1800 MHz and 2.6 GHz spectrum are 2x15 MHz and 2x10 MHz respectively. In Table 5.1 on p. 55, for a bidder with no prior holdings, portfolio c) would thus require the purchase of 2/3 lots of 1800 MHz and portfolio d) would thus require the purchase of 1.5 lots. Since lots are indivisible within the auction, we would characterize this as an inconsistency between the Spectrum Packaging Proposal of Section 8 and the Competition Proposal of Section 5.

Example A. An operator that possesses no 900 MHz or 1800 MHz spectrum.

684 Since the operator has no prior spectrum holdings relevant to the floor, step 1 is skipped.

685 In step 2, none of the five portfolios are found to be strict supersets of any other.

686 In step 3, the menu presented to such a bidder in the 'opt-in' round will contain five alternatives for a minimum spectrum floor portfolio. The menu of minimum incremental portfolios for Example A is summarised in the following table:

Table 27: Menu for operator in example A.

Portfolio	Sub-1 GHz	1800 MHz	2.6 GHz
a)	2x5 MHz	2x15 MHz	
b)	2x5 MHz		2x20 MHz
c)	2x10 MHz	2x10 MHz	
d)	2x10 MHz		2x15 MHz
e)	2x15 MHz		

687 Under the Consultation's proposal, to be eligible for the spectrum floor, the operator must place all bids associated with the reserve prices for all five portfolios. (This is elaborated in the next section.) As currently proposed, these package bids are quite substantial, including £600 million for alternative e). The operator has little remaining in its war chest to express a preference amongst the five alternatives. Even if it does have the money to bid for one or more alternatives in preference, the clock rounds give little in the way of feedback to this bidder about which portfolios remain feasible or likely, so there is little information available on which to base the trade-off. Moreover, the operator is likely to be directly or indirectly bidding up its own price. In short, this operator has very little control over its own destiny in the auction.

Example B. An operator that possesses no 900 MHz spectrum and exactly 2x10 MHz of 1800 MHz spectrum.

688 In step 1, 2x10 MHz of 1800 MHz spectrum is credited toward portfolios a) and c). Incremental portfolio a) becomes 2x5 MHz of sub-1 GHz spectrum and 2x5 MHz of 1800 MHz spectrum and incremental portfolio c) becomes 2x10 MHz of sub-1 GHz spectrum only

689 In step 2, portfolio d) is strictly a superset of incremental portfolio c) with 2x15 MHz of additional 2.6 GHz spectrum. Portfolio e) is also strictly a superset of incremental portfolio c), with an additional 2x5 MHz of Sub-1 GHz spectrum. Portfolios d) and e) are therefore deleted.

690 In step 3, the menu of minimum incremental portfolios for Example B is summarised in the following table:

Table 28: Menu for operator in example B.

Portfolio	Sub-1 GHz	1800 MHz	2.6 GHz
a)	2x5 MHz	2x5 MHz	
b)	2x5 MHz		2x20 MHz
c)	2x10 MHz		
~~d)~~	~~2x10 MHz~~		~~2x15 MHz~~
~~e)~~	~~2x15 MHz~~		

691 This operator must place bids for three portfolios—the operator has very little control over its own destiny in the auction.

Example C. An operator that possesses no 900 MHz spectrum and at least 2x15 MHz of 1800 MHz spectrum.

692 In step 1, there is sufficient 1800 MHz spectrum to credit toward both portfolios a) and c) to attain their full requirements for 1800 MHz spectrum. Hence, incremental portfolio a) becomes 2x5 MHz of 800 MHz spectrum only and incremental portfolio c) becomes 2x10 MHz of 800 MHz spectrum only.

693 In step 2, portfolio b) is strictly a superset of incremental portfolio a) with 2x20 MHz of additional 2.6 GHz spectrum; incremental portfolio c) is strictly a superset of a) with 2x5 MHz of additional 800 MHz spectrum; portfolio d) is strictly a superset of incremental portfolio a) with 2x5 MHz of additional 800 MHz spectrum and 2x15 MHz of additional 2.6 GHz spectrum; and portfolio e) is strictly a superset of incremental portfolio a) with 2x10 MHz of additional 800 MHz spectrum. Thus, portfolios b)-e) are deleted.

694 In step 3, the menu presented becomes a) 2x5 MHz of 800 MHz spectrum.

695 The menu of minimum incremental portfolios for Example C is summarised in the following table:

Table 29: Menu for operator in example C.

Portfolio	Sub-1 GHz	1800 MHz	2.6 GHz
a)	2x5 MHz		
~~b)~~	~~2x5 MHz~~		~~2x20 MHz~~
~~c)~~	~~2x10 MHz~~		
~~d)~~	~~2x10 MHz~~		~~2x15 MHz~~
~~e)~~	~~2x15 MHz~~		

Example D. An operator that possesses at least 2x15MHz of 900MHz spectrum.

696 In step 1, there is sufficient sub-1 GHz spectrum to credit towards all of portfolios a) – e) to attain their full requirements for sub-1 GHz spectrum. In particular, incremental portfolio e) now becomes the empty set.

