



Second consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues

Annex 6: Revised Competition Assessment

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Section 1

Introduction to competition assessment

Introduction

- 1.1 This Annex sets out our revised competition assessment of mobile markets following the auction of 800MHz and 2.6GHz spectrum. Section 4 of the main consultation summarises this assessment, and also describes the relevant legal framework for the assessment.
- 1.2 Our current assessment has been revised in the light of responses to our March 2011 consultation¹ and our own further analysis. While we have taken account of all responses to the March 2011 consultation, this Annex sets out our revised competition assessment without systematically summarising responses on each topic or responding directly to all points made in responses. Instead, Annex 10 summarises the points made in public responses and either gives our view of those responses or explains where the issues are discussed in this Annex. Section 4 of the main consultation summarises how and why our views have changed since the March 2011 consultation.
- 1.3 As we set out in the March 2011 consultation, this competition assessment is an assessment of the likely future competitiveness of markets for the provision of mobile electronic communications services, after the conclusion of the auction. It is therefore a forward looking assessment, based on our analysis as to the likely future competitiveness of mobile markets in light of the evidence currently available to us and our judgement as the regulator. We recognise that any forward looking assessment is inherently uncertain.
- 1.4 The competition assessment has been conducted in accordance with the Direction. This requires us to assess likely future competition in markets for the provision of mobile electronic communications services after the auction, taking into account the possible effects of the auction. We are also required as part of that assessment to consider the potential for new entry into those markets. In the light of the competition assessment, we are required, where we think fit, to put in place appropriate and proportionate measures which will promote competition in those markets after the conclusion of the auction. This assessment is not a formal market review or assessment of Significant Market Power (SMP) under the Communications Act.
- 1.5 The time frame we have considered for our competition assessment is focussed on the next 5 to 10 years from the conclusion of the auction. It is more difficult to consider a longer period because of the growing uncertainty the longer the time scale considered.

Structure for document and analytical framework

- 1.6 The structure of this Annex reflects the way our analysis is built up:
 - Section 2 briefly describes the mobile industry structure and the terminology we use in this competition assessment for different industry participants. It considers

¹ <http://stakeholders.ofcom.org.uk/consultations/combined-award/>

market definition. It also explains that our policy aim is to promote competition in mobile markets and, in that context, why we consider competition at the national wholesale level to be particularly important. It explains that our main competition concern is that the outcome of the auction could ultimately result in a reduction in the number of credible national wholesalers from the current number of four that could be detrimental to consumers' interests. It also considers a lesser competition concern that even if there were at least four credible national wholesalers, one or more of them could be at a disadvantage in competing across a wide range of services and customers.

- Section 3 considers four distinct dimensions to high quality data services that are affected by spectrum in the auction, and which were raised in responses as being important. These are (1) available capacity and average data rates, (2) ability to deliver good quality coverage, (3) ability to deliver highest peak data rates and (4) ability to deliver LTE services. It considers how different spectrum holdings affect the ability to deliver these and the likely importance of these different dimensions of quality.
- Section 4 considers what outcomes from the auction could give rise to the concerns identified in section 2 relating to national wholesale competition. Drawing on the provisional conclusions in Section 3, this section considers whether each of the current national wholesalers is dependent on acquiring spectrum in the auction to be credible, given their existing spectrum holdings. And if they do need to obtain more spectrum, it considers what spectrum they might need. It also considers what spectrum a new entrant may need to acquire to be a credible national wholesaler. This section identifies a number of outcomes from the auction that could give rise to competition concerns and how likely are the associated technical and market conditions.
- Section 5 then considers how likely are the auction outcomes that give rise to concerns to come about if we were to take no measures in the auction, i.e. the likelihood of national wholesalers failing to acquire the spectrum in the auction that they may need. This section includes considering whether some national wholesalers might potentially be victims of strategic investment in spectrum by other national wholesalers aiming to make the market structure less competitive.
- Section 6 considers a range of possible measures we could take to promote national wholesale competition.
- Section 7 considers the regulatory risks with taking measures and the uncertainties inherent in our assessment.
- Section 8 then assesses the effectiveness and proportionality of particular sets of measures. This section draws on the conclusions of sections 2 to 7.
- Section 9 considers other measures (beyond promoting national wholesale competition), in particular potential measures to promote entry by sub-national radio access networks.

Section 2

Our policy aim is to promote competition in mobile markets primarily through national wholesale competition

Introduction and summary

- 2.1 In this section we explain our policy aim of promoting competition and why we consider the national wholesale level to be particularly important.
- 2.2 It is at the national wholesale level that important dimensions of quality are determined. Competition between national wholesalers promotes retail competition:
- Directly, as national wholesalers are themselves significant retail competitors; and
 - Indirectly, through availability of wholesale access on terms which lead to access being successfully negotiated by parties who, as a result, become other types of retail competitors.
- 2.3 We consider that provided retailers are able to obtain national wholesale access as described above, then the retail market is likely to be competitive.
- 2.4 There are currently four national wholesalers. Until recently there were five. Competition has been strong in the UK mobile market up to now. For the reasons set out later in Sections 4 and 5 of this Annex, we consider there is a risk that without measures in the auction the number of competitors may reduce. Given the amount and importance of the spectrum in the auction, this would be likely to shape mobile competition for the foreseeable future.
- 2.5 There is a risk that the market would be significantly less competitive with fewer national wholesalers than now. There can be more national wholesalers than radio access networks, as asset sharing may be possible, thereby avoiding large duplication of fixed costs. We therefore consider there is a strong case for preferring an outcome of the auction where there are at least four credible national wholesalers.
- 2.6 We provisionally conclude that our competition concerns for the national wholesale level are:
- The main concern that there will be fewer than four credible national wholesalers; and
 - A lesser concern that even if there were at least four credible national wholesalers, one or more will be at a disadvantage in competing across a wide range of services and customers.

Framework for determining policy aim

- 2.7 In order to determine an appropriate policy aim, we have had careful regard to the applicable legal framework, including the Secretary of State's Direction to us. As

explained in Section 4 of the main consultation, our primary duty under section 3 of the Communications Act 2003, which implements Article 8 of the Framework Directive, is to further the interests of consumers, where appropriate by promoting competition. In addition, article 8 of the Directive requires us, where we think fit, to put in place appropriate and proportionate measures to promote competition in the markets for the provision of mobile electronic communications services.

- 2.8 In light of this, our policy aim, in summary, is to promote competition in future mobile markets to the benefit of consumers. We set out below in more detail what we mean by this, and what we consider is likely to be necessary to meet this aim. For these purposes we consider the promotion of competition at both the retail and wholesale level.

Promoting competition in retail markets

- 2.9 As discussed in our March 2011 consultation, we consider that provided retailers are able to obtain national wholesale access on terms that allow them to be competitive, then in general the barriers to entry in the retail markets are likely to be relatively low and those markets are likely to be competitive.
- 2.10 However, if wholesale market(s) were to develop such that it was difficult for retailers to obtain wholesale access to national networks, then there could be a significant reduction in competitive intensity in the retail market compared either to today or to what it could be. It could be necessary to enter as a national wholesaler in order to participate in the retail market, and hence barriers to entry at the retail level could be as high as the wholesale level.
- 2.11 We also consider that entry or expansion by sub-national radio access network (RAN) operators could potentially benefit consumers. In particular, such entry could allow competition over more of the value chain than entry by other retailers, and facilitate innovative business models, including through the deployment of 'inside-out' networks. We discuss this further in Section 9 of this Annex.

Promoting national wholesale competition

- 2.12 While we are ultimately concerned about competition at the retail level and the benefits to consumers, we consider that retail markets are likely to remain competitive by promoting competition between national wholesalers. Our views in this regard remain the same as set out in the March 2011 consultation.

Importance of auction for future mobile competition

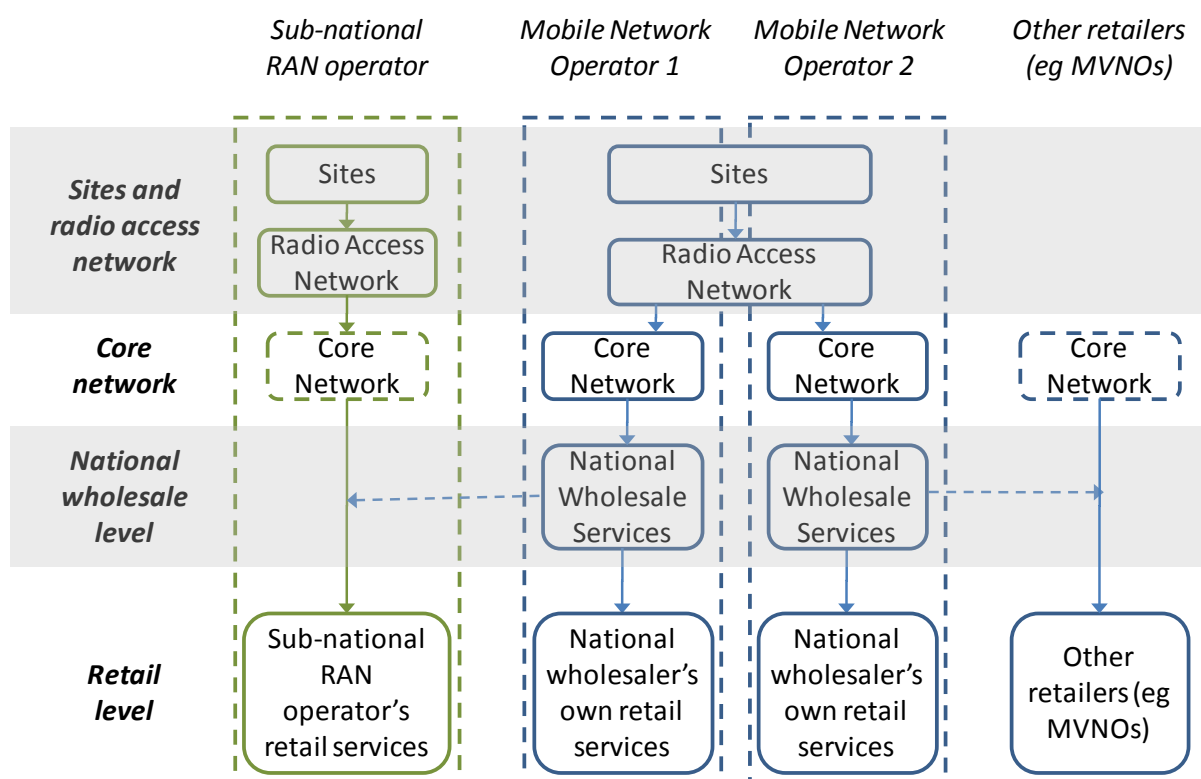
- 2.13 The spectrum in the auction represents a significant increase in total mobile spectrum from about 350MHz to about 600MHz and is expected to be used for LTE technology. The auction is likely to be the last significant opportunity to obtain prime mobile spectrum for the foreseeable future.² The distribution of spectrum after the auction is therefore likely to be particularly important in shaping future competition in mobile markets for at least the next decade.

² Our Call For Input on our future UHF strategy noted that the use of 700 MHz spectrum for LTE mobile service was a question for the longer term. See paragraphs 1.3 and 1.4 of Developing a framework for the long term future of UHF spectrum bands IV and V, Ofcom, 20 April 2011: <http://stakeholders.ofcom.org.uk/binaries/consultations/uhf-spectrum-band/summary2/condoc.pdf>

Industry structure and terminology

- 2.14 As in the March 2011 consultation, we use the term “national wholesaler” to refer to companies that control wholesale access to national RANs.³ We prefer this term to the more traditional “Mobile Network Operator” (MNO) for the purposes of this competition assessment. We find the more traditional terminology unhelpful in the current context, since owners of sub-national RANs are “network operators” on a much smaller scale. Additionally, national wholesalers could share or contract for access to national RANs and still be in a position of controlling wholesale access but not “operating” the network.⁴
- 2.15 The position of national wholesalers in the value chain for mobile services is illustrated in Figure 2.1 below, which for illustrative purposes shows two national wholesalers sharing sites and RAN.

Figure 2.1: Simplified mobile industry vertical structure



- 2.16 National wholesalers could supply access to their RANs to a variety of downstream retail operations, including MVNOs, operators of smaller sub-national RANs and their own downstream retail operations. We include in the term both parties who are already actively supplying third parties in the wholesale market, and those who could

³ In practice this means RANs that provide coverage to a significant portion of the UK. Depending on the measure chosen, existing networks provide outdoor coverage to around 99% of UK premises and around 90% for 3G services. We consider that coverage similar to 3G would be likely to be sufficient to be regarded as being ‘national’.

⁴ See Section 2 of Annex 6 of the March 2011 consultation for more details on mobile industry structure and our terminology:

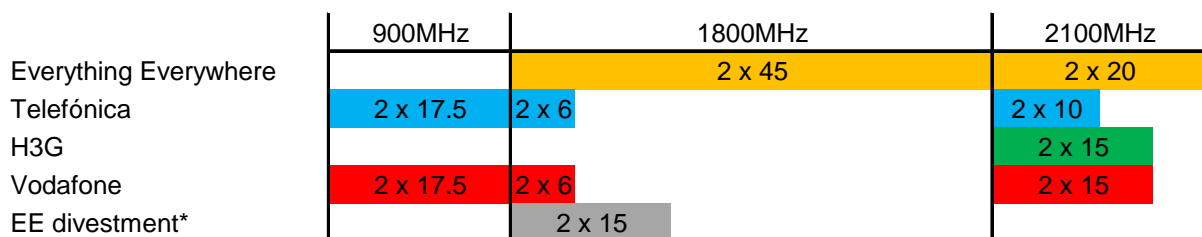
http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/Annex_6.pdf

do so but may currently only be solely engaged in self-supply to their own retail operation.

2.17 There are currently four national wholesalers in the UK, Everything Everywhere, H3G, Telefónica and Vodafone.⁵ There are two main network sharing arrangements in place between these four.⁶ H3G and Everything Everywhere jointly own MBNL⁷, a company set up to deliver a combined 3G network for both operators. For 3G operations, the relationship between H3G and Everything Everywhere is therefore as in Figure 2.1 above, in the sense that they share sites and a RAN. Vodafone and Telefónica have a different sharing arrangement (under the project name Cornerstone) to share sites.⁸

2.18 The current spectrum holdings of the four national wholesalers are shown in Figure 2.2.

Figure 2.2: Current (paired) spectrum holdings of UK national wholesalers



* Spectrum that Everything Everywhere agreed to release as part of the agreement of the merger

Importance of national wholesale level

2.19 As in the March 2011 consultation, we consider that national wholesalers play a central role in the mobile value chain.⁹ Crucially, by controlling access to national RANs and holding spectrum licences, they control many of the key dimensions of quality of services that consumers receive, such as speed and coverage. The importance of national wholesalers is also illustrated by their accounting for a very considerable share of the ‘retained value’ of the mobile value chain.¹⁰

⁵ We therefore do not consider that Vodafone’s argument in its response to the March 2011 consultation that there are currently only three active competitors for supplying MVNOs is relevant. Leaving aside whether Vodafone’s argument is accurate, we consider that an operator can be a credible national wholesaler even if it does not currently sell access to MVNOs, because its own retail activities contribute to retail competition, it has the potential to sell access to MVNOs, and it can act as an indirect constraint on the wholesale activities of other national wholesalers. It can act as an indirect constraint because the wholesale level represents a significant share of total retail revenues. Figure 3.56 of Analysys Mason’s report for Ofcom ‘Assessment of the mobile sector’, 2008, suggests that of the £16.8bn retail mobile revenues, £10bn (or 60%) relates to the wholesale level:

<http://stakeholders.ofcom.org.uk/binaries/consultations/msa08/annexes/msaanalysys.pdf>

⁶ For more details on their sharing arrangements and their current mobile networks, see Ofcom’s UK Communications Infrastructure Report, November 2011: <http://stakeholders.ofcom.org.uk/market-data-research/telecoms-research/broadband-speeds/comms-infrastructure-report/>

⁷ <http://www.mbnl.co.uk/>

⁸ http://pressoffice.Telefonica.com/documentos/nprensa/np090323_en.pdf

⁹ See paragraphs 5.27 to 5.37 of Annex 6 of the March 2011 consultation for more details on why we consider that the national wholesale level plays a central role in the mobile value chain:

http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/Annex_6.pdf

¹⁰ The retained value is the share of revenues retained by a market participant after paying for services or sharing the revenues with other participants. See Figure 5.1 in section 5 of Annex 6 of our

- 2.20 Competition at the national wholesale level is likely to support downstream retail competition in the following ways:
- **Gives scope for competition over more service dimensions.** National wholesalers are very likely to be vertically integrated companies which have significant retail operations in their own right. They are therefore likely to compete over more of the value chain than others at the retail level, since their control over national RANs and spectrum resources gives them additional scope for service innovation and differentiation.
 - **Supports retail competition from other entities.** Competition at the national wholesale level is likely to support competition by other entities at the retail level. In order to provide a retail offering that appeals to mainstream consumers, entities such as sub-national RAN operators and MVNOs need wholesale access to national RANs on terms that allow them to compete. Competition at the national wholesale level is likely to be a prerequisite for this access to be obtained commercially.
- 2.21 We regard spectrum (by which we mean rights to use spectrum) as being the critical asset for national wholesalers. Access to suitable spectrum is essential to provide a national wholesale service. Control over spectrum resources gives greater scope for technological innovation as national wholesalers have significant influence over the technologies and equipment used on their network compared to a company that purchases wholesale access from it. Because of its key importance, national wholesalers are likely to want to hold spectrum licences directly.
- 2.22 We consider that there are high barriers to entry to being a national wholesaler. These include the need to have access to the right quantity and type of spectrum and the fixed costs involved with access to a radio access network. These barriers to entry are very significant for our competition assessment.¹¹

It may be possible for national wholesalers to share assets

- 2.23 We recognise that there are fixed costs involved in RANs. This implies that overall costs would tend to be lower with a smaller number of RANs. But this would be at the risk of a reduction in end-to-end network competition.
- 2.24 As in the March 2011 consultation, we consider that if there were future network sharing agreements, it would still be possible for them to be structured such that the sharers have an incentive and ability to continue to compete as independent national wholesalers. It may also be possible for national wholesalers to share other assets without compromising their independence. This could potentially include spectrum sharing.¹²

March 2011 consultation for details on the retained value shares for different components of the mobile value chain.

¹¹ See paragraphs 5.47 to 5.54 of Annex 6 of our March 2011 consultation for a fuller description of the high barriers to entry for national wholesalers:

http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/Annex_6.pdf

¹² See paragraphs 5.38 to 5.46 of Annex 6 of our March 2011 consultation for a fuller description of potential sharing arrangements:

http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/Annex_6.pdf

- 2.25 We see this as important for this competition assessment. It means that even if it were in consumers' interests to have only a small number of networks, it would still be possible to have a larger number of national wholesalers competing.
- 2.26 We consider that as a result, we should focus in this competition assessment on promoting competition in wholesale markets without taking a strong view on whether it may be in consumers' interests to have sharing arrangements. We do not consider it necessary (or even possible) to take a firm view now on whether future possible sharing agreements may be in consumers' interests. This is because it would depend on the detail of the sharing agreements.

Concerns about future national wholesale competition

Market definition, credible national wholesalers and competition concerns

- 2.27 As in the March 2011 consultation, we remain of the view that it is not useful to undertake a formal market definition exercise for the purposes of this competition assessment. This is because we are unlikely to reach a definitive view on market definition, and there would be considerable scope for error if we tried to do so, because of both the long time frame of this review, and uncertainty over the full implications of LTE.¹³ Also, we note that market definition is anyway only a means to an end, namely, to assess the strength and extent of competition. As we consider the strength and extent of competition directly in terms of the potential sources of concern discussed in Section 4 of this Annex, we consider that market definition per se is less important.¹⁴ Our assessment here is not the same as in a formal market review under the Communications Act 2003/European Framework. In that case, we define a market, consider whether one or more players has Significant Market Power (SMP) and, if so, we impose SMP conditions to apply (usually) for a defined period until a further market review. By contrast here we are conducting a competition assessment with a much longer time horizon, during which the underlying markets may well change as technology and consumer demand develop.
- 2.28 While we are interested in mobile services in general, including both voice and data services, the focus of our assessment is on data which is the growth area in mobile services and for which we expect the spectrum in the auction primarily to be used.
- 2.29 We consider that it is possible that separate markets may develop for the provision of one or more segments of mobile services or customers – as discussed in the March 2011 consultation, possibilities include a separate high quality data market

¹³ See paragraphs 3.3 to 3.4 of Annex 6 of the March 2011 consultation for more explanation. However, we remain of the view that fixed services are unlikely to constrain mobile services for the period we are considering for the reasons set out in the March 2011 consultation. See paragraphs 3.6 to 3.16 and 3.22 to 3.26 of Annex 6:

http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/Annex_6.pdf

¹⁴ Market definition requires a specific boundary to be identified between those services inside the 'market', which provide a strong competitive constraint on each other, and those outside the 'market', which impose a relatively weak constraint. However, products may not fall into these categories of strong and weak constraining influences in a straightforward way, especially where there is a range of differentiated products. As noted in Farrell and Shapiro (2010), Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition, The B.E. Journal of Theoretical Economics, Volume 10, Issue 1 (Policies and Perspectives), Article 9:

"Product differentiation can make defining the relevant market problematic, notably because products must be ruled "in" or "out", creating a risk that the outcome of a merger investigation or case may turn on an inevitably artificial line-drawing exercise." (page 4)

associated with reliable indoor coverage or a separate market associated with higher data speeds and better latency delivered by LTE. For this to happen, the prices in the segment would have to be insufficiently constrained by the main mobile market.¹⁵

The typical way of assessing whether there are separate markets is to use the hypothetical monopolist test, generally by considering a price rise of 5 to 10 per cent.¹⁶ There could be a single mobile market if there were a 'chain of substitution' between different service levels preventing separate markets for high quality data services developing.¹⁷

- 2.30 But even if separate markets did not develop for any segment of high quality data services, it could still be the case that competition was somewhat less intense than it might be for some customers or services if some national wholesalers could not serve those customers effectively. The reasons why there were not separate markets may affect the scale of consumer harm. The potential consumer detriment from price rises by the smaller number of providers of the segment of services or customers would be limited by the competitive constraint from consumers' ability to switch to substitutes. But if competition were less intense for the segment of services or customers, there could nevertheless be material consumer harm, such as from the restrictions on choice or potential for reduced innovation.
- 2.31 In summary, whether or not separate markets develop, there could still be some harm for those customers who want particular high quality data services if some national wholesalers are unable to provide those services. So even if there remain four national wholesalers overall, this could mean that customers for some high quality data services would have a choice of three or fewer providers.
- 2.32 Competitors may have advantages in different aspects of service. Such differentiation between rivals is a feature of many competitive markets, and is not necessarily a cause for concern. It can be a healthy aspect of competition to the benefit of consumers for rivals to seek to exploit their advantages compared to competitors and engage in various ways to mitigate their areas of disadvantage, some of which may be creative or open up new possibilities for consumers. However, (a) we are concerned that a national wholesaler which had too many disadvantages, without offsetting advantages over its rivals, would not be a credible competitor, and (b) we are concerned that there is a risk of consumer detriment if there is limited competition across the range of services. We consider these two points in turn.
- 2.33 A national wholesaler could be a credible competitor even though it is not in a strong position (i) in some dimensions of service, or (ii) for serving some particular of

¹⁵ Even if the lower quality services did not constrain higher quality services, it is possible that higher quality services could constrain lower quality services, meaning that there could be a single market if we were considering lower quality services.

¹⁶ With the hypothetical monopolist test, a service is considered to be in a separate market if a hypothetical monopoly supplier could impose a small but significant, non-transitory increase in price ("SSNIP") above the competitive level without losing sales to such a degree as to make this unprofitable. If such a price rise would be unprofitable the market definition should be expanded to include the substitute services. The OFT Guidelines on Market Definition normally considers a price five to ten per cent above competitive levels to be 'small but significant'.

¹⁷ A chain of substitution may exist, for example, where a customer would not substitute from service A to service C to avoid a SSNIP, but would substitute to service B. This may suggest that service A and B are in the same market but that service A and C are in separate markets. However, if there are customers who would substitute from service B to service C to avoid a SSNIP then this may suggest that service B and C are in the same market. Because of a chain of substitution between services A and B and services B and C, services A and C would be defined to be in the same market.

services or customers segments. For example, a national wholesaler might be credible if it is able to provide good quality of service (such as high data rates and latency) in most indoor locations, even if it cannot compete as strongly for customers that particularly value having a connection even in the most difficult to serve locations. Another example is that a national wholesaler might be credible if it can provide good HSPA+ services but (for a period of time) not LTE services, even if there are some customers that particularly value having LTE services. We consider these questions in greater detail in Sections 3 and 4 of this Annex.

- 2.34 However if the disadvantages suffered were large, were felt across a substantial part of the market, and were not compensated by other advantages, the national wholesaler could cease to be a credible competitor at the national wholesale level. So, whilst the sources of disadvantage may be similar as between (i) whether the national wholesaler was a credible competitor and (ii) whether the national wholesaler could serve a wide range of services/customers, there is a difference in the degree of importance to consumers and competition.
- 2.35 When we assess what auction outcomes might fail to promote competition in Section 4, we consider whether technical and market circumstances could mean that particular spectrum holdings may give a national wholesaler a competitive advantage, and how large that advantage might be. We also consider what spectrum holdings may be sufficient for a national wholesaler to have enough spectrum to be credible, even though it may not be as well placed in all dimensions of service as some other national wholesalers.
- 2.36 Turning to our second concern: while recognising that a degree of differentiation is inevitable, and may have some benefits, we consider that competition between national wholesalers that is too limited across the range of services and customers is not desirable for consumers.
- 2.37 In conclusion, we have two competition concerns for the national wholesale level which could undermine our overall policy aim of promoting competition:
- the main concern that there will be fewer than four credible national wholesalers; and
 - a lesser concern that even if there were at least four credible national wholesalers, one or more national wholesalers will be at a disadvantage in competing across a wide range of services and customers.
- 2.38 We consider that the first type of concern is likely to be more important in terms of potential consumer detriment than the second. This is because most or even all consumers may be affected by the first type of concern, whereas the second risk may be restricted to particular segments of services or customers. Furthermore, there is the possibility that there could be chains of substitution between various segments of the market. So even if for some particular services there are fewer competitors able to provide those services, the extent to which that limited competition can harm consumers through increased prices is likely to be constrained by the greater competition in the broader market. Consumers of those particular services are likely to be able to switch to other similar services which a greater number of competitors can provide. But material detriment may still arise from the absence of other types of benefits that competition can bring, such as increased choice and innovation.

2.39 Market definition is not the focus of our analysis and we do not discuss it further in this Annex. First, this is because we analyse the strength of competition directly in terms of the potential sources of concern outlined above and discussed in greater detail in Section 4. Second, a separate market is not a necessary condition for there to be a significant competition concern with potential for material detriment to consumers. This could arise either from a threat to credibility as a national wholesaler or because of competition being weakened in a segment of services or customers. Third, measures to promote competition across a wide range of services or customers may be appropriate and proportionate whether or not there are separate markets. This is consistent for example with our approach to promoting competition in fixed broadband services. In the 2010 wholesale access market review, we concluded that the remedies we imposed should support competition across the full range of downstream services, for example covering both current and next generation access, despite finding that current generation access and next generation access are in the same market.¹⁸

Benefits of having at least four credible national wholesalers

2.40 Other things being equal, especially in a market with significant barriers to entry, competitive intensity in a market will tend to be higher when there are more competitors, and lower when there are fewer competitors.¹⁹ A reduction in the number of competitors from four to three is typically seen as a substantial increase in concentration in an already highly-concentrated market, and therefore as a potential cause for concern.²⁰ If such an increase in concentration were to occur as a result of a merger (or acquisition), it would be subject to assessment by competition authorities, and the decision of whether to clear, or intervene in, such a merger would depend on a detailed assessment of the facts. We therefore consider it is useful to apply tools of assessment similar to those used in merger assessment, which also consider increases in market concentration. However, we recognise that there are some important differences between the consideration of mergers in which the market structure would reduce from 4 to 3 and the issues with which we are concerned here.

2.41 In the present case, we are not assessing the effect of a specific merger but we are assessing a situation in which the outcome of the auction has the potential to lead to market concentration, for example as a result of market exit or a current national

¹⁸ As a result, we proposed that competitive providers should have access to both current generation access (CGA) based and next generation access (NGA) based access products in the WLA market. We said:

“We consider that it is necessary to have specific access remedies to support competition and investment in NGA, as well as continuing the LLU remedy. This is because this would enable BT’s competitors to compete effectively by providing a full range of CGA and NGA services in downstream markets.” (emphasis added)

See paragraph 8.22 the review of the wholesale local access market, Consultation, March 2010:

<http://stakeholders.ofcom.org.uk/binaries/consultations/wla/summary/wlacondoc.pdf>

See also paragraph 9.30 and the following paragraphs in the following Statement of October 2010:

http://stakeholders.ofcom.org.uk/binaries/consultations/wla/statement/WLA_statement.pdf

¹⁹ Vodafone (paragraph 5) comments that it “does not dispute the basic notion that the presence of a number of LTE infrastructure operators may be relevant to the intensity of competition...” While Everything Everywhere (page 65) says that “the point that more competitors create more competition” is “relatively uncontroversial”.

²⁰ See e.g. Merger Assessment Guidelines, a Joint Publication of the Competition Commission and the Office of Fair Trading, September 2010, paragraph 5.3.5 (discussed below), and Counting Rivals or Measuring Market Share: Modelling Unilateral Effects for Merger Analysis, Malcolm B. Coate, Federal Trade Commission, May 2011.

wholesaler losing credibility as a competitor. We consider in later Sections of this Annex a number of potential effects on current national wholesalers if they fail to acquire spectrum in the auction.

- 2.42 However, unlike a merger control analysis, we are not considering a specific transaction that would increase market concentration, it is not clear over what timescale any exit or weakness would occur, which firms would benefit,²¹ or what the shares of those firms would be (particularly in nascent high-speed data services). As a result – and while merger analysis provides a useful framework for considering the possible outcomes of an increase in market concentration following the auction – the degree of uncertainty as to those outcomes is greater than would be the case if we were assessing a specific merger. In addition, we are also considering a longer future time horizon than a merger authority would usually consider when assessing the likely future effects of a merger.
- 2.43 In this section we begin by commenting on competition in the UK mobile sector to date. Next we consider the likely effect of a reduction from four to three credible national wholesalers.

Competition in the UK mobile sector to date

- 2.44 We described the UK mobile retail market as competitive in our Mobile Evolutions report in 2009. This was evidenced by a range of factors such as shifts in retail and wholesale market shares between existing players, healthy levels of customer switching between suppliers, entry by MVNOs, and innovation by service providers with new service and price options.²² As a result, we noted that the majority of people in the UK used mobile services, use of text and data services was growing; mobile internet access was taking off, and devices could do more while costing less.²³
- 2.45 Our Communications Market Report 2011 noted that average voice and data revenue per mobile connection had fallen steadily since 2007 as a result of falling prices and the introduction of more generous pay-monthly call, messaging and data allowances.²⁴
- 2.46 This report showed (Table 5.1) that the number of mobile voice call minutes have increased steadily, and 3G mobile connections are growing strongly, while average monthly household telecoms spending (including fixed telecoms) has fallen consistently by around 3 to 4% per year since 2006. The report also noted the increasing use of mobile data services via dongles and smartphones resulted in a 67% increase in data transferred over the UK's mobile networks in 2010 (page 246); and the growth of sub-£20 mobile contracts, and one-month SIM-only contracts, which have made pay-monthly contracts affordable for more users (page 259).
- 2.47 According to recent Ofcom research²⁵ six out of ten UK smartphone users agree that their internet connection is always fast enough for what they do online. Smartphone users in Germany, Italy and France were more likely agree that their internet

²¹ Whether by winning market share from a weakened competitor or acquiring its customers in the event of an exit.

²² Mobile Evolutions, Ofcom December 2009, paragraph 3.36:

http://stakeholders.ofcom.org.uk/binaries/consultations/msa/statement/MSA_statement.pdf

²³ Paragraph 1.2.

²⁴ http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CMV_2011_FINAL.pdf

²⁵ See Figure 6.81 of Ofcom's International Communications Market Report 2011: <http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/icmr/ICMR2011.pdf>.

connection was always fast enough (by five to ten percentage points more than among UK users). However, the UK performs well relatively well in overall satisfaction with mobile broadband services: over half are satisfied or very satisfied with their service, while 15% are dissatisfied – a similar result to Germany, but better than satisfaction levels in France and Spain.²⁶

- 2.48 In summary, evidence we have collected appears on the whole to be consistent with the mobile market being one in which competition has delivered a wide range of benefits for consumers.
- 2.49 It should be borne in mind that neither the Mobile Evolutions report nor the Communications Market Report was based on detailed competition assessments. Furthermore the Mobile Evolutions report described a market in which there were five national wholesalers, while the Communications Market report covered the period from 2007 to 2010: for most of this period the market had five players (i.e. prior to the T-Mobile / Orange merger in 2010).

International comparisons

- 2.50 Prices in the UK also appear, to date, to have compared favourably with those in other European countries. Figure 2.3 compares measures of market concentration and typical prices in the UK and other large European countries.²⁷ Following the T-Mobile / Orange merger in 2010, concentration in the UK has, as would be expected, increased significantly, and is now similar to other countries with four players.
- 2.51 As the Figure indicates, UK prices for voice calls have to date been substantially lower than in Germany, Spain, Italy and France. Weighted-average prices fell in the UK from 2010 to 2011. This appears to continue an ongoing trend in declining prices for mobile voice usage.²⁸ The weighted-average price of voice connections declined faster in France and Spain, although there were (smaller) increases in Italy and Germany.
- 2.52 Best-offer prices, for both voice and broadband, are also generally lower in the UK than the other countries shown, though there has been some increase in UK prices over the past year. The report notes that the lowest prices for voice connections tended to be offered by the smaller operators of those included in the analysis. In the UK, Orange and T-Mobile together accounted for seven of the nine best-offer prices (H3G was not included in the assessment of voice services). For mobile broadband, the report notes that lower prices in the UK and Italy may be attributed to the relative maturity of the 3G market, and to the presence of H3G (in the UK two of the three best-offer prices were from H3G).

²⁶ See Figure 6.59 of Ofcom's International Communications Market Report 2011.

²⁷ Based on Ofcom's International Communications Market Review 2011, Figures 6.43, 2.7, 2.8, and 2.12. Note that:

1. The HHI is calculated by adding together the squared values of the percentage market shares of all firms in the market. OFT / CC Merger Assessment Guidelines (see paragraph 5.3.5) note that an increase in HHI of 150 is the threshold at which a merger may be a cause of concern in a highly concentrated (HHI above 2,000) market, so in the present context differences in HHI of more than 150 may be seen as significant.
2. The methodology used for deriving comparative prices is set out in Ofcom's International Communications Market Report, pages 73 to 77 and Appendix B.

²⁸ e.g. see Ofcom's International Communications Market Review 2010, Figure 6.71.

- 2.53 A recent report by Morgan Stanley²⁹ noted that the UK was cheaper than a range of other countries for data services. In particular a 500MB service cost \$5 to \$6 per month in the UK compared to \$10 in Germany, and 1GB costs \$10 in the UK compared to \$15 in Germany and \$10 to \$25 in Spain. The study notes that there are no unlimited high speed data plan offers in Germany or Spain, and only H3G has such an offer in the UK.
- 2.54 H3G's response to our March 2011 consultation presented data indicating that prices were significantly lower for mobile broadband services in the UK than in most other European countries, and at least slightly lower for voice calls in the UK than in Germany, France and Spain, among others.³⁰

Figure 2.3: Concentration and pricing in EU mobile markets

| | Number of wholesalers | HHI (based on share of subscribers) | Weighted average prices of nine voice connections £ | Best-offer prices of nine voice connections £ | Best-offer prices of three mobile broadband connections £ |
|-----------|-----------------------|-------------------------------------|--|--|--|
| UK (2010) | 5 | 2,300 | 210 | 143 | 33 |
| UK (2011) | 4 | 3,000 | 190 | 158 | 38 |
| Germany | 4 | 2,750 | 470 | 408 | 58 |
| Italy | 4 | 2,900 | 360 | 258 | 34 |
| Spain | 4 | 3,000 | 440 | 366 | 54 |
| France | 3 | 3,600 | 290 | 263 | 61 |

Source: IDATE / Ofcom

- 2.55 The European Commission's (EC) decision in March 2010 on the T-Mobile / Orange merger was based on an expectation that, under certain conditions, the UK market would be competitive with four players. However, the EC was concerned about the possibility of a further consolidation to three players, and took steps to ensure this was not an inadvertent consequence of the merger. Whether the market will continue to be as competitive with four players is uncertain – the full effects of the merger may not yet have emerged.
- 2.56 In summary, then, the UK mobile sector appears to have been competitive to date, and this is evidenced both by consumer outcomes and comparisons with other countries. The full effects of the relatively recent consolidation from five to four players may not yet be evident. Our concern is to promote competition in future.

²⁹ Global Mobile: How Data Shifts Market Shares or Promotes Consolidation, 13 September 2011 (page 37).

³⁰ H3G Consultation Response, Figure 12 (Source: Berg Insight, European Commission).

Strong competitive forces

- 2.57 The evidence suggests that all of the current national wholesalers have provided strong competitive forces that have contributed to the desirable outcomes for UK consumers.³¹
- 2.58 Everything Everywhere, Telefónica, Vodafone and H3G are all significant players in the market. With the merger of T-Mobile and Orange, Everything Everywhere has emerged as the largest player, accounting for around 40% of connections. Telefónica was the largest prior to the merger and has continued to grow its share. Vodafone was the second largest player prior to the merger, has seen its market share grow every year since 2006, and now accounts for almost one in four connections (see Figure 5.5).
- 2.59 Although H3G has a significantly smaller market share, the evidence tends to support the view that it has also provided a strong competitive force with a contribution to competition larger than might be inferred from its overall market share, especially in mobile broadband services. For example:
- Despite accounting for around 7% of connections, H3G accounted in Q1 2011 for half of all data/dongle subscribers, and for 44% of data volumes in the market (see Figures 5.4 and 5.7).
 - H3G has also used pricing to differentiate itself from existing competitors, as evidenced by its offering two of the three best offer prices for mobile services (see paragraph 2.53 above).
 - In its Decision on the T-Mobile / Orange merger, the EC noted that H3G was the first UK national wholesaler to introduce a low cost, flat-rate mobile broadband package, and that H3G continued to maintain its price leadership position in mobile broadband services, offering the cheapest mobile broadband data package in the market. The EC also noted that H3G had promoted new services such as Skype and pioneered new products such as mobile broadband dongles aimed at a mass-market audience. It described H3G as an important driving force for competition in the market.³² The EC also noted that Ofcom had confirmed the important role of H3G in the UK market.³³

Effects of an increase in concentration on competition

- 2.60 In the present case, we are considering not a merger or acquisition, but the release into the market of a key strategic asset (spectrum) that could change the competitive

³¹ The variety of retailers (dependent on wholesale access), such as MVNOs and sub-national RAN operators, has also contributed to competition.

³² European Commission, Case No COMP/M.5650 - T-Mobile/ Orange, March 2010.

³³ Ofcom, in its January 2008 submission to the Competition Commission (CC) on the Mobile Call Termination Appeals, commented that H3G's claim to be a "maverick" competitor was unproven and speculative. This was in the context of an argument by H3G that its termination charges should be more lightly regulated, which Ofcom noted would have enabled it to subsidise its retail prices. The CC concluded in January 2009 that the evidence presented by H3G, including a report by Oxera, was unpersuasive. We note that H3G's record as a leader in the provision of data services, which led the Commission to conclude that it is an important driving force for competition in the market, had not been established at the time of the CC report. For example, data services grew tenfold in 2008 and fourfold in 2009/10 – see Figure 5.21 of Ofcom's Communications Market Report 2011: http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CM_2011_FINAL.pdf.

landscape. This additional spectrum will be used for services some of which are not yet available in the market. Demand for these services, and the relative success of firms in supplying them, remains to be seen.

- 2.61 As noted above, there is a greater degree of uncertainty as to the impact of an increase in concentration than would typically be the case in a merger assessment. Nevertheless, the tools of merger assessment are relevant to considering the *possible* outcome if the auction leads to an increase in concentration. In particular we consider factors such as (a) the increase in market concentration; (b) the scope for firms unilaterally to raise prices or reduce quality; (c) the scope for coordinated behaviour between firms; (d) the extent of barriers to entering the market; (e) whether buyers have countervailing bargaining power and (f) whether the consolidation would give rise to greater efficiencies, which would be passed on to consumers e.g. in lower prices.
- 2.62 We consider each of these factors in turn, in relation to provision of mobile services:
- a) *The increase in market concentration:* The present market is already highly concentrated according to standard classifications (HHI is well over 2,000). A consolidation from four to three, e.g. from the exit of the smallest player (H3G) would increase the HHI by around 450 points, well above 150 points which is the threshold for potential competition concern in merger control.³⁴
 - b) *The scope for firms unilaterally to raise prices or reduce quality:* In the context of a market with high barriers to entry, with the removal of a competitor, customers have fewer options and in the absence of offsetting effects are therefore less likely to switch in response to a price increase. Even in the absence of coordination, firms will tend to charge higher prices in a more concentrated market. Unilateral effects will tend to be greater with a larger increase in concentration. They will also depend on how many (and to what extent) customers of the acquiring firm, and other remaining firms, saw the exiting/acquired firm as a close substitute, and on whether the consolidation would involve the removal of a firm that was a strong competitive force.³⁵ As set out above, we consider that each of the four current national wholesalers has provided a strong competitive force in the UK mobile sector.
 - c) *The scope for coordinated behaviour:* This will depend on factors such as the ability of firms to reach a (possibly tacit) coordinated agreement, and to monitor and punish cheating on such an agreement, and the presence or otherwise of an effective competitive fringe,³⁶
 - o As regards the scope for firms to reach and monitor a coordinated agreement, we note that, while retail prices are widely advertised, they are also relatively complex. For example, monthly prices can vary depending on the handset chosen (if any), length of contract, the number of voice minutes and texts, and data limits included in the price. This complexity, along with the presence of selective discounts, could make coordinated pricing difficult to monitor. In the T-Mobile / Orange Netherlands decision, the EC found that pricing did not

³⁴ Merger Assessment Guidelines, a joint publication of the Competition Commission and the Office of Fair Trading, September 2010, paragraph 5.3.5. (discussed above)

³⁵ CC / OFT Guidelines, paragraph 5.4.5.

³⁶ We note that the FCC has identified a threat of coordinated behaviour in the proposed AT&T / T-Mobile merger in the USA. See paragraphs 71 to 84 of the FCC' s Staff Analysis and Findings: http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db1130/DA-11-1955A2.pdf

present the characteristic of transparency which would be necessary to reach common understanding on terms of coordination. It said that tariffs varied on a wide range of elements.³⁷

- Alternatively, firms could in principle coordinate by agreeing not to compete for each others' customers, without specifically coordinating on pricing. If one firm "cheated" on a market-sharing agreement by competing aggressively for its rivals' customers – for example on price – this would quickly become apparent to its rivals. Another form of coordination could be in agreeing to delay the introduction of innovative services or investment in networks.
 - The more competitors there are, the greater is the likelihood that one of them will undermine such a coordinated agreement. This is particularly the case if a competitor faces different incentives from coordinating firms. For example, a competitor with fewer customers, such as H3G, may be more willing to cut prices, or introduce/promote innovative services in order to build market share.³⁸ This could give such a competitor an incentive to cheat on a coordinated outcome, or to disrupt attempts by other parties to coordinate.³⁹
 - If firms are more symmetrical (e.g. of similar size to each other), coordination may be easier to sustain. Market shares in the UK mobile market are not currently particularly symmetrical.
 - If wholesalers coordinated in setting both wholesale and retail prices, it is unlikely that MVNOs could constitute a competitive fringe that would undercut those retail prices. This is because MVNOs are dependent on being able to reach competitive wholesale terms in order to compete at the retail level.
- d) *Entry barriers*: in the extreme case, a market with very low entry barriers could be competitive with only one provider. However, entry as a national wholesaler is subject to high entry barriers, including infrastructure costs and the limited availability of spectrum.
- e) *Countervailing buyer power*: i.e. customers being able to bargain down prices by threatening to buy less or switch to another supplier. While MVNOs may have some scope to bargain down prices by threatening to switch wholesaler, this depends on a competitive wholesale market. Individual retail consumers are unlikely to have buyer power.
- f) *Any efficiency benefits that may arise*: The CC / OFT Guidelines consider a range of potential efficiencies from mergers, of which economies of scale appear most relevant to the present case.⁴⁰ If the consolidation would allow firms to achieve

³⁷ See: http://ec.europa.eu/competition/mergers/cases/decisions/m4748_20070820_20310_en.pdf, paragraph 43.

³⁸ H3G's strength in mobile data services may be an example of the latter: see paragraph 2.60.

³⁹ For example, in the T-Mobile Austria / Tele.ring merger decision, the Commission noted the possibility of coordinated effects, and linked this to the fact that the merger would remove a price-aggressive maverick, leaving two operators of roughly equal size in control of most of the market. See: http://ec.europa.eu/competition/mergers/cases/decisions/m3916_20060426_20600_en.pdf 128.

⁴⁰ Paragraphs 5.7.6 to 5.7.18. Other efficiencies considered by the Guidelines include those relating to 'vertical' mergers between firms at different levels of the supply chain, and 'demand side' efficiencies such as: (a) network effects (where the value of a service to users depends on the number of others users – a typical example would be social networks such as Facebook); (b) mergers

greater economies of scale, and if these savings were likely to be passed on to consumers in lower prices, the net effect could be positive for consumers. However, in the present case, there is significant scope to achieve efficiencies through network sharing without a reduction in the number of national wholesalers (as discussed above).⁴¹

- 2.63 In summary, applying merger control criteria to the present case (while noting the distinctions set out in paragraph 2.42 above), a consolidation from four national wholesalers to three would represent a large increase in concentration in an already highly concentrated market. Other things being equal, this would be likely to give firms an incentive unilaterally to raise prices or to be less competitive in other ways. There is also some risk that coordination between suppliers would become easier, especially if a disruptive competitor were eliminated. This is in the context of a market where barriers to entry are high and there is little scope for buyers to exercise countervailing bargaining power. Finally, there is significant scope to achieve cost efficiencies without a reduction in the number of national wholesalers.
- 2.64 As such, whilst alternative outcomes are possible, it appears credible, and perhaps likely, that a future consolidation from four to three players – and particularly one which eliminated a strong or disruptive competitive force – would lead to a reduction in competitive intensity.

Impact on consumers

- 2.65 A reduction in competition could allow the remaining wholesalers profitably to set higher prices, to invest less in new services, and to be less innovative than would be the case in a more competitive market. This is likely to be to the advantage of those remaining wholesalers. However, the result of such a change would be worse outcomes for consumers, such as in higher prices, reduced choice and delayed access to improved or new services.
- 2.66 The market for mobile services is large, with revenues of £15.1 billion in 2010. The great majority of UK adults (and many children) use these services, with 1.3 active mobile connections per head of population, and one active 3G mobile connection for every two people. The average household spends £63 per month on telecoms, of which mobile services account for around half. Mobile is also important to UK businesses, which account for £6.6 billion of mobile revenues.⁴²
- 2.67 In 2006, Europe Economics produced a report for Ofcom⁴³ which estimated the consumer surplus generated by mobile services. Consumer surplus is defined as the value of a service to a consumer, minus the price paid by the consumer for the service.
- 2.68 Using a range of methods, Europe Economics estimated a total consumer surplus of £19.0 billion from the consumption of mobile services in the UK (both by private and business consumers). Simply adjusting this figure for inflation would suggest a

between providers of complementary products, which create an incentive to reduce prices; and (c) mergers which broaden a firm's range and allow it to offer "one-stop shopping".

⁴¹ See Annex 6 of our March 2011 consultation for a discussion of how economies of scale can be captured through network sharing (paragraphs 5.38 to 5.46).

⁴² All figures from Ofcom's 2011 Communications Market Review, Figure 5.1 and page 298: http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CMV_2011_FINAL.pdf

⁴³ Economic impact of the use of radio spectrum in the UK, A report by Europe Economics, November 2006: http://stakeholders.ofcom.org.uk/binaries/research/spectrum-research/economic_impact.pdf

consumer surplus of £20.7 billion in 2010. Further adjusting for the growth in mobile connections over the period suggests a consumer surplus of around £24.0 billion in 2010.^{44 45}

- 2.69 If consumer surplus is indeed of this order of magnitude, even a moderate reduction in competition could have a substantial detrimental impact. Figure 2.4 illustrates this effect – for example, a 1% decrease in consumer surplus would be equivalent to a £0.2 billion loss of surplus over one year, and if it were sustained over five years the loss of consumer surplus would have a net present value⁴⁶ of £1.1 billion.⁴⁷

Figure 2.4: Impact of a percentage reduction in consumer surplus

| Percentage fall in consumer surplus: | £ billion net present value reduction in consumer surplus over: | | |
|--------------------------------------|---|---------|----------|
| | 1 year | 5 years | 10 years |
| 0.5% | 0.1 | 0.6 | 1.0 |
| 1% | 0.2 | 1.1 | 2.1 |
| 5% | 1.2 | 5.6 | 10.3 |
| 10% | 2.4 | 11.2 | 20.5 |

Provisional Conclusion

- 2.70 Our assessment of the likely future competitiveness in mobile markets above leads us provisionally to conclude that we should be concerned about the risk of a reduction in competition, and hence an adverse impact on consumers, from a reduction in the market from the current four credible national wholesalers to three or fewer. In view of this, in order to promote wholesale competition, we consider that we should design the auction so as to seek to ensure it does not lead to an outcome which has a similar effect, provided we do so in an appropriate and proportionate manner.