697 In other words, this operator already holds alternative e) without any further spectrum acquisition. Therefore, this operator is not eligible to obtain any additional spectrum as part of a minimum spectrum portfolio. In step 2, all five portfolios would be deleted.

698 Consequently, this operator is presented with the "empty" menu, and counts toward the objective of four national wholesale market competitors, regardless of whether this operator enters the auction and regardless of what this operator wins in the auction.

Impact of the Five Alternative Minimum Spectrum Portfolios.

699 Entrants, particularly those with no sub-1 GHz or 1800 MHz spectrum, are disadvantaged in the following ways:

1. Entrants risk being allocated the least suitable of the up to five minimum portfolios;
2. Entrants face a serious adverse selection problem during both winner selection and frequency assignment, possibly paying above market prices for spectrum;
3. Entrants have much diminished ability to express preferences for one minimum portfolio versus another (especially if the high dual reserve pricing proposed in the Consultation is adopted); and
4. Entrants who are uninterested in portfolio e) are nevertheless required to make excessive bidder deposits reflecting the price of portfolio e).

700 The effect of the five alternative minimum spectrum portfolios interacts with, and is magnified by, the dual reserve pricing proposed in the Consultation. Entrants will pay the reserve prices for the minimum spectrum portfolio that turns out to be the most overpriced relative to the ex post realizations of price. Entrants have little ability to express preferences amongst the different minimum spectrum portfolios and face a particular version of the winner's curse: they will receive the portfolios that are of least interest to incumbents.

701 For example, if the prices that the incumbents offer to pay are less than £200 million per 2x5 MHz block of sub-1 GHz spectrum, then the operator in Example A can be forced to pay above market price for a substantial spectrum investment. If, on the other hand, incumbents value the sub-1 GHz highly, there is little corresponding upside for the operator in Example A, as the operator is then likely to receive only one 2x5 MHz block of sub-1 GHz spectrum.

702 There is little scope for the operator to express a preference amongst the five alternatives, as the high reserve prices are likely already to exhaust the entrant's budget. Moreover, by expressing any incremental preferences, the operator is likely directly or indirectly bidding up its own payment further. In short, this operator has very little control over its own destiny in the auction.

703 The winner's curse and lack of control translate into a significant likelihood that no fourth competitor will opt into the spectrum floor. Either there may be no fourth competitor in the national wholesale market, or the fourth competitor may acquire less spectrum than Ofcom considers will make this competitor viable. The predictable effect of requiring the five alternative minimum spectrum portfolios is to harm competition in the national wholesale market and reduce consumer surplus.

Our Understanding (Continued): Package Bids.

704 Once the menu of minimum spectrum portfolios is presented to a bidder, the bidder must decide whether it wishes to opt into the spectrum floor. In order to be eligible for the spectrum floor, the bidder is required to place all package bids (at the reserve price) associated with all minimum incremental portfolios in the menu in the 'opt-in' round. Typically, there are several different packages associated with a minimum incremental spectrum portfolio. For example, there are three different ways to bid for 2x5 MHz of spectrum within the middle and upper 800 MHz bands that are reserved for the spectrum floor (by bidding for A2, A3 or A4). There are also two different ways to bid for 2x20 MHz of 2.6 GHz spectrum (by bidding entirely for C1; or by bidding in part for C1 and in part for C2). See also Table 8.2 of the Consultation document. Thus, there are six different package bids at the reserve prices that yield minimum spectrum portfolio b):

Table 30: All Reserve-Price Package Bids for Minimum Spectrum Portfolio b).

A2	A3	A4	C1	C2	Price
2x5 MHz			2x20 MHz		£280 million
	2x5 MHz		2x20 MHz		£280 million
		2x5 MHz	2x20 MHz		£280 million
2x5 MHz			2x10 MHz	2x10 MHz	£280 million
	2x5 MHz		2x10 MHz	2x10 MHz	£280 million
		2x5 MHz	2x10 MHz	2x10 MHz	£280 million

705 Meanwhile, there are three different ways to bid for 2x10 MHz of spectrum within the middle and upper 800 MHz bands that are reserved for the spectrum floor (utilising lots in A2, A3 or A4). Thus, there are three different package bids at the reserve prices that yield minimum spectrum portfolio e):

Table 31: All Reserve-Price Package Bids for Minimum Spectrum Portfolio e).

A2	A3	A4	C1	C2	Price
2x5 MHz	2x5 MHz	2x5 MHz			£600 million
2x5 MHz		2x10 MHz			£600 million
	2x5 MHz	2x10 MHz			£600 million

706 Lists can similarly be constructed for the other minimum incremental spectrum portfolios

An Alternative Proposal: Portfolio Choice.

707 We propose modifying the spectrum floor to allow operators as much choice as is consistent with satisfying all of Ofcom's objectives.

708 The Consultation apparently has two purposes in requiring entrants to bid the reserve prices on a mandatory set of packages:

1. It wishes to avoid permitting entrants the opportunity to "leverage" the minimum spectrum portfolio to acquire a larger package at preferential prices. For example, a given operator would otherwise be able to bid on a package of 2x20 MHz of 800 MHz without bidding on any subsets—the clearing algorithm would still need to select the given entrant (assuming that at most two operators opted into the spectrum floor). This is avoided by requiring operators to bid on minimum incremental portfolios, so the given operator cannot force winning a larger package (unless it bids higher values for the increment than its competitors in the auction).

2. It wishes to mandate bidding that assures that four competitors (i.e. two firms that do not currently hold the minimum spectrum portfolio) can be satisfied with the available spectrum. In short, it wishes to assure that such bids are "generalisable".

709 Our alternative proposal proceeds as follows:

Step 1. Each operator's prior spectrum holdings are credited toward each of the five spectrum portfolios to obtain five incremental portfolios [the same as before];

Step 2. The minimum incremental portfolios are found by deleting any incremental portfolios that are strict supersets of any of the other incremental portfolios [the same as before]; and

Step 3. A menu comprising each distinct minimum incremental portfolio is presented to each bidder. *If a bidder's menu comprises more than one minimum incremental portfolio, then the bidder opts in to the spectrum floor by selecting at least one minimum incremental portfolio from the menu and by submitting all package bids (at the reserve price) associated with the selected portfolio in the 'opt in' round. The bidder is also free to place other package bids for other minimum incremental portfolios (but is not required to). If the bidder's menu comprises a single incremental portfolio, then the bidder opts in to the spectrum floor by submitting all package bids (at the reserve price) associated with the single portfolio.*

710 One other constraint is placed on the opt-in bidders' choices. The menu of choices is required to be 'generalisable' in the sense that there is sufficient spectrum so that two opt in bidders (if present) who are limited to their respective menus can both win.[143] As a practical matter, if there are two opt-in bidders with no relevant prior holdings (i.e. two opt in bidders of the type described in Example A), this constraint limits them to a choice of portfolio b) or d).[144] (Also note that any menu that contains more than one minimum incremental portfolio is guaranteed to contain portfolio b).) However, if there is only one opt-in bidder, then it is free to select any of the five MSPs.

711 This alternative proposed rule gives the operators in Example A or B substantial control over their destinies while still satisfying Ofcom's objectives:

- The entrant cannot leverage this floor bid into obtaining greater spectrum at discount prices (this is discussed in detail in the next section); and
- There is sufficient spectrum so that there is always a feasible outcome to the winner selection algorithm for two additional national wholesale market competitors.

The Leverage Problem.

712 We begin by describing the leverage problem. Under the competitive measure proposed for the auction, if two or more bidders opt in to compete for the spectrum floor, then Ofcom will only consider solutions to the winner determination problem in which at least two opt in bidders receive spectrum awards that include a minimum spectrum portfolio (MSP). In implementing such a procedure, Ofcom must guard against an entrant 'leveraging' the spectrum floor to force winning a much larger package. For example, suppose that the MSP comprised 2x10MHz of 800MHz spectrum and 2x15MHz of 2.6GHz spectrum and suppose that a given entrant submitted bids only for 2x15MHz of 800MHz spectrum and 2x40MHz of 2.6GHz spectrum. Then Ofcom might only be able to satisfy the constraint of allocating two entrants the MSP by awarding

143 In order for our spectrum choice approach to be consistent with ensuring at least four national wholesale operators with minimum spectrum portfolios, the menu must be 'generalisable' in the sense that there is sufficient spectrum so that two opt-in bidders (if present) can both win.

144 Portfolio b) comprises 2x5 MHz of sub-1 GHz spectrum and 2x20 MHz of 2.6 GHz spectrum. Portfolio d) comprises 2x10 MHz of sub-1 GHz spectrum and 2x15 MHz of 2.6 GHz spectrum. Since there is 2x20 MHz of sub-1 GHz spectrum that is available for fulfilling minimum portfolios and there is 2x60 MHz of 2.6 GHz spectrum that is available for fulfilling minimum spectrum portfolios, there is guaranteed to be sufficient spectrum for each of two operators with no relevant prior holdings to win their selected minimum spectrum portfolio if they both select from portfolio b) or d). Conversely, this would not be guaranteed to be feasible if, say, they both were permitted to select from a set that included portfolio e).

the given entrant its package of 2x15MHz of 800MHz spectrum and 2x40MHz of 2.6GHz spectrum (double the spectrum of the MSP). We refer to this as the leverage problem.

713 Ofcom's rationale for requiring a spectrum-floor bidder with no initial holdings to submit bids for each and every one of the minimum spectrum portfolios is to avoid the leverage problem. The Consultation states: "Requiring reserve price bids from those who wish to compete to benefit from the spectrum reservation addresses the risk that bidders may leverage the competition constraint to win additional spectrum cheaply."[145] Indeed, with this requirement, a spectrum-floor bidder may win an MSP at a discounted price, but it will pay full market price for any incremental spectrum above and beyond the MSP.