⁴⁴ If we compare this figure to industry revenues (£15.1 billion in 2010), we can see that consumer surplus is larger. This suggests that, for example, a customer who paid £15 for a mobile service would typically value that service at £39, so consuming the service creates a consumer surplus of £24 (i.e. £39 minus the £15 price of the service).

⁴⁵ Europe Economics' estimate is an average of results from four different methods. The first, second and fourth of these update a consumer surplus from a previous (2000) study. The third applies the formula: Consumer Surplus = (Price x Quantity) / (own-price elasticity of demand x 2), using an estimate of own-price elasticity of demand of -0.30, which Ofcom had previously used (and another of -0.47 from a study by Teligen Consultants). Applying the -0.30 elasticity estimate to current industry revenues suggests consumer surplus of around £25.2 billion.

⁴⁶ Based on the social time preference rate of 3.5%, as recommended by the HM Treasury Green Book, Chapter 5: http://www.hm-treasury.gov.uk/d/green_book_complete.pdf.

⁴⁷ As a further illustration, suppose a reduction in competition allowed mobile operators to increase prices by an average of 10% (around £18 per connection per annum). We assume an own-price elasticity of -0.30 (as used by Europe Economics). This would lead to a reduction in the number of connections of around 2.5 million, and a loss of consumer surplus of around £1.5 billion per annum, equivalent to a net present value loss of £6.8 billion over five years, due to customers paying higher prices.

- 2.71 In contrast, if we did not seek, in this auction, to maintain at least four national wholesalers, this could lead to an outcome in which there were only three credible competitors. If this led to worse consumer outcomes, in terms of higher prices or delays to innovation, there would be limited scope to reverse this situation.⁴⁸
- 2.72 In conclusion, we therefore consider there is a strong case for seeking an outcome of the auction which ensures at least four credible national wholesalers.⁴⁹

No strong case for measures to promote five national wholesalers

- 2.73 For the reasons set out in the March 2011 consultation⁵⁰, we remain of the view that there is not a strong case for taking measures to promote more than four credible national wholesalers. We consider that there could be greater benefits to consumers and citizens through increased competitive intensity with five compared to fewer but there is a greater risk to inefficiency and we do not currently have clear evidence of interest from stakeholders in becoming a fifth national wholesaler.
- 2.74 We note that if we were to put in place measures to promote at least four national wholesalers, this would not preclude outcomes in which more than four national wholesalers emerged after the auction, if there were sufficient interest and willingness to pay for the necessary spectrum in the combined award.

⁴⁸ While there is scope for further release of spectrum suitable for mobile data services, the timing and extent of any such future releases is uncertain at this stage.

⁴⁹ This outcome of the auction could involve new entrants acquiring spectrum, as we discuss in greater detail in Section 8.

⁵⁰ See paragraphs 6.16 to 6.66 of Annex 6 of the March 2011 consultation:

http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/Annex_6.pdf

Section 3

Importance of holding spectrum to deliver different dimensions of mobile service quality

Introduction and summary

- 3.1 This section identifies the dimensions of mobile service quality and capacity that are affected by the type and quantity of spectrum used. The four key dimensions of mobile services that we identify are: capacity and average data rates; quality of coverage; highest peak data rates and ability to deliver LTE services.
- 3.2 We consider how technical and market conditions are likely to evolve and use this to inform our assessment of the importance of holding spectrum suitable for delivering different quality dimensions. In particular, we consider the extent to which national wholesalers are likely to need to use particular types and quantities of spectrum in order to deliver each of these quality dimensions and the extent to which that will translate into significant competitive advantages. We provisionally conclude that:
- A national wholesaler is likely to need sufficient spectrum in order to serve enough customers with sufficiently high average data rates. We consider that there is some risk that a national wholesaler would not have enough capacity to be credible if it held less than 10 to 15% of total spectrum holdings.
 - A national wholesaler is also likely to need enough sufficiently low frequency spectrum in order to deliver good coverage in most locations cost effectively. There is a material risk that a national wholesaler would not be credible if it did not hold enough sub 2.1GHz spectrum.
 - It is not clear to what extent consumers will value highest peak data rates and therefore the extent to which national wholesalers need to hold spectrum suitable for delivering highest peak data rates in order to be credible.
 - It is also unclear the extent to which consumers are likely to value the features that LTE can deliver over and above HSPA, and therefore the extent to which holding spectrum suitable for early deployment of LTE is important to act as a credible national wholesaler. However, longer term, no route to LTE might be a problem in terms of credibility.
- 3.3 Nevertheless, we consider that, in making an assessment of what spectrum is needed to act as a credible national wholesaler, it is necessary to consider the scope for national wholesalers to provide different quality dimensions in the round. We recognise that, to some extent, disadvantages in respect of some quality dimensions can be compensated by advantages in others.
- 3.4 Even if a national wholesaler is credible, it may not be well placed to deliver certain dimensions of service, or for serving some particular niche products or customer segments that may develop. While recognising that a degree of differentiation is inevitable, and may have some benefits, we consider that competition between

national wholesalers across the range of services and customers that is too limited is not desirable for consumers.

- 3.5 In section 4 we draw on our assessment of the importance of holding particular types and quantities of spectrum to inform the extent to which each of the current national wholesalers is dependent on acquiring spectrum in the auction in order to be credible in the long term, given its existing spectrum holdings. And if they do need to obtain more spectrum, we consider what spectrum they might need. Section 4 also considers what spectrum a new entrant may need to acquire to be a credible national wholesaler.

Approach to assessing the importance of holding spectrum to deliver different dimensions of mobile service quality

- 3.6 There is a range of different types of services and quality dimensions that national wholesalers might provide in future mobile markets. We cannot accurately predict future demand or predict how the market for mobile services will develop. However, it is important for us to identify the range of service dimensions that could be relevant to future national wholesale competition in mobile markets and to consider the extent to which spectrum holdings following the auction could determine the ability of national wholesalers to deliver those service dimensions adequately.

- 3.7 In line with the main issues raised in responses, we consider four distinct dimensions to high quality data services that are affected by spectrum in the auction and that could put national wholesale competition at risk. They are:

- Available capacity and average data rates
- Ability to deliver good quality coverage
- Ability to deliver highest peak data rates
- Ability to deliver LTE services⁵¹

- 3.8 These dimensions of mobile services may affect the overall quality of the mobile services that can be offered to users and/or the number of customers that can be served at a given quality level.

- 3.9 We consider the extent to which national wholesalers need to hold particular types and quantities of spectrum in order to deliver these aspects of mobile services. This is informed by the technical conditions, i.e. the extent to which these quality dimensions can only be delivered using particular types and quantities of spectrum and whether there are alternative approaches or mitigation techniques available to national wholesalers to deliver those quality dimensions without the favoured spectrum portfolios. Where specific spectrum is needed to deliver a quality dimension and there are no adequate alternatives or substitutes, we describe that spectrum as delivering a technical advantage.

⁵¹ An alternative mobile technology for mobile data services to LTE is WiMAX. However, interest in WiMAX in the UK and Europe has diminished substantially in recent years and stakeholder plans suggest that the spectrum in the auction is likely to be used for LTE. However, while we focus here on LTE technology, our proposals will be as technology neutral as possible and so allow licensees the greatest scope possible on technology choice.

- 3.10 It is not necessarily the case that a technical advantage associated with holding particular spectrum portfolios will translate into a significant competitive advantage.⁵² The competitive importance of any technical advantage will depend on the market conditions, i.e. the extent to which consumers value the associated quality dimensions. We consider the available evidence on current consumer trends and demand to inform the likely importance of being able to deliver particular combinations of quality. However, we cannot accurately predict how significant these dimensions of quality are likely to be in future, and therefore there is typically uncertainty about the extent to which technical advantages associated with particular spectrum holdings are likely to translate into significant competitive advantages.
- 3.11 Initially it is helpful to consider each of these quality dimensions in isolation. However, in practice certain aspects of mobile service quality will be closely related and the quality of mobile services experienced by a consumer will depend on a combination of these dimensions. For example, whether a consumer can use a particular service at a given point in time and location will depend on the interaction of a number of quality dimensions, including whether the operator's network has coverage in that area and enough available capacity to serve that consumer at that point in time. We take into account the interaction between coverage and capacity when considering the importance of holding particular types and quantities of spectrum for national wholesale competition. In section 4, we assess the extent to which current national wholesalers can deliver particular combinations of quality dimensions with existing spectrum holdings.
- 3.12 There is an important time dimension to the assessment of which spectrum portfolios can deliver the aspects of quality listed above. Factors such as handset availability, practical limitations on refarming spectrum and the evolution of different technologies will determine when national wholesalers can use different types and amounts of spectrum to deliver particular quality dimensions. It is not possible to accurately predict how all of these factors will evolve and therefore when the above quality measures can be delivered using different types and quantities of spectrum. However, we take into account the likely duration of any possible advantages and disadvantages associated with holding particular spectrum portfolios in terms of whether they can be used to deliver the above quality dimensions.
- 3.13 In undertaking our assessment we have tried to obtain as much evidence as we can, recognising that the assessment is about future competition in the provision of mobile services. In particular, we have looked at: technical modelling of the capabilities of macrocell LTE networks; technical research on evolution of the standards for mobile technologies LTE and HSPA; research on the availability of future mobile handsets; research on the potential use of small cells; consumer survey evidence on mobile consumers' behaviour; and outcomes of similar auctions and spectrum holdings amongst competitors in other countries. This evidence is not definitive and needs careful interpretation. For example there are limitations of the analysis in the case of

⁵² In the March 2011 consultation we referred to 'unmatchable technical advantages' and 'unmatchable competitive advantages'. We described spectrum as delivering an 'unmatchable technical advantage' if it is not technically or practically feasible for a national wholesaler to deliver the same services by using other spectrum or deploying other technologies. An 'unmatchable technical advantage' associated with holding particular spectrum would translate into an 'unmatchable competitive advantage' if it allowed national wholesalers to deliver services that are valued by consumers highly enough for them to have a material impact on competition. Here we conduct similar analysis but we use slightly different terminology. We refer to technical and competitive advantages and in our assessment we take into account how important they are likely to be for national wholesale competition.

the technical modelling. In the case of the evidence listed above, it is either about the current position or heavily conditioned by current expectations. That said we believe by using this evidence we can make more informed judgements in our competition assessment.

Available capacity and ability to deliver high average data rates

- 3.14 Capacity in a mobile network can be defined as a network's ability to supply a given traffic demand at a specified level of quality. Capacity can therefore impact both the number of customers that can be served and the quality of services that can be delivered to them. For a given number of customers, the greater the capacity, the higher the data rates those customers will tend to receive.⁵³

Commercial significance of having sufficient capacity and implications for consumers

- 3.15 Consumer research suggests that consumers value higher data rates. For example, YouGov's Dongle Tracker consumer survey, which tracks the mobile broadband market, finds that download data rates are well correlated to an operator's ratings for quality.⁵⁴
- 3.16 Ofcom's Mobile Broadband Research carried out for the Ofcom Consumer Experience survey 2010 found that slow connection data rate was the most cited problem when accessing the internet via a dongle or mobile phone, both at and away from home (see Figure 3.1 below). For example, over one-third (34%) of laptop/dongle out-of-home users cited slow download data rate as the main cause of dissatisfaction.⁵⁵

Figure 3.1: Main problems experienced when accessing the internet

⁵³ Data traffic, in fact, may differ greatly in terms of quality of service requirements. For example: "VoIP requires a very low but consistent data rate, with low delay. Web browsing is delay tolerant, but requires high data rates for short durations. Video conferencing requires both low delay and high rates, and so on". See Real Wireless report for Ofcom, 4G Capacity Gains:

<http://realwireless.wordpress.com/2011/05/13/ofcom-publishes-4g-capacity-gains-study-by-real-wireless/>

⁵⁴ YouGov, Dongle Tracker Wave 13 July 11

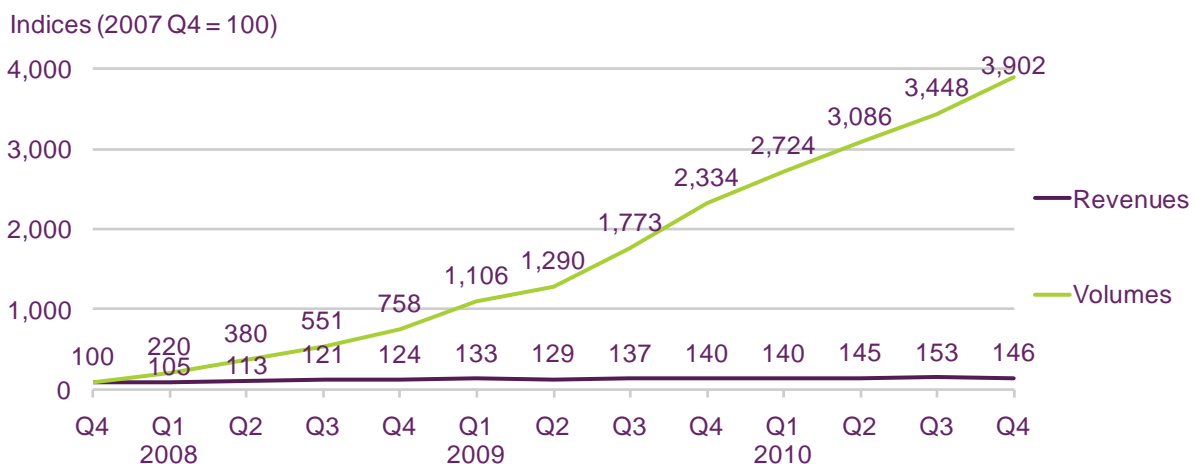
⁵⁵ <http://stakeholders.ofcom.org.uk/binaries/research/consumer-experience/tce-10/mobile-broadband.pdf>

| Are there any problems using (X) to access the Internet? | Fixed line (WiFi) | Fixed line (no WiFi) | Laptop via dongle/USB at home | Laptop via dongle/USB out of home | Mobile phone at home | Mobile phone out of home |
|--|-------------------|----------------------|-------------------------------|-----------------------------------|----------------------|--------------------------|
| Speed of connection is too slow | 18% | 24% | 22% | 34% | 27% | 22% |
| The internet connection is unreliable | 7% | 7% | 12% | 13% | 12% | 12% |
| Poor coverage – it's hard to get a connection | 3% | 2% | 7% | 9% | 6% | 12% |

Source: Ofcom Mobile Broadband Research, 2010 (Base: 2,001 All respondents)

3.17 In the future, data volumes demanded by mobile customers are expected to continue to grow rapidly. There has been a clear trend of rapid increase in mobile data traffic over the past few years, as is illustrated in Figure 3.2 below. Data volumes are increasing rapidly, growing by approximately 70% between Q4 2009 and Q4 2010, and this is part of a trend over a longer period.

Figure 3.2: Mobile data volume and revenue growth



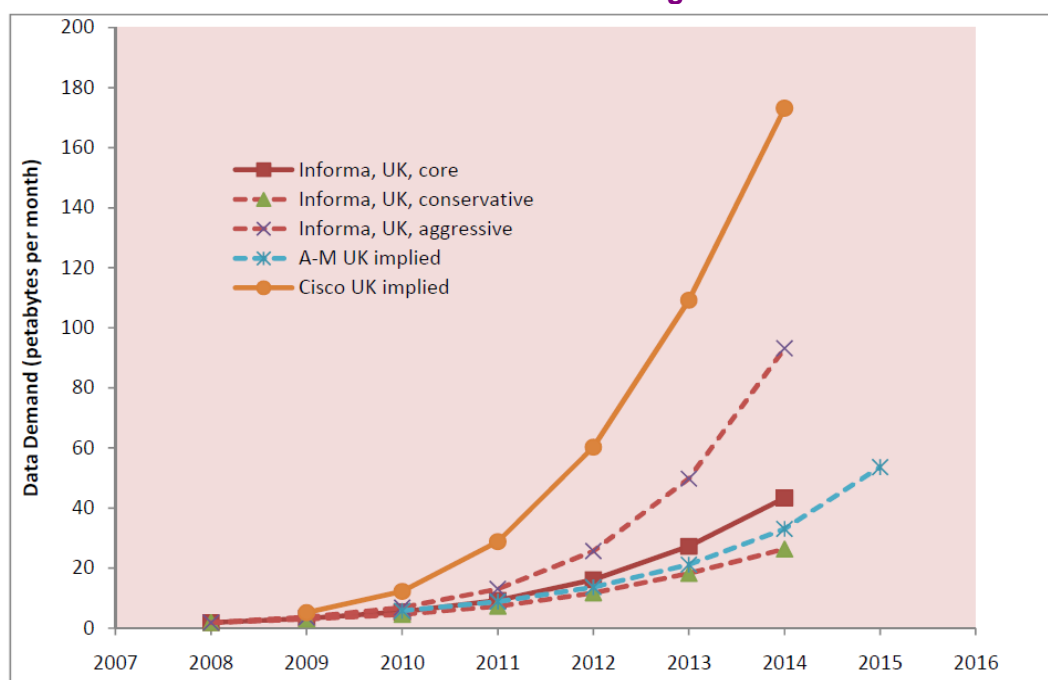
Source: Ofcom / operators

Notes: Data revenues include revenues for data services on mobile phone connections and mobile broadband (dongle) connections, but do not include any allocation for data services which may be bundled with access charges in mobile phone subscriptions; includes estimates where Ofcom does not receive data from operators

3.18 A majority of industry analysts expect this trend to continue. There may be variations in the specific rate of increase forecast, but there is broad agreement regarding the trend for material increases over time. According to a survey of analysts' views carried out by Real Wireless in 2010, UK annual growth rate for the period 2009-2014 is predicted between 24% and 102%.⁵⁶ This is illustrated in Figure 3.3.

⁵⁶ See Figure d-20, at <http://stakeholders.ofcom.org.uk/binaries/research/technology-research/2011/4g/4GCapacityGainsFinalReportA1.pdf>

Figure 3.3: Data demand forecasts for the United Kingdom



- 3.19 This picture of rapidly growing data use is consistent with forecasts by Cisco Systems, which calculated that average monthly data traffic per mobile connection in the UK increasing from 129MB per month in December 2009 to 268MB per month in December 2010. Cisco Systems projects this to increase to 4,023MB per month in 2015, equivalent to a growth rate of 84% a year.⁵⁷
- 3.20 Mobile data services are being accessed by a rapidly increasing portion of UK mobile consumers. In Ofcom's Consumer Experience Report 2011, we found that 38% of mobile phone owners claim to own a smartphone in Q2 2011, compared to 30% in Q1 2011.⁵⁸ The trend of rapidly increasing smartphone take-up is likely to not only fuel growth in overall data traffic, but also increase the importance of the ability to provide good quality data services as a larger portion of the customer base uses them.
- 3.21 Overall, we consider that a lack of capacity could have consequences on the ability to compete in the provision of mobile data services. This is because, in order to be credible, national wholesalers are likely to need to be able to exert a competitive threat across a large proportion of the market. National wholesalers with very little capacity will be limited in the number and type of consumers they can serve and are likely to struggle to compete effectively. Going forward, national wholesalers may need to expand capacity in order to be able to meet increasing demands for data volumes, particularly since we expect increasing take-up of smartphones and other devices (e.g. tablets) that make heavy use of data services.
- 3.22 Nevertheless, it is not the case that national wholesalers that face some constraints on capacity or that are more capacity constrained than their competitors will not be

⁵⁷ See Section 6.1.5 of our International Communications Report 2011: <http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/icmr/ICMR2011.pdf>

⁵⁸ The Consumer Experience 2011, December 2011: http://stakeholders.ofcom.org.uk/binaries/research/consumer-experience/tce-11/research_report_of511a.pdf

credible. They may still be able to act as a competitive constraint across a material proportion of the market. For example, the distribution of heavy users of data services may be such that, by not serving those heavy users, a capacity constrained operator may still be able to deliver services to many consumers.⁵⁹ However, competition in those particular customer segments would be weaker than would otherwise be the case. Also, future trends may change the distribution of heavy users such that the commercial cost to an operator of excluding data hungry users from its customer base will become significant.

Approaches to expanding capacity

3.23 It is not necessary for national wholesalers to have equal spectrum holdings in order to have the same amount of capacity. Network capacity is determined by three key factors⁶⁰:

- **Spectrum** – the quantity and type of spectrum allocated to a network
- **Topology** – the number and mixture of cell sizes and local environments in the network
- **Technology** – the cell spectrum efficiency that can be realised by the given features of a technology

3.24 Below, we consider the impact of topology and technology on capacity and the potential for operators with small quantities of spectrum to expand capacity. We first consider the role of deploying macrocell sites to increase capacity. In particular, we consider whether it is feasible or practical for a national wholesaler with a very small share of spectrum to serve the same number of customers as a national wholesaler with a larger quantity of spectrum, by investing in macrocells. We then consider the extent to which smaller cells, such as microcells or femtocells, can be used to help address any capacity disadvantage associated with holding small quantities of spectrum and the extent to which it is possible to expand capacity by buying capacity from other operators.

3.25 Finally, we consider the impact that the frequency of spectrum used can have on capacity, both directly and indirectly, in terms of the technology that can be used with particular spectrum frequencies in the near term.

The scope to expand capacity through investment in macrocells

3.26 National wholesalers can expand the capacity available to them by deploying more macrocell sites. Macrocell sites are base stations providing coverage over a wide area via antennas placed at or above the height of surrounding buildings and other obstacles, typically mounted on rooftops masts or towers. A national wholesaler with less spectrum than others but access to a larger pool of macrocell sites may be

⁵⁹ An article in Mobile Europe (April/May 2011) suggests that just a few subscribers account for a disproportionately high percentage of mobile traffic. For example, in Europe, 6% of Vodafone subscribers account for 54% of overall traffic:

<http://viewer.zmags.com/publication/9576e079#/9576e079/22>

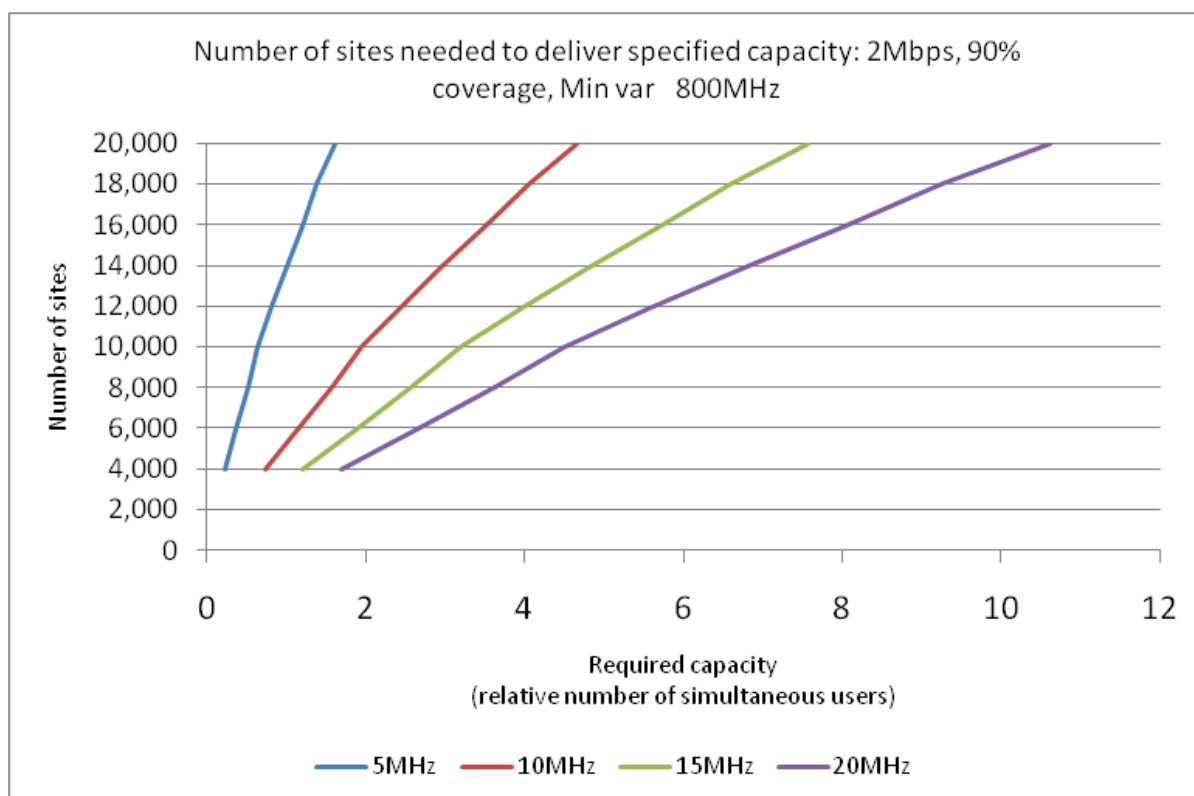
⁶⁰ This section draws partly on Real Wireless's report for Ofcom, 4G Capacity Gains, January 2011: <http://stakeholders.ofcom.org.uk/binaries/research/technology-research/2011/4g/4GCapacityGainsFinalReport.pdf>

better placed to deliver capacity. This is one reason that we do not consider that it is necessary for all national wholesalers to have equal spectrum holdings.⁶¹

3.27 However, if a national wholesaler has a very small share of total mobile spectrum, there could be a risk that it will not be able to establish enough capacity to act as a credible competitor, or at least will be at a disadvantage in competing for customers who have very high data needs (such as consumers using dongles). This is because, given the trade-off between spectrum and site numbers, then more sites will need to be added for any given capacity increase if a national wholesaler has little spectrum. With a very small share of spectrum, a national wholesaler will therefore tend to face higher marginal costs for incremental units of capacity than competitors holding larger shares of spectrum.

3.28 This effect is illustrated in Figure 3.4 below. This shows the number of sites⁶² needed to deliver capacity for four different spectrum holdings at the same frequency (1800MHz), from our technical modelling.⁶³ This is for 2 Mbps, but the basic relationship of the lines would be the same for higher data rates.

Figure 3.4: Number of sites need to deliver a specified level of capacity for various quantities of spectrum



3.29 This graph shows:

⁶¹ We discuss some of the arguments that H3G has made about equal spectrum shares in Annex 10.

⁶² While our technical modelling and the analysis here is in terms of macrocells, the same basic arguments also apply to small cells.

⁶³ See Annex 14 for a description of how we have modelled LTE macrocell networks.

- The trade-off between macrocells and spectrum in terms of delivering capacity. Capacity can be increased by adding sites (by moving along each line) or by increasing spectrum (by moving from one line to another towards the right).
 - The incremental cost of adding capacity through network expansion is higher with less spectrum. This can be seen by comparing the slopes of the lines. With only 2x5MHz of spectrum, the line is very steep, meaning that a lot of sites need to be added to increase capacity. With 2x20MHz of spectrum, the line is flatter, so capacity increases more for any given increase in site numbers.
- 3.30 With a small share of spectrum, the site numbers could become very large to provide a similar level of capacity to a large share of spectrum. As a result, national wholesalers with very small spectrum shares may represent a weak competitive threat because their costs for expanding capacity to serve more consumers at given average data rates or meeting increased expectations of existing customers may be substantially higher than for their competitors.
- 3.31 It is difficult to know how much capacity might be needed in the future for a typical national wholesaler. This can be seen from Figure 3.3, which shows widely divergent future data growth projections, though all show a strong upward trend. However, it is possible that the level of network investment required to serve customers may threaten the financial viability of a national wholesaler if it only had a very small spectrum share.
- 3.32 We use the same graph at paragraph 5.20 below to illustrate that, in general terms, the additional value of a block of spectrum tends to fall the higher the existing holdings of spectrum.

Practical constraints on building very large numbers of sites

- 3.33 As well as the cost, there may also be practical constraints in building large numbers of sites.
- 3.34 If considering very large number of sites, then one practical limitation will be the time that it takes to roll out additional new sites beyond the size of existing networks. In general, building new sites is significantly more difficult and costly than upgrading existing sites. For new sites the process can be longer due partly to the time involved in obtaining planning permission. In previous work we assumed that a national wholesaler may not be able to add more than 1,500 new sites per year and we consider this is still a reasonable assumption.⁶⁴ This indicates that the deployment of additional network sites beyond the existing network size may considerably slow down the process of expanding capacity.
- 3.35 A second practical issue concerns the higher costs per site that national wholesalers are likely to incur as the site number rises. Typically, the extent to which an additional site is effective in increasing capacity depends on its location (for instance, sites close to major traffic sources tend to reduce interferences and, thus, improve performance). Additionally, some sites are not suitable on interference grounds (e.g.

⁶⁴ See paragraph A12.31 in our February 2009 Consultation on 2G liberalisation: <http://stakeholders.ofcom.org.uk/binaries/consultations/spectrumlib/annexes/annex12.pdf>. It is likely to be possible to upgrade a significantly higher number of sites per year (see paragraph 5.78 in the main document which assumes that a total of 3,500 sites could be upgraded or, where necessary built, per year).

they are too high or too close to an existing site). As the most cost-effective sites are usually taken first, national wholesalers that need additional sites are more likely to face the risk of suboptimal solutions. Such a problem may emerge especially in already-congested urban areas where the availability of suitable locations is scarce.

- 3.36 This reinforces the concern that very small spectrum shares may limit how strongly a national wholesaler can compete.

Implications of network sharing

- 3.37 It may be possible to reduce high incremental network costs through network sharing, provided that was consistent with competition law.
- 3.38 These agreements are likely to be most valuable to the sharing parties if they want to build similar networks, in terms of both overall size and specific frequencies used. The nature and amount of spectrum held will affect this. Even if two parties have the same frequencies, if they want to build very different sized networks, then they may find it difficult to reach an agreement. Even if they can reach agreement, it may be that the number of shared sites is much smaller than the party with the smaller spectrum holding would like. It may therefore not significantly reduce the incremental costs of adding capacity for a national wholesaler with a very small spectrum share. It also fails to address the basic limits on the total number of suitable macrocells.
- 3.39 In addition, spectrum holdings may affect the negotiating position of the parties. A strong or comparable spectrum holding may strengthen the negotiating position of a party. In particular, if it is credible for one party to be viable when it builds a network on its own, it will be in a much stronger negotiating position.
- 3.40 The possibility of network sharing therefore does not remove the importance of having a reasonable share of spectrum.

Using small cells to address capacity constraints

- 3.41 Small cells are cells with a smaller coverage area than conventional macrocells, by virtue of lower antenna heights and typically lower powers. They may be deployed outdoors, for example on lampposts and the exterior walls of buildings, where they are typically referred to as microcells, metrocells or outdoor picocells. They may also be deployed indoors in homes, offices or public locations, where they may be described as femtocells, picocells, or access points. Given their smaller coverage area and their placement near to the users to be served, they are less sensitive to differences between frequency bands than macrocells. Wi-Fi systems can be regarded as a form of small cell operating in licence-exempt spectrum. We consider the different small cell technologies in more detail later (see paragraph 3.95) in the context of delivering improved coverage. However, small cells can also be deployed to boost capacity.
- 3.42 The air interface capacity⁶⁵ of each small cell in a given quantity of spectrum may be comparable to the capacity of a sector of a macrocell or even higher due to a more favourable signal quality depending on the location and level of interference from

⁶⁵ The capacity of the small cell hardware may be less than the achievable air interface capacity if it is not required within the coverage area of the cell, but this reduces the device cost rather than acting as a constraint on capacity, provided devices appropriate to the environment (e.g. homes/offices/public spaces) are selected.

nearby co-channel cells. However the overall network capacity in a given area may be increased by a factor related directly to the number of small cells deployed in the area, so the available capacity density can be substantially greater than for macrocells, given that small cells are expected to be lower in cost than a macrocell, and not subject to the same constraints on site acquisition which apply to macrocells.

- 3.43 The extent to which small cells will be used in the future is uncertain. Small cells may have a role to play in helping to address any disadvantages faced by national wholesalers with relatively smaller shares of spectrum. However, they are unlikely to be used as a complete substitute for investment in macrocells to delivery capacity or to fully address the barriers to capacity expansion faced by an operator with very small quantities of spectrum. For example, it is unlikely to be practical to use microcells to deliver capacity over wide areas, even though it might be helpful to deploy them in particular locations of high demand.

National wholesalers may be able to buy capacity

- 3.44 To some extent it may also be possible for national wholesalers to buy capacity rather than build their own networks. For example, national wholesalers currently buy off-load capacity from operators with Wi-Fi networks (such as BT).
- 3.45 In the future there may be wider opportunities to buy capacity. For example, UK Broadband intends to build an LTE network covering all major UK cities and to wholesale services. UK Broadband has a large amount of spectrum (124MHz) in the 3.5 to 4.2GHz range. This spectrum has been included in LTE standards, but it is not clear that there will be a wide range of handsets for these frequencies. But there are other devices that are more likely to use this frequency, including 'MiFi' devices and potentially routers and dongles. In locations reached by this high frequency spectrum, serving these devices with UK Broadband's spectrum could free up national wholesaler capacity for other mobile devices.⁶⁶
- 3.46 While the opportunities for buying data off-load services may increase in the future, we consider that they are unlikely to be used as a complete substitute for investment in macrocells to deliver capacity. They are most likely to be suitable in addressing specific gaps in capacity in certain locations, rather than as an approach to delivering capacity over a wide area. There are also likely to be some risks associated with relying on buying capacity in terms of uncertainties around cost and innovation. Therefore, national wholesalers are likely to need enough spectrum and access to macrocell sites in order to deliver the level of capacity needed to be credible.

Impact of frequency of spectrum on capacity and data rates

Lower frequency spectrum can deliver more capacity

- 3.47 The radio resources (time and frequency) needed to deliver a given level of capacity to users will depend on the radio propagation environment. If large propagation losses are experienced between base stations and mobile users, then the system will need a large quantity of resources to deliver a given level of service (quality and data

⁶⁶ We do not anticipate that UK Broadband could act as a significant competitive influence on the national wholesale market in its own right with its existing spectrum. This is because its spectrum is high frequency (higher than 2.6GHz) and, while in standards, its frequencies do not currently benefit from an internationally harmonised 'ecosystem' for user devices or network equipment to the extent of the mainstream mobile spectrum frequencies.

rate). At lower frequencies, the losses experienced are lower, so a higher quantity of demand can be served with a given quantity of resources, provided that interference between adjacent cells is carefully managed. This effect is likely to be greatest for the hardest to serve locations, where the differences in propagation losses between frequency bands are largest.

- 3.48 This is illustrated in our technical modelling results (see Annex 7). Comparing 800MHz, 1800MHz and 2.6GHz with the same bandwidth and for a given quality of coverage delivered, the higher frequency networks are shown to have consistently less capacity (see Figure 41 and Figure 42 in Annex 7). We can also see that, for a given quality of coverage delivered and available bandwidth, 800MHz spectrum delivers greater single user throughput than 1800MHz spectrum, which in turn delivers more than 2.6GHz spectrum. As we describe in more detail when we consider peak speeds below, single user throughput is the maximum speed that a single user would theoretically be able to receive if the only user in the serving cell demanding service at any particular instant of time, but when the user may not be at a location with ideal signal conditions.

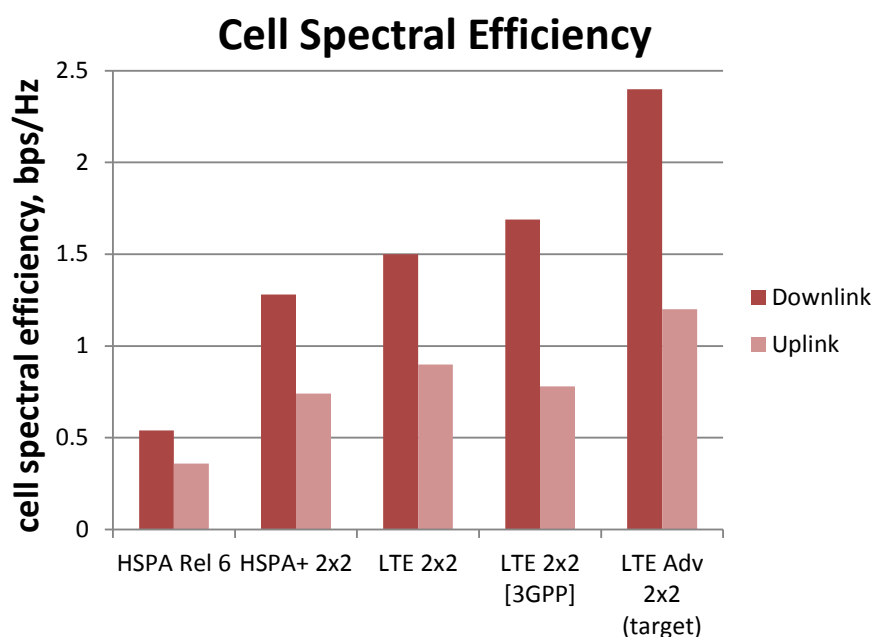
Implications of technology used for capacity

- 3.49 Different technologies can deliver different levels of capacity and data rates, for a given amount and type of spectrum. Therefore the frequency of spectrum held will also have an indirect impact on capacity given that the timing of the technologies that can be deployed will depend on the frequency of spectrum held (e.g. see Figure 3.14 below).
- 3.50 In particular, capacity and ability to deliver high average data rates will be affected by the cell spectral efficiency of the technology. The cell spectral efficiency refers to the total throughput which a cell can provide in a unit spectrum bandwidth, taking account of interference from other cells at a given loading level and the distribution of users around the cell. As a result it provides a measure of the overall capacity which is available to be shared amongst users, normalised to the quantity of spectrum available to deliver it. The capacity may be shared amongst the users equally or otherwise, depending on their needs and the operator policies.
- 3.51 Figure 3.5 below compares cell spectral efficiencies for the various HSPA⁶⁷ and LTE⁶⁸ releases with comparable 2x2 antenna configurations. Actual spectral efficiency achieved in practice will be limited by the availability and penetration of devices, utilisation of the spectrum and the characteristics of traffic that consumers demand.

⁶⁷ By “HSPA” we mean the High Speed Packet Access technology first specified for the downlink (HSDPA) by 3GPP in its Release 5 UTRAN Specification (June 2002) and evolving through subsequent releases, including features in Release 7 (December 2007) and beyond, often referred to as HSPA+.

⁶⁸ By “LTE” we mean the Evolved UTRAN (Universal Terrestrial Radio Access Network) technology first specified by 3GPP starting in their Release 8 Specification (December 2008) and evolving through subsequent releases, including Release 10 (March 2011) features and beyond, often referred to as LTE-Advanced and complying with the ITU-R requirements for IMT-Advanced technology.

Figure 3.5: Cell spectral efficiency (capacity per unit bandwidth) for macrocells with 2x2 antenna configurations, according to technology



Source: "The timing of the consumer and operator features available from HSPA and LTE technology paths", Real Wireless, January 2012

- 3.52 A study by Real Wireless for Ofcom⁶⁹ estimates that in early deployments of LTE it will provide around 20% more capacity for the same spectrum compared to high end HSPA networks available at a similar time. It also indicates that high end HSPA networks can deliver far more capacity than the first UMTS technology.
- 3.53 To the extent that LTE can provide a higher spectrum efficiency than HSPA, the number of sites required to deliver a given capacity level to a given coverage quality will be reduced (all other things being equal, notably the spectrum band and quantity). Hence the costs to the operator may also be reduced.
- 3.54 The wider the bandwidths that are supported by LTE the greater the efficiency benefits. Wider bandwidths provide increased frequency domain scheduling gains, which increase spectral efficiency for the operator.⁷⁰ Wider bandwidths also allow for more flexibility in resource scheduling which can bring efficiency benefits.
- 3.55 High peak data rates can also improve the overall capacity of the network. They do this by minimising the resources needed to serve the users with very good signal conditions, delivering their required data in a short period of time. As a result more resources are available for serving users with poor signal conditions meaning those users can potentially experience a higher data rate or more of those users can be served. Having large contiguous blocks of spectrum suitable for LTE may allow national wholesalers to deliver high peak speeds and any associated capacity benefits. We consider the spectrum needed to deliver high peak speeds in more detail below (see paragraph 3.163 below).

⁶⁹ See section 1.5 of Real Wireless's report for Ofcom, 4G Capacity Gains, January 2011.

⁷⁰ With dual carrier HSPA, some of the associated gains can be had by selecting the best quality of the 5MHz carriers for individual packets. LTE achieves higher gains in this respect, as scheduling can occur at finer grain per 180kHz 'resource block' rather than in 5MHz carriers.

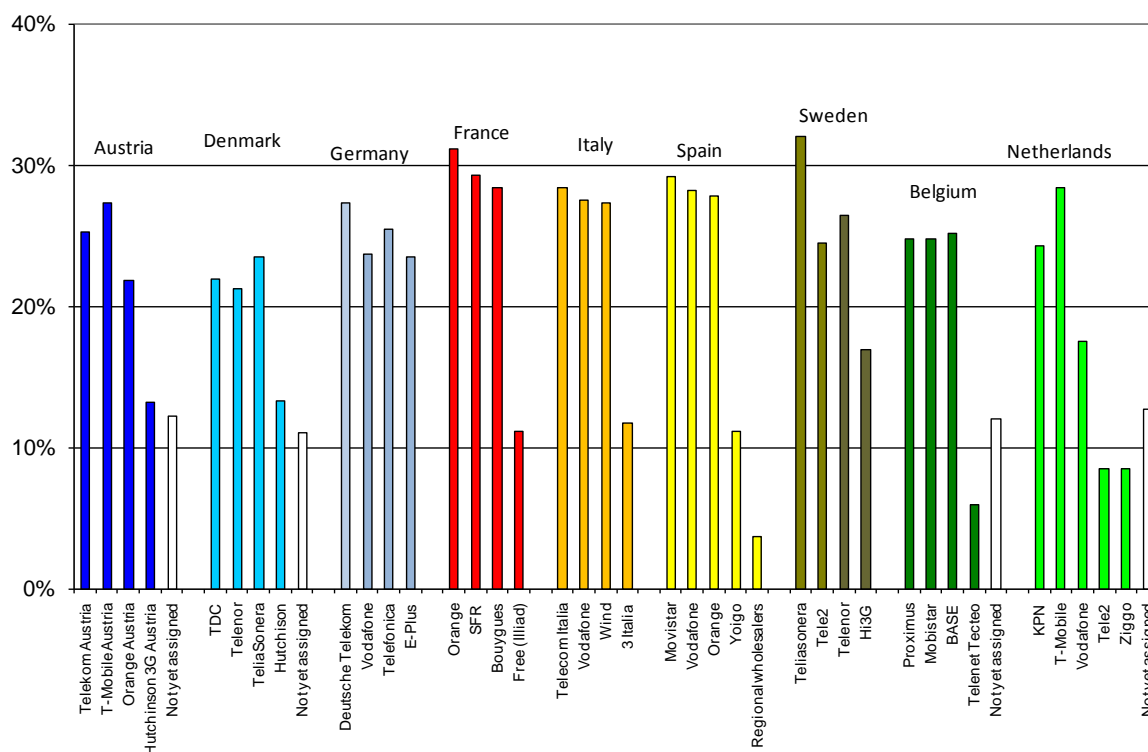
3.56 As we set out below, not all frequencies are likely to be used for LTE in the same time frame. For example, the ecosystem for LTE is not currently available for 2100MHz spectrum. National wholesalers with spectrum that is not suitable for early LTE deployment will face a delay in the availability of this option for increasing capacity and average data rates.

International evidence on the importance of total quantities of spectrum held

- 3.57 While it is difficult to draw any firm lessons from auctions held in other countries, some common features of these auctions may help inform the likely minimum share of spectrum needed to be credible.
- 3.58 The graph below compares the share of (paired) spectrum of national wholesalers in some Western Europe countries with 4 or more wholesalers.⁷¹ It shows:
- The difference in spectrum shares between the smallest and the largest wholesalers is often considerable, with the exception of Germany.
 - Most national wholesalers in these countries have more than 10% of the available spectrum. The exceptions are new entrants in Belgium and the Netherlands: Telenet Tecteo holds 6% of available spectrum in Belgium and Tele2 and Ziggo in the Netherlands both hold 8% of the available spectrum.

⁷¹ Iliad (France) and Telenet Tecteo (Belgium) were awarded a licence to operate a 3G network only recently and they have not yet started to market mobile services. Similarly, in the Netherlands, Tele2 and Ziggo won 2x20 MHz of 2.6 GHz each in 2010 auction but they have not yet started to retail mobile services.

Figure 3.6: Wholesalers' shares of paired mobile spectrum in European countries with 4 national wholesalers^{72 73}



3.59 Those operators with less than 10% of total available spectrum are likely to increase their share in the near future as a result of further European regulation. In particular, Telenet Tecteo in Belgium has the option of buying the 2x4.8 MHz of 900 MHz spectrum and 2x10 MHz of 1800 MHz spectrum released by the other wholesalers (this would raise its share to 12%), and Tele2 and Ziggo may take advantage of the 2x15 MHz in the 800 MHz and 900 MHz that has been reserved for new entrants in the forthcoming auction.

3.60 Figure 3.7 compares the spectrum shares of the “smallest” wholesaler, in terms of spectrum holdings,⁷⁴ in each country. The first column reports the share based on the current holdings, while the second column includes the additional spectrum that the wholesalers are likely to obtain (either because directly assigned by the regulator or because of the reserved spectrum in the auction).⁷⁵

⁷² The white bar represents the 800 MHz band not yet awarded.

⁷³ For Sweden we assumed that Telenor and Tele2 share equally the awarded 2x10 MHz spectrum at 800 MHz.

⁷⁴ For Germany we consider both Telefónica and E-Plus as there is not a single wholesaler who is clearly smaller than the others. Telefónica and E-Plus are the two smallest wholesalers but they are rather similar in terms of market shares and spectrum holding (and they were so even before the auction)

⁷⁵ The minimum expected share of Tele2 and Ziggo in the Netherlands are calculated based on the assumption that they will acquire the spectrum reserved to new entrants in the forthcoming auction. The total reserved spectrum amounts to 2x15 MHz (2x10 of 800 MHz and 2x5 MHz) with a cap of 2x10 MHz on what a new entrant can obtain. The “minimum expected future shares” of Tele2 and

Figure 3.7: Shares of paired mobile spectrum of “fourth” wholesaler in European countries

| Country | “Fourth” wholesaler | Current share | Minimum expected future share |
|-------------|----------------------|---------------|-------------------------------|
| Austria | Hutchison 3G Austria | 13% | 13% |
| Denmark | Hutchison | 15% | 15% |
| Germany | E-Plus | 25% | 25% |
| | Telefonica | 24% | 24% |
| France | Free (Illiad) | 11% | 11% |
| Italy | 3 Italia | 12% | 15% |
| Spain | Yoigo | 11% | 11% |
| Sweden | Hi3G | 17% | 17% |
| Belgium | Telenet Tecteo | 6% | 12% |
| Netherlands | Tele2 | 8% | 11%/13% |
| | Ziggo | 8% | 11%/13% |

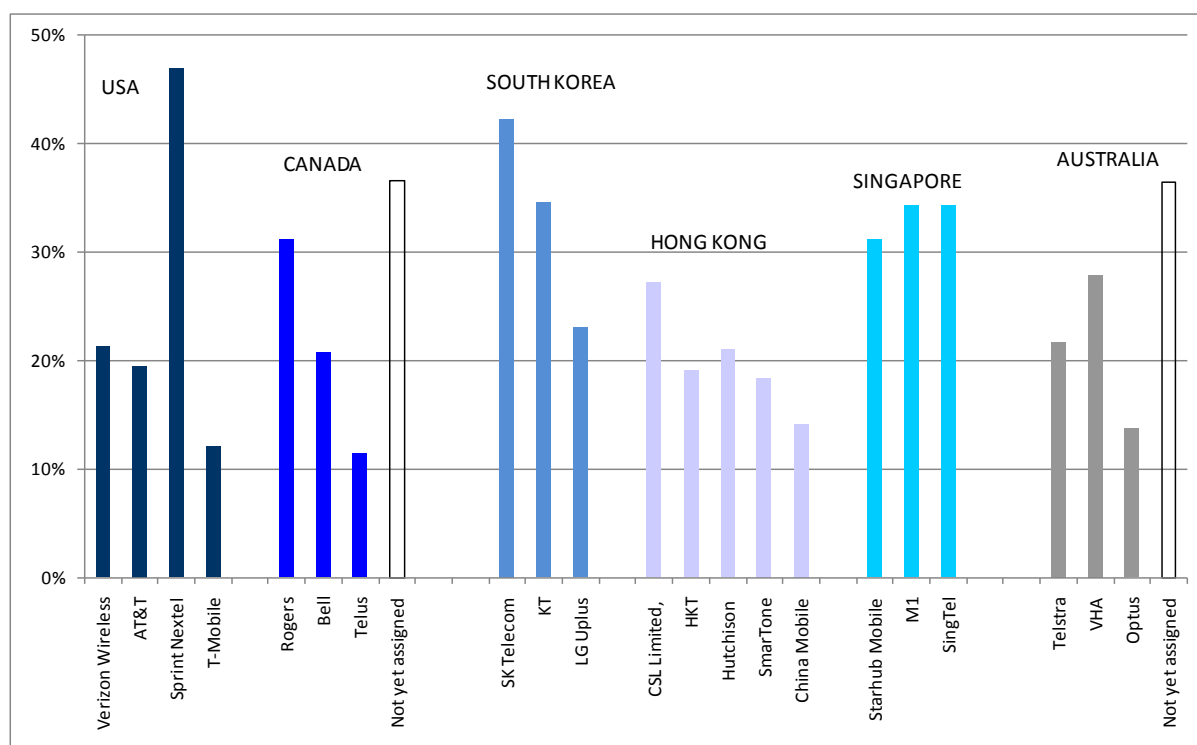
- 3.61 The auction for the 2.6 GHz band has already taken place in all of these countries. However, the auction for 800 MHz has only taken place in five countries⁷⁶: Germany, Italy, Spain, France and Sweden. Of those countries, the smallest national wholesalers are Yoigo in Spain and Illiad in France, which hold just over 10% of total spectrum available. Yoigo in Spain is a recent entrant and has a low, but growing, market share.⁷⁷
- 3.62 Figure 3.8 reports wholesalers’ holdings in USA, Canada, South Korea, Hong Kong, Singapore and Australia and shows that in these non-European countries all national wholesalers hold more than 10% of total paired spectrum.