714 Alternatively, consider instead our 'bidder choice' proposal described above. Under Three's proposal, a bidder opting in to the spectrum floor is still required to submit package bids for a minimum spectrum portfolio (MSP) at the reserve price. However, the bidder is permitted to select its most preferred choice from among the MSPs, and it is then only required to submit bids at the reserve prices for packages corresponding to its chosen MSP—not for all of the MSPs. This imposes a less onerous requirement on entrants.

715 Continuing the above example, suppose that a given bidder's most preferred MSP comprises 2x10MHz of 800MHz spectrum and 2x15MHz of 2.6GHz spectrum. Then this bidder is required to submit reserve price bids for all packages associated with 2x10MHz of 800MHz spectrum and 2x15MHz of 2.6GHz spectrum. The only way that this bidder can win 2x15MHz of 800MHz spectrum and 2x40MHz of 2.6GHz spectrum is to outbid the other bidders (including the incumbents) for the incremental spectrum above and beyond the MSP—i.e. to outbid the other bidders for the incremental 2x5MHz of 800MHz spectrum and 2x25MHz of 2.6GHz spectrum.

716 Thus, bidder choice, as we have proposed it, equally avoids the leverage problem. With bidder choice, a spectrum-floor bidder may win its selected MSP at a discounted price, but it must pay full market price for any incremental spectrum above and beyond this MSP. It can only win incremental spectrum by outbidding the other bidders in the auction, including the incumbents. There is no way for the bidder to 'leverage' the spectrum floor by obtaining any discount on incremental spectrum above and beyond an MSP.

145 consultation para. 9.72.

Conclusion.

717 Requiring minimum bids for as many as five alternative minimum spectrum portfolios leaves entrants with little control over their own destinies. Coupled with dual reserve prices, the rule also subjects them to a winner's curse that makes it less likely for them to be a successful national wholesale market competitor. Allowing operators as much choice as possible amongst the spectrum floor portfolios enhances competition in the national wholesale market by creating a stronger third and fourth competitor.

Annex 9: Analysis of dual reserve pricing.

Produced by Power Auctions LLC.

Executive Summary.

718 Ofcom has proposed reserve prices that are 400% as high for 2.6 GHz spectrum and 667% as high for 800 MHz spectrum for entrants[146] as compared to incumbents[147]. We refer to the proposed application of a higher reserve price for the spectrum floor as compared to general bidding as a "dual reserve". The Consultation document argues that the dual reserve prices are proposed to assure "efficiency", to deter gaming and to assure that winners are serious about deployment.

719 Efficiency must be defined narrowly to include only static valuations in the auction for efficiency to be maximised via this policy. This narrow definition taken to its logical extreme would also support auctioning a single monopoly. The correct definition of efficiency is the maximisation of consumer surplus or social surplus in the mobile services market. Dual reserve pricing harms efficiency when measured correctly.

720 Ofcom refers to two analyses that suggest high reserve prices deter gaming. These analyses are largely inapplicable; to the extent that the proposed combinatorial clock auction induces Vickrey pricing, it already minimises most opportunities for gaming. The principal relevant form of gaming to consider is the strategy known as "demand reduction"; incumbents, rather than entrants, are the primary parties with an incentive for demand reduction. (Furthermore, for an opt-in bidder, demand reduction below the spectrum floor is impossible — it is a minimum spectrum portfolio.) Thus, if it is believed that a high reserve price is needed to deter gaming, then a higher reserve price should be applied to incumbents in general bidding than to entrants.

721 Dual reserve prices are also proposed to mitigate the prospect of a weak competitor winning spectrum and not deploying a viable national wholesale network. Far from mitigating this risk, dual reserve prices exacerbate the risk of build-out not occurring, by draining resources from the entrant. Furthermore, dual reserve prices risk an outcome where no entry whatsoever occurs or where sub-viable entry occurs (from entrants declining to elect the spectrum floor due to the high reserve price). Non deployment is equally or more of an issue for incumbents that already have a minimum viable spectrum portfolio in place and who benefit from market power in the national wholesale market. If it is believed that a

146 For the purposes of this document, an "entrant" refers to a firm that qualifies for the spectrum floor inasmuch as it does not already hold a minimum spectrum portfolio for a national wholesale competitor as defined by Ofcom.

147 For the purposes of this document, an "incumbent" refers to a firm that already holds a minimum spectrum portfolio for a national wholesale competitor as defined by Ofcom.

high reserve price is needed to promote deployment, the same or higher reserve price should be applied to incumbents than to entrants.

722 If new entrants opt in for the spectrum floor at dual reserve prices set to a level based on "the likely value of the spectrum," this would result in new entrants paying higher prices than incumbents in those states of the world where the ex post auction price is less than the ex ante estimate. Dual reserve pricing is thus an artificial (and discriminatory) additional entry barrier that is in contradiction to Ofcom's primary duty—ensuring competition and maximising consumer surplus or social surplus in the mobile services market.

723 The effect of dual reserve pricing interacts with, and is magnified by, the five alternative minimum spectrum portfolios that are included within the spectrum floor. Entrants will pay the reserve prices for the minimum spectrum portfolio that turns out to be the most overpriced relative to the ex post realizations of price. Entrants have little ability to express preferences amongst the different minimum spectrum portfolios and face the winner's curse of receiving the portfolios of least interest to incumbents.

724 Consequently, we propose that the dual reserve price be discarded in favour of uniform reserve prices that are applicable equally to incumbents and entrants.

Dual Reserve Pricing.

725 Ofcom has proposed reserve prices that are 400% as high for 2.6 GHz spectrum and 667% as high for 800 MHz spectrum for entrants[148] as compared to incumbents[149]. We refer to the proposed application of a higher reserve price for the spectrum floor as compared to general bidding as a "dual reserve". The Consultation document argues that the dual reserve prices are proposed to assure "efficiency", to deter gaming and to assure that winners are serious about deployment. These justifications do not support the policy. The undesirable outcomes permitted by the policy appear to be unintended consequences.

148 See footnote 1.
149 See footnote 2.

Efficiency.

726 Auction design is sometimes taken to be a static allocation problem that takes the market structure as given. A design is selected to achieve high "efficiency", defined as the sum of the valuations of the winners, and high auction revenues. While the Consultation document recognises that one must look more broadly to the market structure (and resulting consumer surplus) in introducing the spectrum floor, it appears to be using the narrower notion of efficiency in its discussion of dual reserve prices. This notion, if taken to its logical conclusion, would lead to the reductio ad absurdum that revenue and the sum of bidders' valuations would be maximised if a single monopoly licence were granted.

727 Clearly what should be maximised is not a narrow measure of static efficiency, but a broad measure of consumer surplus or social surplus in the mobile services market. This requires optimising a broader allocation problem that rewards allocations resulting in vigorous competition in the mobile services market. Dual reserve pricing does not maximise competition in the mobile services market.

728 This broader definition of efficiency is embraced by the Consultation's objectives section.[150] In para.9.6, Ofcom considers its "principal duty" is "to further the interests of citizens and consumers, where appropriate by promoting competition … ." The principal duty enunciated there is appropriate. New entrant competition in 3G has brought large benefits to the UK consumer. The higher costs associated with deploying 4 networks instead of 3 are far outweighed by these benefits as detailed in section 3 of the response document.

729 Different stakeholders bear the costs and benefits when there is a change in the number of viable wholesale market competitors. Network cost increases attributable to a 4th competitor are, for the most part, born by investors in the entrant. Cost savings from deploying 3 networks instead of 4 would accrue principally to the operators, as there would be insufficient competition for the savings to be passed along to consumers. Prices would be substantially higher for mobile broadband and for mobile voice without the competition provided by an entrant 3G carrier. There should be a presumption that competition will continue to be vigorous

150 Ofcom, "Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues" (http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/summary/combined-award.pdf).

if the auction results in a 4th entrant achieving the minimum spectrum portfolio needed to be a national wholesale competitor.

730 In para.5.80 of the Consultation, a higher dual reserve price is proposed for new entrants. The dual reserve price is proposed to mitigate "inefficient use of spectrum" as follows:

> We recognise that if more companies win spectrum as a result of measures we take in the combined award there is a risk of some inefficiency. There are a number of aspects to this. First, there is a risk that the reason some companies would not otherwise have acquired spectrum is because they would not use it as efficiently as those who would have bought it. To some extent, it may be possible to mitigate this risk through higher reserve prices.

731 Given the correct notion of efficiency recognises the benefits of vigorous competition in the wholesale market, it is substantially less efficient to have only three competitors in this market than to have four. The justification provided in 5.80 is therefore antithetical to this principal objective of the auction.

Gaming, Demand Reduction and Weak Competition.

732 A further justification for dual reserve prices in the Consultation is found in para.8.108:

> It may be helpful for the purpose of achieving efficient use of the spectrum to use reserve prices, in addition to the auction rules, as a way to manage the risk of strategic behaviour that might occur during or prior to the auction aimed at reducing competition for spectrum (such as bidders reducing their demand to decrease significantly the price they pay). By having material reserve prices, this would likely reduce the maximum potential pay-off that any bidder could receive from bidding strategically. This would be likely to reduce the incentives on any bidder to seek to execute such a strategy.

733 This analysis is incorrect in several ways. First, the combinatorial clock auction proposed for the upcoming auction already minimises opportunities for gaming. In particular, in the paper by Peter Cramton cited as evidence for this paragraph[151], it may appear that there is evidence to support a high reserve price: "High reserve prices reduce

151 Cramton, Peter, "Simultaneous Ascending Auctions," 8 August 2004, p.13 (http://www.cramton.umd.edu/papers2000-2004/cramton-simultaneous-ascending-auction.pdf).

the incentive for demand reduction in a multiple-item auction, since as the reserve price increases the benefit from reducing demands falls. Moreover, higher reserve prices reduce the number of rounds that the bidders have to coordinate a split of the licenses and still face low prices." But the apparent evidence is contradicted a few lines below, "The inefficiencies of demand reduction can be eliminated with a Vickrey auction or more practically with an ascending proxy auction or a clock-proxy auction … ." Thus there is little of a gaming problem to address given Ofcom's selection of the combinatorial clock auction, which is the modern name for the clock-proxy auction.