Ziggo are calculated assuming that they will split among them the reserved spectrum, one obtaining 2x10 MHz and the other the remaining 2x5 MHz. So, according to who gets 2x10MHz, their minimum share could be either 11% or 13%.

⁷⁶ Portugal also awarded the 800 MHz spectrum but it is not considered here because it has less than four national wholesalers.

⁷⁷ It is worth noting that Yoigo did not compete for the 900 MHz band that was auctioned recently, although there was arguably less competition from the three biggest incumbents which were restricted by the spectrum caps (and in fact one block of 2x5 MHz of 900 MHz went unsold).

Figure 3.8: Wholesalers' shares of paired mobile spectrum in non-European countries



3.63 Spectrum holdings in European and non-European countries⁷⁸ provide some indication that it may be difficult to act as a credible national wholesaler when significantly less than 10% of the available spectrum is held. However, there are a number of reasons why we should be cautious when looking at international evidence to inform the minimum share of spectrum needed to be credible. For example:

- It is too early to tell whether any of these players will act as credible national wholesalers going forward and the extent to which their ability to compete is linked to the shares of spectrum they hold. It is possible that those operators with relatively small shares of spectrum struggle to act as credible national wholesalers in future, even if they hold more than 10% of the total available spectrum.⁷⁹
- Similarly, although there are no examples across the selected countries of national wholesalers competing with less than 10% of spectrum (once future interventions have been taken into account), it is not necessarily the case that a national wholesaler with less than 10% of available spectrum cannot act as a credible national wholesaler. It is worth noting that European regulators have

⁷⁸ See Annex 9 for further details on the data used to calculate the spectrum shares.

⁷⁹ We considered whether we can learn anything from looking at the shares of spectrum for potential national wholesalers that exited in other countries. However, we found the circumstances of exit were too specific to draw any meaningful general conclusions. For example, most exits or mergers were some time ago and there have been significant changes over time. In particular, the reasons many of the '3G entrants' failed in Europe may not be relevant today. They may have failed not because of a low share of spectrum but due to not having 2G spectrum. For some customers (e.g. those interested just in voice and text messaging), 2G services may have been more attractive in the past because 2G handsets were cheaper than 3G handsets. This disadvantage may now be reducing rapidly because the difference in the price of 2G and 3G handsets has fallen. Moreover, there is now strong and growing interest in data services (as illustrated by the growth in Smartphones).

redistributed spectrum in favour of smaller existing players and new entrants, and have placed caps on how much can be acquired. Consequently, the observed spectrum shares are largely influenced by what regulators think national wholesalers need to be credible (and not necessarily what national wholesalers perceive or actually need in order to be credible).

- In any case, as we discuss in more detail below, the strength of a national wholesaler and its ability to act as a credible national wholesaler will depend on its ability to deliver a number of quality dimensions and these should be considered in the round. To some extent, it is possible that a national wholesaler with a relatively small share of spectrum can act as credible national wholesaler if its weaknesses in terms of spectrum shares are compensated by significant advantages in other quality dimensions.

Analysts' views on the importance of quantities of spectrum held

3.64 A number of third parties (mainly brokers) have commented on the potential effects of small spectrum holdings (or lack of low frequency bands). Brokers have questioned the viability of poorly spectrum-endowed national wholesalers and point to the risk that those national wholesalers can be the target of future consolidation.

3.65 RBS analysts commenting on 3 Italia's holdings after the recent auction state that:

“3's very limited spectrum acquisition and relatively limited investment is, in our view, likely to lead to further speculation that the business is for sale and that in-market consolidation is likely”.⁸⁰

3.66 Some brokers view a rather tight relationship between spectrum holdings and the ability to sustain competitive strategies in the longer term. Commenting on the results of the recent 2.6 GHz auction in France, J.P. Morgan Cazenove's analysts state that:

“We assume Iliad will achieve 10% market share by 2020, which would seem consistent with owning 12% of the spectrum today, but will probably require some additional spectrum in the longer term, if the others were to boost their position ahead of Iliad in the forthcoming 800MHz auction”.⁸¹

Provisional conclusions on capacity and high average data rates

3.67 We consider it necessary at a minimum for national wholesalers to have sufficient capacity in order to serve enough customers with sufficiently high data rates for them to be credible. However, there are other approaches to building capacity besides acquiring spectrum and national wholesalers with smaller spectrum shares than their competitors may be able to deliver comparable levels of capacity by relying on these other approaches. Also, it is not necessary for national wholesalers to have the same capacity as the largest national wholesaler in order to have a significant influence on competition. Therefore we do not consider that national wholesalers need the same, or close to the same, overall quantities of spectrum in order to act as credible national wholesalers. This is consistent with what we observe in other countries, where shares of spectrum held by operators vary considerably.

⁸⁰ RBS, Telecoms News & Views, 30 September 2011

⁸¹ JP Morgan Cazenove, Europe Equity Research – French Mobile, 22 September 2011

- 3.68 However, we also recognise that, while there are a number of substitutes available, spectrum is an important input to capacity and national wholesalers with very small quantities of spectrum may struggle to deliver the minimum level of capacity and average data rates needed to provide a significant competitive constraint. This is also consistent with evidence from other European and non-European countries, showing that, in general, the minimum share of spectrum held by a national wholesaler is close to 10%. We consider that it will be increasingly important for national wholesalers to have sufficient spectrum and capacity in the longer term, given our expectations for increasing demand for data services.
- 3.69 It is difficult to identify what the minimum level of spectrum a national wholesaler would need in order to be credible. To some extent this will depend on the frequency of spectrum held and the ability of national wholesalers to deliver other quality dimensions. But, broadly, we consider that there is some risk that a national wholesaler would not have enough capacity to be credible if it held less than 10% to 15% of total spectrum holdings. The smaller the share of spectrum held below 10% to 15% the greater the risk that a national wholesaler will not be credible.
- 3.70 In relation to our second type of competition concern about competition across a wide range of services and customers, we recognise that a national wholesaler with lower shares of spectrum relative to its competitors may be a weaker competitor in some particular segments of services or customers, even if it has enough spectrum to act as a credible national wholesaler. In Section 4, we consider the extent to which there is a risk of consumer detriment associated with having some national wholesalers that are credible but weaker competitors due to constraints on capacity.

Ability to provide good quality coverage

- 3.71 Coverage is an important dimension of the quality of mobile data service available to consumers. Looking at quality of coverage from the perspective of the consumer experience, we consider various aspects in the round, such as where the consumer can obtain a service, the speed (and other characteristics of service) where it is available and the consistency of experience as consumers seek to use mobile data services in different locations.
- 3.72 From a technical perspective, we consider two distinct aspects of coverage.
- **Breadth of coverage:** breadth of coverage indicates the extent of service at a given level of data throughput. The service extent is typically measured in terms of the population at residential and/or business locations which are served, or via a measure of the geographical area served. Ordinarily it is used to indicate the service which would be obtained when the network is lightly loaded, so that users experience relatively little interference or congestion.
 - **Depth of coverage:** this is the ability to deliver a service to harder to serve locations, e.g. deeper within buildings (up to 15 metres). The depth could indicate directly the distance within a given building for which adequate in-building service is available. However it may also be taken as a more general indication of the difficulty of providing service, for example to buildings with more challenging construction, and in hard-to-serve locations such as behind tall buildings, within tunnels etc.
- 3.73 Lower frequency spectrum has advantages over higher frequency spectrum in both breadth and depth of coverage, as discussed below.

- 3.74 Consumers are likely to attach value to being able to get mobile coverage on the move. While the issue of breadth of coverage was not raised as an important issue in responses to the March 2011 consultation, we consider that a national wholesaler needs to be able to deliver sufficient breadth of coverage in order to be credible.
- 3.75 Depending on the measure chosen, existing 2G networks provide outdoor coverage to around 99% of UK premises and for 3G services in excess of 90% outdoors, with some variations between operators. We consider that coverage similar to current 3G coverage would be likely to be sufficient to be regarded as being 'national'.
- 3.76 While there are advantages of lower frequency spectrum in terms of delivering breadth of coverage, it is likely to be possible to deliver sufficient breadth of coverage to be credible with higher frequency spectrum. There will not be a particular barrier to achieving coverage comparable to today's 3G coverage, which until recently has been delivered using UMTS2100, with 2100MHz spectrum and below. However coverage using LTE2600 is predicted to be materially less than UMTS2100 and so it is likely to be more challenging to provide national coverage using LTE2600.
- 3.77 This rest of this sub section considers whether there is likely to be a technical and commercial advantage associated with holding lower frequency spectrum in terms of providing depth of coverage:
- First, we use evidence from technical models to compare the coverage performance of different spectrum portfolios at different location types.
 - We then consider the extent to which it is possible to improve the performance of indoor coverage associated with higher frequency spectrum by deploying other technologies, such as Wi-Fi and femtocells.
 - Finally, we consider the extent to which consumers are likely to value the superior coverage offered by lower frequency spectrum, where this cannot be matched using other spectrum or technologies.

Technical modelling evidence

Introduction to technical modelling

- 3.78 To inform our assessment of the likely importance of holding low frequency spectrum to deliver good quality coverage, we draw on evidence based on technical modelling of the performance of LTE networks. The technical model we have used is an evolution of the model developed for the March 2011 consultation. For a comprehensive description of the modelling methodology and the underlying assumptions and parameters see Annex 14.
- 3.79 The technical modelling results provide some useful insights into the nature and scale of any technical advantages that different spectrum portfolios can deliver. However, these results should not be taken as a definitive prediction of the real performance of actual LTE networks. Any attempt to derive the performance of a mobile network using a theoretical modelling approach is inevitably going to be inherently uncertain. This is particularly the case when modelling new technologies such as LTE because the model must, by necessity, include estimates of current performance and potential improvements in performance as the technology matures for which there will be limited empirical evidence.

- 3.80 To reflect the major areas of uncertainty in our model we have chosen to model a range of values for key parameters. To illustrate this range we have chosen to group the parameter values into two sets:
- those that tend to minimise the relative performance variation between frequencies ('Min var'); and
 - those that tend to maximise the relative performance variation ('Max var').
- 3.81 We interpret the gap between the 'Min var' and 'Max var' lines as an indication of the uncertainty there is with respect to the performance predicted by our model. Some of this uncertainty relates to uncertainty over the choices that networks operators might make in future about the operation of their networks;⁸² some relates to uncertainty over how effective some potential measures to improve performance might be; finally some of the uncertainty relates to how effective signals at different frequencies will be at penetrating into buildings and other hard to serve locations, and how variable the signal quality will be. See Annex 7 for more detail on the sources of uncertainty in our results.
- 3.82 For any particular location, we believe that it is more likely than not that performance will lie somewhere between our 'Min var' and 'Max var' lines, but we are not making any specific judgement as to the likely distribution of results within this range. It should however also be noted that there are many more sources of uncertainty than are captured in our 'Min var' and 'Max var' sets. In Annex 14 we have a detailed discussion of a very wide range of these sources and we report the results of an extensive sensitivity analysis of our model to them.
- 3.83 When interpreting the technical modelling results, it is also worth noting:
- The model only looks at the macro-cell layer of any network. Our model does not include alternative methods of dealing with dense traffic 'hot-spots' and/or traffic in hard to serve locations by techniques such as Wi-Fi off-load or deploying femtocells.
 - The model is based on LTE technology. However, the coverage, speed and capacity that can be delivered with a given portfolio of spectrum will depend on the technology used.
 - The results abstract from questions of spectrum availability e.g. how quickly it might be possible to refarm 900MHz and 1800MHz spectrum, and also from issues of equipment availability e.g. availability of equipment that supports 2x15MHz carrier in 900MHz, to focus purely on the prospective capabilities of networks using different portfolios of spectrum.

Technical modelling results for coverage with different frequencies

- 3.84 When comparing the coverage of different frequencies, we consider a relatively low data rate of 1 Mbps services. This provides an indication of the limit of mobile data service coverage that a network is likely to be able to deliver (it being harder to

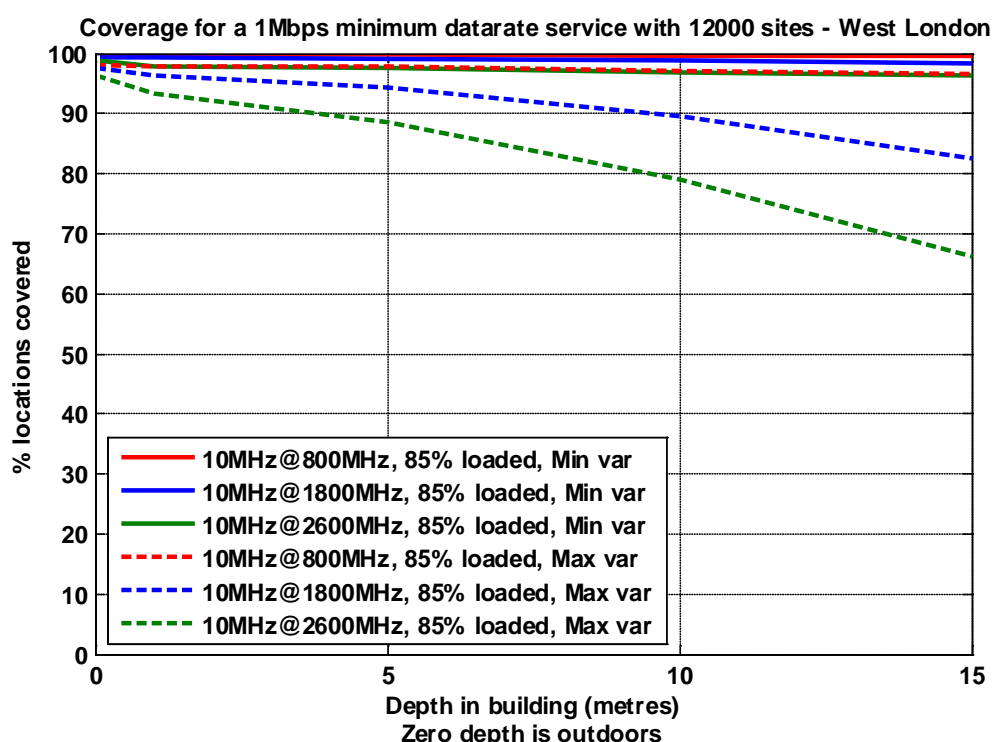
⁸² As we note in Annex 7, in principal, with more information we could reduce or possibly eliminate this source of uncertainty. We would welcome any additional information from operators that could be used to reduce the uncertainty in our model.

deliver higher speeds and hence the coverage available at higher speeds likely being lower).

- 3.85 Figure 3.9 below illustrates the variation in coverage with depth for different frequencies for a particular network size (the equivalent of 12,000 sites nationally) suggested by our model⁸³. The percentage of locations within an urban/suburban simulation area at which it is possible to receive 1 Mbps is shown on the vertical axis and depth in-building on the horizontal axis. The percentage of locations represents the percentage of locations within the West London simulation area where our model suggests that the specified minimum data-rate service can be received.
- 3.86 As per the February 2009 consultation the simulation models signals propagating indoors as being attenuated by two components; firstly a loss at the external wall and secondly by an increasing loss as the signal propagates further and further indoors. Though presented as an actual physical distance from the external wall, we exercise caution in interpreting this literally. For instance, whilst our results for a depth of 1 metre may represent someone very close to the external wall where the major influence is the external wall loss, our results for a depth of 15 metres could be taken to represent a user physically very deep within a relatively low loss building but could also represent a user who is at a shallower physical depth but in a building subject to greater propagation losses e.g. behind several internal walls or in a building with a very thick external wall etc. So our interpretation of the analysis is one of ability to serve a distribution of easier and harder to serve locations, rather than one of serving users at absolute depths in a building. This is discussed in detail in Annex 7 (paragraph 7.21 onwards) and 14.
- 3.87 'Min var' results are displayed with solid lines and 'Max var' results are displayed with dashed lines. For any particular depth, we expect the percentage of locations covered by a particular spectrum portfolio to be somewhere within the range indicated by the 'Min var' and 'Max var' lines. Though these results are shown as continuous smooth lines they are derived from results obtained by modelling at 5 specific depths (outdoors, 1 metre, 5 metres, 10 metres and 15 metres).

⁸³ 12,000 sites represents the lower end of the macrocell network size that existing MNOs are likely to have (we anticipate that all operators are likely to have access to at least this many macrocell sites within 2 to 3 years). For a new entrant it would take some years to build of this network. We consider the implications of this for the spectrum that might be required for a new entrant to be credible in Section 4 below (see paragraph 4.77).

Figure 3.9: Variation of coverage with depth in building for a 1Mbps service, 10MHz, 85% loading, 12,000 sites, various frequencies – West London



3.88 Comparing 800MHz, 1800MHz and 2.6GHz, we find that there is little difference in the predicted coverage outdoors across the three frequency bands. Coverage is predicted by our model to be lower for users inside buildings for all frequencies, with the degradation increasing non-linearly the deeper into the building the user is. The predicted extent of degradation is greater for 2600MHz and smaller for 800MHz, with 1800MHz in between. As indicated by the ‘max var’ line, there is a risk that this difference in degradation between frequencies could be considerable.

3.89 In Annex 7 we present results for a national site count of 18,000 sites (see for example Figure 7).⁸⁴ These results show that the difference in coverage predicted by our model between 2600MHz, 1800MHz and 800MHz frequencies reduces relative to the 12,000 site case but for our ‘Max var’ case there remains a noticeable degradation in the 1800MHz and 2600MHz results for those locations deepest inside buildings (e.g. our 10m and 15m modelled depths).⁸⁵ Annex 7 also shows that, for a notional 1Mbps downlink data-rate service, for all frequencies, coverage is predicted by our model to be noticeably worse with only 5MHz of spectrum as compared with 10MHz, and the differences between coverage of different frequencies are predicted to be greater with small bandwidths (see for example Figures 9 to 14).

⁸⁴ 18,000 sites represents the upper end of the macrocell network size that existing MNOs are likely to have (e.g. in the longer term).

⁸⁵ In Annex 7 we also present results for our Cambridge simulation area. This shows a small difference in the predicted extent of coverage outdoors across the three frequency bands and that for users inside buildings, for all frequencies, the degradation in coverage increases faster than for the West London simulation area. This is as expected as there are relatively fewer base stations in the Cambridge simulation area; hence they are geographically more widely separated than in the West London simulation area. The greater distances between base stations means that signals are generally weaker and hence performance is poorer for all frequencies but especially so for higher frequencies.

- 3.90 The modelling suggests that the more prevalent and important the 10m and 15m depths, the greater the potential advantages associated with lower frequency spectrum. However, as we note above, harder to reach locations are unlikely to have a clear cut relationship with depth as the model suggests. These depths can be taken as a more general indication of the difficulty of providing service, for example to buildings with more challenging construction, and in other hard-to-serve locations such as behind tall buildings, within tunnels etc. While we have evidence to show that a significant proportion of mobile data use takes place indoors, we do not have specific evidence on the prevalence of locations that are particularly 'deep' indoors or difficult to serve.
- 3.91 Nevertheless, given the significantly lower certainty of coverage, we consider there is a material risk that coverage at 2600 MHz would be insufficient to provide a credible national wholesale service. There is also some risk that coverage at 1800MHz is insufficient to provide a credible national wholesale service, however, the risk is lower. The extent of any risk associated with holding higher frequency spectrum will depend on whether there are other technologies available for delivering good quality coverage and also on the extent to which consumers value the quality of coverage that can be delivered using a sub-1 GHz macrocell network. We consider these issues below.

Coverage with higher data rates

- 3.92 As well as considering 1Mbps, Annex 7 also explores coverage for higher guaranteed data rates. Our model predicts that 2x5MHz of 800MHz spectrum (or any other frequency) is likely to struggle to provide a notional 5Mbps service to more than 60% of locations, even when lightly loaded, albeit it may be able to provide a notional 2Mbps service to more than 95% of locations at the same depth (see Figure 29 and 30 in Annex 7.⁸⁶ By contrast networks with 10MHz of spectrum (again of any frequency) are predicted by our model to be able to provide a 5Mbps service to between 65% and 80% of locations when moderately loaded (50% loading) as shown in Figure 31 and 32 in Annex 7). We therefore conclude that 2x5MHz of 800MHz is unlikely to provide adequate coverage for higher data speeds (such as 5Mbps).

Other technologies that can deliver good coverage

- 3.93 The evidence from the technical modelling suggests that, using a macrocell network, lower frequency spectrum can deliver better depth of coverage than higher frequency spectrum, particularly in the hardest to serve locations. This section will consider the extent to which other technologies can be used alongside higher frequency spectrum to deliver the same depth of coverage as a sub-1 GHz operator. Aside from mobile networks operating exclusively with macrocells, there are a number of other technologies that may be used to deliver good quality mobile services. In general, these technologies seek to improve the quality of coverage by placing access equipment closer to the end user. Examples of such technologies include:
- Wi-Fi
 - Femtocells
 - In-building repeaters

⁸⁶ Coverage will be better at shallower depths, but worse at deeper depths.

- 3.94 These technologies could be used with a variety of spectrum resources to improve the depth of coverage, allowing operators to provide mobile services in harder to serve locations.⁸⁷
- 3.95 Small cells can also be used to enhance coverage breadth, by installing small cells (such as microcells) in locations remote from the macrocell network, such as outdoors in a village or small town.
- 3.96 There is evidence of significant use of these technologies. To some extent, there is potential for these solutions to address the coverage disadvantages that an operator without lower frequency spectrum may face. Understanding the nature and extent of any potential substitutability between using lower frequency spectrum with a macrocell and other technologies in terms of delivering high quality indoor coverage is important in assessing the risk to competition if one or more national wholesalers do not hold lower frequency spectrum following the auction.
- 3.97 We first consider the advantages and disadvantages of using these technologies to deliver deep coverage across a large number of locations. We then set out the nature of any likely gap between what these technologies can deliver and what can be delivered using a macrocell network with low frequency spectrum. In particular, we consider whether the scope to deploy these technologies to provide good depth of coverage depends on the frequency of spectrum held (for example, whether it is 1800MHz or 2600MHz spectrum) and the nature and scale of locations that cannot be served using a macrocell network.

Wi-Fi off-loading

- 3.98 Wi-Fi is widely deployed in UK homes, offices and public locations. Many devices designed to make use of mobile data networks, such as smartphones, tablets and laptop PCs (using dongles or data cards) also have the capability to use Wi-Fi networks, which are connected to the fixed network. Cisco estimated that around 30% of smartphone traffic is already off-loaded onto fixed networks and observed that some national wholesalers encourage Wi-Fi off-load by including Wi-Fi hotspot minutes as a part of their monthly contract.⁸⁸
- 3.99 Ofcom's Communications Market Report 2011 found that 75% of fixed broadband connections used a Wi-Fi router.⁸⁹ The roll-out of super-fast broadband provides even greater scope for Wi-Fi to offer connectivity to mobile devices, with consumer research finding that:

“Nearly half of all respondents said that good simultaneous performance on multiple devices was a reason for taking super-fast broadband, indicative of how households are increasingly using Wi-Fi connectivity to provide internet connections to multiple devices, including desktop, laptop and tablet PCs, mobile phones, games consoles and internet enabled televisions.”

⁸⁷ In theory, the propagation characteristics of lower frequency spectrum means that it can still provide better coverage when used with technologies such as femtocells or Wi-Fi hotspots. However, in situations where these technologies would be deployed, it is likely that any frequency dependent coverage advantage will be immaterial in practice.

⁸⁸ See paragraph 8.25 of Ofcom's Infrastructure Report, November 2011:

<http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/bbspeeds2011/infrastructure-report.pdf>

⁸⁹ Q1 2011, from UK household broadband take-up of 67%. Ofcom, The Communications Market 2011

3.100 A number of national wholesalers already encourage Wi-Fi off-loading, including Wi-Fi hotspot minutes in monthly contracts. A number of bilateral deals exist between national wholesalers and owners of Wi-Fi networks to provide customers of mobile services with access to these networks.⁹⁰

3.101 A variety of service providers own, or have plans to construct, public Wi-Fi networks:

- BT is the largest provider of Wi-Fi hotspots in the UK. Its BT FON network comprises over 2 million home broadband subscribers that share access to their Wi-Fi connection, as well as 4,000 OpenZone public hotspots. BT reported that this had totalled 170,000 downloads by November 2010.⁹¹
- BSkyB announced the purchase of The Cloud's UK hotspots, allowing it to deliver its content to customers outside the home. As of October 2011, this network comprises 5,700 live hotspots.⁹²
- O2's has launched its own Wi-Fi network that was initially launched in its own sites but is planned to be extended to 14,000 hotspots by 2013. The service is free and available to anyone, regardless of their service provider.⁹³
- Virgin Media has announced plans to launch a Wi-Fi access network across London, using existing infrastructure by installing Wi-Fi equipment in its street cabinets.⁹⁴
- Nokia has launched a free Wi-Fi access service at 26 sites in London, with plans to expand the service to other cities.⁹⁵

3.102 There are also examples of national wholesalers in other countries offering connectivity to Wi-Fi networks. For example, in the United States, AT&T offers its customers connection to its network of hotspots, along with software that facilitates connection to Wi-Fi access points.⁹⁶

Assessment of the potential for Wi-Fi to deliver coverage depth

3.103 There are a number of advantages Wi-Fi can offer in terms of good quality indoor coverage:

- Wi-Fi delivers a good quality of service (relative to a macrocell network) in several key service dimensions, including data rates. For example, current fixed broadband averages 6.2Mbps compared to 1.5Mbps on 3G.⁹⁷ The gap between the data rates delivered over fixed broadband and mobile data services may

⁹⁰ For example, O2 provide their customers with free access to The Cloud's hotspots, whilst Orange customers can obtain access to BT Openzone:

<http://www.o2.co.uk/explore/tariffs/boltons/paymonthlyboltons/unlimitedwifi>;

<http://help.orange.co.uk/orangeuk/support/personal/527023>

⁹¹ http://www.btopenzone.com/news/news_20101109.jsp

⁹² <http://www.cable.co.uk/news/sky-wi-fi-platform-the-cloud-passes-5700-live-hotspots-800763240/>

⁹³ <http://o2wifi.co.uk/my/about>

⁹⁴ <http://www.telegraph.co.uk/technology/internet/8677182/Virgin-Media-to-take-a-punt-on-free-London-WiFi-network.html>

⁹⁵ <http://conversations.nokia.com/2011/11/01/nokia-sponsors-free-wi-fi/>

⁹⁶ <http://secure.sbc.com/support/faq.adp>

⁹⁷ Ofcom Communications Market Report, 2011:

http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CM_2011_FINAL.pdf

change over time as technologies evolve, but we generally expect fixed broadband will offer a superior service over mobile services.

- Wi-Fi is an established technology that is common on many data enabled devices, at least those that are likely to make heavy use of mobile data networks (e.g. smartphones, tablets, the laptops that use dongles).
- Wi-Fi is considered to be relatively cheap from the perspective of the consumer since Wi-Fi hotspots come as standard with most fixed broadband packages.

3.104 However, there are also limitations of Wi-Fi, which include:

- Wi-Fi networks can experience congestion from other devices in the same spectrum, which national wholesalers cannot control. Wi-Fi congestion is most obvious in public locations, where a large number of devices can cause significant service degradation. Even in a home, where there may be a relatively small number of devices, interference can occur between hotspots and devices in neighbouring premises. Whilst additional spectrum in the 5GHz band is available for Wi-Fi, currently fewer devices support this functionality compared to Wi-Fi operating at 2.4GHz.
- Currently, standard Wi-Fi connectivity is not able to provide all of the services that are available over mobile networks, most notably, standard voice call and text messaging services.⁹⁸ Additional carrier Wi-Fi standards exist that aim to replicate services on mobile networks over Wi-Fi,⁹⁹ but all of these technologies require compatible devices.¹⁰⁰
- Another potential disadvantage of Wi-Fi is that users need to manually register on entry to hotspot networks. This is not likely to be an issue in the home, where users can automatically log on to their Wi-Fi network. But this might be a disadvantage when using Wi-Fi outside the home. There is some evidence that this dissuades users from accessing public Wi-Fi, even when it is available to them.¹⁰¹

3.105 Nevertheless, there are numerous ‘carrier Wi-Fi’ initiatives which aim to address some of the limitations of Wi-Fi to allow national wholesalers to provide a consistent service which is comparable to that deployed over standard mobile networks.

Femtocells

3.106 Another technology that could be used to off-load traffic to the fixed network is femtocells. These are low powered mobile base stations using licensed mobile spectrum, which are backhauled through a fixed broadband connection.

⁹⁸ Although we acknowledge the existence of various “over the top” voice applications and internet messaging solutions.

⁹⁹ Examples include UMA/GAN, HS2.0 and EAP-SIM, with some evidence of commercial deployment, for example, UMA has a commercial deployment in the form of Orange UMA.

¹⁰⁰ Orange UMA, for example, is only available on a limited number of handsets and there is no clear industry consensus on the most appropriate standard to adopt:

<http://help.orange.co.uk/orangeuk/support/personal/446693>

¹⁰¹ <http://news.o2.co.uk/Press-Releases/O2-redefines-Wi-Fi-landscape-with-launch-of-O2-Wifi-2e8.aspx>

3.107 Currently, the only widespread residential deployment of femtocells by a national wholesaler in the UK is Vodafone's Sure Signal product.¹⁰² In an appearance before the Culture, Media and Sport Parliamentary Select Committee, Vodafone described Sure Signal as having "hundreds of thousands of registered users".¹⁰³ Vodafone has also trialled "open access" outdoor femtocell solutions, which have greater potential to serve a wider customer base. O2 have 'pre-launched' their 'Boostbox' femtocell service, which offers both consumer and enterprise variants.¹⁰⁴

3.108 Worldwide, numerous other examples exist of national wholesalers deploying femtocells:

- Vodafone has commercial femtocell offerings in other European countries including Ireland, Italy and Spain.
- In the USA, AT&T¹⁰⁵, Sprint USA¹⁰⁶ and Verizon Wireless¹⁰⁷ all have femtocell offerings.

3.109 In total, there are 36 commercial femtocell deployments in 24 countries around the world, as of October 2011.¹⁰⁸

Assessment of the potential for femtocells to deliver coverage depth

3.110 As regards the potential ability of femtocells to match or mitigate the advantage of lower frequency spectrum:

- Femtocells can make use of large blocks of licensed spectrum to provide very good service quality compared to macrocells. They have full capability and functionality as mobile devices on the macro network, since they use frequencies harmonised for mobile and do not require any changes (e.g. software installation) on the mobile devices.
- Issues in relation to interference with macrocell networks are being addressed as the technology develops and are, in any case, less relevant when the femtocell is being used to enhance coverage.

3.111 The limitations of femtocells include:

- Femtocells will be limited by the reach and capabilities of fixed backhaul in the same manner as Wi-Fi. They are not a substitute for macrocells where mobile services are to be used as an alternative to fixed-line connectivity.
- National wholesalers relying heavily on femtocells will need to manage a much larger number of cells than has previously been the case, so appropriately automated management and optimisation techniques may be critical to the development of small cells.

¹⁰² <http://shop.vodafone.co.uk/shop/mobile-accessories/vodafone-sure-signal>

¹⁰³ <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmcomeds/1258/125808.htm#n105>

¹⁰⁴ <http://www.o2.co.uk/enterprise/products-and-services/prices-and-terms>

¹⁰⁵ <http://www.att.com/shop/wireless/devices/3gmicrocell.jsp?fbid=5XvRG3oeXk>

¹⁰⁶ <http://www.sprintenterprise.com/airave/tellMeMore.html>

¹⁰⁷ <http://www.verizonwireless.com/verizon-network-extender.shtml>

¹⁰⁸ Informa Telecoms & Media, Femtocell Market Status October 2011

- With 3G/HSPA interference with the macrocell network means that some femtocell offerings have to make use of different spectrum to the macrocells, e.g. Sure Signal runs on a separate channel of 2.1GHz to rest of Vodafone's network. However, it is possible to run the femtocell on the same frequencies (AT&T does this). Also, these issues are easier to manage with LTE.
- Femtocells are a relatively new, emerging technology. The cost is currently high, but is likely to fall significantly over time. There are currently no LTE femtocells in commercial service, although SK Telecom recently announced that it had developed the world's first femtocell designed to support LTE which it intends to deploy in 2012.¹⁰⁹

In-building repeaters

3.112 A further technological solution to address the difficulties of providing good indoor coverage is in-building repeaters.

3.113 The only commercial deployment of such a technology in the UK is Everything Everywhere's Nextivity.¹¹⁰

Assessment of potential to deliver coverage depth

3.114 In-building repeaters only require the covering macrocell to have good outdoor coverage. They are not limited by the coverage of the fixed network. However, this implies they are limited by the capabilities of the macrocell network and they need at least good outside coverage on the macrocell. Consequently they are not appropriate for delivering coverage in hard to serve outdoor areas.

Overall assessment of ability of other technologies to provide good quality coverage

3.115 While small cells, such as femtocells and Wi-Fi, can be used to provide good coverage in specific harder to serve locations, there may be practical challenges to using them as a means to providing consistently good coverage depth across all harder to serve locations. First, it may not be the case that small cell solutions such as femtocells, will be available in all harder to serve locations and, second, even where they are available, mobile users will not always have access to them:

- For example, consider a particular property that is hard to serve and is not served well by a high frequency macrocell network though it is by a low frequency macrocell network. Suppose the high frequency network can only serve the building if a small cell is installed. If the property owner uses the low frequency network, he may have no interest in installing (or agreeing to have installed) a small cell for the high frequency network. This means that visitors to the property who use the high frequency network will not be served. Conversely, if the property owner uses the high frequency network and installs a small cell specific for the high frequency network, visitors to the property who use the low frequency network can still be served by the low frequency macrocell network.
- Where femtocells are available, they may be 'closed' – that is, only accessible to devices of the household owning the broadband connection. Technically, this can

¹⁰⁹ See <http://www.koreaherald.com/national/Detail.jsp?newsMLId=20111227000629>

¹¹⁰ <http://www.b2bcorp.co.uk/news/?p=41>

be overcome as it is relatively easy to set up femtocells in “open-access” mode. However, femtocell owners may not have an incentive to allow all devices to connect to their femtocell as this would involve sharing their broadband connection with others.

- 3.116 These factors are less likely to be an issue for Wi-Fi, which is very widely supported by devices and which is relatively easy to make available to visitors. However, as noted above, there may be other practical challenges to Wi-Fi, at least in the near term, that limit the extent to which it can be relied on to provide consistently good coverage depth across all harder to serve locations.
- 3.117 We also note that it is possible for owners of lower frequency spectrum to deploy small cell solutions in order to boost capacity in certain locations (see paragraph 3.42 on capacity). Consequently, the coverage advantage of national wholesalers holding lower frequency spectrum may be enhanced in some areas with the deployment of these technologies as it would allow them to concentrate network resources on harder to serve locations.
- 3.118 In summary, it is likely that there will always be locations or situations where a macrocell network with sub-1 GHz spectrum provides coverage where small cell solutions do not (at least not for all consumers). Therefore, whilst these technologies are likely to be useful for improving coverage in certain scenarios to some extent, there may still be a technical advantage associated with holding sub-1 GHz spectrum in certain locations.
- 3.119 Use of small cell solutions may be particularly helpful in addressing small gaps in coverage and they may be particularly suited to offering consumers good quality coverage in their home or office. However, there are likely to be challenges in relying on small cell solutions to deliver consistently good quality indoor coverage outside the home or office to a large proportion of consumers.

Consumer value of good coverage

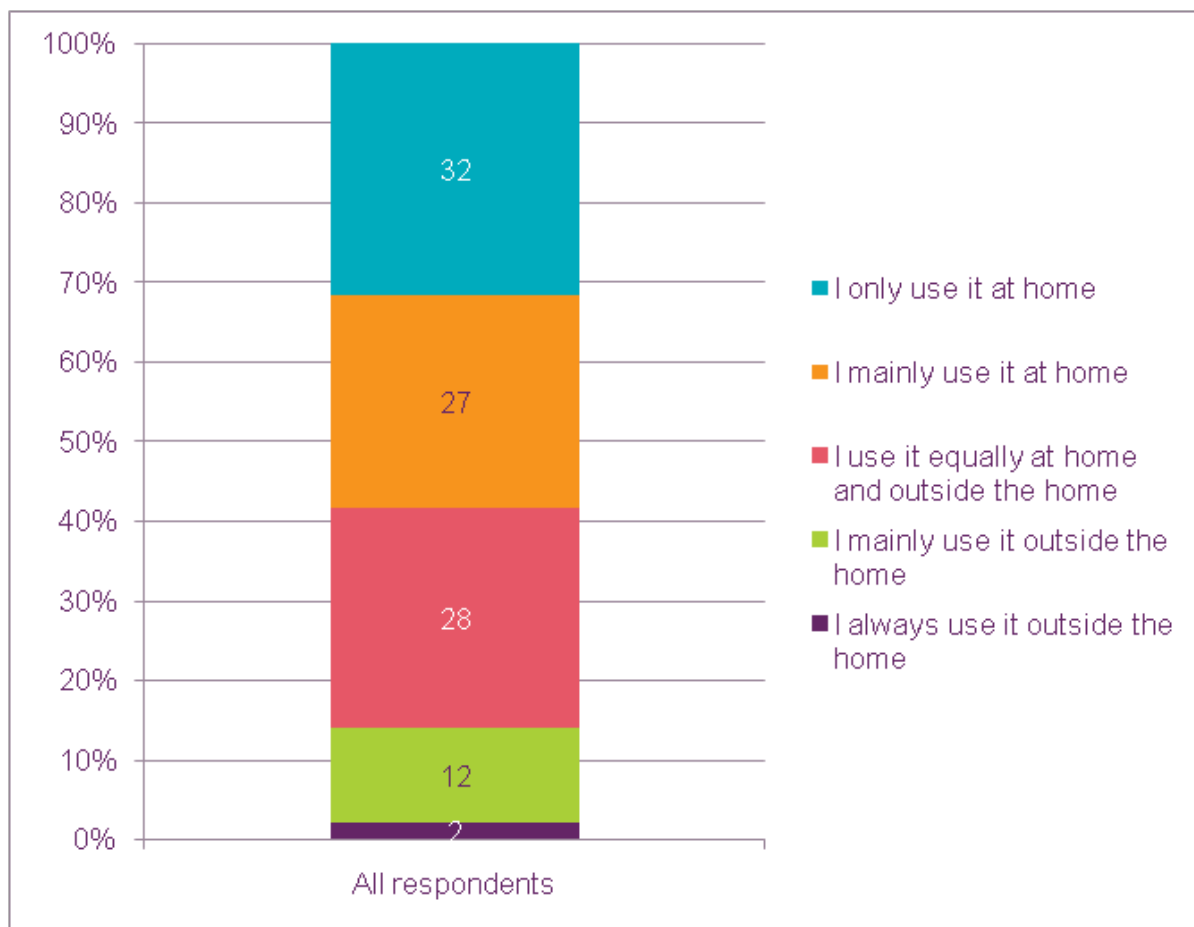
- 3.120 It is not necessarily the case that technical advantages associated with lower frequency spectrum in terms of delivering good depth of coverage will translate into significant competitive advantages. This depends on whether consumers place sufficient value on good quality coverage in harder to serve locations as well as on the extent to which this can be provided using small cell solutions.
- 3.121 The evidence suggests that consumers are likely to value quality of coverage indoors. Most mobile broadband activity occurs in the home or office. According to a survey by Analysys Mason, 72% of mobile broadband subscribers in Europe use mobile broadband service mostly, or solely, at home or work, and for US subscribers this figure is more than 79%. Analysys Mason expects that 90% of mobile data will be downloaded indoors by 2015.¹¹¹
- 3.122 Research carried out for Ofcom’s UHF Strategy consultation¹¹² illustrates locations where consumers with mobile internet use it. Whilst all respondents use mobile internet at home, with only 2% reporting usage exclusively outside of the home, the majority of respondents also report usage in other locations, with only 32% of users

¹¹¹ Analysys Mason, 2010: <http://www.analysysmason.com/About-Us/News/Insight/Is-the-fixed-operator-in-a-position-to-steal-the-mobile-operators-customers/?journey=117,55>

¹¹² Ofcom’s UHF Strategy consultation is due to be published in the first quarter of 2012.

using mobile internet exclusively in the home. This suggests that whilst coverage at home might be most valuable to consumers, coverage in other locations may also be important.

Figure 3.10: Locations where mobile internet used



Source: Ofcom, UK adults 16+ using MBB (1413/554/320/288/251)

3.123 Given that a significant proportion of mobile use takes place indoors (and in particular, in the home) there is a risk that consumers will experience poorer coverage quality if served using higher frequency spectrum with a macrocell (see paragraph 3.90 on technical modelling evidence). However, we do not have evidence on how ‘deep into a building’¹¹³ consumers tend to be when using mobile devices, and therefore on the extent of any degradation consumers could potentially face if served using higher frequency spectrum with a macrocell.

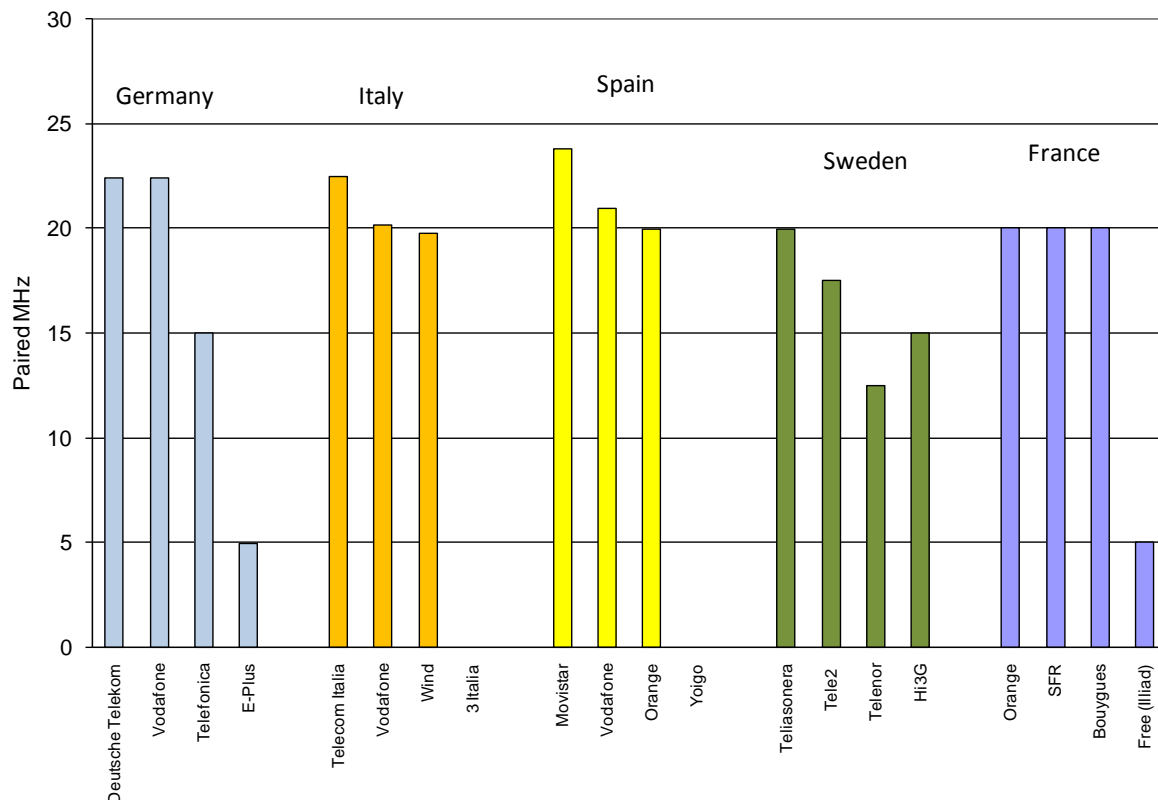
3.124 As noted above, small cell solutions, such as femtocells and Wi-Fi, are well suited to providing good quality coverage in the home. However, to the extent that a significant proportion of mobile usage outside the home takes place in harder to serve locations, and to the extent that there are challenges to using small cell solutions to serve consumers in those locations, there might be a significant competitive advantage to holding lower frequency spectrum.

¹¹³ Depth in-building is used to indicate the difficulty of serving particular locations in general.

International evidence on the importance of lower frequency spectrum

3.125 As noted above, auctions for 800MHz spectrum have only taken place in 5 countries in Europe and these cases may be of interest for providing an indicator of the minimum quantity of sub-1GHz spectrum needed to be credible in future markets. Figure 3.11 illustrates the amount of sub-1 GHz spectrum held by national wholesalers in those countries where there are 4 wholesalers and the 800 MHz auction has already taken place (Germany, Italy, Spain, Sweden and France).

Figure 3.11 Error! Bookmark not defined.: Wholesalers' holdings of sub-1 GHz spectrum in European countries



3.126 With the exception of Sweden where all four wholesalers hold significant shares of sub-1GHz spectrum, there is one national wholesaler in each country that has no (or very little) sub-1 GHz compared to its competitors. E-Plus in Germany and Iliad in France hold 2x5 MHz in the 900 MHz band, whilst 3 Italia might have access in the near future to 2x5 MHz of 900 MHz released by the other wholesalers.¹¹⁴

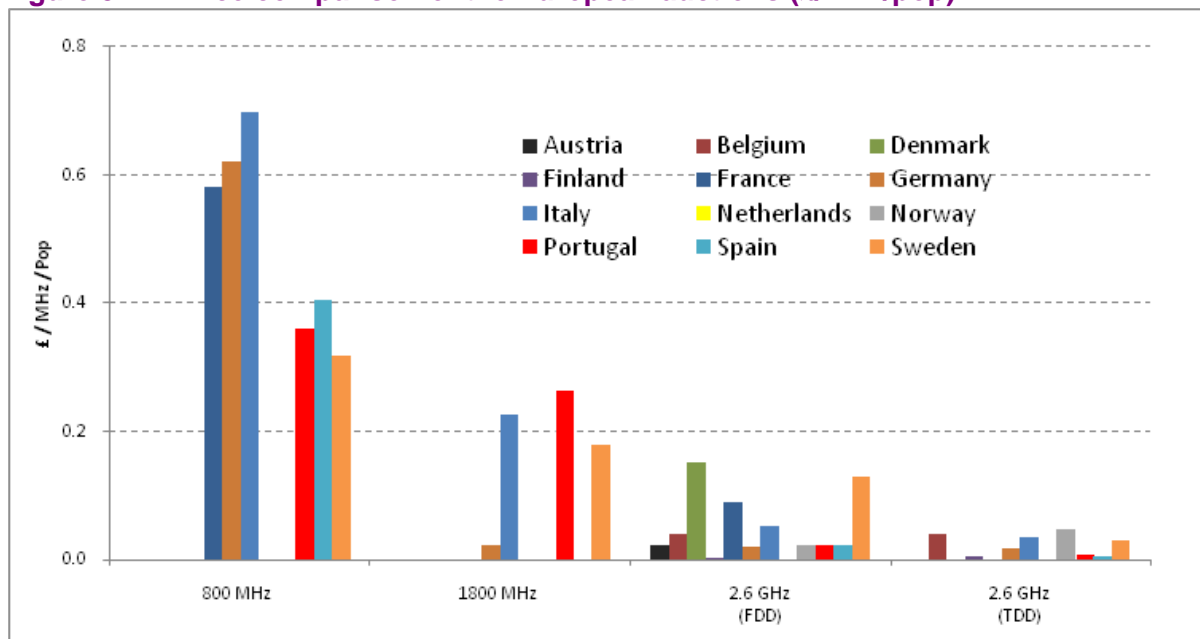
3.127 Yoigo in Spain does not hold any sub-1GHz spectrum; it holds only 1800MHz, 2100MHz and 2.6GHz spectrum. However, it should be noted that Yoigo was given the opportunity to obtain 900 MHz spectrum first, in a beauty contest where Movistar and Vodafone could not take part, and later in the 2011 auction where there was arguably less competition from the three biggest incumbents as they were restricted by spectrum caps but Yoigo did not compete for any sub-1GHz (the auction resulted in one block of 2x5 MHz of 900 MHz unsold).

¹¹⁴ As a condition of the refarming process, 2x5MHz of 900MHz spectrum has been released and reserved for a new entrant or a '3G only' operator (i.e. 3 Italia): <http://www.agcom.it/default.aspx?DocID=2525>

3.128 In the USA, where the auction for 700MHz spectrum has taken place, sub-1GHz spectrum that is suitable for mobile data services is held by only two of four national wholesalers, although a portion of sub-1GHz spectrum is held by much smaller, regional operators.¹¹⁵ The two national wholesalers that do not possess sub-1GHz spectrum have lower market shares compared to those that do.¹¹⁶

3.129 The advantages that lower frequency spectrum can deliver in terms of coverage are reflected in the prices paid for lower frequency spectrum in recent auctions. Figure 3.12 compares auction prices across countries. It shows that national wholesalers are willing to pay significantly more for 800MHz spectrum than for 2.6GHz spectrum. Prices for 1800MHz are somewhere between those for 800MHz and 2.6GHz.

Figure 3.12: Price comparison of the European auctions (£/MHz/pop)



3.130 Evidence from international markets shows that sub-1 GHz is more valuable than higher frequency spectrum. However, it is unclear whether sub-1GHz is needed to be a credible national wholesaler. In many countries all national wholesalers have at least some sub-1 GHz, even if it is a small amount. But there are some exceptions to this, for example, in Spain and the USA. In any case, there are a number of reasons why evidence from international markets should be treated cautiously:

- The auctions of 800MHz spectrum in European markets have happened quite recently, so it is likely to be too early to tell whether sub1GHz spectrum is necessary to being a credible national wholesaler. Even if sub-1GHz is necessary to being a credible national wholesaler, it may be too early to tell

¹¹⁵ We note that a third national wholesaler, Sprint Nextel, has spectrum holdings in the 800MHz and 900MHz bands. However, the FCC does not deem these holdings suitable for mobile data services: Paragraph 220, 15th Annual Mobile Wireless Competition Report, July 27th 2011: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-11-103A1.pdf

¹¹⁶ Verizon Wireless and AT&T have subscriber shares of 31.9% and 29.8% respectively, compared to Sprint Nextel and T-Mobile USA with 16.9% and 11.8% (Table 4 of FCC report).

whether some wholesalers with relatively small holdings have enough to ensure that they continue to be credible in future.