734 Second, to the extent that gaming remains a problem in the current proposed auction, the principal relevant form is demand reduction. Strategic demand reduction is the incentive for a large bidder to reduce its bids on marginal units, in order to reduce the price that it would pay on inframarginal units.[152] As such, it applies much more to the incumbents than to the entrants. (Furthermore, for an opt-in bidder, demand reduction below the spectrum floor is impossible — it is a minimum spectrum portfolio.) Thus, if it is believed that a high reserve price is needed to deter gaming, then a higher reserve price should be applied to incumbents in general bidding than to entrants—the opposite direction as in which the proposed dual reserve pricing currently goes.

735 In the paper by Paul Klemperer cited in support of 8.108, "What Really Matters in Auction Design"[153], the 2000 Swiss 3G auction is used as an example of demand reduction facilitated by low reserve prices. The situation in the 2000 Swiss 3G auction is completely dissimilar to the proposed auction design in the Consultation. In the Swiss 3G auction, the potential bidders were permitted to merge until the number of bidders was no greater than the number of licences. Under the proposed UK rules, if two potential bidders were permitted to merge, they would be treated as only a single national wholesale competitor and they would be eligible for only a single minimum spectrum portfolio. The comparison with Switzerland is inapt.

736 Contrary to the Consultation document, one would anticipate that an entrant would have the incentive to bid approximately its true value for each package—the opposite of gaming. At the same time, there is naturally a lower value associated with being the fourth viable

152 Ausubel, Lawrence M. and Peter Cramton, "Demand Reduction and Inefficiency in Multi-Unit Auctions" 12 July 2002 (http://www.ausubel.com/auction-papers/demand-reduction-r.pdf).
153 Klemperer, Paul, "What Really Matters in Auction Design", Journal of Economic Perspectives, 2002.

competitor in the market than with being the number one or number two incumbents. The fourth viable competitor is bidding for something different—it is bidding to operate a network that, in equilibrium, will operate primarily for the benefit of consumers. The Consultation's Section 5 on competition suggests that the fourth competitor will not generate a sufficient profit to support a licence price that would equal the unrestricted auction price. Only competition amongst entrants will set the value of providing this public service.

737 The Consultation appears to be confusing a desire for efficiency and lack of gaming with an ambivalent desire for increased revenue (which is explicitly disclaimed as an objective in 8.122). The competitive price for a fourth entrant has nothing to do with coordination or gaming amongst the entrant and the incumbents. The competitive price for the fourth minimum spectrum portfolio is determined by the value placed on entering the market by a different candidate to be the fourth viable competitor. If this value is below the unrestricted auction price, then the competitive price for a fourth minimum spectrum portfolio is also below the unrestricted auction price. The Consultation confuses the "market" value of spectrum, which depends on the competition rules and is maximised by restricted entry as much as possible, with the competitive price for spectrum that is encumbered with the restriction that it must go to a fourth viable national wholesale competitor.

738 The whole point of the spectrum floor is to ensure that there will be four viable competitors in the mobile services wholesale market. By setting a high dual reserve price only for entrants, this goal is actively frustrated. The explicit assumption underlying the spectrum floor is that viable entry will be unlikely to occur if prices and allocations are unrestricted in the auction. If minimum bids are set at "a level that is based on the estimate of likely value of the spectrum" (8.113 b) in an unrestricted auction of these portfolios, no encouragement has been provided to entry. In principle, setting dual reserve prices at the estimated value of the spectrum in an unrestricted auction should deter the fourth entrant from participating. In short, the only situation in which a dual reserve price set at the estimate of unrestricted spectrum value is not discriminatory against entrants is when it completely nullifies the primary purpose of promoting four viable national competitors.

739 In para.8.116, there is a further attempt at justifying dual reserve prices:

> There may also be some efficiency reasons to support higher reserve prices in respect of certain lots. These lots are those that are effectively reserved for bidders that do not currently have a portfolio consistent with the minimum requirements for a national wholesale provider that we have identified in our competition assessment. As we require four winners to meet these essential requirements following the auction, competition for these lots may be weak or non-existent.

740 This paragraph is taking the wrong notion of efficiency and is wrongly implying that weak auction competition is sinister. As Section 3 on competition indicates, weak competition for a fourth national wholesale carrier with a minimum spectrum portfolio is to be expected. This is the purpose of the spectrum floor: to increase the number of bidders interested in becoming the fourth viable national competitor. A minimum spectrum portfolio is "effectively reserved for bidders that do not currently have a portfolio consistent with the minimum requirements for a national wholesale provider" for a very good reason. The reason is to promote competition in the mobile services wholesale market, which is of far greater importance than competition in the auction itself. "Efficiency" is clearly viewed too narrowly in this paragraph. In this paragraph, it means maximising auction revenue and winner valuations (which would imply that a monopoly be auctioned), rather than maximising consumer surplus or social surplus in the mobile services market—the principal duty of Ofcom, as recognised in para.9.6.