- The distribution of sub-1GHz spectrum has been influenced by regulatory intervention to allocate such spectrum more widely. As a result, holdings of sub-1GHz spectrum may not reflect what is required to be a credible wholesaler or what national wholesalers themselves believe they need in order to be credible.

Analysts' views on the importance of holding low frequency spectrum

3.131 A number of analysts have commented on the importance of holding sub-1 GHz in the context of 3 Italia's failure to acquire 800 MHz spectrum. For example, Deutsche Bank's analysts noted (when the auction for 1800 MHz and 2.6GHz band was still on) that:

"We expect 3 Italia to bid for the 1800MHz spectrum now (the cost is in the region of E160m vs. E0.5bn for the 800Mhz blocks). However for 3 Italia this means that rolling out an LTE network will become more expensive (the cost can be 2-3 x higher if the network is rolled out based on 1800Mhz rather than 800Mhz). Hence it is another reason for 3 Italia to explore consolidation opportunities".¹¹⁷

3.132 Along the same line, Espirito Santo's analysts state that they are not convinced that 3 could continue to compete without 800 MHz holdings:

"This adds to the woes of 3, which already lacked scale, and will now really struggle to compete in the crucial arena of mobile data into the long term...In our view it chronically undermines the business proposition of 3 Italia to the point that it will have no option but to exit at some point in the next year or so."¹¹⁸

3.133 Others have suggested that it is less important to hold sub-1 GHz spectrum. Again, some of these views were expressed in relation to 3 Italia's failure to acquire 800 MHz spectrum.

3.134 New Street Research highlighted the importance of providing coverage but did not think this necessarily required H3G to acquire sub-1GHz spectrum:

"It was essential¹¹⁹ for Hutchison to win a block in the 1.8GHz band once it had withdrawn from the 800MHz process – it needs spectrum that can provide coverage over its entire existing 3G footprint from its existing 3G cell sites – 1.8GHz is fine for this purpose (whereas 2.6GHz would leave significant coverage gaps)... In our view this [the money saved from not buying 800MHz spectrum] more than covers any incremental capex that KPN or H3G are likely to incur from their lack of 800MHz assets."¹²⁰

¹¹⁷ Deutsche Bank, Company Alert – Telecom Italia, 22 September 2011

¹¹⁸ Espirito Santo, Telco Bullets, 23 September 2011

¹¹⁹ New Street Research has since stated that it only considers it "important" that 3 Italia won 1800MHz spectrum, given that they are likely to gain access to 900MHz spectrum. However, this does not belie the original view that 1800MHz spectrum was sufficient to provide adequate network coverage.

¹²⁰ New Street Research, Italian spectrum auction wrap, 30 September 2011

3.135 In a recent interview, Hutchison Whampoa's Group Managing Director commented on the results of the Italian spectrum auction, where 3 Italia did not acquire any 800MHz spectrum. Whilst he acknowledges the value of 800MHz spectrum in allowing the use of fewer base stations, he states that 3 Italia would be able to achieve comparable performance using recently acquired 1800MHz and 2.6GHz spectrum. He goes on to point out that the cost of doing so for 3 Italia would only be €250-300 million, compared to the over €1billion paid for 800MHz spectrum by 3 Italia's competitors.¹²¹

Provisional conclusions on overall importance of holding spectrum needed for good quality coverage

3.136 As regards technical conditions, there are some technical advantages associated with holding sub-1 GHz spectrum in terms of delivering good quality coverage when using a macrocell network. While there is uncertainty on the extent of any advantage, the technical evidence suggests that, deep in buildings or in other hard to serve locations, the degradation in quality of coverage could be higher for 2600MHz spectrum than 800MHz spectrum, with 1800MHz in between.

3.137 As regards market conditions, the more prevalent and important that harder to serve locations are, the greater the potential advantages associated with lower frequency spectrum. We do not have specific evidence on the prevalence or importance to consumers of locations that are particularly 'deep' indoors or difficult to serve. However, given the materially lower certainty of coverage, we consider there is a material risk that coverage at 2600 MHz would be insufficient to provide good quality coverage in harder to serve locations. There is also some risk that coverage at 2100MHz or 1800MHz is insufficient, but the risk is materially lower.

3.138 The extent of any risk associated with holding higher frequency spectrum will depend on the extent to which consumers value good quality coverage in harder to serve locations and the extent to which this can be delivered using other technologies, such as small cells. We consider that use of small cell solutions may help to address some of the gap in coverage faced by operators with higher frequency spectrum, particularly in terms of offering consumers good quality coverage in their home or office. However, it is likely to be challenging to deploy small cell solutions in all locations where coverage is poor.

3.139 Overall, taking into account the evidence on the technical and market conditions, we consider that there is a material risk that a national wholesaler with just 2600MHz spectrum would not act as a credible national wholesaler. We consider that, although there is some risk, a national wholesaler with just 1800MHz or 2100MHz spectrum is likely to be able to provide sufficient quality of coverage to be credible, particularly taking into account available mitigation techniques, such as small cell solutions.

3.140 Nevertheless, in relation to our second type of competition concern about competition across a wide range of services and customers, we recognise that, even if a national wholesaler can provide sufficiently good quality coverage to act as a credible national wholesaler, if it does not hold sub-1 GHz spectrum it may be a weaker competitor in

¹²¹ Interview with Canning Fok in Corriere Della Sera, 18 October 2011: http://archiviostorico.corriere.it/2011/ottobre/18/progetti_Hutchison_Non_vendiamo_anzi_co_9_11101_8042.shtml (Note: Text in Italian)

particular service or customer segments than a wholesaler with sub-1 GHz in particular segments of services or customers.

Interaction between capacity and coverage

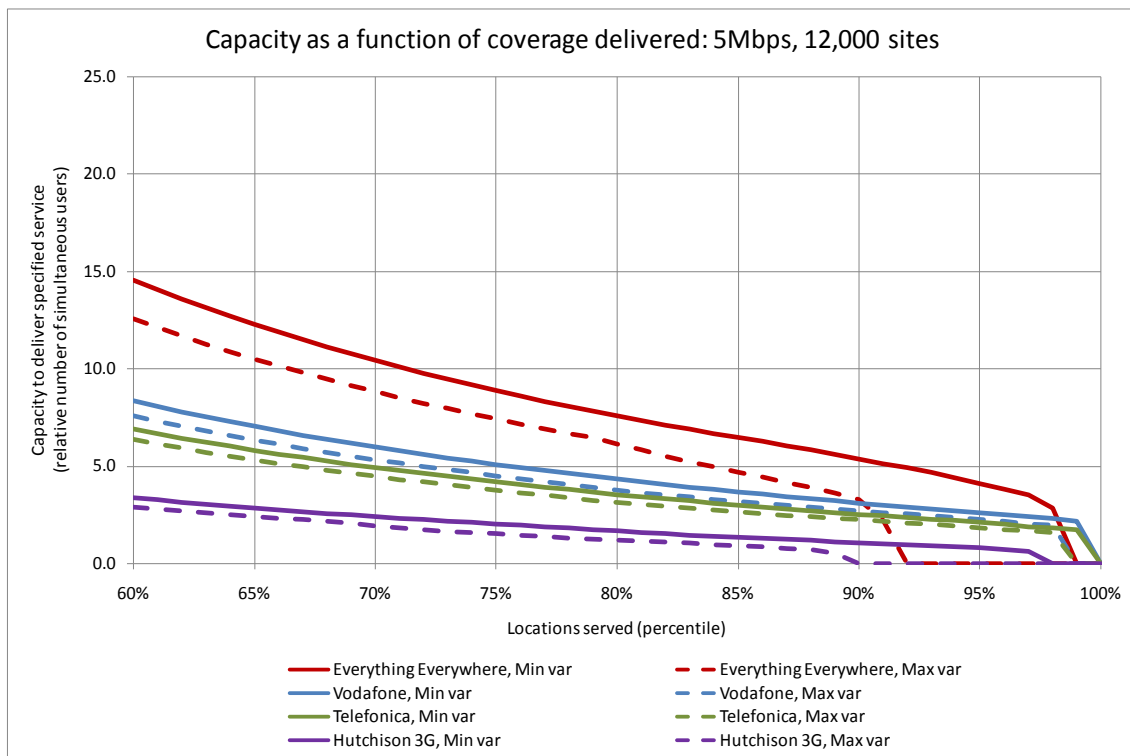
Technical modelling evidence

- 3.141 We have explored the interaction between capacity and coverage in our technical modelling. We provisionally conclude in Annex 7 that capacity is largely a function of the total bandwidth of spectrum available to a network, rather than the specific mix of frequencies, at least for networks with more than 2x20MHz of spectrum bandwidth in total and provided that the network operator does not try to provide coverage beyond the limit of what can be provided efficiently with the spectrum available (see paragraph A7.105). The certainty of capacity over locations, however, can vary materially according to the mix of bandwidths between frequencies.
- 3.142 We also show in Annex 7 the predicted performance that the existing national wholesalers could potentially provide with their existing spectrum holdings in the longer term (once the majority of existing spectrum has been refarmed for LTE). We show this below to illustrate the interaction between capacity and coverage. We look at the capacity to deliver a notional 5Mbps services (since we consider this to be a reasonable basis for the comparison of network capacities in this context) for networks with 12,000 and 1,800 sites. In Figure 3.13 below we show the results for 12,000 sites (which we consider to be a reasonable estimate of the total number of macrocell sites that an existing operator is likely to have access to in the next 2 to 3 years).¹²²

¹²² For the purpose of this chart we have used 800MHz as a proxy for 900MHz, and 1800MHz as a proxy for 2100MHz. We have also used the following quantities of spectrum to represent the existing spectrum holdings of the various existing MNOs:

- For Everything Everywhere: 2x40MHz of 1800MHz + 2x20MHz of 2100MHz
- For Vodafone: 2x5MHz of 900MHz + 2x5MHz of 1800MHz + 2x15MHz of 2100MHz
- For Telefónica: 2x15MHz of 900MHz + 2x5MHz of 1800MHz + 2x10MHz of 2100MHz
- For H3G: 2x15MHz of 2100MHz.

Figure 3.13: Longer term relative capacity and coverage of MNOs' existing spectrum portfolios: 5Mbps, 12,000 sites



3.143 Capacity is shown on the vertical axis and quality of coverage delivered on the horizontal axis. See Annex 7 for more details.

3.144 For locations on the horizontal axis, in the absence of better information, we have assumed that each of the five depths we consider is equally likely (i.e. there are exactly the same number of sample points at each of these five depths in our simulations).

3.145 We see that:

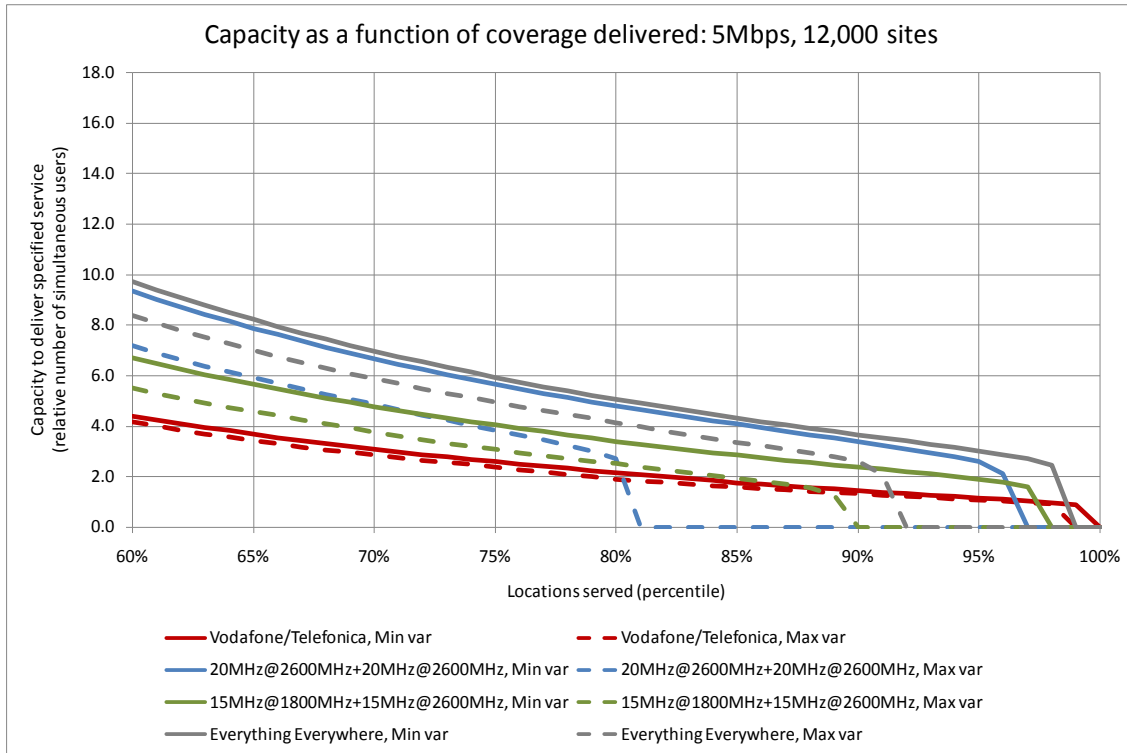
- Everything Everywhere is predicted by our model to have significantly more capacity than any of the other existing national wholesalers, but with uncertainty over the extent of their coverage affecting the hardest to serve 5% of locations;
- Vodafone and Telefónica are predicted by our model to have about half the capacity of Everything Everywhere, but with certainty of coverage to almost 100% of locations;
- H3G is predicted to have the least capacity, less than half that of Vodafone and Telefónica, and less than a quarter that of Everything Everywhere; the uncertainty of their coverage is also larger even than Everything Everywhere's.

3.146 We consider in Annex 7 how these existing spectrum holdings would be improved by additional spectrum holdings and how they compare to other portfolios. This includes considering portfolios of spectrum that do not include sub-1GHz spectrum and we also consider portfolios that only contain 2.6GHz spectrum. For simplicity we focus

on capacity and coverage derived from spectrum other than the existing 2100MHz spectrum.¹²³

3.147 Figure 3.14 below shows how a large portfolio consisting only of 2.6GHz spectrum and a portfolio consisting of 2x15MHz of 1800MHz + 2x15MHz of 2600MHz compare to Vodafone / Telefónica and Everything Everywhere's existing spectrum (excluding 2.1GHz) for a network with 12,000 sites.

Figure 3.14: Large portfolios of higher frequency spectrum, 5Mbps, 12,000 sites



3.148 This shows that there is material uncertainty over the extent of coverage achievable with the large portfolios compared to the existing holdings of Vodafone, Telefónica and Everything Everywhere. In the case of the portfolio of 2x15MHz of 1800MHz plus 2x15MHz of 2600MHz, uncertainty over the extent of coverage is comparable to, but slightly worse than that predicted for Everything Everywhere. In the case of the portfolio of 2x40MHz of 2600MHz, the uncertainty is materially greater, with coverage of just under 20% of the hardest to serve locations being uncertain (for a 5Mbps service and a network with 12,000 sites).

3.149 National wholesalers would also need to have sufficient capacity at 2.1GHz and below to serve demand that can only be reached with those frequencies. This may be particularly relevant to considering the position of H3G, which only has 2x15MHz of 2.1GHz (in terms of paired spectrum). 2x15MHz at 2.1GHz will represent less than 8% of the spectrum available after the auction at 2.1GHz and below. This is significantly less than is held by the other existing national wholesalers, which also have holdings at 900MHz or 1800MHz (or both), as well as at 2.1GHz. For a national

¹²³ For comparison Figure 14 presents the same spectrum holdings for existing national wholesalers than Figure 13 but excluding 2100 MHz.

wholesaler with 2.1GHz as its lowest frequency spectrum the capacity provided in locations that are harder to serve would also be reduced since this frequency band is on the slowest route to LTE (see Figure 3.15 below) and HSPA provides less capacity than LTE because it is less spectrally efficient (see paragraphs 3.49-3.56 above). In addition, 2.1GHz spectrum has slightly worse quality of coverage than 1800MHz spectrum.¹²⁴

Conclusion on interaction of capacity and coverage

- 3.150 To some extent there is a trade-off between capacity and coverage. However, this trade-off has limits. For even a large portfolio of 2.6GHz spectrum there remains considerable uncertainty over the depth of coverage that can be provided as compared with spectrum at 2.1GHz and below.
- 3.151 For a national wholesaler with 2.1GHz as its lowest frequency spectrum (such as H3G with its existing holdings), when combined with 2.6GHz spectrum, it is possible that this will be sufficient to provide a sufficient combination of capacity and quality of coverage. However as well as providing a lower quality of coverage than sub-1GHz spectrum (and perhaps also than 1800MHz), the capacity delivered by 2.1GHz is expected to be reduced by the lower spectral efficiency of HSPA compared to LTE for a longer period of time than other frequency bands. The adequacy of H3G's 2x15MHz at 2.1GHz and below will also depend on the prevalence and importance of locations that can be served with 2.1GHz but which 2.6GHz spectrum cannot easily reach with a macrocell network, as well as the extent to which small cell solutions can be used to offer capacity and good quality coverage in harder to serve locations.
- 3.152 Our provisional view is that there is a material risk that 2x15MHz of 2.1GHz may not be enough to provide a sufficient combination of capacity and quality of coverage necessary to be a credible national wholesaler.

Ability to provide services with highest peak data rates

- 3.153 There are three forms of data rate that can be considered:
- **The peak data rate** which the technology can deliver under ideal signal conditions and without contention between users (i.e. a single user occupying all of the resources of one cell). We refer to this as the peak data rate.
 - **The single user throughput** is the maximum speed that a single user would theoretically be able to receive if the only user in the serving cell demanding service at any particular instant of time, but when the user may not be at a location with ideal signal conditions. If the user is very close to the base station, the single user throughput would be the same as the peak data rate.¹²⁵
 - **The average data rate** is the data rate which users actually experience under realistic conditions in a network shared with other users.
- 3.154 We consider the importance of high data rates earlier in this section (see paragraph 3.15). In this sub section we are considering the highest peak data rates only. We will:

¹²⁴ However, as noted in Annex 7, our model predicts that the differences between LTE networks operating at 2100MHz as opposed to 1800MHz are relatively minor.

¹²⁵ We consider single user throughput in our technical modelling (see Annex 7)

- consider what high peak rates might mean for consumers;
- discuss the relationship between spectrum and the highest peak data rates;
- briefly review the technologies used to obtain the highest speeds; and
- consider the highest rates from the perspective of LTE and HSPA.

Peak data rates and consumers

- 3.155 Consumers clearly value the data rate they experience. But this does not mean that a network's peak data rate is necessarily important to consumers. This is because the relationship between the user experience and peak data rate is not straightforward.
- 3.156 Whilst peak data rates indicate the 'top speed' of technologies, they are only achieved under the right conditions. This is where there is only one consumer's device being served per cell and that device has excellent channel conditions.
- 3.157 Consumers are unlikely to often experience these 'right' conditions and therefore they are unlikely to experience the highest peak data rates very often in practice. They will normally be sharing a cell with other consumers and their channel conditions will be less than excellent due to interference from other cells or because the consumer is far away from the base station or inside a building.
- 3.158 The right conditions for the highest data rates are more likely to occur in small cells than macrocells. On small cells there are likely to be fewer users and the channel conditions are more likely to be close to the 'excellent' levels needed for the highest data rates.
- 3.159 Users may be motivated to join a network which can offer at least the potential for the highest data rates as compared with a network which cannot, even though such rates may not typically be available to them. Finally, as noted earlier, high peak data rates can also benefit consumers indirectly, by improving the overall capacity of the network (see paragraph 3.56).

Factors that determine ability to offer highest peak data rates

- 3.160 The peak data rate potentially available from newer mobile standards such as LTE and HSPA+ is larger than that from earlier standards for two main reasons:
- The **data rate available per unit bandwidth** for a given number of cells (spectrum efficiency) is increased, primarily via the use of higher-order modulation¹²⁶ and coding schemes and via more antennas at both transmitter and receiver (MIMO and diversity).
 - They support the **use of wider bandwidths** for delivering services to an individual user.
- 3.161 To make use of higher data rates per unit bandwidth, the equipment used, notably the mobile devices, needs to support the relevant modulation schemes and antenna

¹²⁶ Both HSPA and LTE support a max of 64QAM, although it's mandatory on the LTE DL, but not in all device categories on the HSPA DL.

techniques. For example, devices complying with all releases of LTE (Release 8 and beyond) support 64 QAM modulation (the modulation technique with the highest peak spectrum efficiency) as a mandatory feature. While HSPA supports 64 QAM from Release 7, this is an optional feature in devices. Similarly, LTE devices will almost all support MIMO using at least 2 antennas, but this is only available in some HSPA devices.

- 3.162 To make use of wider bandwidths, networks need to have access to sufficient spectrum. For example LTE (release 8 and 9) allows contiguous blocks of spectrum up to 2x20MHz to be used to provide services to the same user providing the possibility of very high peak data rates.
- 3.163 Later releases of both LTE and HSPA also allow multiple blocks of spectrum in the same or potentially different spectrum bands to be used together to serve a single consumer. This is often referred to as carrier aggregation, dual carrier or dual cell. In the case of inter-band carrier aggregation an operator with spectrum spread across a number of bands could in theory provide the highest data rates comparable with those achievable from a large contiguous block of spectrum in a single band.
- 3.164 This flexibility currently only applies to a subset of the possible bands. So if an operator had a spectrum portfolio that does not match the combinations specified in the standards they would not be able to exploit this unless the standards were updated.
- 3.165 Table 3.1 sets out the required spectrum and technology requirements to deliver the highest available peak speed for each standards release for both HSPA and LTE individually. We note that peak speeds delivered using HSPA are increasing. Nevertheless, these are significantly less than the peak speeds that can be delivered for the same standards release using LTE. Assuming equipment for either technology becomes available in a similar timescale, with LTE, this could result in an advantage for customers and operators for whom peak speed is important. However, the maximum peak speed in a given release will only be available given the full set of technology elements (bandwidth, band, antennas) identified in the table and the equipment supporting all of these may not easily be available or cost-effective in practice.
- 3.166 Longer term the specific spectrum bands held by an operator are likely to become a less important determinant of the maximum peak data rates as standards become more flexible in their ability to aggregate blocks of spectrum in different bands for a single user and the total amount of spectrum becomes more important. However, there is still likely to be a difference in the maximum peak rate which can be offered by an operator of HSPA compared to an operator of LTE.

Table 3.1: Roadmap for peak rate support in HSPA and LTE

| 3GPP Release (Freeze date) | HSPA | | LTE | |
|-------------------------------|------------|---|------------|---|
| | Peak rates | Description of spectrum and technology required (bandwidth, UK-specific bands, antennas) | Peak rates | Description of spectrum and technology required (bandwidth, UK-specific bands, antennas) |
| Rel 5-6 (Jun 02 – | 14 Mbps | 2 x 5 MHz, 2100 MHz, single antenna | N/A | N/A |

| | | | | |
|---------------------------|----------|---|----------|--|
| Mar 05) | | | | |
| Rel 7 (Dec 07) | 28 Mbps | 2 x 5 MHz, 2600, 2100, 1800 or 900 MHz, 64 QAM or 2 layer MIMO | N/A | N/A |
| Rel 8 (Dec 08) | 42 Mbps | 2 x 5 MHz, 2100, 2600, 1800 or 900 MHz., Dual carrier or 2 layer MIMO | 300 Mbps | 2 x 1.4 – 20MHz, 2100, 2600, 900MHz (up to 10MHz) 2 and 4 layer MIMO |
| Rel 9 (Dec 09) | 84 Mbps | 2 x 5 MHz, 2100, 2600, 1800, 900 or 800 MHz, 2 layer MIMO | 300 Mbps | 2 x 1.4 – 20MHz, 800, 2100, 2600, 900MHz (up to 10MHz) Up to 4 layer MIMO |
| Rel 10 (Mar 11) | 169 Mbps | 4x5 MHz, 3500, 2100, 2600, 1800, 900, 800 (including 1 x 2 x 5 MHz @ 900 & 3 x 2 x 5 MHz in 2100 MHz), 2 layer MIMO | 3 Gbps | Up to 5 x 2 x 20MHz. 800, 2100, 2600, 3500 900MHz (up to 2 x 10MHz) up to 8 layer MIMO |

Source: Real Wireless based on 3GPP¹²⁷

3.167 In the European Commission’s (EC’s) Decision on the merger of T-Mobile and Orange it considered that large blocks of spectrum used for LTE could give competitive advantages.¹²⁸ The EC concluded that, without divestment, the parties’ (i.e. T-Mobile’s and Orange’s) 1800MHz spectrum holdings would give them an early route to LTE with large contiguous bandwidth and this would give them a significant advantage over other national wholesalers:

“ ... there are strong grounds to conclude that the parties would still have a significant technological and marketing advantage over competitors. In particular, the parties will be able to offer superior network quality in terms of maximum download data throughput, and potentially also in terms of consistency of provision of lower download data throughputs. The parties will also have a significant time advantage due to the uncertain timing of the auction and the time needed to clear the sub-1 GHz spectrum. In addition, the 2600 MHz spectrum presents lower coverage performance compared to the 1800 MHz spectrum, which makes it hardly suitable for areas other than urban.” (paragraph 128)

3.168 The EC’s Decision was focussed on the near term (“the next few years”)¹²⁹ as longer term other spectrum would be available for LTE, through the auction and re-farming of the 900MHz spectrum. The EC considered that the divestment of 2x15MHz of 1800MHz spectrum was sufficient to alleviate the concerns it identified. It considered that this would allow the acquirer to enable a 2x15MHz LTE network on the 1800MHz band, or even a 2x20MHz shared network if combined with Vodafone’s 2x5.8MHz of

¹²⁷ See The timing of the consumer and operator features available from HSPA and LTE technology paths, Real Wireless, January 2012.

¹²⁸ http://ec.europa.eu/competition/mergers/cases/decisions/M5650_20100301_20212_247214_EN.pdf

¹²⁹ See paragraph 138 of the EC’s Decision.

spectrum at 1800MHz. It considered that this would allow the acquirer to compete on an almost equal footing with Everything Everywhere.

- 3.169 We consider that, while 2x20MHz of contiguous spectrum suitable for LTE is needed to deliver the highest possible peak speeds in the near term, 2x15MHz of contiguous spectrum suitable for LTE will deliver relatively high peak speeds and is likely to allow national wholesalers to avoid a significant competitive disadvantage even for customers that value high peak speeds in the near term. Longer term, it may be possible to deliver very high peak speeds (up to 3Gbps) with larger quantities of spectrum suitable for LTE (up to 5 blocks of 2x20MHz). However, there will be more flexibility in aggregating blocks of spectrum in different bands so the total amount of spectrum, rather than the specific bands and contiguity of spectrum, will become more important.

Provisional conclusion on significance of spectrum for peak data rates

- 3.170 Peak data rates will only be experienced by consumers in particular technical conditions. These conditions are unlikely to arise often in practice for consumers that are served using a macrocell for a large proportion of the time or locations and therefore the benefits to being able to deliver highest peak speeds over a macrocell are uncertain. The conditions are more likely to arise when consumers are served using smaller cells and therefore it is possible that being able to deliver high peak speeds using small cells delivers a significant competitive advantage. But we have seen little evidence on the extent that consumers value high (or highest possible) peak data rates or how much consumers value applications and services that rely on high peak data rates. Overall it is unclear whether this capability is necessary to be a credible national wholesaler.
- 3.171 However, in relation to our second type of competition concern about competition across a wide range of services and customers, even if delivering highest peak speeds is not important for acting as a credible national wholesaler, national wholesalers that do not hold the spectrum necessary for delivering high peak speeds could be weaker competitors in some particular segments of services or customers than national wholesalers that are able to deliver high peak speeds.
- 3.172 We consider that, in the near term, national wholesalers would need to hold at least 2x15MHz of contiguous spectrum suitable for LTE in order to compete effectively for customers and national wholesalers that value peak speeds. While peak speeds delivered using HSPA are increasing, these are less than the peak speeds that can be delivered using the same standards release using LTE. Longer term the specific spectrum bands held by an operator are likely to become a less important determinant of the maximum peak data rates as standards become more flexible in their ability to aggregate blocks of spectrum in different bands for a single user and the total amount of spectrum becomes more important. However, there is still likely to be a difference in the maximum peak rate which can be offered by an operator of HSPA compared to an operator of LTE.

Ability to provide LTE services

- 3.173 In the March 2011 consultation we considered that the ability to provide LTE services could give a technical and competitive advantage relative to those with the ability to provide HSPA services. If this were the case, it could be significant, as not all the spectrum suitable for mobile spectrum will be equally useful for LTE services at least in the near term.

3.174 In the following sections we consider:

- Extent of difference between LTE and HSPA
- Spectrum most suitable for LTE
- Provisional conclusions on importance of spectrum suitable for LTE

3.175 We conclude that there are some advantages of LTE over HSPA, both from the perspective of the operator and consumers. The advantages delivered are in terms of low latency and quality of service guarantees, such as 'guaranteed bit rate'. LTE may also be attractive to early adopters and others influenced by having access to the latest technology. Other benefits from LTE relative to HSPA include higher peak speeds and enhanced capacity. However, we consider these quality dimensions (and the importance of LTE to delivering them) explicitly elsewhere in this Section.

3.176 Over the near term, only those national wholesalers with particular frequencies of spectrum are likely to be able to offer LTE services. In particular, we expect LTE to be deployed in 800MHz, 1800MHz and 2.6GHz spectrum soon. Based on the available evidence we consider that LTE will not be deployed in the 900MHz band until some years later and LTE in the 2.1GHz band will be even further into the future.

3.177 It is unclear the extent to which consumers are likely to value the features that LTE can deliver over and above HSPA, and therefore the extent to which holding spectrum suitable for early deployment of LTE will deliver a significant commercial advantage. It may be that the features associated with LTE are only valued by a small group of consumers. In any case, we expect that any commercial advantage associated with holding spectrum suitable for LTE will be time limited albeit potentially lasting a number of years.

Extent of difference between LTE and HSPA

3.178 There are many similarities between LTE and more advanced releases of HSPA. Details of the steps in the evolution of both technologies are provided in the Real Wireless report on the features available from HSPA and LTE technology that is to be published alongside this consultation document.¹³⁰ However, there are fundamental differences between the technologies:

- a) HSPA uses wideband CDMA technology, where spreading codes are shared between users in a way which allows a controlled level of interference between users who simultaneously access the same radio channel. LTE uses OFDMA technology, which divides the available resources into a grid of frequency and time units, which are separate for each user and shared out amongst users. At high levels of loading HSPA runs into stability issues, which limit the practical level of loading which can be achieved, while the separated resources in LTE avoid such instabilities and allow it to run with a larger proportion of potential resources allocated to users.
- b) HSPA uses a 2 x 5 MHz block of spectrum as a minimum amount and is usually deployed today with only a single such block available to a given user, although

¹³⁰ See The timing of the consumer and operator features available from HSPA and LTE technology paths, Real Wireless, January 2012.

newer versions of HSPA standards and HSPA devices provide some support for multiple carriers to an individual user. LTE uses a flexible channel bandwidth between 1.4 and 20 MHz in each of the downlink and uplink and newer versions of LTE (LTE-Advanced) support carrier aggregation, which allows a multiple of these bandwidths to be used together to provide higher data rates, in some cases even between different frequency bands. These features may allow operators with spectrum bands which are well supported in LTE to make more flexible use of their spectrum portfolio.

- c) LTE was designed after HSPA and was specifically created to meet evolving needs for data services and has incorporated features based on this experience. For example, from the beginning of LTE standardisation, LTE has supported higher order modulation schemes and antenna technology which allow it to operate at higher data rates in a given spectrum bandwidth than earlier versions of HSPA. HSPA is being evolved to support many of these features, but there are potential differences in the rate of progress and extent of support in devices at given points in time supporting either technology.
- d) LTE is a radio technology, but has been standardised in close conjunction with the Enhanced Packet Core (EPC) network architecture, which removes a layer of connectivity to permit lower latency in the core network (and potential cost savings). Operators are expected to deploy EPC along with LTE. Such architectural advantages can also be deployed with HSPA, but may not be so readily available from suppliers.

3.179 These underlying differences enable LTE to operate more efficiently with respect to the use of spectrum. Specific aspects of network performance where LTE delivers advantages over HSPA include:

- Peak rates
- Cell spectral efficiency
- Latency
- Ability to prioritise traffic
- Voice support and capacity

3.180 A number of these aspects relate to other quality dimensions we have identified as being potentially important for consumers. We discuss cell spectral efficiency associated with LTE technology earlier in this section when we consider the factors that will determine the capacity available to an operator (see paragraphs 3.49 – 3.56). We consider peak rates above (see paragraph 3.153) and discuss the benefits that LTE can deliver in respect of peak rates within that section. The rest of this sub-section considers the benefits of LTE in terms of latency, ability to prioritise traffic and voice support and capacity.

Latency

3.181 Latency is a measure of the time it takes a single packet of data to travel from its source to its destination. The overall responsiveness of a mobile network from a consumer's perspective will be affected by the latency and the data throughput together. For example, when loading a web page, the latency will set the time for the user to first see the page starting to load, while the throughput will affect the time for

the page to finish loading. Latency is likely to be important for real time applications that are sensitive to delays and require a high degree of responsiveness, including VoIP (Voice over IP), video streaming, video conferencing and gaming.

3.182 The latency experienced by users is impacted by several elements:

- by the radio (air) interface between base stations and mobile devices;
- by the core network which connects the radio network to other networks (such as the internet or other mobile networks); and
- by the other networks themselves.

3.183 Differences between LTE and HSPA network latency are primarily issues of the air interface, although the ability of LTE to deliver low latency is additionally a function of the EPC architecture.

3.184 Table 3.2 shows how latency and other features may vary between LTE and HSPA according to the standards releases. Devices supporting these releases for either technology will typically start to appear on the market starting from two years after the release 'freeze date' indicated in the table.

Table 3.2: comparison of key performance criteria for LTE and HSPA by Release

| 3GPP Release | | Rel 5-6 | Rel 8 | Rel 9 | Rel 10 |
|---|-----------|-------------|---------------|---------------|---------------|
| Standards Freeze | | Jun 02 | Dec 08 | Dec 09 | Mar 11 |
| UK Commercial | | Jun 03 | Jan 13 | Jul 14 | Jan 16 |
| Mass adoption | | May 04 | Jan 15 | Jul 16 | Jan 18 |
| Peak Rates | HSPA | 14 Mbps | 42Mbps | 84 Mbps | 169 Mbps |
| | LTE | - | 300 Mbps | 300 Mbps | 3 Gbps |
| Capacity (Cell Spectral Efficiency) | HSPA | 0.54 bps/Hz | 1.28 bps / Hz | | |
| | LTE (2x2) | - | 1.5 bps/Hz | 1.5 bps/Hz | 2.4 bps/Hz |
| User Plane Latency | HSPA | ~100ms | <25ms | | |
| | LTE | - | <25ms | <25ms | <LTE Rel 8 |
| Connection Setup time | HSPA | ~1s | <100ms | | |
| | LTE | - | <100ms | <100ms | <50ms |
| Carrier Bandwidth and multicarrier support | HSPA | 5MHz x 1 | 5MHz x 2 | 5MHz x 2 | 5MHz x 4 |
| | LTE | - | 1.4-20MHz x 1 | 1.4-20MHz x 1 | 1.4-20MHz x 5 |

Sources for dates: 3GPP¹³¹, Real Wireless¹³², Informa¹³³ (gaps in the table indicate that no relevant information has been located)

3.185 The table above shows that latency is improving with new releases of technology. Based on this information, LTE appears to have a more developed roadmap to reduce latency over time than corresponding releases of HSPA, particularly from release 10 onwards, although the gap is arguably not large. However, when earlier releases of HSPA (before release 8) are compared with LTE at release 8 and

¹³¹ 3GPP Work plan (inclrel 12):

http://www.3gpp.org/ftp/Information/WORK_PLAN/Description_Releases/

¹³² 4G Capacity Gains, Real Wireless, January 2011: <http://stakeholders.ofcom.org.uk/market-data-research/technology-research/2011/4G-Capacity-Gains/>

¹³³ Future of Mobile Networks Report, Informa, Media and Telecoms, 2010

beyond, the difference is more pronounced. This comparison corresponds to an operator deploying LTE initially in comparison to an operator with existing HSPA infrastructure. While the HSPA infrastructure (both the radio and core network) could in principle be upgraded to achieve similar latency to LTE, the cost may be substantial and the gap is likely to widen over time.

- 3.186 The extent to which consumers will be aware of these differences in latency will depend on the service offered and the delays in other parts of the network(s) delivering the service.

Ability to prioritise traffic

- 3.187 LTE includes specific features which allow the operator to tag data with quality of service information (QoS) allowing the tagged data to be treated at different levels of priority depending on the application. For example, delay sensitive traffic (like voice) can jump ahead of delay tolerant traffic (like file transfer) in the queues, minimising the impact to user experience. Similarly, an operator can run guaranteed bit rate services (such as high-quality video streaming service) along with 'best efforts' traffic such as multiple web browsing users in the same bandwidth.
- 3.188 These features effectively allow the overall network capacity (the cell spectral efficiency multiplied by the quantity of spectrum) to be shared unequally amongst users, depending on their requirements, tariff package, signal conditions etc. Likewise it allows the system latency to be varied by service by giving prioritised packets access to the available capacity before others. It could allow operators to introduce differential tariffs for users seeking different levels of service, for example providing good performance for users with needs for video conferencing, interactive gaming and synchronisation separately.
- 3.189 Although HSPA also incorporates such features, the WCDMA technology means that the differing services may cause some level of interference to each other. Also implementation of these QoS features is seen as complex relative to the 'native' support for QoS in LTE.¹³⁴
- 3.190 The benefits to consumers of using a technology that can prioritise traffic could be potentially significant in the future, particularly if it leads to new innovative services that are better tailored to consumers needs.¹³⁵ However, these benefits are very uncertain and will depend on the sorts of applications and services that consumers will use in future.

Voice support and capacity

- 3.191 3G technology (on which HSPA is built) offers built-in support for voice services with dedicated circuit-switched connections for voice users. By contrast, LTE offers no support for circuit-switching and all voice services have to be realised using some form of prioritised packet access and has to be appropriately supported in the devices and the network.

¹³⁴ Olsson et. al. (2009), SAE and the Evolved Packet Core, Wiley.

¹³⁵ A recent article in 'The Register' discussed how the BT/Everything Everywhere trial of LTE in Cornwall had "demonstrated how easily an LTE network could prioritise a video stream, at the cost of other network traffic, and while tariffs weren't discussed it's obvious that one might decide to pay for such prioritisation services": http://www.theregister.co.uk/2011/11/30/lte_trial/

- 3.192 Some early LTE deployments¹³⁶ therefore rely on circuit-switched fall-back operation, where data services are transported over LTE but voice services rely on existing 2G and 3G networks.
- 3.193 LTE in release 8 can however support potentially more than twice as many calls per unit of spectrum as HSPA in release 7 (or in release 8 without MIMO or high order modulation).¹³⁷

Marketing advantages associated with early deployment of LTE

- 3.194 Consumers will value LTE technology according to the features it can offer rather than because of the underlying technology per se. However, there might be some marketing advantages from the operator perspective associated with a new technology early. LTE may offer a marketing advantage to national wholesalers, beyond the inherent technical capabilities of the technology, which lead to additional competitive advantages.
- 3.195 In some countries, such as the USA, operators that have launched LTE have engaged in major marketing campaigns to promote its benefits, including on the throughput rates achieved being significantly above HSPA. Operators advertising much higher throughput rates on LTE include:
- In the USA, Verizon and AT&T advertise LTE as having 'speeds up to 10x faster than 3G'.¹³⁸
 - In Scandinavia, TeliaSonera reports that typical data rates in its LTE networks are in the 20 to 80Mbps range, which it says is ten times higher than HSPA.¹³⁹
 - In Japan, DoCoMo reports its LTE services as approximately 10 times faster than its HSPA services.¹⁴⁰
- 3.196 However, these higher throughput rates relative to HSPA are largely due to the fact that LTE networks are likely to be uncongested initially due to lack of penetration of LTE user devices. This allows national wholesalers to more lightly load the networks and therefore offer higher throughput rates. These benefits are therefore not specific to the technology being offered, and could in principle be delivered by an operator deploying HSPA, provided they had enough spectrum. The differences may also be due partly to HSPA being an earlier release of HSPA compared to release 8 used for LTE.
- 3.197 In the USA, Verizon Wireless has also promoted the improved latency of its LTE services.¹⁴¹

¹³⁶Such as those of AT&T and Verizon in the USA.

¹³⁷ See The timing of the consumer and operator features available from HSPA and LTE technology paths, Real Wireless, January 2012.

¹³⁸ Verizon Wireless: <http://network4g.verizonwireless.com/#/coverage>
<http://www.verizonwireless.com/pantech-4g-lte-usb-modem.shtml>

AT&T: <http://www.att.com/network/>

¹³⁹ <http://feed.ne.cision.com/wpyfs/00/00/00/00/00/13/28/17/wkr0007.pdf>

¹⁴⁰ <http://www.nttdocomo.com/features/mobility31/index.html>

¹⁴¹ Verizon advert: "4G LTE Response Time is Over 2x faster"

The gap between HSPA and LTE technology will change over time

3.198 LTE Advanced (Release 10) deployments are expected within a few years. Some commentators have noted that the LTE ecosystem is developing rapidly and that LTE Advanced will be deployed around 2015 accounting for time to market expectations.¹⁴² There are also indications that some US operators may start to deploy LTE Advanced in 2013.¹⁴³ We expect that the gap between what LTE and HSPA can deliver to increase over time. Longer term, when the gap between HSPA and LTE increases, it may be important for national wholesalers to hold spectrum suitable for delivering LTE services.

International evidence on take-up and consumer demand for LTE services

3.199 It is not clear yet how important LTE services will be for consumers. In the USA, there is research indicating that 75% of respondents see “4G” as an “Ideal phone feature”¹⁴⁴, indicating significant consumer appetite for “new” services. However, in the USA, HSPA+ has also been marketed as a 4G technology¹⁴⁵, so this does not, in itself, reflect consumer appetite for LTE services. Also, it is possible that consumers may not be able to distinguish the advantages of LTE over other technologies in terms of improvements in latency (faster connection time, increased responsiveness of “real time” services) from higher data rates.¹⁴⁶

3.200 It is possible that, once LTE is widely deployed, consumers’ habits could change as they adapt to the improved capabilities that the new technology can offer. TeliaSonera reports that, when the world’s first 4G users were surveyed “many respondents reported dramatic changes to their media consumption habits”.¹⁴⁷ However, this survey is based on early adopters of LTE, who may be more likely to change their usage patterns in response to improved capabilities than the average user.

Summary of when different bands are likely to be used for LTE

3.201 There is a wide consensus that 800MHz and 2.6GHz spectrum will be used for LTE. 1800MHz is also emerging as an important band for LTE. LTE1800 networks are being deployed in a number of countries with other countries planning to deploy it.¹⁴⁸ As this Consultation is concerned with assessing competition after the auction, we

¹⁴² http://www.ict-befemto.eu/fileadmin/documents/publications/workshop_2011/F_PUJOL_IDATE_15_05_2011.pdf

¹⁴³ Sprint in the US is reported to be planning LTE Advanced in 2013: http://news.cnet.com/8301-1035_3-20125328-94/sprint-to-move-into-lte-advanced-by-2013-report-says/
AT&T has also said it would deploy LTE Advanced in 2013: <http://www.telecoms.com/36604/att-reveals-lte-advanced-plans/>

¹⁴⁴ <http://www.instat.com/newmk.asp?ID=3284>

¹⁴⁵ <http://deals.t-mobile.com/plans>

¹⁴⁶ Signals Research, Beyond HSPA+ - Keeping up with the Joneses, March 2011: “users will notice a faster connection time, although they could erroneously attribute the improved user experience to a faster data rate.”

¹⁴⁷ <http://feed.ne.cision.com/wpyfs/00/00/00/00/13/28/17/wkr0007.pdf>

¹⁴⁸ A GSA report, LTE developments worldwide, including interest in 1800MHz (LTE1800), November 2011, stated that 10 commercial LTE1800 networks have been launched, with very strong interest in LTE1800 around the world. The 10 countries were: Poland, Lithuania, Singapore, Germany, Latvia, Finland, Saudi Arabia, Australia, and Denmark:
http://www.gsacom.com/downloads/pdf/GSA_LTE_developments_worldwide_including_LTE1800_24_1111.php4

assume for these purposes that 1800MHz spectrum has been liberalised for LTE by that time. There is also growing evidence that LTE capable handsets are likely to be available in the next few years that will use these three bands.¹⁴⁹

- 3.202 We expect LTE to be deployed in 800MHz and 2.6GHz spectrum soon after the spectrum becomes available. This will be from around the end of 2013, though this will vary slightly between the two bands, as discussed in Section 3 of the main consultation. If the 1800MHz spectrum were liberalised, we expect Everything Everywhere to start to deploy LTE in the 1800MHz earlier than this. The acquirer of the divested 1800MHz would be able to deploy LTE1800 from the end of 2013. This is illustrated in Figure 3.14 below.
- 3.203 For the 900MHz spectrum, we consider the move to LTE is longer term and there is considerable uncertainty over when it might occur. Research on unannounced product roadmaps suggests there could eventually be a similar number of devices available for LTE900 as for LTE1800.¹⁵⁰ However, there are currently few public announcements on LTE900 devices and, while it is possible that LTE900 could catch up with LTE1800 over time, today LTE900 is some way behind LTE1800.
- 3.204 The precise timings for when LTE will be deployed using 900MHz are very uncertain. This is partly because it will be driven by the extent of any commercial advantage of LTE over HSPA, which in turn will influence how quickly the ecosystem for LTE900 develops. If LTE has a significant commercial advantage over HSPA, then we would expect the availability of LTE900 devices to increase and operators with 900MHz spectrum to progressively re-farm this for LTE.¹⁵¹ However, the market for LTE devices is international and the extent to which 900MHz operators in the UK alone can drive the development of an LTE900 ecosystem may be limited. We have reflected the uncertainty over when LTE might be deployed in the 900MHz band in Figure 3.14 below by showing a wide range for when it may begin.
- 3.205 In the March 2011 consultation, we set out that we considered it less likely that 2.1GHz spectrum would be used for LTE services in Europe than other bands within the timescales of this assessment (the five to ten years from the conclusion of the auction). This was principally because of considerable uncertainty over whether LTE equipment will be available for the 2.1GHz band within this timescale. We do not consider there was strong evidence questioning this view in responses. We therefore remain of the view that 2.1GHz is less likely to be used for LTE in Europe in the timescales we are considering.¹⁵² However, if LTE did give a significant commercial advantage over HSPA, then this would tend to make it more likely that equipment would be available and national wholesalers would start to move spectrum to LTE more rapidly, even at 2.1GHz. In Figure 3.15 below, we have shown LTE at 2.1GHz

¹⁴⁹ See The timing of the consumer and operator features available from HSPA and LTE technology paths, Real Wireless, January 2012.

¹⁵⁰ See The timing of the consumer and operator features available from HSPA and LTE technology paths, Real Wireless, January 2012.

¹⁵¹ See Annex 8

¹⁵² This is consistent with the absence of LTE2100 devices in product roadmaps from device manufacturers for the European market, as shown in 'The timing of the consumer and operator features available from HSPA and LTE technology paths' (Real Wireless, January 2012). We recognise that 2.1GHz is used for LTE in Japan by DoCoMo, and that smartphones at 2100LTE are starting to be available in Japan (e.g. <http://techmulti.com/390/samsung-galaxy-s-ii-lte-introduced-in-japan-via-ntt-docomo.html>). Potentially this may make it easier to deploy LTE2100 handsets in Europe if there were demand.

being later and have reflected the considerable uncertainty over exactly when this might occur.

Figure 3.15: Indicative timescales for deployment of LTE in different bands



Availability and stock of LTE user devices

- 3.206 Currently there are no devices being used for LTE in the UK, besides those being used in trials. It may take time for a stock of LTE devices to grow, especially for user devices that are expensive to replace (such as tablets and smartphones). This is in contrast with devices suitable for 3G services, which are rapidly becoming a substantial share of user devices (see Figure 3.16 below).
- 3.207 What matters for competition is the willingness of consumers to change devices when they change provider. This is likely to differ between consumers: some consumers may wish to retain their existing devices when they change provider, while others may value acquiring the best available technology. The incentives for consumers to upgrade their devices will, to some extent, depend on the advantages of LTE over other technologies, and also on the nature and cost of devices in the future.
- 3.208 It is unclear how quickly the range of LTE devices will grow and how quickly this will be comparable to the current range and variety of 3G devices. It is also unclear how quickly the stock of LTE devices will grow and the extent to which this matters for competition. It is quite possible that, for some period of time, there will be advantages to holding spectrum suitable for HSPA rather than LTE, because of a larger range or stock of compatible devices.

Figure 3.16: Mobile Subscriptions, by technology



Source: Ofcom / operators

Significance of temporary advantages associated with an early route to LTE

3.209 It is not inevitable that, if some national wholesalers hold spectrum that allows them to deliver LTE services before others, this temporary advantage would be detrimental to national wholesale competition. It is not unusual for some competitors to have temporary advantages over others at particular points in time. For the mobile sector, in addition to this happening because of different spectrum holdings, it could happen because different national wholesalers have access to different technologies, have different sized networks, are at different points in the investment cycle or simply because some are more effective than others. Such differences are a common feature of the competitive process, can offer significant benefits to consumers and would not normally be a cause for concern.

3.210 Nevertheless, there are two potential sources of competition concern that could arise if only a limited number of national wholesalers are able to provide LTE services immediately following the auction:

- First, competitive forces in the provision of LTE services could be weaker than might otherwise be possible during the period in which only a limited number of national wholesalers are able to deploy LTE services. This could lead to higher prices, slower deployment or poorer quality services for consumers.
- Second, it is possible that those national wholesalers that are able to provide LTE services ahead of their competitors will be able to establish and maintain a 'first mover advantage' which could persist even once other operators are able to deploy LTE. This could reduce competitive intensity and benefits to consumers over the longer term.

3.211 It is possible that competition in the provision of LTE services will be weak until all national wholesalers are able to deploy LTE services. However, operators will face competitive pressure from national wholesalers using other technologies, particularly where consumers see those technologies, or the mobile services provided using them, as close substitutes. National wholesalers also face the threat of future entry, once other national wholesalers are able to deploy LTE. They might be discouraged from setting very high prices for LTE services since this might incentivise competitors to deploy LTE earlier than they otherwise would.

- 3.212 The magnitude of the impact on competition and consumers could be limited by the period of time over which some national wholesalers are constrained in their ability to deploy LTE. The timeline above suggests that any advantage a holder of 1800MHz spectrum is likely to have over a holder of 900MHz spectrum, in terms of ability to deliver LTE services, could be for a number of years.
- 3.213 There is potentially a greater risk to competition if the competitive advantage of being one of the first national wholesalers to deliver LTE persists even after other national wholesalers can deploy LTE. A first mover advantage might arise if national wholesalers with an early route to LTE:
- gain a reputation for offering high quality mobile data services; and/or
 - are able to lock in customers and market share during the first mover period due to:
 - contract terms and length and cost of contract termination
 - non contractual switching costs
- 3.214 Reputation effects may arise where early adopters of LTE technology establish an improved reputation for quality network provision over and above competitors that are restricted to deploying HSPA. However, were reputational advantages to arise, we do not have evidence to suggest that they would persist beyond the point at which all national wholesalers are in the position to offer LTE services. For example, H3G was the first operator to launch 3G services in the UK, yet the available evidence does not suggest that this allowed it to benefit from a persistent first mover advantage (see the discussion of 3G take-up by operator in Section 5 below).
- 3.215 We discuss the extent of switching costs and customer inertia in the market for mobile services in more detail in Section 5. The evidence presented suggests that the factors that could lock in customers during the first mover period are unlikely to be significant. While there might be some impediments to switching provider, survey evidence suggests that most consumers find the process easy. In any case, these factors may also undermine the first mover advantage of launching LTE early since lagging firms may be protected by their existing customers' inertia.
- 3.216 Also, even if early LTE customers are completely locked in, the pool of potential customers will be expanding over time as people upgrade. For a persistent first mover advantage to be significant a national wholesaler would have to lock-in not only early adopters but many other potential LTE customers.
- 3.217 Finally, it is also plausible that a first mover may find itself at a competitive disadvantage in the longer term compared to national wholesalers that deploy LTE at a later stage. National wholesalers with an early route to LTE may face uncertainty in offering a new set of services. Later entrants may benefit from a first mover's investment in developing LTE services and consumer demand and could for example 'free ride' on this.

Provisional conclusions on significance of spectrum suitable for LTE

- 3.218 We conclude that there are some advantages of LTE over HSPA, both from the perspective of the operator and the consumer. The key advantages delivered are in terms of lower latency and quality of service guarantees, such as 'guaranteed bit

rate'. LTE may also be attractive to early adopters and others influenced by having access to the latest technology.

- 3.219 National wholesalers with particular frequencies of spectrum are likely to be able to offer LTE services more quickly. In particular, we expect it to be possible to deploy LTE in 800MHz, 1800MHz and 2.6GHz spectrum earlier than in other bands. The evidence suggests that LTE will not be available in the 900MHz band until some years later and LTE in the 2.1GHz band is unlikely to be available until even further into the future.
- 3.220 It is unclear the extent to which consumers are likely to value the features that LTE can deliver over and above HSPA, and therefore the extent to which holding spectrum suitable for early deployment of LTE will deliver a significant competitive advantage. It is possible that any competitive advantage associated with holding spectrum suitable for early deployment of LTE could last for some years. However, it may be that the features associated with LTE are only valued by a small group of consumers, particularly in the early stages of LTE deployment. Indeed, for a period, there could also be advantages of HSPA over LTE because of a larger range or stock of compatible devices. Overall it is unclear that national wholesaler will need an early route to LTE in order to be credible. However, in the longer term it may be more important to be able to offer LTE services, as the advantages over HSPA are likely to become more pronounced.
- 3.221 Finally, in relation to our second type of competition concern about competition across a wide range of services and customers, even if having an early route to LTE is not important for acting as a credible national wholesaler, national wholesalers that do not hold the spectrum necessary for an early route to LTE may act as weaker competitors in some particular segments of services or customers than national wholesalers that are able to offer LTE services soon.

Summary assessment of spectrum needed to be a credible national wholesaler

- 3.222 Our provisional conclusions on the importance of delivering particular quality dimensions for being a credible national wholesaler and the types and quantities of spectrum needed for this are summarised in Table 3.3 below. Overall we consider that it is likely to be necessary to deliver sufficient quality of coverage and capacity in order to be a credible national wholesaler. It is unclear whether having an early route to LTE and being able to deliver highest peak rates is important for being a credible national wholesaler.

Table 3.3: Provisional conclusions on importance of different dimensions of mobile service quality for credibility as a national wholesaler

| | Importance for credibility | Implications for spectrum |
|---|---|--|
| Capacity and average data rates | Sufficient capacity to deliver a competitive average data rate is necessary to be a credible national wholesaler | Material risk if hold less than 10-15% of paired spectrum after auction |
| Quality of coverage | Sufficient quality of coverage (including capacity to serve harder to serve locations) is necessary to be a credible national wholesaler | Material risk if do not hold a sufficient quantity of sub-2.1GHz spectrum |
| Highest peak data rates | Unclear that inability to deliver highest peak speeds undermines credibility as a national wholesaler | Unclear that access to a 2x15MHz or 2x20MHz contiguous block of 800MHz, 1800MHz or 2.6GHz spectrum is necessary to be credible |
| Early route to LTE¹⁵³ | Unclear that absence of an early route to LTE undermines credibility as a national wholesaler in the longer term. However, longer term, no route to LTE might be a problem in terms of credibility. | Unclear that access to 800MHz, 1800MHz or 2.6GHz spectrum is necessary to be credible |

3.223 We consider that a national wholesaler can have a significant influence on competition in the provision of mobile services in general even if it is disadvantaged in some areas relative to others. This is provided the disadvantages are not too large or are compensated by advantages in other quality dimensions. In Section 4, we therefore consider whether a spectrum portfolio is sufficient for a national wholesaler to be credible in the future 'in the round' taking account of any advantages and disadvantages of its spectrum portfolio and the relative importance of those advantages and disadvantages.

3.224 The assessment in Table 3.3 is in terms of whether the quality dimensions are essential to enable a national wholesaler to be credible. But even if they are not essential for this, some quality dimensions could be very important to particular consumer groups, and a lack of competition for the provision of services to such consumers might be a concern. This relates to our second type of competition concern about competition across a wide range of services and customers. We return to this in Section 4 after we have considered what spectrum portfolios might be the minimum necessary to allow a national wholesaler to be credible.

¹⁵³ Excluding aspects covered in the dimensions above, such as capacity and peak data rates.

Section 4

Auction outcomes that might give rise to concerns about national wholesale competition

Introduction and summary

- 4.1 This section considers what outcomes from the auction could give rise to the concerns identified in Section 2 about national wholesale competition, relating to the: (i) number of credible national wholesalers; and (ii) strength of competition across a wide range of services and customers. Drawing on the provisional conclusions in Section 3, this section considers whether each of the current national wholesalers is dependent on acquiring spectrum in the auction to be credible in the long term, given its existing spectrum holdings. And if they do need to obtain more spectrum, it considers what spectrum they might need. It also considers what spectrum a new entrant may need to acquire to be a credible national wholesaler.
- 4.2 Our provisional conclusions in this section are:
- Everything Everywhere's existing holdings are likely to be sufficient for it to be a credible national wholesaler in the future even if it wins no additional spectrum in the auction¹⁵⁴;
 - Telefónica and Vodafone's existing holdings are likely to be sufficient for them to be credible in the near term, for at least as long as HSPA900 is competitive with LTE, but there is some potential risk of them not being credible in the longer term if LTE900 equipment is not available soon thereafter, or because of the relatively limited overall spectrum share they would hold if they did not win spectrum in the auction;
 - H3G is unlikely to be credible without additional spectrum; and
 - A new entrant obviously needs to obtain spectrum in the auction to be credible.
- 4.3 We therefore consider that there are auction outcomes that could effectively result in fewer than four credible national wholesalers. In Section 5, we go on to consider how likely these auction outcomes are, i.e. the risk that national wholesalers will fail to acquire the spectrum they may need to be credible (in an auction without measures to promote competition).
- 4.4 We also consider auction outcomes where, even if there were at least four credible national wholesalers, one or more national wholesalers may be at a disadvantage in competing across a wide range of services and customers.
- 4.5 The structure of the rest of this section is as follows:

¹⁵⁴ Please note that although we discuss the current spectrum portfolios of each of Everything Everywhere, Telefónica and Vodafone, our conclusions in respect of each of these companies would be equally applicable to any company that has an equivalent spectrum portfolio.

- Framework for considering spectrum needed to be a credible national wholesaler
- Future credibility of Everything Everywhere as a national wholesaler
- Future credibility of Telefónica as a national wholesaler
- Future credibility of Vodafone as a national wholesaler
- Future credibility of H3G as a national wholesaler
- Credibility of new entrant as a national wholesaler
- Summary of auction outcomes that might give rise to competition concerns

Framework for considering spectrum needed to be a credible national wholesaler

4.6 Below we set out the framework we will use to consider whether spectrum portfolios are sufficient to make a national wholesaler credible.¹⁵⁵

Colour coded table to assess strengths and weaknesses of spectrum holdings

4.7 In Section 3, we considered four dimensions of quality:

- Available capacity and average data rates;
- Ability to deliver good quality coverage;
- Ability to deliver highest peak data rates; and
- Ability to deliver LTE services.

4.8 There are interactions between these dimensions of quality, especially between good quality coverage and the other three. For example, with 2.6GHz spectrum it will be possible to deliver an LTE service, but not with certainty of good quality of coverage with LTE in harder to serve locations.

4.9 To enable us to consider these potential interactions, we use Table 4.1 as a standard format to consider the potential strengths and weaknesses of different spectrum holdings in the rest of this section. The purpose of this Table is to summarise the risks in terms of what can be delivered with a macrocell network. It does not take account of the importance of the different dimensions nor whether any potential weaknesses could be partially mitigated through other means (for example, by relying on Wi-Fi or femtocells to provide capacity and coverage in buildings). The Table needs therefore to be combined with an assessment of these considerations before drawing conclusions.

¹⁵⁵ In the March 2011 consultation, we used the terminology 'minimum spectrum portfolios' to describe the minimum amount of spectrum required for a national wholesaler to be credible. Here we do not use this terminology as we do not look at the spectrum required to be credible in a standalone way. We take into account the potential strengths and weaknesses of existing spectrum holdings in terms of delivering different quality dimensions and consider these in the round in order to assess whether national wholesalers need to acquire more spectrum in order to be credible competitors.

Table 4.1: Framework for assessing spectrum needed to be a credible national wholesaler

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|-------------|
| 1. Capacity and average data rate – near term | | | |
| 2. Capacity and average data rate – longer term | | | |
| 3. Early route to LTE | | | |
| 4. Highest peak data rate with early LTE | | | |

4.10 The columns help to inform the assessment of the ability to deliver good quality coverage. The columns show whether holdings of spectrum at different frequencies are capable of delivering the quality dimensions in each of the rows. Although it is not straightforward, there is a degree of correlation between spectrum frequency and quality of coverage, as discussed in Section 3. The format of Table 4.1 allows us to show how the other quality dimensions - shown in the rows - may vary with frequency (and quality of coverage). For example, taking account of the interaction between capacity (and average data rates) and coverage, we concluded in Section 3 that there is a material risk of not being a credible national wholesaler without sufficient spectrum at 2.1GHz and below.

4.11 The rows show the other three quality dimensions we described in Section 3. But we have sub-divided two of these quality dimensions as between the near term and the longer term: (i) available capacity and average data rate and (ii) the ability to deliver peak data rates. This enables us to distinguish how they may change over time with different spectrum holdings. The rows consider:

- **Capacity and average data rate – near term:** capacity suitable for data services soon after the auction. This will include the auctioned spectrum, the divested spectrum, but not all of the 900MHz and other 1800MHz spectrum, some of which we expect would still be used for 2G.
- **Capacity and average data rate – longer term:** capacity suitable for data services in the longer term, when it would be possible to refarm all the 900MHz and 1800MHz to LTE (whether or not national wholesalers actually find it more profitable to retain a small amount of this for 2G or 3G use).
- **Early route to LTE:** the ability to launch an LTE service either before or soon after the auction. It will be possible to do this with the 800MHz and 2.6GHz spectrum in the auction, with the divested 1800MHz spectrum, and we expect that Everything Everywhere will be able to do this using some of its retained 1800MHz spectrum.
- **Highest peak data rate with early LTE:** by “early LTE” we mean network and user equipment complying with LTE Release 8 or 9, which is what we expect to

be used in the UK initially after the auction.¹⁵⁶ With early LTE the highest peak data rates can be delivered in contiguous blocks of 2x20MHz.

- 4.12 We do not have a row that considers the highest peak data rate after early LTE. Later releases of LTE allow higher peak data rates. For example, Release 10 of LTE (LTE Advanced) allows carrier aggregation with up to five blocks of 2x20MHz carriers to be combined to give a much higher peak data rate. But this would only be possible for the particular bands specified in standards, with these bands being specified independent of the releases. As well as the standards, whether higher peak data rates can actually be used with particular bands will also depend on whether there are user devices available that support them for that band. We consider there is considerable uncertainty on this after early LTE. We have therefore not included this in the table above. Eventually, we anticipate that highest peak data rates will be determined by overall spectrum holdings. If so, this would mean that the scores would be the same as shown for row 2 of Table 4.1 above (i.e. Capacity and average data rate – longer term).
- 4.13 For each spectrum portfolio that we assess, we use a traffic light scoring system for the ability to deliver different combinations of service:
- Cells marked green imply that the spectrum would allow a national wholesaler to deliver the relevant dimension of service.
 - Cells are marked amber where the assessment is not clear, or where the spectrum may be sufficient to deliver the relevant dimension of service to a partial extent.
 - Cells marked red imply the spectrum is not sufficient to allow the national wholesaler to deliver the dimension of service.
- 4.14 To some extent, the assessment in the tables reflects how well a national wholesaler can deliver a dimension of service relative to its competitors. For example, in considering capacity and average data rates, we take into account the shares of total available spectrum held at the relevant frequencies rather than absolute quantities of spectrum held (see for example paragraph 4.36).
- 4.15 This colour coding provides a useful visual representation of advantages and disadvantages of different spectrum portfolios. However, we recognise that the colour-coding approach masks some of the more subtle differences between capabilities. Cells may be scored the same colour even when the risk over whether the spectrum is sufficient to deliver the service is not identical. The risk might be higher for one cell than another, but both could have the same colour because the difference is not sufficiently large.
- 4.16 When we use the colour-coded scoring of the capabilities of different spectrum portfolios we merely assess whether the portfolio allows a particular service dimension to be met. We are not making any judgement about the importance of that service dimension or the extent to which weaknesses can be mitigated.

¹⁵⁶ The initial LTE deployments in Europe and elsewhere are with Release 8 or 9, rather than Release 10. However, we also recognise that Release 10 (LTE Advanced) may be deployed relatively soon at least in the USA, as discussed in Section 3 above. When Release 10 will be deployed in Europe may depend in part on when there will be user devices capable of using Release 10 for the frequencies used in Europe.

- 4.17 However, when we assess whether a spectrum portfolio may be sufficient to enable a national wholesaler to be credible, we take into account the importance of the quality dimensions we consider. This draws on our provisional conclusions on the importance of the four quality dimensions for credibility as set out in Table 3.3 above. As explained at the end of Section 3, we consider the credibility of a national wholesaler ‘in the round’ taking account of the relative strength and importance of different advantages and disadvantages of its spectrum portfolios.
- 4.18 Whether a national wholesaler is credible may depend on how the remaining spectrum is distributed among other national wholesalers. However, this does not mean that all national wholesalers need an equal amount of spectrum in order to be credible. When we consider whether a national wholesaler is likely to be credible we do not assume that the remaining spectrum is held in a highly asymmetric way. Rather we assume that there are at least three other national wholesalers and that the remaining spectrum in the auction is not all obtained by a single company.¹⁵⁷
- 4.19 We now discuss in turn the spectrum holdings and future credibility of each of the existing national wholesalers.

Future credibility of Everything Everywhere as a national wholesaler

Existing spectrum holdings

- 4.20 When we consider Everything Everywhere’s existing spectrum holdings, we exclude the 2x15MHz of 1800MHz spectrum that Everything Everywhere will divest.¹⁵⁸ We therefore consider its existing holdings to be:
- 2x45MHz of 1800MHz spectrum; and
 - 2x20MHz of 2.1GHz spectrum.
- 4.21 Our assessment of these holdings is summarised in Table 4.2 below, with colour coded scores. The reasons for the scores are explained in the paragraphs below the table.

¹⁵⁷ In Section 8 we explain that we propose to put in place safeguard caps in order to avoid such very asymmetric outcomes that could be damaging to competition.

¹⁵⁸ Everything Everywhere has agreed to divest 2x15MHz of its current 2x60MHz of 1800MHz spectrum. It is required to release 2x10MHz of this by September 2013 and the remaining 2x5MHz by September 2015.

Table 4.2: Everything Everywhere’s existing spectrum holdings

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|---|--|-------------|
| 1. Capacity and average data rate – near term | 2x40MHz | 2x40MHz | - |
| 2. Capacity and average data rate – longer term | 2x65MHz (after refarming complete) (24%) ¹⁵⁹ | 2x65MHz (after refarming complete) (33%) | (0%) |
| 3. Early route to LTE | 2x20MHz | 2x20MHz | - |
| 4. Highest peak data rate with early LTE | 2x20MHz | 2x20MHz | - |

4.22 As we explain in Annex 8, we anticipate that Everything Everywhere will be able to start refarming 1800MHz spectrum to LTE quickly, and is likely to be able to refarm at least 2x10MHz by the time of the first tranche of divestment in September 2013. We also consider that it is likely to be able to deploy a 2x20MHz LTE carrier relatively quickly. This means that it would have 2x20MHz available for an early route to LTE (cells A3 and B3). Combined with its 2x20MHz of 2.1GHz spectrum, Everything Everywhere would have 2x40MHz available for capacity and average data rates in the near term (cells A1 and B1). Once it has refarmed 2x20MHz, it would be able to offer the highest peak data rates in early LTE (cells A4 and B4).

4.23 Thereafter, Everything Everywhere can progressively refarm the rest of its 2x45MHz of 1800MHz over time, as 2G-only devices rapidly fall in importance over the next few years with the continued growth of smartphones (along with its 2.1GHz, providing 2x65MHz for capacity and average data rates in the longer term – cells A2 and B2). We have therefore scored all of the cells in the columns A and B as green. Column C is red as Everything Everywhere does not have any sub-1 GHz spectrum.

Importance of strengths of existing spectrum holdings

4.24 Everything Everywhere’s existing spectrum portfolio has important strengths. It is currently the largest of the existing national wholesalers’ holdings. After the auction, this still represents a significant share of spectrum, at 24% of the total paired spectrum and 33% of the paired spectrum at 2.1GHz spectrum and below.

4.25 It also has an early route to LTE with its large amount of 1800MHz spectrum and the ability to deploy a 2x20MHz LTE carrier, though it is unclear how important these potential advantages will be. Compared to spectrum used for HSPA, this will give Everything Everywhere’s capacity a further boost, because LTE is more spectrally efficient than HSPA.

4.26 Everything Everywhere also has an advantage in the near term in terms of its large site base, with more than 18,000 sites. But in the longer term other national wholesalers could vary their site numbers to match or exceed this.

¹⁵⁹ This percentage is of the 2x266MHz of total paired spectrum available after the auction, assuming Everything Everywhere wins no spectrum in the auction. The percentage in column B (2.1GHz and below) is for the 2x196MHz spectrum at 2.1GHz and below that will be available after the auction; and in column C (sub-1GHz) for the 2x65MHz of 800MHz and 900MHz spectrum that will be available after the auction.

Importance of weaknesses of existing spectrum holdings

4.27 Everything Everywhere has no sub-1GHz spectrum. This means that it may be more challenging to deliver a high quality service in locations that are harder to serve or deep inside buildings.

Provisional conclusion on credibility of Everything Everywhere with existing spectrum holdings

4.28 Everything Everywhere's existing spectrum portfolio has strengths and weaknesses. It has no sub-1GHz spectrum, but we consider it is likely to be able to deliver sufficient quality of coverage to be a credible national wholesaler with its significant holdings of 1800MHz and 2.1GHz spectrum (see paragraph 3.141 above). Its potential advantages include its share of spectrum, early route to LTE, ability to deploy a 2x20MHz LTE carrier and its large number of existing sites.

4.29 On balance we consider its existing holdings are likely to be sufficient for it to be a credible national wholesaler in the future even if it wins no additional spectrum in the auction.

If Everything Everywhere were not credible with its existing spectrum holdings, what spectrum would it need to become credible?

4.30 While we consider it unlikely, it is possible that sub-1GHz spectrum could be so important that Everything Everywhere would not be credible without it. In this situation, we assess three possible amounts of sub-1GHz that Everything Everywhere might need to be credible:

- Portfolio 1: 2x5MHz of 800MHz spectrum;
- Portfolio 2: 2x10MHz of 800MHz spectrum; and
- Portfolio 3: 2x15MHz of 800MHz spectrum.

4.31 We assess these in turn in the tables below.

Portfolio 1: Everything Everywhere's current holding with 2x5 MHz of 800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|----------------|
| 1. Capacity and average data rate – near term | 2x45MHz | 2x45MHz | 2x5MHz |
| 2. Capacity and average data rate – longer term | 2x70MHz (26%) | 2x70MHz (36%) | 2x5MHz (8%) |
| 3. Early route to LTE | 2x25MHz | 2x25MHz | 2x5MHz |
| 4. Highest peak data rate with early LTE | 2x20MHz | 2x20MHz | 2x5MHz |

Portfolio 2: Everything Everywhere's current holding with 2x10 MHz of 800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|---------------|
| 1. Capacity and average data rate – near term | 2x50MHz | 2x50MHz | 2x10MHz |
| 2. Capacity and average data rate – longer term | 2x75MHz (28%) | 2x75MHz (38%) | 2x10MHz (15%) |
| 3. Early route to LTE | 2x30MHz | 2x30MHz | 2x10MHz |
| 4. Highest peak data rate with early LTE | 2x20MHz | 2x20MHz | 2x10MHz |

Portfolio 3: Everything Everywhere's current holding with 2x15 MHz of 800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|---------------|
| 1. Capacity and average data rate – near term | 2x55MHz | 2x55MHz | 2x15MHz |
| 2. Capacity and average data rate – longer term | 2x80MHz (30%) | 2x80MHz (41%) | 2x15MHz (23%) |
| 3. Early route to LTE | 2x35MHz | 2x35MHz | 2x15MHz |
| 4. Highest peak data rate with early LTE | 2x20MHz | 2x20MHz | 2x15MHz |

4.32 If technical and market conditions were such that sub-1GHz was essential to be credible, we consider that portfolio 3 (2x15MHz of 800MHz) would be very likely to make Everything Everywhere credible. We consider that 2x10MHz of 800MHz spectrum would also be likely to be sufficient to make Everything Everywhere credible. Given its large holdings of 1800MHz and 2.1GHz spectrum, we consider that it is possible that 2x5MHz of 800MHz may be sufficient for Everything Everywhere to be credible even if it were very important to deliver a consistent high quality service in locations that are harder to serve or deep inside buildings. However, as set out in paragraph 3.94 above, only 2x5MHz of 800MHz is unlikely to provide adequate coverage for higher data speeds (such as 5Mbps).

Future credibility of Telefónica as a national wholesaler

Existing spectrum holdings

4.33 Telefónica currently holds:

- 2x17.4MHz of 900MHz spectrum
- 2x5.8MHz of 1800MHz spectrum
- 2x10MHz of 2.1GHz spectrum

4.34 We score Telefónica's existing spectrum holdings as shown in the table below, which we explain in the following paragraphs.

Table 4.3: Telefónica's existing spectrum holdings

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--|--|-----------------|
| 1. Capacity and average data rate – near term | 2x15-20MHz | 2x15-20MHz | 2x5-10MHz |
| 2. Capacity and average data rate – longer term | 2x33MHz (after refarming complete) (12%) | 2x33MHz (after refarming complete) (17%) | 2x17.4MHz (27%) |
| 3. Early route to LTE | - | - | - |
| 4. Highest peak data rate with early LTE | - | - | - |

- 4.35 We have scored A1 and B1 in the first row as amber because Telefónica has relatively limited capacity currently, though this will increase as it refarms more 900MHz spectrum. It has already refarmed 2x5MHz of the 900MHz spectrum for HSPA and is likely to be able to refarm at least a further 2x5MHz from 2G to HSPA by around 2016 (as we set out in Annex 8). We recognise that while this is used for HSPA it will add less capacity than spectrum used for LTE. However, in the near term, there is a potential off-setting effect due to the current greater availability and greater stock of UMTS900 capable user devices compared to LTE.
- 4.36 We have scored A2 in the second row amber because Telefónica has relatively limited capacity even in the longer term, with 12% of spectrum overall post auction. It has a higher share of the lower frequency spectrum, so we have scored the other columns green in this row (B2 and C2).
- 4.37 The third and fourth rows are red because we do not consider that the 900MHz or 2.1GHz spectrum that Telefónica holds will provide an early route to LTE. While Telefónica has 2x5MHz of 1800MHz, which could provide an early route to LTE, such a network would have limited LTE capacity. We therefore do not consider that Telefónica has a credible early route to LTE.

Importance of strengths of existing spectrum holdings

- 4.38 An important strength of Telefónica's existing spectrum portfolio is its 900MHz spectrum, which represents over 25% of sub-1GHz spectrum post auction. It is therefore well placed to deliver consistency of coverage even in the hardest to serve locations, especially in the longer term.
- 4.39 We also consider that the rapidly growing stock of UMTS900 handsets may give those with 900MHz spectrum an advantage until there is a reasonable selection of LTE handsets.
- 4.40 Longer term, we consider that Telefónica can refarm 900MHz for LTE, which will give it an advantage given its significant share of sub-1GHz spectrum.

Importance of weaknesses of existing spectrum holdings

- 4.41 One weakness of Telefónica's existing spectrum is the overall share of spectrum, at 12%. At this level, we consider there is a risk that it is insufficient to enable Telefónica to be credible in the longer term.

- 4.42 Another weakness is that the 900MHz and 2.1GHz spectrum are not suitable for an early route to LTE nor for high peak data rates with early LTE, though the importance of these is unclear. If this were important, it would last until Telefónica could deploy LTE at 900MHz, which may not be for some years. We consider that the timing is, to some extent, likely to depend on whether LTE is significantly better than HSPA: the better LTE is, the more quickly we might expect 900MHz to move to LTE. But we recognise that this may depend on international demand for LTE900 rather than just demand in the UK.
- 4.43 We also recognise that the standards currently do not allow 2x15MHz contiguous blocks to be deployed with LTE at 900MHz, reducing the peak data rates that could be used with 900MHz. It is possible that the standards could be changed (or that this may become less relevant with carrier aggregation), but we accept that there is some risk that the standards may not allow high peak speeds to be delivered with 900MHz spectrum. We consider the importance of high peak speeds for credibility as a national wholesaler is unclear.

Provisional conclusion on credibility of Telefónica with existing spectrum holdings

- 4.44 There are important strengths and weaknesses of Telefónica's existing spectrum portfolio. On balance, we consider that Telefónica's existing holdings are likely to be sufficient for it to be credible in the near term, for at least as long as HSPA900 is competitive with LTE. But there is some potential risk of it not being credible in the longer term if LTE900 equipment is not available soon thereafter, or because of the relatively limited overall spectrum share it will hold if it did not win spectrum in the auction.

If Telefónica were not credible with its existing spectrum holdings, what spectrum would it need to become credible?

- 4.45 In the event that its existing spectrum holdings were insufficient to make it credible, we consider that it would probably be sufficient for Telefónica to obtain 1800MHz or 2.6GHz spectrum. Enough spectrum at 1800MHz or 2.6GHz would be sufficient to deliver the capacity that Telefónica may need and to obtain an early route to LTE that would be good enough to serve most locations. While it is possible that this is inferior to having LTE at 800MHz, we consider the quality of coverage provided by UMTS900 would be sufficient for Telefónica to be credible, and in the longer term the 900MHz spectrum can be used for LTE. Also, it is possible that there is an advantage with UMTS900 until the stock of user devices capable of using LTE grows.
- 4.46 We consider three groups of portfolios that Telefónica may need to be credible. Within each group there are a number of alternative portfolios, any one of which might be sufficient to make Telefónica credible. The portfolios in each group are intended to be broadly comparable in the impact they have on making Telefónica credible. For example, we consider that either of Portfolios 4 or 5 in the table below would have a similar impact in terms of the likelihood of making Telefónica credible, if it were not credible with its existing holdings (although the exact commercial strategy may differ between the portfolios because of differences in characteristics of spectrum at different frequencies).
- 4.47 Even the group of smaller portfolios would raise Telefónica's share of overall paired spectrum to between 14% to 16%. As can be seen from the colours of the tables below, these two portfolios have different strengths and weaknesses. We consider

that there is some risk that the portfolios in this group may not be sufficient to make Telefónica credible.

Group of smaller portfolios Telefónica may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|--------------|--------|---------|--------|
| Portfolio 4: | 2x5 | | |
| Portfolio 5: | | | 2x10 |

Portfolio 4: Telefónica's current holding with 2x5 MHz of 800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x20-25MHz | 2x20-25MHz | 2x10-15MHz |
| 2. Capacity and average data rate – longer term | 2x38MHz (14%) | 2x38MHz (20%) | 2x22MHz (35%) |
| 3. Early route to LTE | 2x5MHz | 2x5MHz | 2x5MHz |
| 4. Highest peak data rate with early LTE | 2x5MHz | 2x5MHz | 2x5MHz |

Portfolio 5: Telefónica's current holding with 2x10 MHz of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x25-30MHz | 2x15-20MHz | 2x5-10MHz |
| 2. Capacity and average data rate – longer term | 2x43MHz (16%) | 2x33MHz (17%) | 2x17MHz (27%) |
| 3. Early route to LTE | 2x10MHz | - | - |
| 4. Highest peak data rate with early LTE | 2x10MHz | - | - |

4.48 The group of medium portfolios below raises Telefónica share of overall paired spectrum to 16-20% (depending on the portfolio). It also provides an early route to LTE, though the importance of that is unclear. We consider that Telefónica would be likely to be credible with one of the portfolios in this group.

Group of medium portfolios Telefónica may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|--------------|--------|---------|--------|
| Portfolio 6: | 2x10 | | |
| Portfolio 7: | | 2x15 | |
| Portfolio 8: | | | 2x20 |

Portfolio 6: Telefónica's current holding with 2x10 MHz of 800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x25-30MHz | 2x25-30MHz | 2x15-20MHz |
| 2. Capacity and average data rate – longer term | 2x43MHz (16%) | 2x43MHz (22%) | 2x27MHz (42%) |
| 3. Early route to LTE | 2x10MHz | 2x10MHz | 2x10MHz |
| 4. Highest peak data rate with early LTE | 2x10MHz | 2x10MHz | 2x10MHz |

Portfolio 7: Telefónica's current holding with 2x15 MHz of 1800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x30-35MHz | 2x30-35Hz | 2x5-15MHz |
| 2. Capacity and average data rate – longer term | 2x48MHz (18%) | 2x48MHz (25%) | 2x17MHz (27%) |
| 3. Early route to LTE | 2x15MHz | 2x15MHz | - |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x15MHz | - |

Portfolio 8: Telefónica's current holding with 2x20 MHz of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x35-40MHz | 2x15-20MHz | 2x5-15MHz |
| 2. Capacity and average data rate – longer term | 2x53MHz (20%) | 2x33MHz (17%) | 2x17MHz (27%) |
| 3. Early route to LTE | 2x20MHz | - | - |
| 4. Highest peak data rate with early LTE | 2x20MHz | - | - |

Group of larger portfolios Telefónica may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|--------|---------|--------|
| Portfolio 9: | 2x10 | | 2x10 |
| Portfolio 10: | | 2x15 | 2x10 |
| Portfolio 11: | | | 2x30 |

Portfolio 9: Telefónica's current holding with 2x10 MHz of 800MHz and 2x10 of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x35-40MHz | 2x25-30MHz | 2x15-20MHz |
| 2. Capacity and average data rate – longer term | 2x53MHz (20%) | 2x43MHz (22%) | 2x27MHz (42%) |
| 3. Early route to LTE | 2x20MHz | 2x10MHz | 2x10MHz |
| 4. Highest peak data rate with early LTE | 2x10MHz | 2x10MHz | 2x10MHz |

Portfolio 10: Telefónica's current holding with 2x15 MHz of 1800MHz spectrum and 2x10 of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x40-45MHz | 2x30-35Hz | 2x5-15MHz |
| 2. Capacity and average data rate – longer term | 2x58MHz (22%) | 2x48MHz (25%) | 2x17MHz (27%) |
| 3. Early route to LTE | 2x25MHz | 2x15MHz | - |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x15MHz | - |

Portfolio 11: Telefónica's current holding with 2x30 MHz of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x45-50MHz | 2x15-20MHz | 2x5-15MHz |
| 2. Capacity and average data rate – longer term | 2x63MHz (24%) | 2x33MHz (17%) | 2x17MHz (27%) |
| 3. Early route to LTE | 2x30MHz | - | - |
| 4. Highest peak data rate with early LTE | 2x20MHz | - | - |

- 4.49 The group of larger portfolios involves more spectrum at 2.6GHz compared to the middle group (even if the colour coding in the tables for the group of larger portfolios does not change). The group of larger portfolios raises Telefónica's share to 20-22%, making it very likely that this group would make Telefónica credible.
- 4.50 While we consider it unlikely, it is conceivable that Telefónica may specifically need 800MHz or 1800MHz spectrum to be credible, and that 2.6GHz spectrum would not be sufficient. If this were the case then the portfolios in the groups above that only include 2.6GHz spectrum would not be sufficient to allow Telefónica to be credible.
- 4.51 Also, if the unpaired 2.6GHz spectrum were good enough to be a substitute for paired 2.6GHz spectrum, then all of groups could be supplemented to also include portfolios that included unpaired 2.6GHz spectrum instead of paired 2.6GHz spectrum.

- 4.52 The middle and larger groups include portfolios with the divested 1800MHz spectrum, either because it is assumed to be in the auction or is acquired by Telefónica before the auction. If acquired by someone else before the auction, the groups would exclude the portfolios with 1800MHz.

Future credibility of Vodafone as a national wholesaler

- 4.53 Vodafone's spectrum holdings are the same as Telefónica's except that it acquired 2x5MHz more 2.1GHz spectrum in the 2000 auction. Compared to Telefónica, its overall spectrum share is 14% rather than 12%.
- 4.54 Despite a larger amount of 2.1GHz spectrum, we consider that the assessment for Telefónica above is also broadly applicable for Vodafone. The strengths and weaknesses of Vodafone's spectrum are largely the same as for Telefónica. Our provisional conclusion is also the same. There are therefore important strengths and weaknesses of Vodafone's existing spectrum portfolio. On balance, we consider that they are likely to be sufficient for it to be credible in the near term, for at least as long as HSPA900 is competitive with LTE. But there is some potential risk of it not being credible in the longer term if LTE900 equipment is not available soon thereafter, or because of the relatively limited overall spectrum share it will hold if it did not win spectrum in the auction.
- 4.55 If its existing portfolio were insufficient for Vodafone to be credible, then it might be possible for it become credible with a slightly smaller amount of spectrum than Telefónica, given its extra 2x5MHz of 2.1GHz spectrum. However, we consider that the spectrum portfolios that Vodafone would need are likely to be similar as for Telefónica. In the rest of this consultation we assume that the same groups of portfolios might be needed to make Vodafone credible as apply to Telefónica.

Future credibility of H3G as a national wholesaler

Existing spectrum holdings

- 4.56 H3G currently holds 2x15MHz of 2.1GHz spectrum.
- 4.57 Our assessment of this is shown using the traffic light colouring in Table 4.4 below.

Table 4.4: H3G’s existing spectrum holdings

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------------------|--------------------|-------------|
| 1. Capacity and average data rate – near term | 2x15MHz | 2x15MHz | - |
| 2. Capacity and average data rate – longer term | 2x15MHz (6%) ¹⁶⁰ | 2x15MHz (8%) | - (0%) |
| 3. Early route to LTE | - | - | - |
| 4. Highest peak data rate with early LTE | - | - | - |

4.58 With just 2x15MHz of 2.1GHz spectrum, we consider that H3G’s existing spectrum holdings are red in all these dimensions. It has limited capacity in the near term and longer term, no early route to LTE, an insufficiently large block of spectrum to deliver the highest peak data rate and no sub-1GHz spectrum.

Importance of strengths of existing spectrum holdings

4.59 H3G’s spectrum is already used for HSPA and can be upgraded to future versions. It has 2x15MHz of 2.1GHz, compared to 2x10MHz for Telefónica, 2x15MHz for Vodafone and 2x20 for Everything Everywhere at this frequency band.

Importance of weaknesses of existing spectrum holdings

4.60 With only 6% of spectrum overall, we consider there is a significant risk that H3G would not be credible with its existing spectrum holdings. This is reinforced by H3G’s 2.1GHz spectrum being likely to be used for HSPA for some time, as HSPA has lower spectral cell efficiency than LTE. We consider the limited spectrum amount to be an important weakness of H3G’s current holdings.

4.61 H3G’s current spectrum holdings will also leave it weak in other respects. There is a material risk that its holdings are insufficient to provide sufficient quality of coverage (including capacity to serve harder to serve locations) that is necessary to be a credible national wholesaler (see paragraph 3.155 above). It also has no early route to LTE and is unable to deliver as high peak speeds, though we regard the importance of these as unclear.

4.62 We consider that taken together these represent very significant disadvantages.

Provisional conclusion on credibility of H3G with existing spectrum holdings

4.63 We consider that H3G is unlikely to be credible without additional spectrum in the auction. This is particularly because of its small share of overall spectrum and the material risk that 2x15MHz of 2.1GHz is insufficient given the absence of sub-1GHz

¹⁶⁰ This percentage is of the 2x266MHz of total paired spectrum available after the auction, assuming that H3G wins no spectrum in the auction. The 2x266MHz consists of 2x30MHz of 800MHz, 2x35MHz of 900MHz, 2x72MHz of 1800MHz, 2x59MHz of 2.1GHz and 2x70MHz of 2600MHz spectrum. We have excluded unpaired 2.1GHz and 2.6GHz spectrum from the calculation of spectrum shares. The percentage in the 2.1GHz and below column is for the 2x196MHz spectrum at 2.1GHz and below that will be available after the auction, and in the sub-1GHz column is of the 2x65MHz of 800MHz and 900MHz spectrum that will be available after the auction.

in its holdings. There are also risks, of unclear importance, arising from its lack of spectrum suitable for an early route to LTE and high peak speeds.

If H3G were not credible with its existing spectrum holdings, what spectrum would it need to become credible?

4.64 We consider three groups of portfolios that H3G might need to be credible. The group of smaller portfolios may involve some residual risk that the portfolios are not sufficient, whereas we consider that the group of larger portfolios would reduce this risk significantly. The middle group sits somewhere between these, with some residual risk, but not as much as the group of smaller portfolios.

Group of smaller portfolios for spectrum H3G may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|------------------------------|--------|---------|--------|
| Portfolio 12: ¹⁶¹ | 2x10 | | |
| Portfolio 13: | | 2x15 | |

4.65 In Annex 7 we use evidence from our technical modelling to consider the performance of these portfolios in terms of capacity and coverage and compare them to other portfolios, and in the tables below we assess each of these portfolios in turn.

Portfolio 12: H3G's current holding plus 2x10MHz of 800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x25MHz | 2x25MHz | 2x10MHz |
| 2. Capacity and average data rate – longer term | 2x25MHz (9%) | 2x25MHz (13%) | 2x10MHz (15%) |
| 3. Early route to LTE | 2x10MHz | 2x10MHz | 2x10MHz |
| 4. Highest peak data rate with early LTE | 2x10MHz | 2x10MHz | 2x10MHz |

Portfolio 13: H3G's current holding plus 2x15MHz of 1800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|-------------|
| 1. Capacity and average data rate – near term | 2x30MHz | 2x30MHz | - |
| 2. Capacity and average data rate – longer term | 2x30MHz (11%) | 2x30MHz (15%) | - (0%) |
| 3. Early route to LTE | 2x15MHz | 2x15MHz | - |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x15MHz | - |

4.66 Portfolios 12 and 13 would both provide an early route to LTE. Both would also increase capacity, though portfolio 2 increases overall spectrum slightly more than portfolio 12. While they have these similarities, portfolios 12 and 13 have different

¹⁶¹ This is the same as portfolio 1 above that we considered for Everything Everywhere, but we have given it another number in the context of considering it in combination with H3G's existing holdings rather than Everything Everywhere's existing holdings to avoid confusion. Similarly for some other portfolios.

strengths and weaknesses. Portfolio 12 has the advantage of having sub-1GHz spectrum, which provides quality of coverage including consistency of coverage in hardest to serve locations. Portfolio 13 does not have sub-1GHz spectrum, but gives more capacity overall and gives a larger contiguous block that allows higher peak data rates.

- 4.67 Both these portfolios would still only give H3G a relatively limited share of spectrum overall at 9-11%. Primarily for this reason, we consider that this group of smaller portfolios would only give a low level of confidence that H3G would be credible. There remains significant residual risk, as indicated by the red and amber cells in the tables above.
- 4.68 It is possible that there are other portfolios that have a similar level of residual risk in terms of whether they are sufficient for H3G to be credible. For example, another possible portfolio might be 2x5MHz of 800MHz spectrum plus 2x10MHz of 2.6GHz spectrum. But there may be concerns with such a portfolio about coverage (especially at higher speeds) and capacity. Another possibility may be a portfolio with only a large quantity of 2.6GHz spectrum, such as 2x20MHz, but there would be a material risk that the combination of capacity and quality of coverage in the resulting spectrum holding would not be sufficient. For the reasons given in paragraph 3.149 above we consider that there is a greater risk that these portfolios would be insufficient to make H3G credible.
- 4.69 The middle group involves less residual risk than the group of smaller portfolios as shown in the tables below.

Group of medium portfolios for spectrum H3G may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|--------|---------|--------|
| Portfolio 14: | 2x15 | | |
| Portfolio 15: | 2x10 | | 2x10 |
| Portfolio 16: | | 2x15 | 2x10 |

Portfolio 14: H3G’s current holding plus 2x15MHz of 800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|---------------|
| 1. Capacity and average data rate – near term | 2x30MHz | 2x30MHz | 2x15MHz |
| 2. Capacity and average data rate – longer term | 2x30MHz (11%) | 2x30MHz (15%) | 2x15MHz (23%) |
| 3. Early route to LTE | 2x15MHz | 2x15MHz | 2x15MHz |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x15MHz | 2x15MHz |

Portfolio 15: H3G's current holding plus 2x10MHz of 800MHz spectrum + 2x10MHz of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x35MHz | 2x25MHz | 2x10MHz |
| 2. Capacity and average data rate – longer term | 2x35MHz (13%) | 2x25MHz (13%) | 2x10MHz (15%) |
| 3. Early route to LTE | 2x20MHz | 2x10MHz | 2x10MHz |
| 4. Highest peak data rate with early LTE | 2x10MHz | 2x10MHz | 2x10MHz |

Portfolio 16: H3G's current holding plus 2x15MHz of 1800MHz spectrum + 2x10MHz of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|-------------|
| 1. Capacity and average data rate – near term | 2x40MHz | 2x30MHz | - |
| 2. Capacity and average data rate – longer term | 2x40MHz (15%) | 2x30MHz (15%) | - (0%) |
| 3. Early route to LTE | 2x25MHz | 2x15MHz | - |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x15MHz | - |

4.70 Portfolios 14, 15 and 16 range from 11-15% in terms of the total spectrum they contain. This is broadly similar to that of Telefónica's and Vodafone's existing holdings, in the longer term when all spectrum has been refarmed. This is especially the case with Portfolio 14.¹⁶² The different portfolios have different strengths and weaknesses, as shown by the tables above. We consider that these portfolios involve less residual risk than the group of smaller portfolios in terms of being sufficient for H3G to be credible.

4.71 Portfolio 16 is the only portfolio in the middle group without 800MHz spectrum. This could present a particular risk depending on the technical and market conditions, i.e. if quality of coverage in harder to serve locations were important and it was not possible to provide this with the amount of higher frequency spectrum in this portfolio.

4.72 As with the group of smaller portfolios, there might potentially be other portfolios that have a similar level of residual risk to those in the middle group. For example, another possible portfolio might be 2x5MHz of 800MHz spectrum plus 2x15MHz of 1800MHz spectrum, or 2x5MHz of 800MHz spectrum plus 2x15-20MHz of 2.6GHz spectrum. But there may be concerns with such a portfolio about coverage (especially at higher speeds) and capacity. Another possibility may be a portfolio with only a large quantity of 2.6GHz spectrum, such as 2x30MHz, but there would be a material risk that the combination of capacity and quality of coverage would not be sufficient.

¹⁶² Portfolio 14 is 2x15MHz of 800MHz spectrum. When combined with H3G's current 2x15MHz of 2.1GHz spectrum this compares to Telefónica's 2x17.4MHz of 900MHz, 2x10MHz of 2.1GHz and 2x5.8MHz of 1800MHz. The amounts of sub-1GHz spectrum are roughly equally and the amounts of 1800/2100MHz spectrum are roughly equal.

Group of larger portfolios for spectrum H3G may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|---------------|----------------|---------------|
| Portfolio 17: | 2x20 | | |
| Portfolio 18: | 2x15 | | 2x10 |
| Portfolio 19: | 2x10 | | 2x15 |
| Portfolio 20: | 2x10 | 2x15 | |
| Portfolio 21: | | 2x15 | 2x15 |

Portfolio 17: H3G's current holding plus 2x20MHz of 800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|---------------|
| 1. Capacity and average data rate – near term | 2x35MHz | 2x35MHz | 2x20MHz |
| 2. Capacity and average data rate – longer term | 2x35MHz (13%) | 2x35MHz (18%) | 2x20MHz (31%) |
| 3. Early route to LTE | 2x20MHz | 2x20MHz | 2x20MHz |
| 4. Highest peak data rate with early LTE | 2x20MHz | 2x20MHz | 2x20MHz |

Portfolio 18: H3G's current holding plus 2x15MHz of 800MHz spectrum + 2x10MHz of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|---------------|
| 1. Capacity and average data rate – near term | 2x40MHz | 2x30MHz | 2x15MHz |
| 2. Capacity and average data rate – longer term | 2x40MHz (15%) | 2x30MHz (15%) | 2x15MHz (23%) |
| 3. Early route to LTE | 2x25MHz | 2x15MHz | 2x15MHz |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x15MHz | 2x15MHz |

Portfolio 19: H3G's current holding plus 2x10MHz of 800MHz spectrum + 2x15MHz of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|---------------|
| 1. Capacity and average data rate – near term | 2x40MHz | 2x25MHz | 2x10MHz |
| 2. Capacity and average data rate – longer term | 2x40MHz (15%) | 2x25MHz (13%) | 2x10MHz (15%) |
| 3. Early route to LTE | 2x25MHz | 2x10MHz | 2x10MHz |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x10MHz | 2x10MHz |

Portfolio 20: H3G’s current holding plus 2x10MHz of 800MHz spectrum + 2x15MHz of 1800MHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|------------------|
| 1. Capacity and average data rate – near term | 2x40MHz | 2x40MHz | 2x10MHz |
| 2. Capacity and average data rate – longer term | 2x40MHz (15%) | 2x40MHz (20%) | 2x10MHz (15%) |
| 3. Early route to LTE | 2x25MHz | 2x25MHz | 2x10MHz |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x15MHz | 2x10MHz |

Portfolio 21: H3G’s current holding plus 2x15MHz of 1800MHz spectrum + 15MHz of 2.6GHz spectrum

| | A: 2.6 GHz & below | B: 2.1 GHz & below | C: Sub-1GHz |
|---|--------------------|--------------------|-------------|
| 1. Capacity and average data rate – near term | 2x45MHz | 2x30MHz | - |
| 2. Capacity and average data rate – longer term | 2x45MHz (17%) | 2x30MHz (15%) | - (0%) |
| 3. Early route to LTE | 2x30MHz | 2x15MHz | - |
| 4. Highest peak data rate with early LTE | 2x15MHz | 2x15MHz | - |

- 4.73 We consider that this group of larger portfolios is likely to be sufficient for H3G to be a credible national wholesaler, though there is some residual risk. We note that if H3G were to obtain spectrum in the auction equal to these portfolios, it could have more spectrum than the other existing national wholesalers’ current holdings, particularly Telefónica, which has a lower share than Vodafone or Everything Everywhere.
- 4.74 Portfolio 21 is the only portfolio in this larger portfolio group without 800MHz. This portfolio may be insufficient if technical and market conditions are such that sub-1GHz were particularly important.
- 4.75 As with the smaller and middle group, there might potentially be other portfolios that have a similar level of residual risk to those in this group. For example, another possible portfolio might be 2x5MHz of 800MHz spectrum plus 2x25MHz of 2.6GHz spectrum, or 2x5MHz of 800MHz spectrum plus 2x15MHz of 1800MHz plus 2x10MHz of 2.6GHz spectrum. Another possibility may be a portfolio with a large quantity of 2.6GHz spectrum, such as 2x40MHz.
- 4.76 If the unpaired 2.6GHz spectrum were good enough to be a substitute for paired 2.6GHz spectrum, then all of groups could be supplemented to also include portfolios with unpaired 2.6GHz spectrum instead of paired 2.6GHz spectrum.
- 4.77 The groups of portfolios above include the divested 1800MHz spectrum, either because it is assumed to be in the auction or is acquired by H3G before the auction. If acquired by someone else before the auction, the groups would exclude the portfolios with 1800MHz.