741 Note that "weak or non-existent" competition is defined only with respect to a particular minimum bid price. If the minimum bid price were set sufficiently low (possibly including a subsidy), then there would be many candidates to be a fourth national wholesale provider. If Ofcom wants vigorous competition in the auction to assure competitive price discovery for the fourth winner to achieve this portfolio, Ofcom should set the starting price as low as possible. Since there is no opportunity for market division of this indivisible "minimum spectrum portfolio", we should expect no gaming or demand reduction in this situation.

Deployment.

742 In 8.117, the Consultation considers the risk that the winner of the fourth minimum spectrum portfolio will not deploy a network sufficient to be a national wholesale provider:

> Weak or non-existent competition would not be a problem if we could be certain that the winning bidders for these lots would in all cases have the resources, know-how and intention to be effective competitors in the relevant mobile markets. There is however a risk, for example if a number of the parties that might be effective competitors proved to be disinterested in bidding for this spectrum, that one or more of the winning bidders would not have the capability, or perhaps even the intention, to be an effective competitor. If the reserve price were low they might also be significantly less efficient users of the spectrum. There may therefore be a risk of failure fully to achieve the intended purpose of the competition constraint.

743 The quoted paragraph appears to call for a dual reserve price that creates an artificial barrier to entry, in order to assure that entrants are serious about deploying. This suggestion is deeply flawed. By creating an artificial barrier to entry, the dual reserve price if anything makes it less likely that the entrant will have sufficient resources remaining to deploy an effective national network. Furthermore, an artificial barrier to entry makes it more likely that no entry whatsoever will occur.

744 There are much better targeted policy choices than establishing discriminatorily high reserve prices, for assuring that bidders deploy effective national networks for the spectrum they win. For example, monies for build-out can be required to be escrowed by all spectrum winners. We further note the evidence that Three has marshalled that it was the incumbents and not the entrants who deployed 3G slowly, so any such required assurances should apply equally (or greater) to incumbents than to entrants.

745 We encourage Ofcom to make the business case for entry as attractive as possible. This means imposing as few restrictions as possible on entrants. The capital markets will ensure that only the best possible candidate can win the minimum portfolio to deploy an effective national wholesale network. In contrast, if there is an artificial barrier to entry, it becomes more likely that this operator will not be funded by capital markets and it becomes more likely that there will be no effective fourth

national wholesale competitor. Para.8.117 implicitly contains the premise that it is better in some cases if no bidder comes forward to win a fourth minimum spectrum portfolio. Ofcom should instead focus on its stated principal objective—maximising the probability of four viable national competitors.

746 In para.8.121, Ofcom proposes that the minimum bid for new entrants be set at 400% of the incumbent price for 2.6 GHz spectrum, and at 667% of the incumbent price for 800 MHz spectrum. No justification is provided as to why using estimated market prices as reserve prices applicable only to entrants will reduce gaming, increase efficiency or improve the likelihood of deployment.

747 Also observe that, in an auction for a single item, setting the reserve price equal to the expected market value results in no sale occurring a reasonable fraction of the time.

748 Given a significant likelihood of paying more than incumbents for the same spectrum, entrants may decline to participate altogether. Alternatively they may participate in the auction but opt out of competing for the spectrum floor. If entrants opt out of the spectrum floor, they may win portfolios that are smaller than Ofcom regards as sufficient to be an effective national wholesale competitor. This outcome would be precisely the anti-competitive outcome that the spectrum floor is attempting to avoid.

749 Finally, Ofcom should be cognizant that if entrants opt in to compete for the spectrum floor at the proposed dual reserve prices, then a likely outcome is that the entrants will pay more than the incumbents for equivalent spectrum. This would completely turn on its head the notion that entry is being encouraged.

Uniform Reserve Prices.

750 The simplest and most common alternative to a dual reserve price is a single, uniform reserve price. Indeed, it is difficult to name any auction in any country at any time in which a higher reserve price has been applied to entrants rather than to incumbents.

751 One would expect that any analysis of the appropriate level for a single uniform reserve price would lead to a number strictly between the current proposed level for entrants and the current proposed level for

incumbents. For example, for the 2x5 MHz blocks in the 800 MHz band, a single reserve price should presumably be set significantly greater than £30 million, if this would be viewed as an unseemly low price at which to provide spectrum to entrants. (However, it should be emphasized that this ought to be viewed equally as an unseemly low price at which to provide spectrum to incumbents.)