Credibility of new entrant as a national wholesaler

- 4.78 A new entrant obviously needs to obtain spectrum in the auction to be credible. In terms of the type and amount of spectrum to be credible, we consider that it may need to obtain more than the groups of portfolios we have considered above for H3G. This is because we considered those portfolios would be sufficient to make a national wholesaler credible in the longer term when combined with 2x15MHz of 2.1GHz spectrum.
- 4.79 However, if a new entrant obtained only the spectrum portfolios we considered for H3G, it is likely to be possible for it to roll out an LTE network that would allow it to be credible in the short term. In the longer term, however, there is a material risk that its share of spectrum may not be sufficient for it to be credible on its own.
- 4.80 We also recognise that sub-1GHz spectrum might be particularly important to a new entrant to assist it to roll out a network quickly, because it would allow it to obtain national coverage with a much smaller site number than higher frequencies. For example, with 4,000 sites, it might have reasonable national coverage, albeit that such a network would have little capacity, which would need to be increased subsequently.
- 4.81 When we consider measures in Section 8 of this Annex we consider whether a new entrant should be treated the same as H3G or differently - see paragraph 8.49 – 8.54.

Summary of auction outcomes that might give rise to competition concerns

Fewer than four credible national wholesalers

- 4.82 Our main competition concern is that there could be fewer than four credible national wholesalers. We would therefore be concerned with any auction outcome that resulted in fewer than four national wholesalers obtaining the spectrum they need to be credible. By national wholesaler we mean either one of the existing national wholesalers or a potential new entrant who could become a national wholesaler.
- 4.83 We have considered whether the four existing national wholesalers are likely to be credible in the longer term with their current spectrum holdings and have considered the position of a new entrant. Our provisional conclusions are:
- Everything Everywhere's existing holdings are likely to be sufficient for it to be a credible national wholesaler in the future even if it wins no additional spectrum in the auction;
 - Telefónica and Vodafone's existing holdings are likely to be sufficient for them to be credible in the near term, for at least as long as HSPA900 is competitive with LTE. But there is some potential risk of them not being credible in the longer term if LTE900 equipment is not available soon thereafter, or because of the relatively limited overall spectrum share they would hold if they did not win spectrum in the auction;
 - H3G is unlikely to be credible without additional spectrum; and
 - A new entrant obviously needs to obtain spectrum in the auction to be credible.

- 4.84 We have also identified a range of possible spectrum portfolios that each of the existing national wholesalers may need to obtain to become credible, which varied depending on their existing holdings.
- 4.85 While we consider it unlikely, it is possible that sub-1GHz spectrum could be so important that Everything Everywhere would not be credible without it. In this situation, we consider that 2x10MHz of 800MHz spectrum is likely to be sufficient to make Everything Everywhere credible (and it would be very likely with 2x15MHz of 800MHz).
- 4.86 Given its large holdings of 1800MHz and 2.1GHz spectrum, we consider that it is possible that 2x5MHz of 800MHz may be sufficient for Everything Everywhere to be credible even if it were very important to deliver a consistent high quality service in locations that are harder to serve or deep inside buildings. However, as set out in paragraph 3.94 above, only 2x5MHz of 800MHz is unlikely to provide adequate coverage for higher data speeds (such as 5Mbps).
- 4.87 If Telefónica and Vodafone needed spectrum to be credible, one of the portfolios in the following group would be likely to be sufficient:

Group of medium portfolios Telefónica and Vodafone may need to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|--------------|---------------|----------------|---------------|
| Portfolio 6: | 2x10 | | |
| Portfolio 7: | | 2x15 | |
| Portfolio 8: | | | 2x20 |

- 4.88 We have also considered a group of larger portfolios that would further increase the likelihood that Telefónica and Vodafone would be credible.
- 4.89 When we consider in Section 5 whether Vodafone and Telefónica are likely to obtain the spectrum they each may need to be credible without measures in the auction, we consider them as one category of national wholesaler. This is because their existing spectrum holdings have similar strengths and weaknesses, and we consider they need similar spectrum to be credible.
- 4.90 For H3G, we have considered three groups of portfolios for spectrum that H3G might need to be credible, with each group intended to include portfolios that are broadly comparable in the impact they have on the likelihood of making H3G credible, although sometimes with different strengths and weaknesses.
- 4.91 The group of smaller portfolios may involve some residual risk that the portfolios considered are not sufficient, whereas we consider that the larger portfolio group would reduce this risk significantly. The middle group sits somewhere between these, with some residual risk, but not as much as the group of smaller portfolios.

Group of smaller portfolios for spectrum H3G may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|---------------|----------------|---------------|
| Portfolio 12: | 2x10 | | |
| Portfolio 13: | | 2x15 | |

Group of medium portfolios for spectrum H3G may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|--------|---------|--------|
| Portfolio 14: | 2x15 | | |
| Portfolio 15: | 2x10 | | 2x10 |
| Portfolio 16: | | 2x15 | 2x10 |

Group of larger portfolios for spectrum H3G may need to acquire to be credible

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|--------|---------|--------|
| Portfolio 17: | 2x20 | | |
| Portfolio 18: | 2x15 | | 2x10 |
| Portfolio 19: | 2x10 | | 2x15 |
| Portfolio 20: | 2x10 | 2x15 | |
| Portfolio 21: | | 2x15 | 2x15 |

- 4.92 We have also considered the position of a new entrant. A new entrant obviously needs to obtain spectrum in the auction to be credible. In terms of the type and amount of spectrum, the portfolios for H3G are likely to be sufficient for it to be credible in the near terms. However, in the longer term we consider that it would need to obtain more than the groups of portfolios we have considered above that are necessary to make H3G credible. This is because we consider those portfolios would be sufficient to make a national wholesaler credible in the longer term when combined with 2x15MHz of 2.1GHz spectrum.
- 4.93 In Section 5 we consider H3G and a potential new entrant as a single category, referring to a “fourth national wholesaler” to mean either H3G or a potential new entrant.

Competition concerns across a range of services and customers

- 4.94 Even if a national wholesaler is credible, it may not be well placed to deliver certain dimensions of service, or for serving some particular niche products or customers that may develop. While recognising that a degree of differentiation is inevitable, and may have some benefits, we consider that competition between national wholesalers across the range of services and customers that is too limited is not desirable for consumers.
- 4.95 Below we consider competition concerns that could arise even if there were four credible national wholesalers, relating to one or more of the national wholesalers being constrained in its ability to deliver particular quality dimensions. As set out in Section 2, we consider these are a lesser competition concern than the concern that there could be fewer than four credible national wholesalers. This is because most or even all consumers may be affected by there being fewer than four credible national wholesalers, but only particular segments of services or customers might be affected by the second type of concern.

Weaker competition because one or more competitors does not have sub-1GHz spectrum

- 4.96 This competition concern arises if one or more national wholesaler is at a disadvantage because it does not have sub-1GHz spectrum, e.g. Everywhere Everywhere, H3G or a new entrant. Sub-1GHz spectrum provides superior quality of coverage than higher frequency spectrum. While we do not consider it is clear that the difference is so significant that a national wholesaler cannot be credible without

sub-1GHz spectrum, competition for particular segments of services or customers might be weaker if not all national wholesalers had sub-1GHz spectrum.

Weaker competition because one or more competitors does not have early route to LTE

- 4.97 This competition concern arises if one or more national wholesalers does not have an early route to LTE. The divestment of 1800MHz by Everything Everywhere mitigates this competition concern to some extent, independent of the auction. It ensures at least two national wholesalers have an early route to LTE plus any others acquiring spectrum in the auction.
- 4.98 Even if LTE were important and the auction outcome was that the spectrum suitable for LTE remained heavily concentrated, then any detrimental impact on competition would reduce over time. This is because 900MHz spectrum is likely to be used for LTE at some point in the future, although this may be some years after 800MHz, 1800MHz and 2600MHz. When this occurs at least three competitors (Everything Everywhere, Vodafone and Telefónica) will all have spectrum suitable for LTE. Thereafter, 2.1GHz spectrum is also likely to be suitable for LTE or any successor technology, which would mean that H3G would also have suitable spectrum.

Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE

- 4.99 This competition concern arises if one or more national wholesalers is not capable of delivering the high peak data rates that are possible with LTE and large contiguous blocks. The divestment of 1800MHz by Everything Everywhere mitigates this competition concern to some extent, independent of the auction. It ensures at least two national wholesalers have at least 2x15MHz, and possible that at least two have 2x20MHz (depending on who acquires the divested spectrum).

Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates

- 4.100 This competition concern arises if one or more national wholesalers has insufficient spectrum for capacity and average data rates to compete strongly for some segments of services or customers. A smaller share of spectrum is likely to mean higher marginal costs for adding capacity through building more sites. This may tend to make a national wholesaler with a smaller spectrum share a weaker competitor, at least for some customers or services. For example, if one national wholesaler was unable to compete strongly for very intensive data users, and had to concentrate on users with lower data needs. However, the extent of this would be limited because this category of competition concerns is on the basis that at least four national wholesalers have sufficient spectrum to be credible.

Weaker competition because one competitor has a very large share of spectrum

- 4.101 Finally, we have a concern that competition might be weaker if one national wholesaler held a very large share of spectrum after the auction and, as a consequence, the other national wholesalers may exert a weaker competitive constraint than they could have done if the spectrum shares were more widely distributed. Again, the extent of this would be limited because we are assuming that at least four national wholesalers would have sufficient spectrum to be credible.

Section 5

Likelihood of auction outcomes which give rise to competition concerns

Introduction and summary

- 5.1 Section 4 of this Annex identifies some potential auction outcomes that could give rise to competition concerns in some circumstances. In this section we consider how likely those auction outcomes are to come about, if there were no measures in the auction, i.e. the concern that, if entities need to acquire spectrum in the auction, they fail to do so. This includes considering the possibility of other national wholesalers bidding in the auction to deliberately change the structure of the market to make it less competitive.
- 5.2 In considering strategic investment in this way, we are not suggesting that any bidder, either individually or collectively, would act or intend to act in any prohibited manner. Indeed, strategic investment may be an entirely rational and legitimate course of action from a commercial perspective. Our concern is to consider whether such behaviour by one or more bidders might result in an outcome that made the market less competitive, such that it posed a risk to our policy objective to promote competition through the auction.
- 5.3 Clearly, if we do not expect outcomes that give rise to competition concerns to result, imposing measures in the auction to address these would be unnecessary.
- 5.4 Together with Section 4, we use the analysis in this section to identify a set of competition concerns and their expected importance that we include in the assessment of measures in Sections 6 to 8 of this Annex. By *importance* we mean the combined effect of three factors:
- likely magnitude of the competition concern from that auction outcome and the associated size of consumer detriment;
 - likelihood of technical and market conditions being such that detriment arises with an auction outcome; and
 - likelihood of national wholesalers failing to acquire the required spectrum to avoid that auction outcome.
- 5.5 We considered the first factor of size of detriment in Section 2 and assessed the second factor of likelihood of technical and market conditions in Section 4. In Section 5 we deal with the third one and, at the end, we bring the three together in summarising our competition concerns in the absence of measures in the auction.
- 5.6 This section discusses, first, the main determinants that we consider are likely to affect the auction outcome in general terms, including the drivers of the 'intrinsic value' of spectrum for each bidder and introducing what we mean by 'strategic

investment¹⁶³ in spectrum. Then we assess the likelihood of each of the potential detrimental auction outcomes.

5.7 One of the auction outcomes we identified in Section 4 that would cause competition concerns was that a fourth national wholesaler (i.e. H3G or a new entrant) may not obtain sufficient spectrum to be a credible national wholesaler. In this section we provisionally conclude that there is a material risk of this outcome without measures in the auction to prevent it. There are two reasons why we consider that this outcome may come about:

- H3G or a new entrant may have a lower 'intrinsic value' for the spectrum than the other three existing national wholesalers (Vodafone, Telefónica and Everything Everywhere); or
- Everything Everywhere, Vodafone and/or Telefónica may have commercial incentives to seek to invest strategically in spectrum in order to reduce the likelihood of a fourth national wholesaler from winning sufficient spectrum to be credible.

5.8 We considered in Section 4 that Everything Everywhere's existing holdings are likely to be sufficient for it to be a credible national wholesaler in the future. However, we explore in this section whether if it did need sub-1GHz spectrum to be credible it would be at risk. Our provisional conclusion is that the risk that Everything Everywhere may be a victim of strategic investment cannot be ruled out if it does need sub-1GHz spectrum.

5.9 We also considered in Section 4 that Telefónica and Vodafone's existing holdings are likely to be sufficient for them to be credible in the near term, for at least as long as HSPA900 is competitive with LTE. But there is some potential risk of them not being credible in the longer term if LTE900 equipment is not available soon thereafter, or because of the relatively limited overall spectrum share they would hold if they did not win spectrum in the auction. In this section we provisionally conclude that strategic investment is unlikely to prevent them from obtaining spectrum they may need to be credible. This is assuming that there is a range of spectrum that would allow them to be credible, including 2x20MHz at 2.6GHz.

5.10 The structure of this section is as follows:

- Likely determinants of auction outcome;
- Concern that a fourth national wholesaler fails to acquire the spectrum it is likely to need to be a credible national wholesaler or avoid a disadvantage in competing across a wide range of services and customers;

¹⁶³ Throughout this Section by 'strategic investment' we will mean bidding behaviour aimed at altering future competition conditions in mobile services. More specifically, strategic investment describes the case where bidders seek to acquire more spectrum than would otherwise maximise profits in the hope of significantly weakening one or more competitors or deterring entry, resulting in exclusion or otherwise reducing competitive pressures. This is more specific than the terminology we adopted in the March 2011 consultation where we referred more generically to strategic bidding which also includes other concepts, such as distorted bids that do not reflect operators' private value of spectrum but some perceived or actual opportunity to game the rules of the auction, in particular in an attempt to reduce the price the bidder might pay in the auction or to manipulate ALF through strategic demand reduction.

- Similar concerns in relation to Everything Everywhere;
- Similar concerns in relation to Vodafone or Telefónica;
- Concern that one national wholesaler obtains a very large share of spectrum; and
- Summary of competition concerns.

Likely determinants of the auction outcome

- 5.11 The allocation of spectrum in an auction without measures is determined by the relative bids that participants make. This is likely in turn to be determined by the bidders' expected difference in profits from supplying wholesale and retail services with and without the spectrum in question.
- 5.12 We distinguish between two sources of value (i.e. profits) in bidding for spectrum:
- Intrinsic value.** The present value of additional profits a bidder expects to earn when holding the spectrum compared to not holding it, in the absence of any strategic considerations to obtain spectrum to reduce competition in mobile services from the existing level;
 - Strategic investment value.** The present value of additional expected profits earned from bids aimed at affecting the future structure of competition in the downstream market(s) by depriving one or more competitors of spectrum.
- 5.13 These factors will influence the likelihood of the competition concerns identified in Section 4 materialising.

Intrinsic value of spectrum

- 5.14 The intrinsic value of spectrum to each bidder will be determined by a number of factors. Some key determinants of this value are likely to be similar across bidders interested in being national wholesalers:
- The nature of the services it will provide using the spectrum. This is likely to be similar for all national wholesalers bidding for the spectrum; all are seeking to acquire spectrum in order to launch national mass-market mobile data services.
 - Characteristics of the spectrum (including the frequency, whether it is contiguous and the licence conditions that are attached).
- 5.15 However, the allocation in an auction will depend on the *relative* value to bidders of a given frequency and amount of spectrum (as expressed in their bids). This will be affected by a number of factors including, amongst other things:
- Existing holdings of spectrum at each frequency and the quantity a national wholesaler is seeking to acquire. In very general terms, we would expect a bidder to place a higher value per MHz on spectrum, the smaller its existing holdings. However, there may be important exceptions such as arising from synergies between spectrum holdings that counterbalance or more than offset this.
 - Existing position in the market. Whether the firm is present in the market, size of its existing customer base, commercial strategy etc;

- c) Capabilities of the firm, including technical, strategic and organisational capabilities and access to capital.
 - d) Difficulty/uncertainty in forecasting spectrum value. Since bids are based on forecast profits the auction outcome will also be affected by bidders' potential errors in evaluating the spectrum value. The auction format seeks to mitigate the effect of common value uncertainty, since bidders can reconsider their own forecasts as they observe the level of demand in the auction, but there may still remain room for bidders' errors in forecasting their private value.
- 5.16 We expand on each of these below. Whether the potential outcomes that give rise to competition concerns identified in Section 4 are likely to materialise will depend on whether these factors tend to favour a particular allocation or not. In general, as discussed in more detail below, we would expect the first factor (i.e. of existing spectrum holdings) to increase spectrum value for H3G or a new entrant and the second factor (i.e. of existing position in the market) to increase spectrum value for Everything Everywhere, Telefónica and Vodafone. We do not consider that the last two factors favour any particular national wholesaler. However, the strength of these different factors is not easy to assess, not least because they are forward looking and relate to a market with a lot of uncertainty.
- 5.17 As a general point, we note that in an auction even small differences in intrinsic values - irrespective of the causes - may have a large impact on the auction outcome as they can increase significantly the probability that the bidder with the highest intrinsic value wins. Intuitively, a bidder with a slightly higher value is willing to bid a bit more aggressively than the other bidders. In ascending (almost) common-value auctions¹⁶⁴, this direct effect, even if small, can be reinforced by a larger indirect effect which relates to the increased 'winner's curse' faced by competitors.¹⁶⁵ In short, a small initial advantage may be multiplied by the operation of the 'winner's curse'. When there is uncertainty over the value of the auctioned item, in this case spectrum, bidders face the risk of paying more for the spectrum than the value to them. If bidder A has a higher intrinsic value and this is known to other bidders, the other bidders anticipate that bidder A can afford to pay more than they can. Therefore, the disadvantaged bidders may be worried that if they win it is because they have overpaid for the spectrum (i.e. winner's curse). This makes them more cautious in their bidding, with the result that bidder A is even more likely to win the auction, and pay less for the item than it would have in absence of any asymmetries between bidders.
- 5.18 The consequences of small differences in intrinsic value could be large not only in terms of the auction outcome but also for consumers and competition in mobile services. If a small difference in intrinsic value leads one or more national wholesalers to fail to acquire the spectrum it needs to become or remain credible in future mobile market(s), there could be a relatively large detrimental impact on competition and consumers (as discussed in Section 2).

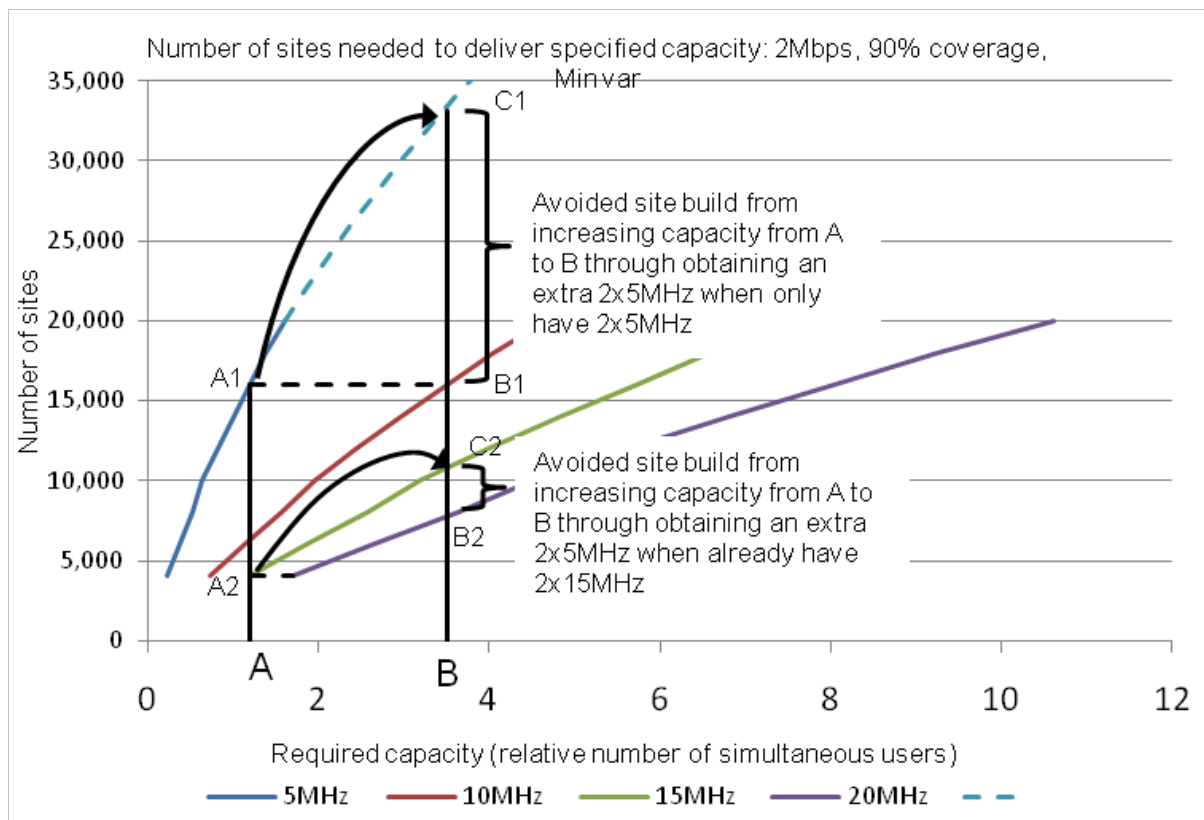
¹⁶⁴ Common value means that the value of the object at auction is the same to everyone but different bidders have different estimates about the actual value. 'Almost' refers to the fact that there might be small asymmetries between bidders, i.e. one or more bidders have a valuation advantage over all other bidders.

¹⁶⁵ Klemperer, P. (1998), Auctions with Almost Common Values: The 'Wallet Game' and Its Applications, *European Economic Review*, 42, 775-69; and Bulow, J., Huang, M. and P. Klemperer (1999), Toeholds and Takeovers, *Journal of Political Economy*, Vol.107(3), 427-54.

Existing holdings of spectrum and quantity sought

- 5.19 The value of additional spectrum to a national wholesaler will, in part, be determined by its existing spectrum holdings. In very general terms, we would expect that the marginal value a national wholesaler would place on spectrum would tend to fall as its existing holdings (or the amount it seeks to acquire) increases. In other words, the demand curve will slope downwards. For example, in part spectrum will be valued because it allows a national wholesaler to avoid network build costs, and avoided network costs fall as more spectrum is obtained, which tends to lower spectrum demand as spectrum holdings grow.¹⁶⁶
- 5.20 This is illustrated in the graph below. This shows the number of sites needed to deliver capacity for four different spectrum holdings at 1800MHz, from our technical modelling. This is for 2 Mbps, but the basic relationship of the lines would be the same for higher data rates.¹⁶⁷

Figure 5.1: Comparison of avoided number of sites by adding more spectrum to increase capacity



- 5.21 Consider the cost of increasing capacity to go from A to B on the horizontal axis. If a national wholesaler only has 2x5MHz of spectrum then it would need to build sites equivalent to B1 to C1. If it obtained another 2x5MHz of spectrum (so to have

¹⁶⁶ This abstracts from various complicating factors including the time dimension (as capacity is expected to grow over time and some network investment can be postponed whereas spectrum investment cannot) and that spectrum and network investment may be different to the extent they are 'sunk'. These factors may be particularly important given there is considerable uncertainty over future demand.

¹⁶⁷ We have extrapolated the 5MHz line beyond that produced with our technical modelling. The dashed part of the line is the extrapolation.

2x10MHz in total), it would avoid all of these network costs. It would increase capacity by going from A1 to B1 by obtaining the extra 2x5MHz of spectrum.

- 5.22 In contrast, if a national wholesaler has 2x15MHz to begin with, it could increase capacity from A to B by building sites so as to go from A2 to C2. Even if it obtained an extra 2x5MHz of spectrum (to have 2x20MHz in total), it would still need to build some sites to increase capacity to B: it would need to build sites to go from A2 to B2. However, by obtaining an extra 2x5MHz, it could still avoid the cost of building sites to go from B2 to C2. Its avoided network costs from obtaining an extra 2x5MHz are therefore represented by B2 to C2. These are considerably smaller than the avoided network costs for the national wholesaler who only has 2x5MHz, represented by B1 to C1. This illustrates how avoided network costs fall as holdings of spectrum rise.
- 5.23 However, spectrum is heterogeneous and demand will also be affected by the particular characteristics, including:
- The specific frequency;
 - Amount and whether contiguous;
 - Any particular licence conditions attached to the spectrum.
- 5.24 This means that, even if a national wholesaler holds a large amount of spectrum, its value for extra spectrum may not fall if it has characteristics that meet specific requirements. For example, a wholesaler such as Everything Everywhere that currently has no sub-1GHz spectrum may place a high value on spectrum in the 800MHz band despite large existing holdings at higher frequencies.
- 5.25 Also, demand for spectrum could, over some range and in some circumstances increase because of synergies (i.e. there may be discontinuities in demand with the price per MHz the bidder is willing to pay increasing with quantity). For example, because of the benefits of larger contiguous blocks, the incremental value of say 2x10MHz of contiguous spectrum over 2x5MHz may well exceed the value of 2x5MHz alone (i.e. in such a case the marginal value of spectrum increases with the amount). There may also be synergies in holding spectrum across different frequencies. Some network architectures for example may combine low and high frequency spectrum and a national wholesaler adopting such a multi-frequency approach will tend to value the combination of frequencies more than each alone.
- 5.26 The importance of existing holdings of spectrum is relevant for the outcome of the auction in two ways. Firstly, national wholesalers will begin the auction with different existing holdings of spectrum which is likely to affect the value they place on the spectrum being awarded.
- 5.27 Secondly, assuming no strategic investment, if only three national wholesalers emerge from the auction with sufficient spectrum to be credible it means they must have been willing to outbid the fourth despite one or more of the three bidding for much larger quantities of the relevant spectrum and therefore being further down their demand curve. If a fourth national wholesaler is squeezed out it means one or more of the other bidders must place a higher value on *additional* spectrum beyond that required for credibility than the fourth bidder places on having *sufficient* spectrum to do so.

5.28 We discuss how the existing holdings of spectrum may affect the intrinsic values of particular national wholesalers as we consider each of the competition concerns below.

Existing position in the market

5.29 Independent of its spectrum holdings, a national wholesaler's existing position in the market for mobile services can affect its spectrum valuation:

- A national wholesaler with a smaller existing customer base may find it harder to obtain value from using the spectrum as quickly;
- A national wholesaler with a larger existing customer base may have less incentive to introduce new products if this largely replaces (or 'cannibalises') existing sales; and
- A firm that is not present in the market will not yet have sunk the fixed costs associated with entry.

5.30 A national wholesaler with a smaller existing customer base may find it harder to obtain value from new spectrum if it cannot attract customers onto services using the spectrum as quickly. A customer base for both voice and data services is likely to be relevant since there will be scope to upsell data plans to those customers currently taking only voice services. A customer base could be relevant because it may take time to acquire customers or is expensive relative to customer retention. This could affect the value a national wholesaler with a smaller existing customer base (in practice, H3G or a new entrant) places on spectrum in the auction.

5.31 When we consider the concern that a fourth national wholesaler may not obtain the spectrum it needs to be a credible national wholesaler after the auction, we consider in detail how the existing customer base might affect intrinsic value. We do not consider existing market position to be of concern when we consider the risks relating to Everything Everywhere, Vodafone and Telefónica. This is because while the market shares of Everything Everywhere, Vodafone and Telefónica are not equal, they all have a relatively high share of total subscribers, which are materially above that of H3G (and obviously of a new entrant). Vodafone has the smallest share of the three, but still has 25% of total subscribers. In contrast, H3G's share of total subscribers has been consistently lower, being around 7% in 2010.

5.32 Even if there were some limits to how quickly market share could grow, we would not expect there to be absolute barriers to acquiring customers. The past experience of H3G in 3G services shows that it is possible to enter the market for mobile services and grow over time.¹⁶⁸ H3G entered the market in 2003 and had 5.6 million subscribers in 2010, a share of 6.9% of mobile subscriptions and 16.9% of 3G connections.¹⁶⁹

5.33 National wholesalers with larger customer bases (i.e. Everything Everywhere, Vodafone and Telefónica) may face offsetting effects. They could have a larger

¹⁶⁸ Similarly, at the retail level, there has been entry by numerous MVNOs, including (amongst many others) Virgin Mobile in 1999, Tesco Mobile in 2003, Asda Mobile in 2007, Lebara Mobile in 2007, Lyca Mobile in 2008 and Talk Talk in 2010.

¹⁶⁹ See Figures 5.54 and 5.56 of the Communications Market Report 2011:

http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CMCR_2011_FINAL.pdf

intrinsic value because they can monetise new spectrum faster than smaller wholesalers for the reasons discussed above. But they may also face a 'cannibalisation effect'¹⁷⁰ that could reduce their intrinsic value of the spectrum. The value to a national wholesaler of a sale to a new customer is the entire margin that is earned, whereas the value of an existing customer is only the incremental profit (e.g. price premium or cost reduction) that can be earned from the new spectrum. However, if the customer would otherwise have switched supplier, it is the entire margin that is relevant and there is no cannibalisation effect. We discuss the relevance of the cannibalisation effect in further detail below (see paragraphs 5.102 to 5.113).

- 5.34 Regarding barriers to entry, a completely new entrant will need to incur the sunk costs associated with entry, including investment in a network and potentially costs at the retail level, such as developing a brand. Existing firms will already have sunk many of the costs required to launch LTE services including, at the wholesale level, a network of mast sites and associated infrastructure and these costs will not reduce the amount they are willing to bid in the auction.

Capabilities of the firm

- 5.35 The ability of firms to generate sales and earn profits will differ for a number of reasons. Some factors affecting profitability, such as the knowledge and skills of the workforce, are relatively easy for managers and shareholders to identify and we can expect differences between firms to reduce relatively rapidly in a competitive market.
- 5.36 However, firms also differ in their capabilities for reasons that are more elusive and persistent, particularly in dynamic industries where the management of innovation is crucial. There are many examples of highly innovative market leaders whose recipes for success are not easy for competitors to identify or emulate (for example Google or Apple). But equally, positions can change rapidly and previously leading firms may no longer find themselves at the forefront (for example Atari in the videogames market or Nokia in mobile handsets).
- 5.37 In general, it is difficult to make reliable assessments about the capabilities of individual firms or to say whether asymmetries in this could be important in affecting the auction outcome. The past performance of firms will be affected by a number of factors and even if the contribution of the capabilities of the firm could be identified (e.g. if there was a clear consensus among market analysts) it may provide an unreliable basis for assessing the future position as capabilities can be temporary or more permanent.

Inherent difficulty of forecasting spectrum value

- 5.38 Given the uncertainty surrounding the future profitability of mobile data and the roles of different frequencies and amounts of spectrum, all bidders' forecasts will be subject to potentially large errors. It may be that the bidder who wins the auction is not necessarily the one with the highest value but rather the most optimistic. As far as bidders face common value uncertainty this possibility is mitigated by the auction design which allows bidders to review their estimates in the light of others' demand

¹⁷⁰ This effect is also called the 'replacement effect' in the economic literature, e.g. Jean Tirole (1997), *The Theory of Industrial Organization*, MIT Press.

for spectrum. However, bids are likely to include also a private-value element that reflects idiosyncratic factors affecting each bidder's valuation of the spectrum. Uncertainty regarding the private value, e.g. arising from forecast errors, would be unaffected by observing other bidders' behaviour in the auction and could lead to either over- or under-estimating the spectrum value.

Strategic investment incentives

- 5.39 Spectrum is a strategic asset for national wholesalers. In Section 2 of this Annex, we set out why we consider access to suitable spectrum is essential for providing a wholesale service, and is a key factor in determining the quality of the service offered. Lack of a large enough spectrum portfolio may severely affect the business strength of mobile carriers and in some circumstances it can impair the relative ability to compete of one or more wholesalers.
- 5.40 Moreover, spectrum is a scarce resource and the forthcoming auction for 800MHz and 2.6GHz is likely to be the sole opportunity for many years to access additional prime spectrum resources suitable for the provision of mobile services.
- 5.41 This suggests that the outcome of the auction could potentially shape the future competitiveness of the mobile sector for a long period. Recognising this potential lasting impact, some national wholesalers might have an incentive to buy more spectrum than would otherwise be the case with the aim of weakening rivals and thereby reducing the competitive constraint that they will face in future in mobile services.
- 5.42 We are concerned that, even though they may have lower intrinsic value than rivals for some spectrum, some national wholesalers could be willing to acquire additional spectrum if this limits or prevents rivals competing and if, by doing so, they may enjoy a stronger position in the market once the rival(s) has been foreclosed.
- 5.43 We set out our view in Section 2 of the potential for a detrimental impact on consumers if there were fewer than four credible national wholesalers after the auction. Therefore, if successful, strategic conduct may result in a reduction in competition reflected in, for example, higher prices for mobile data (and perhaps also voice) services, lower quality, narrower variety of service offerings, and reduced incentives to invest in infrastructure and innovation (compared to the situation without the reduction in competition).¹⁷¹ The flip-side of such a detrimental impact on consumers is likely to be increased profits for the remaining national wholesalers.
- 5.44 The conditions for strategic investment are facilitated because, although (as noted above) spectrum is essential for a national wholesaler, the cost of spectrum generally only forms a relatively small proportion of the total costs of providing mobile services. Therefore, it may only require, for example, the prospect of a relatively small percentage increase in wholesale or retail prices by strategic investors in future after the strategic investment has been successful to more than offset the costs of purchasing additional spectrum in the auction to weaken the rival(s). We discuss this in more detail below in a quantified illustration of possible payoffs and costs of strategic investment to deny a fourth national wholesaler access to the spectrum it may require to be credible (see paragraph 5.132-5.145 below). For example, in that

¹⁷¹ In addition to the negative effect on competition, strategic investment may also result in an inefficient spectrum allocation where the winning bidder may not be the wholesaler with the highest valuation.

simplified illustration an increase in retail prices of less than 2% may be sufficient to make strategic investment profitable for strategic investors.

5.45 However, we do not consider that it is always feasible to weaken rivals in the auction and, even when it is feasible, it is not necessarily profitable to engage in strategic investment. The risk that an operator will engage in strategic investment in spectrum in order to deter or weaken competition depends on:

- *Feasibility*: whether operators can acquire spectrum in a way that prevents other operators from acquiring the spectrum they need in order to compete as a credible national wholesaler (or across a wide range of services and customers); and
- *Incentives*: whether the expected profits associated with strategic investment, as a result of lower competition, outweigh the costs of acquiring the additional spectrum.

5.46 In the following paragraphs we assess the feasibility and the incentives that operators may have in pursuing strategic investment under the assumption of an auction without measures. We recognise that assessing future conduct inherently involves uncertainty. We therefore consider that our assessment is only able to establish whether there is a potential risk that strategic investment behaviour may occur.

5.47 As a preliminary step, we discuss the main factors that could affect the feasibility and the incentives to engage in strategic investment. We then consider the risk of different categories of national wholesaler being denied spectrum in order to weaken their competitive position through strategic investment by other national wholesalers.

Feasibility of strategic investment

5.48 Feasibility concerns the range of auction outcomes that would result in one or more wholesalers not being credible because of the lack of sufficient spectrum (either in terms of quantity or type of frequency, or both).

5.49 A first condition for the feasibility of strategic investment is the existence of one or more operators that currently do not hold sufficient spectrum to be credible. Only such wholesalers are potentially vulnerable to strategic investment by other wholesalers. If no wholesaler was vulnerable, there would not be any auction outcomes that would lead to exclusion or reduction in competition, and thereby strategic investment would not be rational (i.e. profitable) in the first place.

5.50 A related condition for feasibility is how much additional spectrum a vulnerable wholesaler (referred to hereafter as the potential 'victim') needs to be credible. Intuitively, the less additional spectrum it needs, the narrower is the scope for strategic investment as the investors must acquire more spectrum to prevent the victim from having the opportunity to become credible. This reduces the range of auction outcomes that lead to exclusion (of course, this also impacts on the cost of strategic investments and thus we will discuss the issue also in the next subsection on incentives).

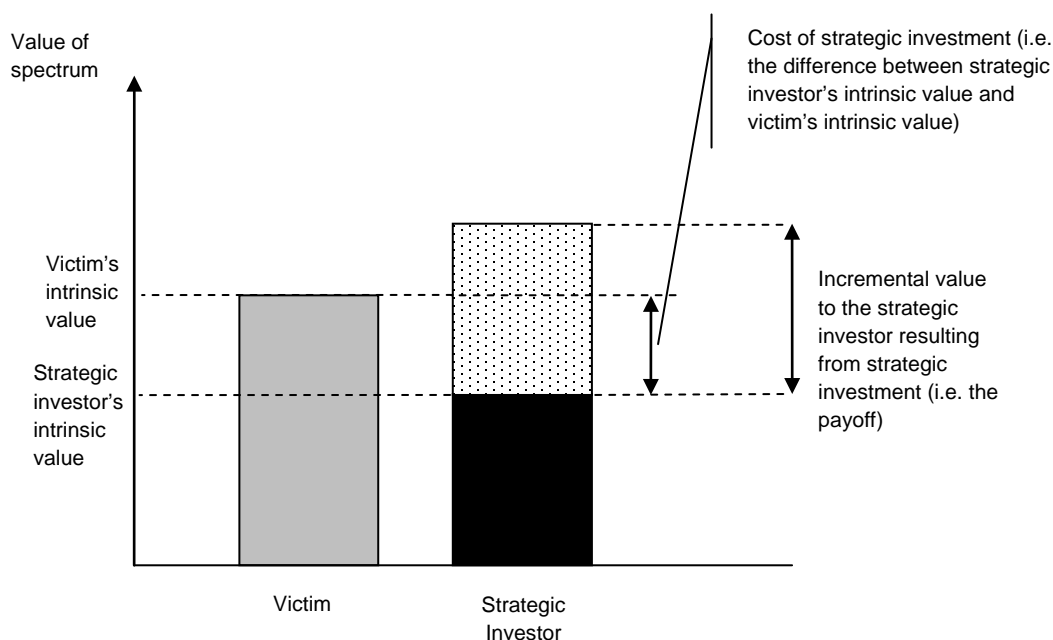
5.51 However, it is not only quantity but also the type (frequency) of spectrum a wholesaler needs that matters for the feasibility of strategic investment. If the victim needs a small amount but of a specific frequency (say, for example, 800 MHz

spectrum), the range of auction outcomes conducive to exclusion would be wider than when frequency does not matter.

Incentives to invest strategically

5.52 Whether participants actually choose to engage in strategic investment will depend on the cost and expected payoff. We illustrate the interaction between these two elements in the diagram below.

Figure 5.2: Cost of strategic investment and expected payoff



5.53 The grey area represents the victim's intrinsic value while the black area identifies the lower intrinsic value of the strategic investor absent any strategic incentives (i.e. the diagram illustrates the case of interest for strategic investment where the victim would be expected to win the spectrum in the absence of strategic investment). The dotted area above the black one illustrates the incremental benefits potentially arising from the exclusion of the victim (i.e. the payoff). This is the difference in profit for the strategic investor with and without the reduction in competition caused by the strategic investment in spectrum.

5.54 Finally, the difference between the victim's and strategic investor's intrinsic value represents the costs of the strategic investment behaviour.¹⁷² This is because the strategic investor will have to be prepared to pay more for the spectrum than the victim to prevent the victim obtaining the spectrum, and the price the strategic investor will have to pay for the spectrum will then be set by the victim's intrinsic value, which is higher than the strategic investor's intrinsic value. In this illustration,

¹⁷² Note that the price premium paid by the strategic investor(s) does not depend on whether it knows the victim's intrinsic value. Indeed, even if the strategic investor bid is higher than the victim's intrinsic value (because, for example, it overestimates the value) it would nonetheless pay a price at auction set at the victim's intrinsic value. That is because the winning price in the auction is set according to a second-price rule. None the less, as we will discuss later, uncertainty over the victim's intrinsic value may modify the expected profitability of strategic investment and thereby the incentives to engage in it in the first place.

we show only the case where strategic payoffs are higher than the corresponding costs, but of course, as we discuss below, this may not always be the case.

Payoff of strategic investment

- 5.55 The incentives to undertake strategic investment clearly depend on the increase in profits that the investors expect to earn should the conduct succeed in reducing competition through denying spectrum to one or more competitors. Specifically, the payoff will be determined by the expected present value of the additional profits a firm can earn over time from reducing competition. The magnitude of the increase in profits is influenced by the extent of the reduction in competition and the size and characteristics of the market. The presence of barriers to entry and the availability of additional spectrum in the future are likely to affect the duration of the payoff.
- 5.56 The potential payoff resulting from reduced competition has already been assessed indirectly in Section 2 of this Annex, where we discussed the potential consumer detriment that may arise from a reduction in the number of credible national wholesalers.¹⁷³

Costs of strategic investment

- 5.57 On the cost side, relevant factors to assess the firms' incentives to strategically invest are:
- The incremental cost of acquiring more spectrum than national wholesalers would have bought without strategic investment; and
 - Any knock-on effect that strategic investment might have for annual licence fees.
- 5.58 The first factor concerns the amount of 'extra spectrum' needed to weaken rivals and the additional price (or 'premium') that strategic investors have to pay above their intrinsic value to buy the extra spectrum. Both the extra spectrum and the price premium are implicitly determined by the intrinsic value of the potential victim and the strategic investors.
- 5.59 The extra spectrum depends on the spectrum quantity for which the victim's intrinsic value exceeds the strategic investor's. It is therefore related to the distribution of spectrum that would result without strategic investment. The larger the amount a victim would have acquired beyond what it strictly needs to be credible, the more spectrum a rival firm has to purchase in order to weaken the competition constraint it will provide (i.e. additional to what it would have secured absent strategic investment).
- 5.60 The price premium depends on the extent to which the victim's intrinsic value exceeds the strategic investor's. The larger the difference between the intrinsic value of the victim and that of the strategic investor, the higher the cost incurred by a strategic investor to outbid the victim and deny it access to the spectrum.
- 5.61 Another possible source of costs for the 900MHz and 1800 MHz licence holders (currently Vodafone, Telefónica and Everything Everywhere) from strategic

¹⁷³ Strictly, the 'producer surplus' gained by producers from a price increase is less than the 'consumer surplus' loss, due to a 'deadweight loss'. However, unless the market is highly elastic, a large part of the 'consumers surplus' loss will translate into a 'producer surplus' gain.

investment may arise if annual licence fees on the 900MHz and 1800MHz spectrum they hold were to increase as a result of strategic investment. As explained in Section 8 of the main Consultation and Annex 13, prices for spectrum in the auction may be an input into setting annual licence fees for 900MHz and 1800MHz spectrum. To the extent that strategic investment pushes up auction prices and if these increase annual licence fees, then this increases the costs of strategic investment for national wholesalers who already hold licences to use 900MHz and 1800MHz spectrum. However, we also discuss in Section 8 and Annex 13 other considerations that may affect the future review of annual licence fees, and explain that amounts bid in the auction by those who already hold 900MHz and 1800MHz spectrum will be one of a number of potential factors which we will take into account in setting future annual licence fees. Therefore we do not consider this factor is by itself enough to remove any incentive for strategic investment.

Other issues

- 5.62 Uncertainty is relevant to the analysis of strategic investment. We envisage at least two important sources of uncertainty.
- 5.63 First, there is a wide uncertainty over the development of technologies and the future market evolution. Wholesalers might have different views, for example with respect to the amount and type of spectrum that is needed to be credible, and they are expected to value the spectrum consistently with their private views. As a result, intrinsic values of wholesalers may not be common knowledge. In this context any choice of whether to engage in strategic investment is likely to be based on the strategic investor's expectation of the victim's likely intrinsic value. This has an important implication as it may not only affect incentives but also introduces uncertainty over the success of strategic investment, as explained below.¹⁷⁴
- 5.64 It is difficult to speculate if, and the extent to which, this source of uncertainty affects the risk of strategic investment. However, in the case in which only the victim correctly establishes what it needs to be credible, but this information is unknown to the strategic investor(s) (because, for instance, spectrum requirements depend on the market strategy and the technology solution that each wholesaler intends to pursue), strategic investment may be less likely. Indeed, when faced with uncertainty, strategic investors could either end up wrongly denying access to a part of the spectrum which is not essential to the victim or overestimating the needs of the victim and secure less spectrum than needed to deny the required spectrum to the victim. In both cases the conduct would fail the objective of foreclosing the victim. Strategic investors could also underestimate the spectrum needs of the victim; in such a case, strategic investment could still be successful but investors would buy more spectrum than necessary to exclude the victim. This would raise the costs of strategic investment, making it less attractive in the first place.
- 5.65 Second, even if intrinsic values of wholesalers were common knowledge across the industry, there are two further factors that may influence the incentives of strategic investment by increasing the uncertainty over the likelihood of successful strategic behaviour:

¹⁷⁴ In the following discussion, we will not make a further distinction between actual and expected intrinsic value but we will implicitly consider that any time wholesalers do not know with certainty the value placed on spectrum by rivals their evaluation over the profitability of strategic investment will be based the *expected* intrinsic value.

- free-riding incentives; and
 - the extent of information available in the auction.
- 5.66 Free-riding incentives can arise because national wholesalers remaining in the market will benefit from the reduction in competition regardless of whether they themselves participated in, and therefore incurred the costs of, strategic investment. Consequently, each wholesaler may prefer that others play a bigger role in acquiring the extra spectrum that excludes or marginalises one or more competitors. In this way, they would incur lower costs of strategic investment while still receiving the benefits. They may therefore all have an incentive to try to free-ride on the others' strategic investment. Absent coordination, free-riding incentives could make it less likely that strategic investment takes place.
- 5.67 We note, however, that free-riding does not imply that strategic investment is never profitable as a completely unilateral strategy. Even though the benefits would be shared with other competitors, the strategic investor may nevertheless receive a share that more than offsets the costs of strategic investment.¹⁷⁵ That is, if the costs of exclusion are modest relative to the payoff, a firm may be willing to do it regardless of its expectation about what others will do.¹⁷⁶
- 5.68 In general terms, we may expect that the smaller the number of potential strategic investors, the lower the incentive to free-ride. This is because when there is a large number of potential strategic investors, bidders may tend to be more confident that others will take responsibility over the exclusion of the victim (i.e. they will incur the costs), and thus they may be more likely to free-ride. By contrast, when the number of strategic investors is small, the risk that free-riding leads to a failure of the exclusionary strategy may be perceived as higher, therefore providing a stronger constraint on incentives to free-ride.
- 5.69 If there is no unilateral incentive, but instead coordination is required between more than one strategic investor, free-riding incentives are likely to be stronger. However, the possibility of spectrum trading can to some extent mitigate the free-riding concern. Consider the hypothetical case in which a strategic investor is willing to engage in strategic investment as long as the costs of it are evenly split with the other investors (because otherwise the cost would exceed the payoff to each individual strategic investor). For illustrative purposes we assume that the extra spectrum that three investors need jointly to obtain is 2x15 MHz and each individually expects that the other potential investors participate in the strategic conduct by securing 2x5 MHz each. Because of free-riding, investors may end up incurring the costs of strategic investment (i.e. paying the spectrum more than their intrinsic value absent strategic intent) even when the exclusionary strategy is not successful because the other investors have not done their part. This possibility would tend to discourage strategic investment in the first place. However, spectrum trading can reduce the expected costs of strategic investment, as if the strategic investment is unsuccessful it provides an opportunity to resell the spectrum to those wholesalers

¹⁷⁵ Although it is not always the case, it can be shown, using common economic models of oligopolistic competition, such as Bertrand with differentiated products or Cournot, that there may be conditions under which the payoff earned by a strategic investor – even though others also benefit from the exclusion of the victim - can be such as to outweigh the total costs of strategic investment.

¹⁷⁶ Furthermore, coordination may not be needed simply because there is only one strategic investor whose intrinsic value is less than the victim's.

who value it more. In this way the strategic investor that bought additional spectrum could recover, at least in part, its costs of the failed strategic investment.

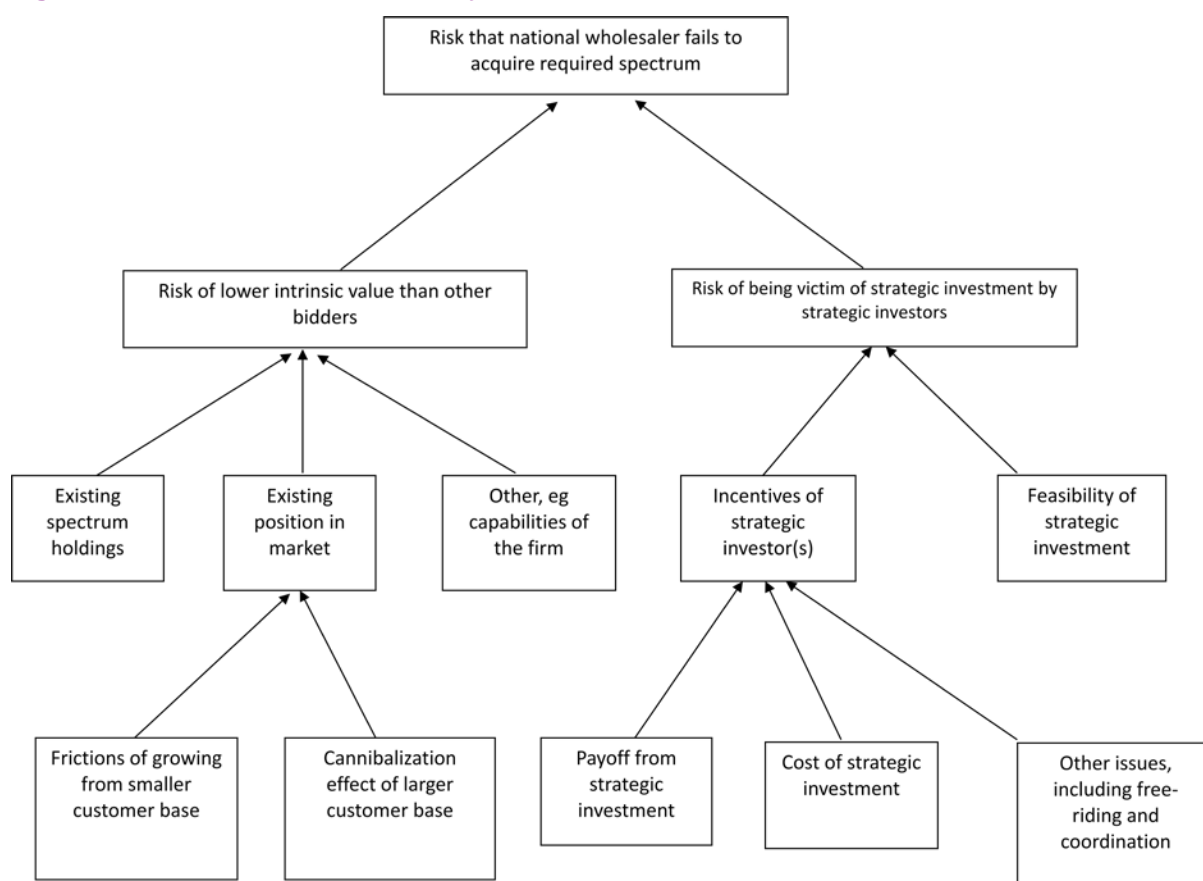
- 5.70 Limited information available during the auction can also reduce the incentives for strategic investment. Depending on the details of the auction design, bidders may be able to observe the level of demand but not the identity of bidders. For example, bidders seeking to over-invest in spectrum in order to deter another from becoming a credible national wholesaler may reduce their demand for spectrum before the victim has dropped out (in the false belief that that it had dropped out) and fail to achieve their strategic investment objective. Or they may achieve their outcome but only at a higher cost than necessary because two strategic investors go on competing against one another even after the victim has dropped out. These risks may make it less attractive to adopt a strategic investment approach as it reduces the probability of success and raises the costs of such behaviour.
- 5.71 Our proposed auction involves bidding for packages of spectrum with a second price rule (see Section 7 in the main Consultation). This allows bidders to compete for a larger package of spectrum (e.g. 2x20MHz) without inducing the price of a smaller package of spectrum (e.g. 2x10MHz) to rise as a consequence of their bids. This feature of the auction implies that, if there were a single strategic investor, it need not be concerned about the consequence of attempted strategic investment that turns out to be unsuccessful in excluding a competitor. The reason is that the bids offered on the extra spectrum seeking to achieve exclusion do not necessarily increase the price paid on the remaining spectrum the strategic investor is bidding for. So, for example, a strategic investor could bid its intrinsic value for a smaller package but in its bid for a larger package, which is seeking to deny spectrum to the victim and reduce future competition in mobile services, also include (some or all of) its strategic investment value.
- 5.72 This could be profitable for the strategic investor whether the attempt at strategic investment is successful or fails. If the strategic investor wins the larger package and the strategic investment is successful, it is profitable because the strategic investor gains the benefit of reducing competition in mobile services which offsets the higher auction price it paid for the larger package of spectrum. But if the strategic investor fails to win the larger package and instead only wins the smaller package, i.e. the attempt at strategic investment is unsuccessful, it is also profitable for the strategic investor because it only has to pay (at most) its intrinsic value. However, if there is more than one strategic investor, the situation is more complicated and there is also the possibility that competition in the auction between two strategic investors may bid up prices, as noted in paragraph 5.70 above.
- 5.73 There is therefore an important distinction between strategic investment and other types of strategic bidding, such as strategic demand reduction. In essence, a bidder engaging in strategic investment purchases *additional* spectrum to deny spectrum to competitors and reduce competition in mobile services; whereas for strategic demand reduction a bidder purchases *less* spectrum to reduce the auction price that it pays for the spectrum it does buy. The feature of our auction design described above - that bidding for larger packages need not affect the price of smaller packages - reduces the incentives for strategic demand reduction. However, it may

not reduce the incentives for strategic investment as described in the previous paragraph).¹⁷⁷

Summary of the determinants of the auction outcome

5.74 The previous paragraphs discuss the various factors that may affect the intrinsic value to bidders and the risk of strategic investment. In the following chart we illustrate graphically how these factors relate one to each other.

Figure 5.3: Illustration of the analytical framework



5.75 The risk of national wholesalers failing to acquire the required spectrum can be caused by: (i) a lower intrinsic value compared to other bidders; or (ii) strategic investment by competitors deliberately aimed at denying the victim access to the required spectrum (when the latter would be expected to obtain it based on its intrinsic value):

- *Lower intrinsic value*: the value placed by bidders on a given frequency and amount of spectrum, i.e. their expectation of the profits they can generate from the spectrum, is affected by a number of factors, including the existing holdings of spectrum, the existing position in the market, and other aspects, such as the general technical and organisational capabilities of the bidders. Frictions in the switching process, on the one side, and cannibalisation effect, on the other side,

¹⁷⁷ This is one reason we disagree with the argument put forward by some respondents to our March 2011 consultation that our auction design precludes strategic behaviour.

are relevant factors that may determine the extent to which unequal existing market positions result in different intrinsic values.

- *Strategic investment*: the likelihood of strategic investment depends on two distinct elements: feasibility, i.e. the existence of auction outcomes that can result in the victim being squeezed out, and incentives, i.e. the profitability of the strategy. Incentives for strategic investment are in turn affected by three factors: (i) the payoff, i.e. the incremental profits arising from the exclusion of the victim; (ii) the costs, i.e. the additional price that strategic investors have to pay to achieve the exclusion; and (iii) other issues, such as free-riding and coordination, that may jeopardize the probability of success of the strategy, thereby affecting the incentives to engage in strategic investment in the first place.

5.76 Throughout this Section we will follow the analytical framework illustrated in the chart above to assess the likelihood of each of the potential detrimental auction outcomes. We identified such auction outcomes in Section 4 by category of national wholesaler: a fourth national wholesaler (i.e. H3G or a new entrant), Everything Everywhere, and Vodafone or Telefónica.

Concern that a fourth national wholesaler fails to acquire required spectrum to be credible national wholesaler or avoid disadvantage in competing across a wide range of services and customers

5.77 For the reasons set out in Section 4 we consider there is a risk that a fourth national wholesaler may cease to be a credible national wholesaler in the future if it failed to acquire sufficient spectrum of the right type and quantity in the auction.

5.78 Below we discuss the likelihood of a fourth national wholesaler failing to obtain the required spectrum in case of an auction without measures.

Lower intrinsic value

5.79 If a fourth national wholesaler has a lower intrinsic value than rival bidders for the spectrum it requires to be able to be a credible national wholesaler, it is likely to fail to win the spectrum in an auction without measures. Given the beneficial effects on competition, however, a fourth national wholesaler obtaining the spectrum may still be the most efficient allocation from the point of view of consumers. In later Sections we consider in more detail the trade-offs involved in allocating spectrum to a national wholesaler with lower intrinsic value. For now, we concentrate on the likelihood that a fourth national wholesaler will not win sufficient spectrum absent measures in the auction to facilitate this.

5.80 One difference between H3G and a new entrant is the impact on intrinsic value stemming from the sunk costs of entry which will only apply to a new entrant.

Existing holdings of spectrum and the quantity being acquired

5.81 H3G's only existing paired mobile spectrum is 2x15MHz of 2.1GHz spectrum. It therefore has no sub-1GHz spectrum, no early route to LTE and a limited share of the total spectrum that will be available after the auction.

5.82 Everything else equal, its low overall share of spectrum, would tend to suggest that it should have a high intrinsic value for additional spectrum, for the reasons set out in paragraphs 5.19 to 5.28 above. Also, if sub-1GHz spectrum were necessary for H3G

to be a credible national wholesaler in the future we would expect H3G to have a correspondingly high valuation for sub-1GHz spectrum that reflects this. Similar considerations may apply to a new entrant.

5.83 However, differences in intrinsic value between H3G or a new entrant and the other national wholesalers owing to differences in existing holdings need not be large. In particular, a fourth national wholesaler's valuation for 800MHz spectrum may not be significantly higher than other operators since sub-1GHz spectrum is currently scarce for all operators. Telefónica and Vodafone currently have 900MHz spectrum but argue that they cannot refarm it for LTE use in the near future. Everything Everywhere does not hold any sub-1GHz spectrum and regards it as crucial for providing good indoor coverage. All three operators have indicated in their consultation responses a strong desire to win 800MHz spectrum.

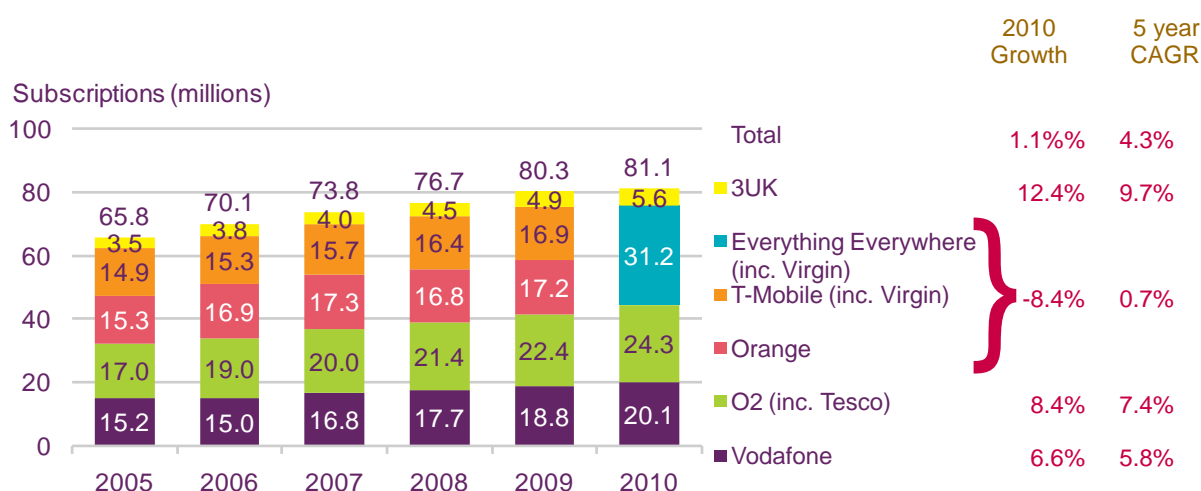
Existing position in the market

Slower or more expensive customer acquisition

5.84 As we discussed above (see paragraph 5.30) there may be advantages from having a large established base of customers purchasing mobile services if their demand for capacity is growing and they have some tendency to remain with their existing provider.

5.85 In terms of the effect on the auction, if an existing customer base is an advantage this would clearly hinder a completely new entrant. Of current national wholesalers, H3G has by far the smallest market share when 2G and 3G customers are combined, whether this is measured in terms of subscriber numbers or retail revenues (see Figure 5.4 and Figure 5.5 below). This suggests that, if an existing customer base (combining 2G and 3G customers) were important for obtaining value from the new spectrum, H3G could be at a disadvantage as well as a new entrant.

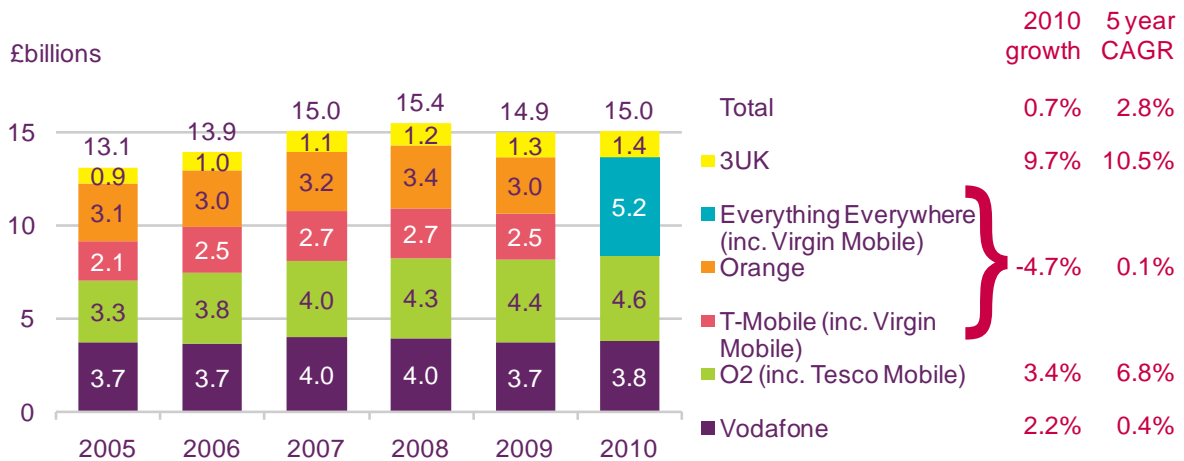
Figure 5.4: Mobile connections, by operator



Source: Ofcom/operators

Note: includes estimates where Ofcom does not receive data from operators

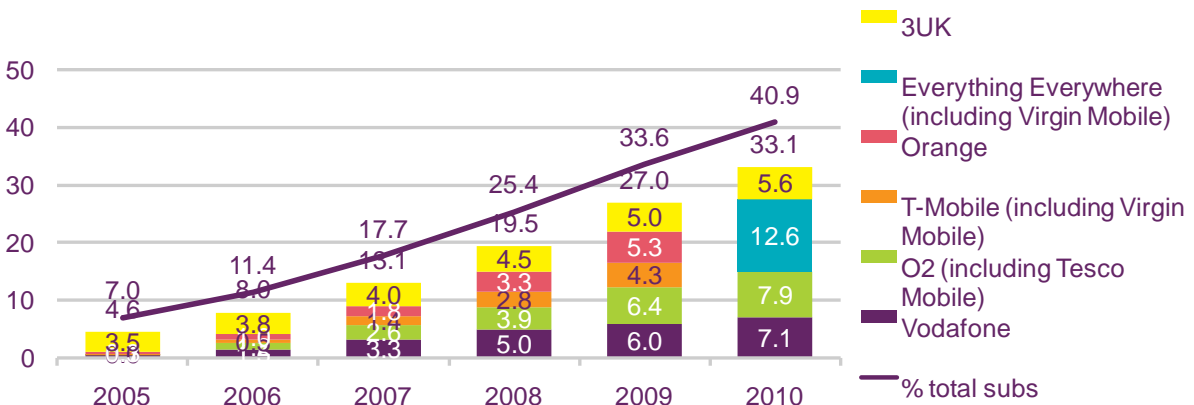
Figure 5.5: Mobile telecoms retail revenue by provider



Source: Ofcom / operators

5.86 On the other hand, if what matters is an existing base of customers already using 3G services or already using dongles/data cards H3G would be at less of a disadvantage (see Figure 5.6). There is a possibility that initial users of the awarded spectrum will tend to be those customers currently using 3G services, in which case numbers of 3G customers may be a more relevant metric.

Figure 5.6: 3G subscriptions

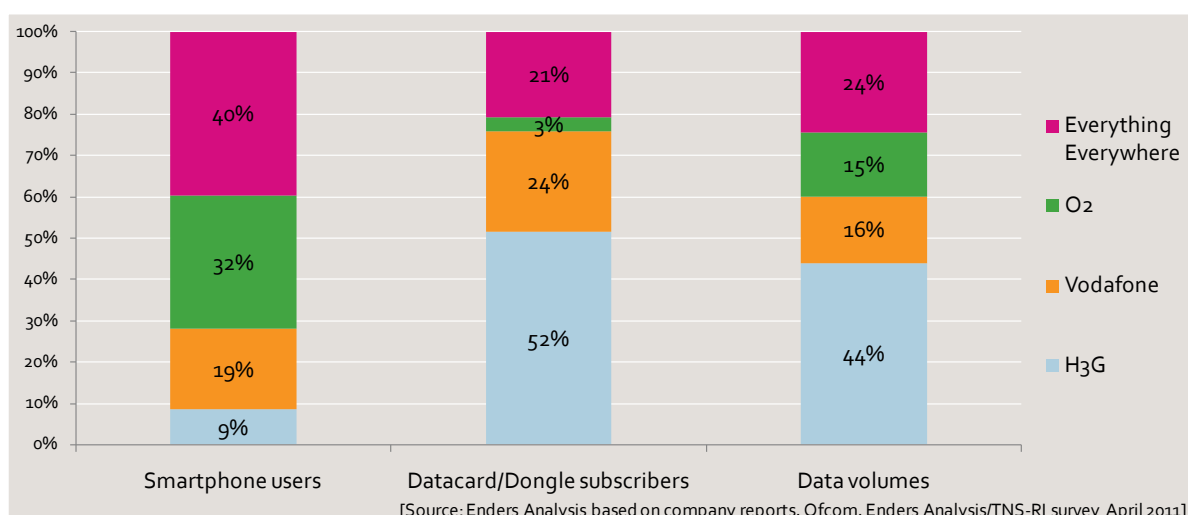


Source: Ofcom/operators

Note: includes estimates where Ofcom does not receive data from operators

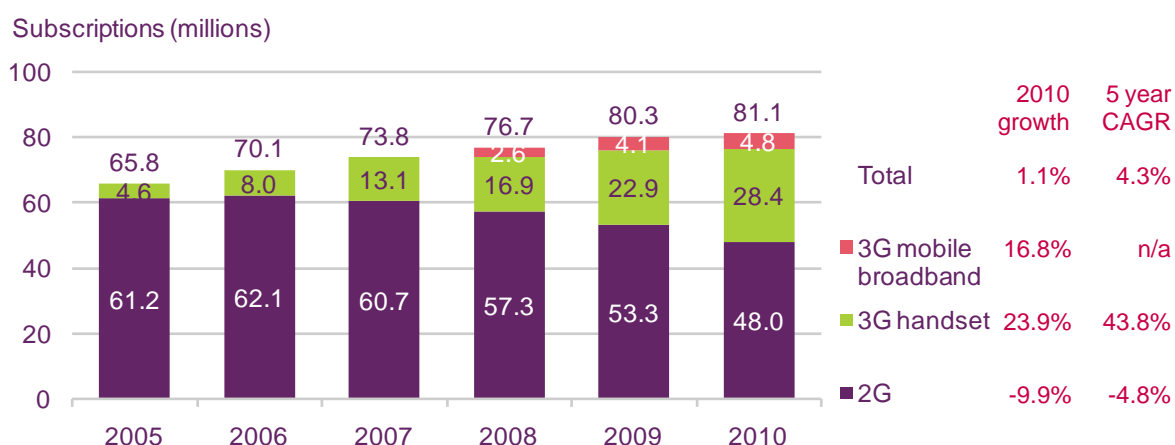
5.87 Furthermore, H3G has the highest share of dongle/data card users and a corresponding high share of data volumes. If those customers most likely to upgrade are heavy users, H3G might even have an advantage, since its share of data volumes suggests it has a much larger share of these customers (see Figure 5.7).

Figure 5.7: UK market shares of subscribers and data volumes, Q1 2011



5.88 However, there is a clear trend towards moving away from 2G services to high speed data services (see Figure 5.8 below), which is forecast to continue in the future.¹⁷⁸ This suggests that 2G customers are generally likely to want to upgrade to high speed data services. This could mean that those with a large base of 2G customers may be able to obtain value from the auction spectrum more rapidly.

Figure 5.8: Mobile subscriptions by technology



Source: Ofcom / operators

5.89 National wholesalers with a larger customer base could benefit in terms of retaining customers with growing demand, or selling any premium 'LTE service' to existing customers in the following ways:

- More effective marketing and retention activity. Each national wholesaler has a lot of information about existing customers, making it easier to target marketing and focus retention activity at more valuable consumers, or those consumers likely to buy LTE services;

¹⁷⁸ See Annex 8 for future forecasts of smartphones.

- Consumers may be drawn to purchase LTE from their current supplier because of lower search and switching costs;
 - The ability to upgrade existing customers who are within a minimum contract period (i.e. waiving early termination charge from an existing contract).
- 5.90 We do not have evidence on how important the first factor is likely to be, but we consider that marketing and retention advantages stemming from a customer base are likely to exist since it allows more targeted (and therefore cost effective) activity by the current provider.
- 5.91 Evidence on the importance of switching costs comes from various surveys on consumers switching that Ofcom has conducted. These provide some indication of the likely presence of frictions to growth that a new entrant or H3G might face. The surveys used here are those conducted as part of the Consumer Experience Report 2011¹⁷⁹, the Communications Market Report 2011¹⁸⁰ and the Strategic review of Consumer Switching 2010.¹⁸¹
- 5.92 The research suggests that many consumers in the market can be classified as 'inactive' in that they show no interest in switching supplier. The consumer experience report found that only 18% of the consumers in the mobile market were classified as 'engaged' and 80% had taken no action in the market in the past 12 months. Similarly research for the Strategic Review of Consumer Switching found that 85% of mobile consumers were 'inactive' in that they had neither switched nor considered switching in the past year.
- 5.93 This however does not necessarily suggest barriers to switching and may just indicate that many consumers are content with their existing supplier. It is also true that active consumers, who are more likely to switch suppliers, may be the ones most likely to purchase LTE services.
- 5.94 Surveys also show that switching is generally regarded as easy, but that some impediments do exist. The Consumer Experience Report 2011 found that 90% of those who had switched mobile supplier found the process 'very easy' or 'fairly easy'.¹⁸² Of those who never switched 76% still expected switching to be easy or fairly easy. Of those who considered switching but didn't (8% of consumers), 16% cited the hassle of switching as the reason for not switching. 17% cited existing contractual commitments.
- 5.95 The Strategic Review of Consumer Switching found that a substantial minority of consumers in communications markets agree with the statement that 'switching provider seems like too much hassle' (31% of those who had switched, 48% of those who had neither switched nor considered switching).¹⁸³ The review also found that of those mobile customers who considered switching in the last 12 months but did not switch, 18% cited their own inertia as the reason.
- 5.96 Overall, the survey evidence suggests that although only a minority of consumers can be considered active in the market, it is not clear that consumers perceive there

¹⁷⁹ http://stakeholders.ofcom.org.uk/binaries/research/consumer-experience/tce-11/research_report_of511a.pdf

¹⁸⁰ http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CMR_2011_FINAL.pdf

¹⁸¹ <http://stakeholders.ofcom.org.uk/binaries/consultations/consumer-switching/summary/switching.pdf>

¹⁸² See Figure 5.4.

¹⁸³ See Figure 10.

to be major barriers to switching. However, a large proportion of consumers do consider switching a 'hassle' and factors such as inertia or contractual conditions are cited as a barrier for at least some consumers. Switching costs or inertia tend to limit the competitive strength of new entrants or smaller incumbents especially in mature markets where the growth must be achieved mainly through attracting competitors' customers rather by acquiring new users. In this regard, we note that mobile penetration in the UK is already well above 100% (an average of 1.31 mobile connections per person at the end of 2010)¹⁸⁴ and the average rate of mobile connection growth in the last five years had been rather low compared to other countries (4.3%),¹⁸⁵ suggesting that while the volume of services demanded by mobile users is expected to increase significantly in the next years, the growth of mobile subscribers is likely to be much more limited.

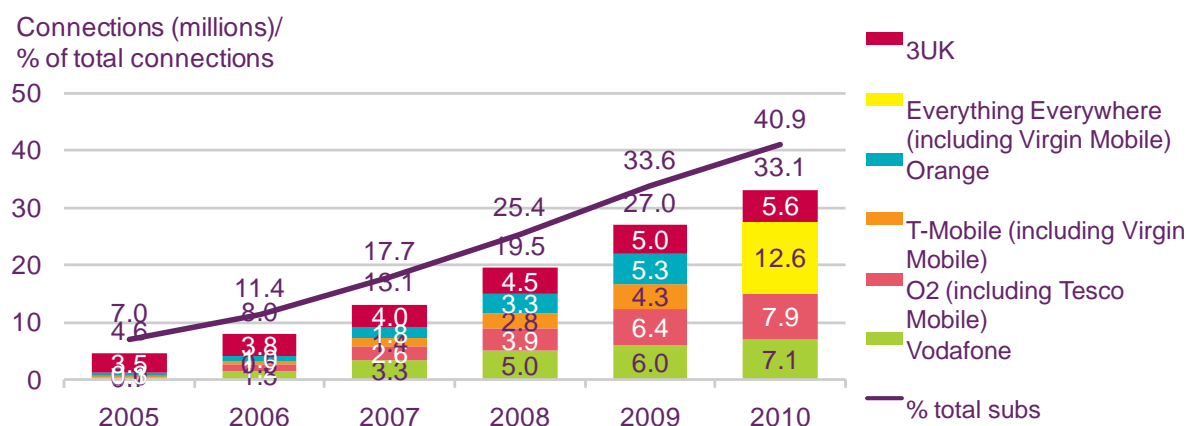
Experience with take up of 3G services

- 5.97 We can also look at the patterns of growth for 3G services to see if they provide any indication of how having a 2G customer base might have affected growth for 3G data services. From this we may be able to draw parallels for LTE services. H3G was the first operator to launch a 3G service (in 2003) and enjoyed initial success, accounting for 76% of 3G subscriptions by 2005. This may suggest that it did not suffer any significant disadvantages as a result of not having an existing 2G customer base. However, its early success may also have been due to its earlier launch or perhaps to other factors such as a greater marketing spend.
- 5.98 The years since 2005 have seen a relative decline in H3G's position. This coincided with two main developments in the 3G retail products supplied to consumers: a growing sophistication of mobile handsets (and an increase in mobile-specific content supplied via mobile data, including smartphone apps) and the launch of dongles. The three largest national wholesalers have had a lot of success in selling 3G services with smartphones; Telefónica, for example, initially had an exclusive agreement to supply the iPhone. H3G on the other hand has pursued a strategy focussing on aggressive pricing of data services to high-use customers, in particular through dongles (although in recent months it has also seen strong sales of smartphones). Nevertheless, in terms of subscriber numbers, its position now lags behind the other national wholesalers.
- 5.99 By 2010 H3G's share of 3G customers had fallen to 16.9% during a period of growth in total 3G subscriptions from 4.6 million to 33.1 million (see Figure 5.9 below). Meanwhile, the other four operators (three after the Orange/T-Mobile merger in 2010) all experienced stronger growth in 3G subscribers over the period, without large changes in their relative positions. This pattern might suggest the existence of a common factor that the largest national wholesalers all benefitted from (and to more-or-less equal effect) but that H3G did not. In our view the clearest candidate is that these national wholesalers had an advantage in terms of retaining their existing customers as they upgraded from 2G to 3G services. H3G's relative reliance on dongle sales also might support this since it could suggest difficulties in persuading customers to end their relationship with their existing supplier of voice services.

¹⁸⁴ See Ofcom's International Communications Market Report 2011 (14 December 2011).

¹⁸⁵ Figure 6.38 of Ofcom's International Communications Market Report 2011 (14 December 2011).

Figure 5.9: 3G connections by operator



Source: Ofcom / operators

Note: 3G includes connections made via laptops/dongles as well as mobile handsets

5.100 There are, of course, a number of possible factors other than an existing 2G customer base that could explain the trend for H3G to have acquired fewer customers since 2005 than other national wholesalers. These include if its service quality was perceived to be weaker by consumers or if it pursued less effective marketing strategies. We therefore consider that the evidence on 3G experience is consistent with an existing customer base being important, but is not the only interpretation of the data.

5.101 We also note that H3G's market share may be increasing and that this will tend to reduce any effect from having a smaller existing customer base. H3G has stated its ambition to double its customer base to 10 million by 2014 or 2015.¹⁸⁶

Impact of cannibalisation

5.102 The factors listed above will reduce the value of spectrum for a national wholesaler with a smaller existing customer base since it will either be slower in acquiring LTE customers or need to spend more on customer acquisition in order to persuade people to switch (e.g. more intense marketing or heavily discounted trial offers).

5.103 However, the value of spectrum in the auction to a national wholesaler with a larger existing customer base could be reduced through a cannibalisation effect. For example, the profit from sales of LTE using new spectrum to a newly acquired customer, e.g. for a new entrant or a national wholesaler with a smaller customer base, is the entire margin that is earned. But the profit from LTE in new spectrum from an existing customer, e.g. for a national wholesaler with a larger customer base, is only the incremental profit that can be earned from the new spectrum, since the effect is only to replace ('cannibalise') sales of current services. The incremental profit may arise from a price premium in selling LTE services or lower costs as a result of the national wholesaler using LTE.

5.104 But there may be no cannibalisation effect if the customers would otherwise have switched supplier, had their existing supplier failed to offer LTE in new spectrum, e.g.

¹⁸⁶ <http://www.ft.com/cms/s/0/29530da0-8d02-11e0-815d-00144feab49a.html#axzz1gQlIteVPo>
http://www.mobiletoday.co.uk/News/12772/Three%E2%80%99s_unlimited_data_tariffs_tempt_O2_customers.aspx

switching instead to another supplier that was offering LTE services. In such circumstances the incremental profit from offering LTE in new spectrum is the entire margin (as for another supplier acquiring them as new customers).

- 5.105 For national wholesalers with a larger customer base, i.e. Everything Everywhere, Telefónica and Vodafone, the cannibalisation effect will be less likely to reduce their intrinsic value of spectrum in the auction (relative to bidders with smaller customer bases) when:
- There is a large price premium for LTE over existing services.¹⁸⁷
 - New spectrum is important for customer retention. For example, customers may want a particular level of quality that cannot be provided without the new spectrum, and will switch provider if they do not get that level of quality. This might be because they particularly value LTE, or could be because they desire higher average data speeds which national wholesalers need more spectrum in order to be able to provide.¹⁸⁸
 - New spectrum offers other advantages to national wholesalers such as cost savings through lower-frequency spectrum or LTE having greater spectral efficiency (as discussed in Section 3). Everything Everywhere, Telefónica or Vodafone may be able to earn a greater profit from such cost savings because of their larger customer bases.
- 5.106 Everything Everywhere is not dependent on new spectrum for an early route to LTE, because of its large holdings of 1800MHz. Therefore, the first factor listed above (LTE price premium) may not be relevant to it. Instead its intrinsic value of spectrum in the auction is more likely to be driven by other considerations, such as, for 800MHz, the benefits of sub-1 GHz spectrum (which is not part of Everything Everywhere's current spectrum holdings). These benefits may include improved quality of coverage, which may assist with customer retention (i.e. the second factor listed above), or cost savings with sub-1GHz spectrum from the smaller number of sites needed in some circumstances (i.e. the third factor).
- 5.107 As discussed in Section 4, we do not consider that Telefónica and Vodafone have an early route to LTE without new spectrum. So all three of the factors listed above may be relevant to their intrinsic value.
- 5.108 In countries that have launched LTE to date, there is mixed evidence in terms of a price premium for LTE compared to 3G. Some operators have priced LTE at a premium, especially in Europe¹⁸⁹ while others have effectively priced LTE more

¹⁸⁷ Or offering LTE as well as existing services increases the ability to price discriminate between customers. For a discussion of the relationship between incentives to innovate and competition, see Richard J Gilbert (2006), *Competition and Innovation, in Issues in Competition Law and Policy*, ed. Wayne Dale Collins, American Bar Association Antitrust Section:
http://works.bepress.com/cgi/viewcontent.cgi?article=1011&context=richard_gilbert

¹⁸⁸ There is clearly strong growth in data demand and this is forecast to continue. This can be seen from Figures 3.2 and 3.3 above.

¹⁸⁹ A report by Ovum, *LTE Tariff Comparison: Europe, Asia-Pacific, and the US*, July 2011 looked at LTE tariffs offered by operators in nine markets. It is reported to have found that many operators charge a premium for LTE services compared to 3G, with the premium varying greatly between operators: <http://store.ovum.com/Product/toc.aspx?productId=OT00096-008>
See also Economist Intelligence Unit, *Saving mobile broadband - '4G' first movers: network and pricing strategies*: <http://store.eiu.com/Product.aspx?pid=1788649763&gid=0>; and

cheaply than 3G.¹⁹⁰ For example, sometimes LTE has effectively been priced more cheaply in order to encourage consumers onto the relatively lightly loaded LTE layer and off the congested 3G layer in order to avoid the cost of 3G capacity expansion.¹⁹¹ But the pricing of early deployments of LTE may not be reliable as a longer term indicator of pricing differences. On one hand, a discounted initial price may be used as an introductory price structure to generate interest in LTE, and on the other a high initial premium might only be relevant in the early phase of LTE or might be due to competitive forces being weak initially as only a minority of operators have LTE. We therefore consider that the extent of a price premium for LTE over existing services is unclear.

- 5.109 On customer retention, it is likely that early adopters of LTE services will have a significant preference for higher service quality, which could overcome the frictions involved in switching supplier when service quality among suppliers varies. Also, early adoption of LTE services in other countries has occurred mainly through dongles which typically do not involve tight contractual relationships (and therefore potential relevant switching costs) between customers and providers. This means that, for early adopters, Telefónica and Vodafone could regard sales of LTE in new spectrum as a customer retention strategy (and therefore one which does not involve significant cannibalisation).
- 5.110 More generally, the importance of new spectrum to customer retention is related to the comparison between LTE and HSPA in Section 3 and our assessment in Section 4 of the risk of Telefónica and Vodafone needing new spectrum to have sufficient capacity and the capability to offer sufficiently high average data rates. Our provisional conclusion in Section 3 is that there are some advantages of LTE over HSPA, such as lower latency and quality of service guarantees, but that it is unclear the extent to which consumers are likely to value these features. This may mean that it is also unclear whether the cannibalisation effect will be mitigated by the importance of LTE for customer retention.
- 5.111 In Section 4 we provisionally concluded that, as regards capacity and average data rates, Telefónica and Vodafone's existing holdings are likely to be sufficient for them to be credible in the near term, but there is some potential risk of them not being credible in the longer term because of the relatively limited overall spectrum share they would hold if they did not win spectrum in the auction. This may mean that new spectrum is relevant to customer retention by Telefónica and Vodafone especially in the longer term, which will tend to reduce the relevance of the cannibalisation effect in affecting their intrinsic value of spectrum in the auction.

http://www.pcworld.com/businesscenter/article/206063/swedes_first_to_bear_brunt_of_fullprice_lte.html

¹⁹⁰ In connection with the report, Taking LTE to Market: LTE Marketing Messages and Pricing Approaches, September 2011, Strategy Analytics was reported as saying: "In tracking LTE pricing for modems, Strategy Analytics has observed a range of pricing approaches, including introductory price discounts over 3G tariffs to encourage users to upgrade to 4G, offerings with various speed and data cap tiers, as well as bundling larger data allocations with higher speeds in premium tiers":

<http://www.businesswire.com/news/home/20111004006599/en/Strategy-Analytics-4G-LTE-Mobile-Broadband-Pricing>

See also: <http://www.itnews.com.au/News/275346,telstra-avoids-lte-premium-pricing-trap.aspx>

¹⁹¹ For example, Verizon offered greater data allowances on LTE layer compared to 3G:

<http://www.rethink-wireless.com/2011/11/10/verizons-lte-data-deal-eases-iphone-strain-3g.htm>

http://www.pcworld.com/businesscenter/article/212186/verizons_lte_pricing_may_trigger_4g_rate_war.html

- 5.112 On cost savings, there are other advantages of LTE to national wholesalers, such as greater spectral efficiency, which may offset any cannibalisation effect. If such efficiencies increase the profit margin earned from existing customers, they will tend to favour national wholesalers with larger customer bases because they can obtain the benefits of the cost efficiencies over more customers.
- 5.113 Overall, we consider that any cannibalisation effect that could reduce the intrinsic value of spectrum in the auction for national wholesalers with larger customer bases is likely to be mitigated to a significant extent, such as through the benefits that new spectrum may provide for Everything Everywhere, Telefónica and Vodafone in their future customer retention and cost savings.

Barriers to entry

- 5.114 Regarding barriers to entry, a completely new entrant will need to incur the sunk costs associated with entry, including investment in a network and costs at the retail level, such as developing a brand.¹⁹² Existing firms will already have sunk these costs and so they will not reduce the amount they are willing to bid in the auction.

Provisional conclusion on intrinsic value

- 5.115 H3G's smaller existing holdings mean it might place a high value on obtaining more spectrum (i.e. it is higher up its demand curve than other national wholesalers). However we identify reasons why others may have a strong valuation despite their existing holdings, including the importance of sub-1GHz spectrum and spectrum suitable for an early route to LTE (which is likely to mitigate any cannibalisation effect). We consider that, on balance, H3G's smaller existing customer base is likely to reduce its value of spectrum relative to other national wholesalers to some degree. Although there is uncertainty as to the size of the effect, even small differences in intrinsic values may have a large impact on the outcome of the auction, and hence on competition and consumers.
- 5.116 The same reasoning broadly applies to a new entrant, except that a new entrant has no spectrum and may have no customer base (depending on the nature of the new entrant). However, a new entrant would also need to incur the sunk costs associated with entry including investment in a network and potentially costs at the retail level.
- 5.117 While it is difficult to conclude what the most likely outcome is based on intrinsic value, the evidence suggests there is a material risk that a fourth national wholesaler has a lower intrinsic value for the spectrum it requires to be credible and, as we pointed out above, given the nature of the auction process even small advantages in intrinsic values may have a large impact on the auction outcomes.

Strategic investment

- 5.118 Depending on the importance of different technical and market conditions, we set out in Section 4 a range of possible groups of alternative portfolios that a fourth national wholesaler might require to be a credible national wholesaler:

¹⁹² A potential entrant could mitigate the cost of building a brand by supplying wholesale services to an MVNO with an established retail brand. Also, an entrant may have an established brand in another market.

Group of smaller portfolios for fourth national wholesaler

| 800MHz | 1800MHz | 2.6GHz |
|--------|---------|--------|
| 2x10 | | |
| | 2x15 | |

Group of medium portfolios for fourth national wholesaler

| 800MHz | 1800MHz | 2.6GHz |
|--------|---------|--------|
| 2x15 | | |
| 2x10 | | 2x10 |
| | 2x15 | 2x10 |

Group of larger portfolios for fourth national wholesaler

| 800MHz | 1800MHz | 2.6GHz |
|--------|---------|--------|
| 2x20 | | |
| 2x15 | | 2x10 |
| 2x10 | | 2x15 |
| 2x10 | 2x15 | |
| | 2x15 | 2x15 |

5.119 In Section 4 we also considered variants of these. In particular, we considered variants where portfolios without sub-1GHz were excluded, and considered variants where unpaired 2.6GHz spectrum was good enough to be a substitute for paired 2.6GHz spectrum. In terms of strategic investment incentives it makes a significant difference what portfolios a fourth national wholesaler may need to be credible. We therefore consider below the following scenarios for what spectrum is needed:

- Scenario A: 2x10MHz of 800MHz;
- Scenario B: either of the portfolios in the group of smaller portfolios, i.e. (2x10 MHz of 800 MHz) or (2x15 MHz of 1800 MHz);
- Scenario C: any of the portfolios in the middle group plus one portfolio from the larger portfolio group: 2x10MHz of 800MHz and 2x15MHz of 1800MHz spectrum.¹⁹³
- Scenario D: any of the portfolios in the middle group, excluding the last portfolio which does not include any 800MHz;
- Scenario E: any of the portfolios in the middle group, with the addition of the unpaired 2.6 GHz spectrum as an alternative to the paired band;
- Scenario F: any of the portfolios in the larger portfolio group;
- Scenario G: any of the portfolios in the larger portfolio group, excluding the last portfolio which does not include any 800MHz;

¹⁹³ As this portfolio is from the larger group of portfolios, it should give a greater degree of confidence that the fourth national wholesaler will be credible than the portfolios in the middle group (i.e. the other portfolios in Scenario C). Therefore if the fourth national wholesaler obtained this portfolio it would be more likely to be credible than any of the portfolios in the middle group. We do not need to include any of the other portfolios from the larger group, as they are all larger versions of the same spectrum in the middle group.

- Scenario H: any of the portfolios in the larger portfolio group, with the addition of the unpaired 2.6 GHz spectrum as an alternative to the paired band.

5.120 In general terms, the Scenarios listed above differ mainly along two dimensions: the quantity of the required spectrum and the types (frequencies) that constitute suitable alternatives. First, when the spectrum requirement of the victim rises, the scope for strategic investment increase as strategic investors need to secure less spectrum to foreclose the victim. This implies that scenarios that include additional quantity in one or more frequencies tend to be more exposed to strategic investment. This is the case, for example, for Scenario C compared to Scenario B, Scenario F compared to Scenario C, and Scenario H compared to E. Second, when the victim has a choice of frequencies for the spectrum it requires, the risk of strategic investment decreases as strategic investors need to deny the victim access to a larger amount of spectrum. This is the case for Scenario B compared to Scenario A, Scenario E compared to C, and Scenario H compared to F.

5.121 The following paragraphs assess both the feasibility and incentives of Vodafone, Telefónica and/or Everything Everywhere to undertake strategic investment to deny a fourth national wholesaler sufficient spectrum to be a credible national wholesaler. Also, we separately consider the risk of strategic investment to put a fourth national wholesaler at a disadvantage in competing across a wide range of services and customers (even if it remains credible overall).

Risk that a fourth national wholesaler fails to acquire required spectrum to be credible national wholesaler

5.122 We first consider in detail the scenario where a fourth national wholesaler needs to obtain 2x10 MHz of 800 MHz spectrum to be credible (i.e. Scenario A). Thereafter we discuss the other scenarios in terms of their differences from the analysis of the first scenario.

Scenario A: a fourth national wholesaler not credible if it does not acquire at least 2x10 MHz of 800 MHz

Feasibility

5.123 In this scenario, the feasibility of strategic investment by Vodafone, Telefónica and/or Everything Everywhere requires there to be at least one possible auction outcome in which a fourth national wholesaler does not win 2x10MHz of 800MHz spectrum. This is clearly possible as there are several auction outcomes that could meet this condition, including, amongst others: Vodafone, Telefónica and Everything Everywhere win 2x10 MHz of 800 MHz spectrum each; two of them win 2x15 MHz; two win 2x10 MHz and the third wins 2x5 MHz; etc.

Incentives

Payoff of strategic investment

5.124 We have already expressed our concerns (see Section 2) in relation to the potential detrimental effect for consumers if fewer than four national wholesalers were credible after the auction. It follows that we expect the payoff of successful strategic investment may be considerable if a fourth national wholesaler did not acquire sufficient spectrum to be credible.

Costs of strategic investment

- 5.125 The costs of strategic investment are driven by the difference between the victim's and the strategic investors' intrinsic value. We set out above that it is not clear whether a fourth national wholesaler (either H3G or a new entrant) would have a higher intrinsic value than rivals even if 2x10 MHz of 800 MHz was essential to be a credible national wholesaler. However, if this was the case we noted that two major factors may generate differences in the way wholesalers value the spectrum: existing market positions and existing spectrum holdings.
- 5.126 As to the first factor, paragraphs 5.110 and 5.114 above summarise our view that H3G's (and, all the more, a new entrant's) willingness to pay for spectrum may be constrained by its smaller customer base and the associated frictions to growth based on new services. These elements may limit its prospects of future profits and, as a consequence, the value it places on the spectrum. This suggests that even if higher (e.g. because of small existing spectrum holdings), H3G's intrinsic value might be relatively close to that of the other wholesalers.
- 5.127 Existing holdings of spectrum can also play a role in affecting the intrinsic value of spectrum to wholesalers. Wholesalers' valuation of spectrum in the auction is likely to depend on whether, and the extent to which, any existing spectrum holdings will allow them to meet the relevant technical and market conditions that may affect whether they are credible competitors. Below we briefly discuss the implications for costs of strategic investment of the different sets of technical and market conditions that may mean that a fourth national wholesaler needs to acquire at least 2x10 MHz of 800 MHz to be credible:
- *Sub-1GHz very important for quality of coverage:* under this condition a fourth national wholesaler and Everything Everywhere may value the 800 MHz spectrum more than Telefónica and Vodafone. This is because Telefónica and Vodafone already hold sub-1GHz spectrum and so are unlikely to value more sub-1GHz spectrum as highly as wholesalers who hold no sub-1 GHz spectrum. The costs of strategic investment for Telefónica and Vodafone could then be higher than for Everything Everywhere.
 - *800MHz very important for quality of coverage and to deliver LTE services soon and to provide capacity:* Vodafone's and Telefónica's existing holdings do not provide an early route to LTE. If failure to provide LTE services was perceived as a major weakness by customers and any short term advantage enjoyed by wholesalers capable of delivering LTE in the short term was expected to have long-lasting effect, they would likely place a high value on the 800 MHz even though they already hold sub-1GHz spectrum. Similarly, Vodafone and Telefónica may need to expand capacity to some extent, unlike Everything Everywhere which already has large holdings at 1800 MHz. Under these technical and market conditions, all wholesalers would likely place a relatively high value on the 800 MHz spectrum, although for different reasons. Consequently, the costs of strategic investment of Telefónica and Vodafone, on the one hand, and Everything Everywhere, on the other hand, might not be very different and relatively low. However, the intrinsic value of the 800 MHz spectrum for Vodafone and Telefónica will also depend on the extent to which they consider different (typically cheaper) frequencies as substitutable for the scope of deploying LTE and providing capacity. For example, should they value the 2.6 GHz as being good enough for LTE, they may tend to place less value on the 800 MHz and their costs of strategically precluding a fourth national wholesaler access to the 800 MHz band would then be higher.

- 5.128 To sum up, the costs of strategic investment across wholesalers are likely to vary depending on the applicable set of technical and market conditions. In the first set of technical and market conditions considered above, two wholesalers, Vodafone and Telefónica, would suffer higher costs of strategic investment, but the costs for Everything Everywhere would be rather limited. In the second set of conditions all wholesalers could face lower costs as all may place a large value on the 800 MHz spectrum. However, this depends on the extent to which Vodafone and Telefónica consider higher frequencies suitable to deploy LTE and provide capacity.
- 5.129 The second set of technical and market conditions is broadly in line with the views expressed by wholesalers in their responses to the March 2011 consultation. Telefónica, Vodafone and Everything Everywhere have all argued that 800 MHz is likely to be very important although for slightly different reasons. Vodafone and Telefónica claim that 800 MHz spectrum (or the divested 1800MHz spectrum) is important to guarantee an early route to LTE deployment as they maintain that 900 MHz spectrum cannot be refarmed in the short term. Everything Everywhere, instead, indicates that 800 MHz spectrum is a crucial factor to provide good indoor coverage. This suggests they all are interested in acquiring at least some amount of 800 MHz. Since their intrinsic value is likely to be based on their view (whether or not they turn out to be correct) on the relevant technical and market conditions, we may expect the difference in intrinsic value between a fourth national wholesaler and the other wholesalers, if any, may be relatively small.
- 5.130 We note that under the first set of technical and market conditions Everything Everywhere could be the victim rather than a strategic investor because, like H3G or a new entrant, it currently does not hold sub-1GHz spectrum. If so, Vodafone and Telefónica would potentially face two vulnerable wholesalers and they could successfully foreclose one of the two rivals by acquiring between them 2x15 MHz in the auction as this would ensure that at most one other wholesaler obtains the necessary spectrum to be credible. Therefore, the costs of strategic investment could be lower compared to the case where there is only one vulnerable wholesaler (either an existing wholesaler or a new entrant) as in the latter case Vodafone and Telefónica might need to secure up to 2x25 MHz to guarantee that the victim does not get the spectrum it needs (2x10 MHz).
- 5.131 Also, in such a case, Vodafone and Telefónica could be willing to stop both Everything Everywhere and a fourth national wholesaler from accessing the 800 MHz band, as this could result in only two credible national wholesalers. It is, however, unclear whether the incentives to strategically invest would be stronger or weaker in this case as the expected payoff would be higher because of the larger reduction in competition but the costs of strategic investment would increase too. Costs could be larger also because Everything Everywhere's intrinsic value might be even higher than H3G's (and, all the more, a new entrant's). This is because they both would be expected to value highly the spectrum if it is essential to be credible, but Everything Everywhere has a larger customer base which could permit it to extract value more quickly from using the spectrum.

Illustration of possible payoffs and costs of strategic investment

- 5.132 We do not consider it would be informative to try to model the likely payoffs and costs of strategic investment in a definitive way. This is because there are many uncertainties over a wide range of factors potentially affect payoffs and costs and any attempt to model them would likely be subject to wide error margins. However, below we provide an illustration of how much strategic investors might need to increase their retail prices as a payoff from strategic investment in order to offset the possible

costs of strategic investment where the latter are roughly estimated based on the outcomes of spectrum auctions in other European countries. For the purpose of this illustration we initially consider a simple scenario in which Vodafone, Telefónica and Everything Everywhere would only need to acquire at most an extra 2x5 MHz block of 800 MHz each (beyond what they would have obtained anyway) to stop a fourth national wholesaler being a credible national wholesaler,¹⁹⁴ i.e. between them these strategic investors have higher intrinsic value than a fourth national wholesaler for at least 2x10MHz of 800MHz (so that each acquiring a further 2x5MHz would leave at most 2x5MHz available for a fourth wholesaler).¹⁹⁵

- 5.133 Figure 9.2 in Annex 9 reports the auction prices for 800 MHz in France, Germany, Italy, Portugal, Spain and Sweden. The average price across these countries (expressed in 'implied' UK price, i.e. the price after adjusting for differences in currency and population between each country and the UK) has been around £1,730 million for 2x30MHz, which implies a cost of £288 million for a block of 2x5 MHz.¹⁹⁶ For simplicity we assume that the intrinsic value for the strategic investors to acquire the additional 2x5 MHz would be nil, or in other words that strategic investors would not place any value on the 'extra spectrum' but for strategic reasons. This assumption is clearly unrealistic (strategic investors are likely to place some value on the additional spectrum, for example because it permits a reduction in network costs) but it is prudent as it tends to overestimate the costs of strategic investment.
- 5.134 As discussed above (see paragraph 5.53) the potential payoffs from strategic investment are the difference in strategic investors' profits between two states of the world: one where strategic investment successfully leads to the foreclosure of the victim (*profits with strategic investment*) and another where no strategic investment conduct is carried out and thus no wholesaler is foreclosed (*profits without strategic investment*).
- 5.135 Strategic investment, if successful, can be expected to affect strategic investors' profits through changes in the retail prices charged and/or in the volume sold to consumers or other reduced costs as a result of less competition (such as lower investment in quality or innovation). Strategic investors that are successful are indeed likely to set higher retail prices than would otherwise be the case, exploiting the reduced level of competition following the foreclosure of the victim. But this would trigger a response by consumers who might reduce the volume of services purchased. There is, however, a second effect on volume that moves in the opposite direction. The wholesalers remaining in the market would, in fact, benefit from the possibility of capturing the share of demand freed by the exit or marginalisation of the victim.