752 By the same token, for the 2x5 MHz blocks in the 800 MHz band, a single uniform reserve price should presumably be set at only a fraction of £200 million. As we understand it, the figure of £200 million was selected based on "the likely value of the spectrum". (See, also, the Consultation document at paras 8.116 to 8.122.) Unfortunately, as the Consultation correctly observes in para.8.112: "However, higher reserve prices create risks. They may deter participation, reduce the scope for entry, distort the outcome of the auction and, in the extreme, lead to unsold spectrum. These effects are likely to be more pronounced as reserve prices get higher and closer to the likely value of the spectrum."

753 The considerations identified in para.8.112 would point to a single uniform reserve price at only a fraction of £200 million per 2x5 MHz block in the 800 MHz band, and at only a fraction of £40 million per 2x10 MHz block in the 2.6 GHz band.

Conclusion.

754 We reiterate that all justifications put forward by the Consultation for a high reserve price for entrants apply equally well to incumbents. Thus, there is no justification for dual reserve prices. The simplest and most common alternative would be uniform reserve prices.

Annex 10: 800MHz and 2.6GHz auction eligibility points.

Produced by Power Auctions LLC.

755 Properly chosen eligibility points in a clock auction facilitate the truthful expression of values among alternative spectrum blocks and help to establish market values. Poorly selected eligibility points can result in unduly long auctions, while bidders "park" eligibility in portfolios containing spectrum blocks with high eligibility points in relation to their expected market values. In some situations, poorly selected eligibility points can distort bidding and the ultimate allocation and pricing of spectrum.

756 Ofcom has proposed in its Consultation[154] eligibility points as follows:

Table 33: Ofcom's proposed eligibility points.

Lot Description	Proposed points per lot
800MHz 2x5MHz	30
2.6GHz 2x10MHz high power	10
2.6GHz 2x10MHz low power	1
2.6GHz unpaired 50MHz	20
Sub-1GHz relinquishment per 2x5MHz	30
Above 1GHz relinquishment per 2x10MHz	10
Possible 1800MHz 2x15MHz relinquishment	**15**

757 The advantages of the proposed eligibility points are as follows:

- the eligibility of 800MHz blocks is an integer multiple of the eligibility of paired 2.6GHz blocks, allowing switching to occur back and forth;
- the eligibility of the unpaired 2.6GHz block is also an integer multiple of the eligibility of paired 2.6GHz blocks, allowing switching to occur back and forth;
- the ratio of eligibility points for 800MHz blocks vs. unpaired 2.6GHz blocks is reasonably near to Ofcom's view of the ratio of their expected market values[155]; and
- the 800MHz blocks are expected to be the largest proportion of the budget for bidders, so a high likelihood of resolving these prices before the 2.6GHz prices should more rapidly reduce common value uncertainty.

154 Ofcom, "Consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues", http://stakeholders.ofcom.org.uk/binaries/ consultations/combined-award/summary/combined-award.pdf

155 Consultation, p. 108, gives an indication of Ofcom's views of expected market values.

758 The principal weakness of the proposed eligibility points is as follows:
- the eligibility of the possible 1800MHz block is not an integer multiple of the eligibility of the 800MHz or 2.6GHz blocks;
- a bidder can only switch into the 1800MHz block by switching out of 800MHz or 2.6GHz blocks and reducing its eligibility by at least 5 points;
- a bidder can only switch out of the 1800MHz block by switching into 800MHz or 2.6GHz blocks and reducing its eligibility by at least 5 points; and
- therefore, the point values do not allowing switching to occur in and out of the possible 1800MHz block.

759 Bidders' inability to switch in and out of the possible 1800MHz block without reducing their eligibility points are a potential barrier to the auction determining the true market price of the possible 1800MHz block.

760 Therefore, Ofcom might consider assigning the following alternative eligibility points (the suggested change is marked in **bold type**):

Table 34: Power Auctions proposed amendments to eligibility points.

Lot Description	Proposed points per lot
800MHz 2x5 MHz	30
2.6GHz 2x10 MHz high power	10
2.6GHz 2x10 MHz low power	1
2.6GHz unpaired 50 MHz	20
Sub-1GHz relinquishment per 2x5MHz	30
Above 1GHz relinquishment per 2x10MHz	10
Possible 1800 MHz 2x15 MHz relinquishment	**20**

761 With this suggested change, bidders would be able to freely move in and out of the possible 1800 MHz block, enabling them to arbitrage value.

762 In addition, with the suggested change, the eligibility points would more closely match Ofcom's assessment of the relationship between 1800MHz spectrum and 2.6GHz spectrum made in the determination of the spectrum floor. In particular, in defining minimum spectrum portfolios a)

and b), Ofcom is implicitly asserting that 2x15MHz of 1800MHz spectrum and 2x20MHz of 2.6 GHz spectrum (in conjunction with 2x5MHz of 800MHz spectrum) are equivalent. If this assertion is true, then their expected market values should be the same and therefore their eligibility points should be the same.

763 With this change, the eligibility points proposed in the Consultation appear to be chosen well. These eligibility points should facilitate the truthful expression of values among the alternative spectrum blocks and help to establish market values. They will help to ensure that the auction mitigates common value uncertainty without taking too many rounds of bidding.