¹⁹⁴ Below we also consider alternative scenarios in which the strategic investors need to acquire larger quantities of extra spectrum to exclude the victim.

¹⁹⁵ Note that for the sake of simplicity in this example we abstract from any issue related to risk of free-riding, i.e. we implicitly assume that all investors know what a fourth national wholesaler needs to be credible and they are all willing to share equally the costs of foreclosing it. Also, we abstract from any consideration concerning the technical suitability of a single block of 2x5 MHz in the 800 MHz, i.e. we implicitly assume that the investors may have a higher intrinsic value than the victim for an initial block of 2x5 MHz when they do not have holdings at 800 MHz but their value is lower than the victim for any additional blocks.

¹⁹⁶ These average prices exclude France, as the calculations were done before the French auction results were announced. The French prices were within the range of the prices from other countries and only fractionally increase the average, to around £1,790 for 2x30MHz of 800MHz spectrum, and around £300m for a block of 2x5MHz.

- 5.136 In theory, one would need to know the demand elasticity to evaluate the impact of price increases on volume sold, and the similarity between the services offered by the victim and the strategic investors to estimate how the latter would share the demand left over by the victim. But for simplicity throughout this example we assume that the net volume effect for each investor is nil (i.e. the reduction in volume due to price increase is assumed to be offset by an increase of the same amount that comes from the possibility of capturing the volume previously served by the fourth national wholesaler). Under the assumption that the volume sold by the strategic investors is the same with or without strategic investment, the change in profits is only driven by the increase in revenues due to the higher retail price.¹⁹⁷ While this assumption might not be realistic, it may either overestimate or underestimate the incentives for strategic investment. For instance, if we consider, as in Section 2, an industry demand¹⁹⁸ elasticity of -0.3, the price increase that would trigger a reduction in volume larger than the demand currently served by H3G (around 6-7%) is considerable, about 20-23%. For any price increase below that level the positive effect on volume sold resulting from the possibility of capturing the volume previously served by H3G would likely be stronger than the negative effect due to the price increase, thereby further increasing the payoffs from strategic investment.
- 5.137 To calculate the price increase that would outweigh the costs of strategic investment we start by considering an illustration of what the revenues of investors would be absent strategic investment, i.e. the expected revenues earned by investors should current competition not change. Over the last four years (2007-2010), mobile industry revenues have been fairly stable at around £15 billion with slight variations in 2008 (+2.5%) and in 2009 (-0.7%).¹⁹⁹ While we recognise that past figures may not be good predictors for future revenues especially in a fast-changing industry as is the mobile sector, for the purpose of this illustrative example we assume that industry revenues will remain constant in the absence of strategic investment, i.e. equal to £15 billion (we also assume that the market shares of wholesalers do not change over time and remain the same as in 2010).²⁰⁰ Nonetheless, below we also consider how the results would change if we assumed a different pattern for the future revenues (either increasing or decreasing).
- 5.138 Figure 5.10 below reports the revenues of Vodafone, Telefónica and Everything Everywhere in 2010 that, as discussed above, we assume as the wholesalers' revenues in case of no strategic investment.

¹⁹⁷ Formally the profits without strategic investment can be expressed as: $\Pi_{without} = (p-c) \cdot q$, where p is the retail price, c are the marginal costs of production and q are the volume sold. A price increase of, say, $\alpha\%$ following a successful strategic investment would result in the following profits: $\Pi_{with} = (p(1+\alpha) - c) \cdot (q + \Delta q)$, where Δq is the volume variation that can be either positive or negative depending on which of the two effects described above prevails. The previous expression can be rearranged as follows: $\Pi_{with} = (p-c) \cdot q + p \cdot \alpha \cdot q + (p(1+\alpha) - c) \cdot \Delta q$. Thus, if the volume sold by strategic investors was the same with or without strategic investment ($\Delta q = 0$), the profits resulting from strategic investment would be equal to profits without strategic investment plus the increase in revenues due to the higher price, i.e. $\Pi_{with} = \Pi_{without} + p \cdot \alpha \cdot q$.

¹⁹⁸ The demand includes both voice and data services.

¹⁹⁹ See Figure 5.48 in Ofcom's Communications Market Report 2011:

http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CM_R_2011_FINAL.pdf

²⁰⁰ This would be the case if, for instance, the volume sold and the average revenue per user (ARPU) did not change in the future. But also it can be the result of an increase in the volume sold offset by a reduction in ARPU of the same magnitude.

Figure 5.10: Illustrative future revenues without strategic investment (£m)

| £m | Vodafone | Telefónica | Everything Everywhere |
|--|----------|------------|-----------------------|
| Illustrative revenues without strategic investment | 3,800 | 4,600 | 5,200 |

Source: Ofcom's Communications Market Report 2011 – Table 5.48

5.139 To be profitable, strategic investment should be such that the increment in the average revenue per user resulting from reduced competition outweighs the costs of acquiring the spectrum that would lead to a fourth national wholesaler being excluded. We assume that the benefits from strategic investment will extend for the next 5 to 10 years²⁰¹ (and to quantify the present value of the flow of payoffs over the entire period we use a discount factor of 6.2%²⁰²). We can then estimate how much (in terms of percentage) each investor would need to increase the price (and so the ARPU) on a yearly basis in order to offset the costs of engaging in strategic investment. The necessary percentage price increase is given by the ratio between costs of strategic investment (around £283 million) and the present value of the flow of the revenues without strategic investment (assumed constant over time). The table below shows the price (ARPU) increase under two different assumptions over the payoff duration (5 and 10 years).

Figure 5.11: Retail price increase that would make strategic investment profitable

| % | Vodafone | Telefónica | Everything Everywhere |
|---|----------|------------|-----------------------|
| Price increase necessary to offset costs of strategic investment 5 years | 1.8% | 1.5% | 1.3% |
| Price increase necessary to offset costs of strategic investment 10 years | 1.0% | 0.9% | 0.8% |

Source: Ofcom's calculations

5.140 In this simple illustration strategic investors would need to increase their retail prices by less than 2% in the case of a payoff duration of 5 years (and by 1% or less in case of a 10-year payoff duration) in order to outweigh the additional costs of acquiring 2x5 MHz of 800 MHz to foreclose a fourth national wholesaler.²⁰³ Even considering the highest price paid for 800 MHz so far in Europe, i.e. £0.699/MHz/pop in Italy (corresponding approximately to £420m for a block of 2x5 MHz, expressed in 'implied' UK price), the retail price increase that would offset the costs of strategic investment would not exceed 2.7% in case of payoff duration of 5 years or 1.5% in case of 10-year payoff duration.

5.141 Obviously, the larger the amount of extra spectrum (beyond the quantity they would have bought absent strategic investment) strategic investors would need to secure in

²⁰¹ We have limited the period over which we have considered any revenue increase to 5-10 years, consistently with the time frame we have considered throughout our competition assessment.

²⁰² For the discount factor we used the WACC Ofcom recently used for the wholesale mobile voice call termination charge control, i.e. 6.2% (pre-tax real). See paragraph 9.61 in:

http://stakeholders.ofcom.org.uk/binaries/consultations/mtr/statement/MCT_statement.pdf

²⁰³ For simplicity we assume that different magnitude of the price increases do not induce customers switching across strategic investors.

order to squeeze a fourth national wholesaler out, the larger the costs would be, and consequently the higher the price increase needed to offset the costs of strategic investment. Figure 5.12 illustrates how large an increase in retail price would need to be if the amount of additional spectrum rose, considering a range of spectrum quantities that a potential investor may be required to secure.

Figure 5.12: Retail price increase that would make strategic investment profitable considering different amounts of extra spectrum

| spectrum required | 5 Years | | | 10 Years | | |
|-------------------|----------|------------|-----------------------|----------|------------|-----------------------|
| | Vodafone | Telefónica | Everything Everywhere | Vodafone | Telefónica | Everything Everywhere |
| 2x5 MHz | 1.8% | 1.5% | 1.3% | 1.0% | 0.9% | 0.8% |
| 2x10 MHz | 3.6% | 3.0% | 2.6% | 2.1% | 1.7% | 1.5% |
| 2x15 MHz | 5.4% | 4.5% | 3.9% | 3.1% | 2.6% | 2.3% |
| 2x20 MHz | 7.2% | 5.9% | 5.3% | 4.2% | 3.4% | 3.0% |
| 2x25 MHz | 9.0% | 7.4% | 6.6% | 5.2% | 4.3% | 3.8% |

Source: Ofcom's calculations

5.142 The last row reflects a rather extreme scenario in which: first, the fourth national wholesaler has a higher intrinsic value than strategic investors for any amount of 800 MHz spectrum; second, it needs at least 2x10 MHz; and, finally, no other wholesaler is willing to share the costs of strategic investment. In this case, a single strategic investor needs to secure 2x25 MHz to foreclose a fourth national wholesaler. Even under these extreme (and probably not very realistic) conditions, the price increase that would make strategic investment profitable would not be higher than 9% in case of a 5-year payoff and 5.2% in case of a 10-year payoff.

5.143 Since in our simplified illustration the profit increase is only driven by a rise in the revenues, we also analyse how the price increase that would offset the costs of strategic investment varies as the expected future revenue for mobile services changes. We assume 2x5 MHz of 800 MHz as the extra spectrum that investors need to obtain and consider a revenue variation ranging from -10% to +10%. Figure 5.13 reports the results.

Figure 5.13: Retail price increase that would make strategic investment profitable assuming future revenue variation for mobile services

| Revenue variation | 5 Years | | | 10 Years | | |
|-------------------|----------|------------|-----------------------|----------|------------|-----------------------|
| | Vodafone | Telefónica | Everything Everywhere | Vodafone | Telefónica | Everything Everywhere |
| -10% | 2.0% | 1.6% | 1.5% | 1.2% | 1.0% | 0.8% |
| -5% | 1.9% | 1.6% | 1.4% | 1.1% | 0.9% | 0.8% |
| 0% | 1.8% | 1.5% | 1.3% | 1.0% | 0.9% | 0.8% |
| 5% | 1.7% | 1.4% | 1.3% | 1.0% | 0.8% | 0.7% |
| 10% | 1.6% | 1.3% | 1.2% | 0.9% | 0.8% | 0.7% |

Source: Ofcom's calculations

5.144 Clearly, when the revenues without strategic investment are higher, a smaller price increase could offset the costs of acquiring extra spectrum for strategic investment. Interestingly, even if the revenues shrunk by 10% (which we consider unlikely) the 'break-even' price increase would still be rather limited as it would not exceed 2%.

5.145 We stress that this exercise has been undertaken only for illustrative purposes (e.g. it abstracts from coordination and free-riding, which is discussed below) and is not intended to provide any firm conclusion in relation to the actual payoffs and costs that

can arise from strategic investment. Yet, we note that the scale of price increases presented in the tables above that would make strategic investment profitable is, in general, not very large (unless a considerable amount of extra spectrum needs to be acquired to achieve exclusion). This is despite the fact we made rather conservative assumptions, such as, in particular, strategic investors having zero intrinsic value of additional spectrum and no increase in volume following successful strategic investment.

Other issues

- 5.146 Even when there are incentives to strategically invest, the free-riding problem may reduce the probability of success as each of the investors would prefer, in principle, others to bear a larger part (or all) of the costs to secure the extra spectrum.
- 5.147 However, in the scenario under examination (a fourth national wholesaler needs 2x10 MHz of 800 MHz) the required coordination between Vodafone, Telefónica and Everything Everywhere may not be complex. For example, to deny a fourth national wholesaler access to the 2x30 MHz available at 800 MHz, the three remaining wholesalers could implicitly coordinate on acquiring 2x10 MHz each. As well as being intuitive, an even split of the 800 MHz band with three companies buying 2x10MHz of 800MHz has been the outcome of all the European auctions for that band that have taken place so far, namely in France, Germany, Italy, Portugal, Spain and Sweden. This suggests that such an outcome could be relatively easily identified as a focal point over which strategic investors could coordinate. In addition, there might be technical synergies in holding 2x10 MHz of 800 MHz compared to a single block of 2x5 MHz which may further ease the identification of 2x10 MHz as a focal point for coordination.
- 5.148 We acknowledge that the coordination problem could be aggravated if investors placed very different values on the extra spectrum. We discussed above that this may result in asymmetric costs of strategic investment, and, as a consequence, asymmetric incentives for strategic investment. Consider, for instance, the first set of technical and market conditions above (i.e. 800 MHz required for quality of coverage). Vodafone and Telefónica would have intrinsic values lower than Everything Everywhere and could then expect the latter to take a larger responsibility in terms of the share of the extra spectrum that needs to be secured to foreclose a fourth national wholesaler. However, it is not necessarily the case that different intrinsic values reduce the likelihood of strategic investment. Suppose that, under the same technical and market conditions, Everything Everywhere has a higher valuation of 800 MHz than a fourth national wholesaler's (perhaps also because it can benefit from a larger customer base), and then it would likely be able to secure, say, 2x10 MHz of 800 MHz even without any strategic intent. If Vodafone and Telefónica anticipated this, they could find it relatively easy to coordinate for obtaining 2x10 MHz of 800 MHz each in the auction to deny a fourth national wholesaler access to the amount of spectrum it needs.

Provisional conclusion on strategic investment to prevent a fourth national wholesaler acquiring 2x10MHz of 800MHz

- 5.149 There are many considerations that can affect the payoffs and cost of strategic investment, including the range of technical and market conditions we consider in Sections 3 and 4. While the costs can be significant, our view (established in Section 2) is that the payoff from a reduction in the number of credible national wholesalers could be large and therefore potentially more than offset the costs of strategic investment. Also, should coordination be needed the experience in other European

countries indicates that an auction outcome in which Vodafone, Telefónica and/or Everything Everywhere strategically invest to deny a fourth national wholesaler access to 800 MHz spectrum by acquiring 2x10 MHz each could be fairly easily identified as a focal point for strategic investment. On balance, therefore, whilst incentives may not be present in all circumstances, we consider that the risk of such strategic investment is realistic.

Scenario B: a fourth national wholesaler not credible if it does not acquire at least 2x10 MHz of 800 MHz or 2x15 of 1800 MHz

- 5.150 On the feasibility of strategic investment in Scenario B, there are a number of outcomes that may result in a fourth national wholesaler failing to acquire either 2x10 MHz of 800 MHz or 2x15 MHz of 1800 MHz. For example: Vodafone, Telefónica and Everything Everywhere obtain 2x10 MHz of 800 MHz spectrum each and one among Vodafone and Telefónica acquires the block of 2x15MHz at 1800MHz; or Vodafone (or Telefónica) and Everything Everywhere obtains 2x15 MHz of 800 MHz spectrum each (or one obtains 2x15MHz and the other 2x10MHz) and Telefónica (or Vodafone) acquires the block of 2x15MHz at 1800MHz, etc.
- 5.151 On incentives, the difference in the incentives of strategic investment compared to the first scenario assessed above is, however, less clear. The costs of strategic investment would likely be higher as Telefónica, Vodafone and/or Everything Everywhere would need to prevent a fourth national wholesaler from obtaining not only 2x10MHz of 800 MHz spectrum but also the divested 2x15MHz of 1800 MHz spectrum. As a rough indication of the potential costs, we observe that under this Scenario there are in principle four potential 'slots' of spectrum available in the auction that would allow a fourth national wholesaler to obtain the minimum amount they need (three slots of 2x10 MHz in the 800 MHz band and one slot of 2x15 in the 1800 MHz band). This is one more slot compared to Scenario A. However, given the potentially large payoff, we do not consider that this would necessarily remove any incentive for strategic investment by Vodafone, Telefónica and Everything Everywhere.
- 5.152 Like Scenario A, the cost of strategic investment is influenced by the technical and market conditions that are expected to prevail. We set out our view in Section 4 that either 800MHz or 1800MHz can be essential to be credible, possibly coupled with the ability to deliver LTE services soon or to provide capacity. Below we discuss how these different sets of conditions impact on the incentives to strategic investment:
- *800 MHz or 1800 MHz (sub 2 GHz) important for quality of coverage:* while H3G or a new entrant (a fourth national wholesaler) currently has no access to sub 2GHz spectrum, the remaining wholesalers hold spectrum below 2 GHz. Everything Everywhere has 2x45 MHz of 1800 MHz and Telefónica and Vodafone each holds 2x17.4 MHz of 900 MHz. Under these conditions, the intrinsic value of Vodafone, Telefónica and Everything Everywhere would likely be smaller than in Scenario A – and, consequently, their costs of strategic investment higher.
 - *Sub 2 GHz, delivering LTE services soon and capacity are all important:* Everything Everywhere is well placed with respect to all these quality dimensions given its current large holding of 1800 MHz. Vodafone and Telefónica have sub 2 GHz spectrum but they lack an early route to deliver LTE services. Also Vodafone and Telefónica may need some spectrum to expand their capacity. Costs of strategic investment for Vodafone and Telefónica may then be smaller than for Everything Everywhere. As we discussed above, the value placed by

Vodafone and Telefónica on the 800 MHz and 1800 MHz may depend, however, on the extent to which they consider the 2.6 GHz good enough to deliver LTE services and provide capacity. The more they consider higher (and usually cheaper) frequencies as substitutable, the less they value the 800 MHz and 1800 MHz band (and thereby the higher the costs of strategic investment).

- 5.153 The costs of strategic investment across wholesalers appear to vary depending on the applicable set of technical and market conditions. In general, when sub 2 GHz spectrum is required to be credible the total costs of strategic investment may be higher, and therefore the likelihood of strategic conduct lower, than when the ability to deliver LTE services soon and provide capacity are also critical elements to be credible national wholesalers. This is because all three potential investors, Vodafone, Telefónica and Everything Everywhere, already hold sub 2 GHz spectrum which would tend to reduce their willingness to pay for further spectrum (absent strategic investment). But Vodafone's and Telefónica's costs of strategic investment may be lower because of any constraints in deploying LTE in the short term or need to expand capacity to meet the expected demand increase (as these may increase their intrinsic value of 800MHz and 1800MHz).
- 5.154 Similarly to Scenario A, under some specific technical and market conditions there could be other wholesalers potentially vulnerable to strategic investment. More precisely, when ability to deploy LTE soon and to provide capacity – in addition to good quality of coverage - are major competitive dimensions to ensure credibility (the second set of conditions considered above), Vodafone and Telefónica, like a fourth national wholesaler, could be, in principle, exposed to strategic investment by Everything Everywhere. In particular, those wholesalers that will not acquire the divested 1800 MHz spectrum may be the target of strategic investment aimed at preventing them to access the required 800 MHz. Payoffs could be very large if competition was to reduce from 4 to 2 national wholesalers, but costs of strategic investment would likely be higher too as Everything Everywhere (and conceivably the wholesaler which has acquired the divested 1800 MHz) would need to secure the entire (or a vast majority) of the 800 MHz band. The overall effect on the incentives to strategically invest is, therefore, unclear.
- 5.155 Scenario B involves strategic investment in 1800MHz in addition to 800MHz as considered in the first scenario. This adds a further element to the required coordination for the strategic investment to be successful. However, if Everything Everywhere sold the divested spectrum of 1800 MHz in advance of the auction to either Vodafone or Telefónica, coordination would be limited to deny a fourth national wholesaler access to the necessary spectrum at 800 MHz, similarly to Scenario A.
- 5.156 In conclusion, we consider that the risk of strategic investment is likely to be slightly lower than the previous case of Scenario A, but given the potential size of the payoff it is not unrealistic for Vodafone, Telefónica and/or Everything Everywhere to strategically invest in order to prevent a fourth national wholesaler from obtaining both the 800 MHz spectrum and the divested block at 1800 MHz.

Scenario C: a fourth national wholesaler not credible if it does not acquire at least (2x15 MHz of 800 MHz) or (2x10 MHz of 800 MHz + 2x10 MHz of 2.6 GHz) or (2x15 MHz of 1800 MHz + 2x10 MHz of 2.6 GHz) or (2x10 MHz of 800 MHz + 2x15 MHz of 1800 MHz).

- 5.157 Most of the portfolios included in Scenario C contain additional spectrum in one or more frequencies compared to the previous scenario. While in terms of slots available to a fourth national wholesaler Scenario C is similar to Scenario B,²⁰⁴ the additional spectrum requirement makes strategic investment more likely. This is because it increases the number of auction outcomes resulting in a fourth national wholesaler acquiring less than what it needs (i.e. it enhances feasibility). It also reduces the costs of strategic investment since the extra spectrum investors need to acquire in order to foreclose a fourth national wholesaler is smaller.
- 5.158 The sets of technical and market conditions that may underlie the portfolios included in Scenario C are similar to those of Scenario B - see the discussion above (paragraph 5.152) for a discussion on how costs of strategic investment vary according to the relevant sets of conditions.
- 5.159 While this scenario might involve strategic investment in 2.6 GHz in addition to 800MHz and 1800 MHz as considered in Scenario B, this does not need to be the case. Strategic investment could be successful even if a fourth national wholesaler managed to acquire a large part of the 2.6 GHz band provided that its access to the 800 MHz and 1800 MHz spectrum is impeded. Therefore, in terms of the required coordination, this portfolio does not necessarily add severe obstacles compared to Scenario B. Also, as we discussed for Scenario B, strategic investment could be limited to the 800 MHz band if Everything Everywhere were to sell the divested spectrum at 1800 MHz in advance of the auction to Vodafone or Telefónica.
- 5.160 In general the risk of strategic investment aimed to deny a fourth national wholesaler access to the spectrum requirements implied in Scenario C is higher than in Scenario B. It is unclear, however, whether it is higher or lower than Scenario A. On the one hand, the possibility of relying on 1800 MHz as an alternative to sub-1GHz makes strategic investment more costly. On the other hand, however, the stronger requirement in terms of additional spectrum in the 2.6 GHz band renders the victim more vulnerable to strategic investment. Overall therefore, as for Scenario A, we consider the risks of strategic investment implied by Scenario C are realistic.

Scenario D: a fourth national wholesaler not credible if it does not acquire at least (2x15 MHz of 800 MHz) or (2x10 MHz of 800 MHz + 2x10 MHz of 2.6 GHz) or (2x10 MHz of 800 MHz + 2x15 MHz of 1800 MHz).

- 5.161 Scenario D differs from Scenario C in that some spectrum below 1GHz is essential to be credible. Lack of alternatives to 800 MHz augments the prospects of strategic investment as the set of strategies that Vodafone, Telefónica and Everything Everywhere can carry out to exclude a fourth national wholesaler from acquiring the required spectrum is wider. A fourth national wholesaler would be then more vulnerable to strategic investment (compared to Scenario C the available slots would be fewer as the 1800 MHz is not considered a suitable alternative to 800 MHz). The technical and market conditions relevant to the Scenario under examination resemble

²⁰⁴ The need to acquire some quantity in the lower frequency bands where the spectrum is scarcer constrains the number of alternative options, i.e. slots, available to a fourth national wholesaler to acquire what it requires regardless of its need in higher frequencies.

those discussed for Scenario A (see paragraph 5.127) with the addition of the need for greater capacity to the first set of technical and market conditions. Below we discuss how this further concern may modify the costs of strategic investment:

- *Sub-1GHz very important for quality of coverage and need for capacity.* we set out above that when sub-1 GHz is essential to be credible we expect Everything Everywhere to have lower costs of strategic investment than Telefónica or Vodafone, because the former lack holdings below 1GHz. On the other hand, Everything Everywhere is better placed than Vodafone and Telefónica when it comes to capacity and it may then have a lower intrinsic value than them for additional spectrum (especially in frequencies other than 800 MHz). In terms of costs of strategic investment, this could imply relatively low costs of Everything Everywhere for the 800 MHz band and of Vodafone and Telefónica for the higher frequencies (1800 MHz and 2.6 GHz).
- *800MHz very important for quality of coverage and to deliver LTE services soon and need for capacity.* the effect on the costs of strategic investment when these technical and market conditions are relevant has been already discussed in the assessment of Scenario A to which we then refer (see paragraph 5.127).

5.162 As regards the potential coordination among strategic investors, we note that compared to the previous Scenario strategic investors might, in principle, only need to stop a fourth national wholesaler acquiring spectrum in the 800 MHz band, irrespective of their additional requirement in higher frequencies. This would make coordination relatively easier.

5.163 Overall we consider the risk of strategic investment for Scenario D to be higher than for Scenario C. Also, strategic investment in this case tends to be more likely than for Scenario A.

Scenario E: a fourth national wholesaler not credible if it does not acquire at least (2x15 MHz of 800 MHz) or (2x10 MHz of 800 MHz + 20 MHz of 2.6 GHz) or (2x15 MHz of 1800 MHz + 40 MHz of 2.6 GHz) or (2x10 MHz of 800 MHz + 2x15 MHz of 1800 MHz).

5.164 Minimum spectrum requirements in Scenario E are equal to those in Scenario C in all respects but for the possibility for a fourth national wholesaler to rely on the unpaired 2.6 GHz band in addition to the paired one.

5.165 The assessment of the risk of strategic investment is, therefore, identical to Scenario C with the sole difference that the larger availability of suitable spectrum in the 2.6 GHz band (overall 190 MHz compared to the 140 MHz available for Scenario C)²⁰⁵ would make strategic investment harder as a fourth national wholesaler has more ways of obtaining the spectrum it needs.

Scenarios F, G and H

5.166 These scenarios include a requirement for a fourth national wholesaler to acquire more spectrum than the previous Scenarios discussed above. They are intended to address the same underlying concerns in terms of lack of relevant spectrum for a

²⁰⁵ In terms of slots available to a fourth national wholesaler to secure what it requires, Scenario E is similar to Scenario C because the number of slots remains constrained by the need of spectrum in the lower frequencies despite the wider availability of spectrum in the 2.6 GHz band.

fourth national wholesaler, only they envisage the case where capacity requirements are larger.

- 5.167 The vast majority of the considerations we put forward with respect to Scenarios C, D, and E holds true for these further scenarios. The main difference, of course, lies in the fact that the larger spectrum requirements involved in Scenarios F, G, and H make the task for strategic investors easier, as they can rely on a broader range of successful auction outcomes (and there are fewer slots available to a fourth national wholesaler to obtain the spectrum it requires) and they would face lower costs of strategic investment by virtue of the smaller amount of extra spectrum they would need to secure (beyond what they would have acquired absent strategic investment). Also, the larger spectrum requirements implied by Scenarios F, G and H tend to make strategic investment more likely to be profitable even as a unilateral strategy because of the smaller spectrum that overall strategic investors need to secure to foreclose the victim.
- 5.168 Depending on the applicable technical and market conditions, there may be a second difference in that Scenarios F, G, and H could address a further potential competitive concern for a fourth national wholesaler, i.e. the lack of suitable spectrum to provide high peak speeds. In case this quality dimension was essential to be a credible national wholesaler, costs of strategic investment could be higher for Everything Everywhere since it already has a large block of contiguous spectrum (2x45 MHz) in 1800 MHz. Costs for Vodafone and Telefónica could be slightly lower as they do not currently hold blocks of 2x20 MHz contiguous spectrum.

Risk that a fourth national wholesaler fails to acquire required spectrum to avoid a disadvantage in competing across a wide range of services or customers (although a credible national wholesaler)

- 5.169 Even if H3G or a new entrant is a credible national wholesaler, their spectrum portfolio could put them at a disadvantage in competing for certain types of customers or in offering some services. We consider whether a fourth national wholesaler may be the target of strategic investment by Vodafone, Telefónica and/or Everything Everywhere to achieve this outcome. However, for the reasons we set out below the effect on the incentives to strategic investment, compared to the case when the spectrum is required to be credible, is ambiguous.
- 5.170 As discussed in Section 4, the magnitude of the consumer detriment is expected to be smaller than for fewer than four credible national wholesalers. Correspondingly, we also expect the payoff resulting from strategic investment to be smaller.
- 5.171 But the costs of strategic investment could also be lower than considered above for reductions in the number of credible national wholesalers, because the victim's intrinsic value could be lower, whereas the intrinsic value of the strategic investor(s) may be similar. When specific spectrum is essential to be credible, failing to acquire it has a large impact on the victim national wholesaler's profitability. In the worst scenario where this leads to exit, the intrinsic value that a victim places on the required spectrum is very high because it reflects the fact that without it its overall profits would be (close to) zero. Instead, if the same spectrum was not essential to be credible, but failing to acquire it would make the national wholesaler more limited in the range of services and customers it could supply, there would be a smaller impact on the victim's profits, and thus on the value it associated with the spectrum. Conversely, for strategic investors that already hold enough spectrum to avoid that disadvantage in competing across a wide range of services and customers, the benefits from holding an additional amount of spectrum, and therefore the value that

operators place on it, would likely be similar to the case where the concerned spectrum is essential to be credible. This explains why the costs of strategic investment could be lower since they reflect the difference in intrinsic value between the victim and the strategic investors.

5.172 The costs of strategic investment could nonetheless be broadly similar to the case in which the spectrum is required to be credible, if strategic investors, like the victim, also need some further spectrum. When this is the case, the difference in intrinsic value between the victim and the strategic investors may not vary significantly irrespective of whether the spectrum is essential to be credible or not.

5.173 Figure 5.14 illustrates how the intrinsic values may change according to whether the spectrum in question is essential to be credible or not, and how this may affect the relative costs of strategic investment. Figure 5.14 shows the case in which the strategic investor may also need some spectrum of the type required by the victim. The chart on the left shows the intrinsic values of the victim and the strategic investor when the spectrum is essential, while the chart on the right illustrates the case when the spectrum is not essential. In the latter case both the victim and strategic investor can be expected to place a lower value on it compared to the case when the spectrum is essential (dotted arrows). Consequently, the cost of strategic investment (which is represented by the difference in intrinsic values between the victim and the strategic investor) need not be very different between the two cases, i.e. when the spectrum is essential and when it is not.

5.174 Figure 5.15 instead illustrates the situation in which the strategic investor does not need further spectrum because it already holds enough spectrum to deliver the quality dimension(s) under consideration (irrespective of whether it is essential to be credible or not). In this case, we can expect that the strategic investor's valuation does not vary considerably whether the spectrum is essential or not (for illustrative purposes in the chart we assume the variation is nil). Thus, the only driver of the change in costs of strategic investment when the spectrum is not essential is the reduction in intrinsic value of the victim. This explains why compared to the case when the spectrum is essential the costs of strategic investment may be lower.

Figure 5.14: Costs of strategic investment: spectrum essential vs spectrum not essential – the case in which also strategic investor needs further spectrum

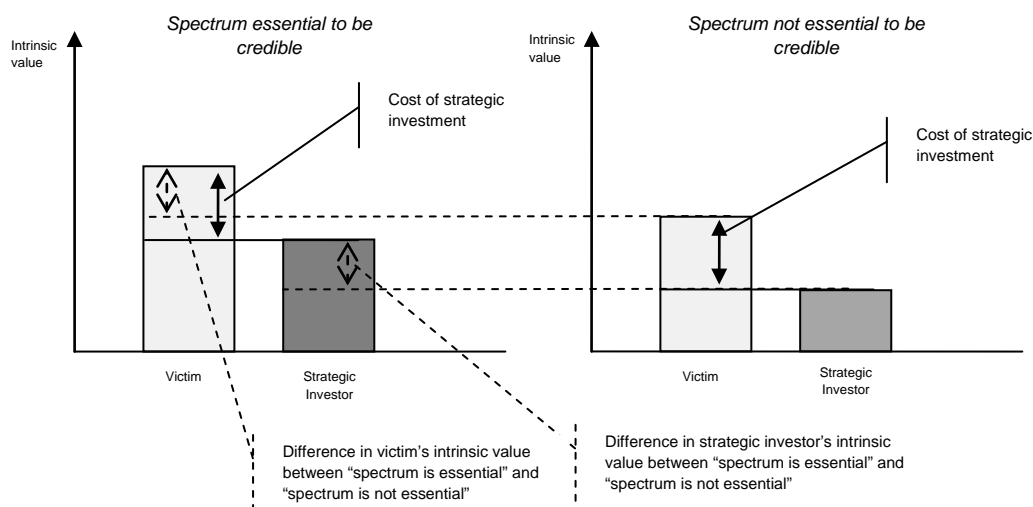
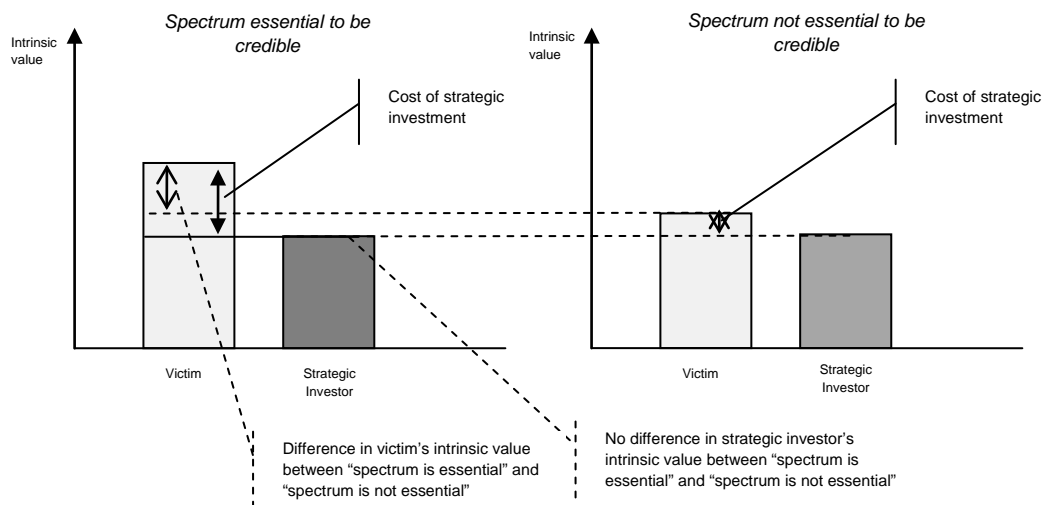


Figure 5.15: Costs of strategic investment: spectrum essential vs spectrum not essential – the case in which also strategic investor does not need further spectrum



5.175 Of course, whether strategic investors already hold relevant spectrum depends on the specific segment of services or customers under consideration. In Section 4 we set out there might be several different concerns where a fourth national wholesaler may be at a disadvantage in competing if it fails to acquire the right amount and/or type of spectrum in the auction. Below we discuss how the costs of strategic investment may vary according to the segment of services or customers to which strategic investors might want to deny a fourth national wholesaler. Costs of strategic investment are considered relative to the analysis set out above (i.e. for the alternative cases in which the spectrum is required to be a credible national wholesaler):

- *sub-1 GHz*: compared to the case in which the spectrum is required to be a credible national wholesaler, the costs of strategic investment may be lower for Vodafone and Telefónica as they already hold sub-1GHz, but broadly similar for Everything Everywhere.
- *LTE services in short term*: contrary to the previous case, we may expect Everything Everywhere to have relatively lower costs compared to the situation where the spectrum is required to be a credible national wholesaler as it already holds suitable spectrum for providing LTE in the short term, but the costs would be more or less similar for Vodafone and Telefónica.
- *contiguous block of 2x15 MHz or 2x20 MHz for LTE in any frequency*: unlike a fourth national wholesaler, Vodafone and Telefónica and Everything Everywhere already hold large blocks of spectrum. So their valuation of further large blocks of contiguous spectrum can be expected to remain broadly unaffected²⁰⁶ regardless of whether this spectrum is essential to be credible. Their costs of strategic investment would thus be lower compared to the case where the spectrum is required.

²⁰⁶ See paragraph 5.168 for a brief discussion on the reasons why the intrinsic values of Vodafone and Telefónica may nonetheless differ, to some extent, from that of Everything Everywhere.

- *Capacity and average data rates (spectrum of any frequency)*: in terms of costs of strategic investment, these conditions would imply a scenario opposite to the first set of conditions considered above with Everything Everywhere having lower costs compared to the situation where capacity is an essential component to be credible with Vodafone's and Telefónica's costs being broadly similar. This is because Everything Everywhere currently has larger holdings than Vodafone and Telefónica.

5.176 Overall, compared to the case where the spectrum is required to be a credible national wholesaler, the incentives to strategically invest are likely to be lower if the potential investor also needs some spectrum of the relevant type to compete in a specific market segment. This is because the expected payoffs are lower but the costs of strategic investment remain broadly similar even if the specific quality dimension is not essential to be credible. Less clear, however, is the impact on incentives to strategically invest for those investors that already hold enough spectrum of the right type. We argued above that payoffs are lower but costs can be lower too. Overall, the effect on the incentives to strategically invest is, therefore, ambiguous.

Provisional conclusion on concern that a fourth national wholesaler fails to acquire spectrum

5.177 It is very difficult to predict with certainty whether a fourth national wholesaler would have a sufficiently high intrinsic value that they would, absent strategic investment, outbid competitors in an auction to obtain the spectrum they need to be a credible national wholesaler. There are both reasons why a fourth national wholesaler may have a higher intrinsic value for spectrum (its smaller existing holdings) and a lower intrinsic value (the frictions of building a customer base). While it is difficult to conclude what the most likely outcome is based on intrinsic value, we regard there as being a material risk that the intrinsic value of a fourth national wholesaler is less than that of Everything Everywhere, Vodafone and Telefónica for at least some of the spectrum it may require.

5.178 Even if a fourth national wholesaler has a higher intrinsic value, based on the analysis set out above, we consider that the concern of a fourth national wholesaler failing to acquire the required spectrum is bolstered by the possibility of strategic investment by Everything Everywhere, Vodafone and Telefónica. The profitability and feasibility of such a strategy depends on the amount and the frequency of the spectrum that a fourth national wholesaler requires to be credible. As a general point, the larger the amount it would require, the higher the risk of it being the victim of strategic investment. Our view is that even if these requirements were rather limited (as in Scenarios A and B) there would still be a realistic risk that a fourth national wholesaler will be excluded or weakened because of strategic investment.

5.179 Taken together, we provisionally conclude that there is a material risk that a fourth national wholesaler would not be a credible national wholesaler through failing to acquire spectrum in the auction (or would be at a disadvantage in competing across a wide range of services and customers).

Concern that Everything Everywhere fails to acquire required spectrum to be credible national wholesaler or avoid disadvantage in competing across a wide range of services and customers

- 5.180 If it were the case that Everything Everywhere was not credible without sub-1GHz spectrum, there could be some risk of it not obtaining this in the auction. Below we discuss the likelihood of Everything Everywhere failing to acquire the relevant spectrum in case of a auction without measures.
- 5.181 Also, we assess the risk of Everything Everywhere failing to obtain sub-1 GHz spectrum when it is not essential to be credible but it may nonetheless constrain Everything Everywhere's ability to provide good quality of coverage.

Intrinsic value

- 5.182 Everything Everywhere has a well established position in the market and should not face the frictions to growth that we identified were a possibility for a fourth national wholesaler. The main determinant of its intrinsic value is therefore likely to be its existing holdings of spectrum (as noted above we do not consider firm capabilities or optimism in the auction in our analysis).
- 5.183 Excluding the 1800MHz spectrum it must divest, Everything Everywhere's existing paired mobile spectrum consists of 2x45MHz of 1800MHz and 2x20MHz of 2.1GHz spectrum. It therefore has no sub-1GHz spectrum, but on the other hand has an early route to LTE and a relatively high share of the total spectrum that will be available after the auction, as shown in Figure 4.2 in Section 4.
- 5.184 In the relevant set of technical and market conditions (in which it requires sub-1GHz spectrum to be credible), the fact it does not hold any sub-1GHz spectrum would suggest that Everything Everywhere would place a high value on sub-1GHz spectrum. In this Section we only consider this set of conditions and assess the prospects for Everything Everywhere being the victim of strategic investment (if Everything Everywhere does not need to acquire any spectrum in the auction to be credible, it would not be feasible for it to be the victim of strategic investment).

Strategic investment

- 5.185 In Section 4 we set out a range of possible spectrum acquisitions that could allow Everything Everywhere to remain credible in the relevant set of technical and market conditions:
- Group 1: 2x10 MHz of 800 MHz;
 - Group 2: 2x15 MHz of 800 MHz;
 - Group 3: 2x5 MHz of 800 MHz.
- 5.186 The following paragraphs consider both feasibility and incentives of Vodafone, and Telefónica (and conceivably a fourth national wholesaler²⁰⁷) undertaking strategic

²⁰⁷ It appears unlikely that a fourth national wholesaler would have an incentive to strategically invest to foreclose Everything Everywhere. The strategic investment logic rests on the proposition that the strategic investor may value the spectrum more than the victim once the payoffs resulting from the exclusion of the victim are included. By contrast the victim's value is based on its valuation taking as

investment to deny Everything Everywhere sufficient spectrum to be a credible national wholesaler.

Risk that Everything Everywhere fails to acquire required spectrum to be credible national wholesaler

5.187 We first assess the risk of strategic investment by Vodafone, Telefónica (and conceivably a fourth national wholesaler) in case a block of 2x10 MHz of 800 MHz was required by Everything Everywhere to be a credible national wholesaler.

Group 1: Everything Everywhere not credible if it does not acquire at least 2x10 MHz of 800 MHz

Feasibility

5.188 A number of outcomes may result in Everything Everywhere not winning 2x10 MHz of 800 MHz. For example: Telefónica wins 2x15 MHz and Vodafone wins 2x10 MHz of 800 MHz spectrum, Vodafone and Telefónica win 2x10 MHz of 800 MHz spectrum each and a fourth national wholesaler acquires 2x5 MHz, etc. This indicates that, at least in principle, strategic investment aimed at securing this outcome is feasible.

Incentives

5.189 Many of the considerations affecting the incentives on Vodafone and Telefónica to strategically invest to squeeze out Everything Everywhere are similar in nature²⁰⁸ to those discussed above in relation to strategic investment when a fourth national wholesaler is the target and what it needs to be credible is 2x10 MHz of 800 MHz (Scenario A).

given the competitive structure as it cannot reasonably expect to induce lower competition through its bidding behaviour in the auction. If two wholesalers are equally vulnerable to exclusionary conduct, they may both place an additional value on the spectrum reflecting the possibility that they obtain the required spectrum but the other vulnerable wholesaler does not. However, given the large difference in existing holdings (especially at 1800MHz), a fourth national wholesaler is vulnerable under a wider set of technical and market conditions than Everything Everywhere. In light of the uncertainty about the technical and market conditions that will be relevant in the future, the expected payoff to a fourth national wholesaler is then unlikely to be higher than the expected payoff that Everything Everywhere would earn by foreclosing a fourth national wholesaler. This might change if measures were in place in the auction to promote a fourth national wholesaler's access to some spectrum. This Section focuses on the risk of strategic investment under the assumption of an auction without measures – the effect of measures on the incentives for strategic investment are considered in Section 8.

²⁰⁸ Including the number of slots available (3) to the victim in the auction to obtain the spectrum it requires to be a credible national wholesaler.

Payoffs of strategic investment

- 5.190 In terms of payoffs, the benefits for Vodafone and Telefónica from Everything Everywhere not being a credible national wholesaler could be considerable.²⁰⁹

Costs of strategic investment

- 5.191 In theory, the costs of strategic investment could be relatively large as Vodafone and Telefónica would need to acquire 2x25 MHz at 800 MHz to prevent Everything Everywhere from access to 2x10 MHz. However, how much extra spectrum (beyond the amount they would have obtained absent strategic investment) Vodafone and Telefónica would need to acquire depends also on what a fourth national wholesaler may be expected to obtain based on their intrinsic value. For example, should a fourth national wholesaler be expected to obtain 2x10 MHz of 800 MHz in the auction because of its higher intrinsic value,²¹⁰ Vodafone and Telefónica would need to acquire jointly 2x15 MHz to strategically block Everything Everywhere from accessing spectrum in the relevant 800 MHz band.
- 5.192 Also, as pointed out in paragraph 5.130, were 2x10 MHz of sub-1 GHz spectrum necessary to be credible national wholesalers, both Everything Everywhere and a fourth national wholesaler would be potentially vulnerable to strategic investment. In this case Vodafone and Telefónica could ensure at most one other national wholesale competitor by winning between them 2x15 MHz of 800 MHz.
- 5.193 In terms of the price premium that Vodafone and Telefónica may have to pay in order to outbid Everything Everywhere's intrinsic value, we consider that under the applicable technical and market conditions Telefónica's and Vodafone's costs of strategic investment could be considerable as they already hold spectrum below 1 GHz and they could therefore place a significantly lower value than Everything Everywhere on the 800 MHz spectrum. However, if an early route to LTE in low frequencies (either 800 MHz or 1800 MHz) was also an important competitive dimension to be credible (though we consider it unlikely, see paragraph 4.49), Vodafone's and Telefónica's intrinsic values need not be significantly lower than Everything Everywhere's because their existing holdings at 900 MHz may not be suitable to deploy LTE services in the near term.

Other issues

- 5.194 Free-riding incentives may constitute an obstacle to strategic investment. Nevertheless, as for the case when a fourth national wholesaler is the potential victim, we consider them not insurmountable. An even split of the 800 MHz spectrum with Vodafone and Telefónica winning 2x15 MHz each²¹¹ (or 2x10 MHz each in case

²⁰⁹ Similarly to Scenario A for a fourth national wholesaler, we note that if sub-1 GHz was required to be credible, Vodafone and Telefónica might, in principle, seek to squeeze out Everything Everywhere and a fourth national wholesaler as both lack holdings below 1 GHz. In such a case, payoffs would be of course even larger as only two credible wholesalers would remain in the market but at the same time the costs of strategic investment would increase due to the need to block two wholesalers from having access to the relevant spectrum. The impact on the incentives to strategically invest is therefore ambiguous.

²¹⁰ Or because of measures in the auction, as discussed in Section 8 – see paragraph 8.59.

²¹¹ We note that the award of 800 MHz in other countries so far has not resulted in operators acquiring more than 2x10 MHz each which may suggest that this outcome can be difficult to achieve. However, we consider that the caps imposed by national regulators were in some cases rather strict thereby impeding some wholesalers from acquiring more than 2x10 MHz of 800 MHz in the auction. For

a fourth national wholesaler was expected to acquire at least 2x5 MHz anyway) seems a focal point on which the two can coordinate their strategies.

Group 2: Everything Everywhere not credible if it does not acquire at least 2x15 MHz of 800 MHz

- 5.195 When the amount of spectrum required by Everything Everywhere to be a credible national wholesaler rises, the likelihood of strategic investment increases too. Not only would the number of auction outcomes that could result in Everything Everywhere holding less than 2x15 MHz be larger (and the slots available to Everything Everywhere fewer), but also the incentives for the investors would be stronger. This is because the strategic investors would need to secure a lower quantity of spectrum to prevent Everything Everywhere from being credible, thereby reducing the costs of strategic investment.
- 5.196 Moreover, the coordination issues may be easier for Group 2 as winning 2x10 MHz of 800 MHz each would suffice for Vodafone and Telefónica to successfully achieve the exclusion of Everything Everywhere from the required amount of 800 MHz (irrespective of the conduct of other bidders).
- 5.197 The risk of strategic investment is therefore higher for Group 2 than for Group 1.

Group 3: Everything Everywhere not credible if it does not acquire at least 2x5 MHz of 800 MHz

- 5.198 By contrast to Group 2, if the amount of spectrum required by Everything Everywhere to be a credible national wholesaler is lower, strategic investment becomes less likely. The number of auction outcomes that could result in Everything Everywhere holding less than 2x5 MHz is smaller (plus the number of spectrum slots available to Everything Everywhere would be twice as large as in the Group 1, i.e. six). Furthermore, the costs of strategic investment could be high given that Vodafone and Telefónica would need to ensure that Everything Everywhere does not obtain any spectrum in the 800 MHz band.
- 5.199 So the likelihood of strategic investment for Group 3 is lower than for Group 1 (and, all the more, for Group 2).

Risk that Everything Everywhere fails to acquire required spectrum to avoid disadvantage in competing across a wide range of services and customers (although a credible national wholesaler)

- 5.200 In Section 4 we identified the possibility that due to the lack of sub-1 GHz spectrum Everything Everywhere may face a disadvantage in competing for some services or customers. But Everything Everywhere's large holdings in the 1800 MHz band mean that it avoids other potential disadvantages that other national wholesalers may face, because it has an early route to LTE, a large contiguous block for LTE and significant capacity.
- 5.201 Compared to the scenarios considered above when sub-1 GHz is essential to be a credible national wholesaler, the expected payoffs of strategic investment are likely to

example, in Germany the regulator set a cap of 2x10 MHz on T-Mobile and Vodafone, and similarly in Sweden where a 2x10 MHz cap was imposed. Italy and Spain adopted caps on sub-1 GHz which de facto resulted in binding caps on the acquisition of 800 MHz in the auction.

be smaller. But the costs of strategic investment for Vodafone and Telefónica could be lower too. This is because Vodafone and Telefónica already have holdings below 1 GHz, so their valuation of the 800 MHz spectrum may not vary significantly whether or not sub-1 GHz spectrum is essential to be credible, while the intrinsic value of Everything Everywhere would be lower should the 800 MHz band be less critical to competition. Overall strategic investment could be less likely, although this is not clear.

Provisional conclusion on concern that Everything Everywhere fails to acquire spectrum when it requires it to be credible or avoid a competitive disadvantage

- 5.202 Everything Everywhere can count on a well established position in the market and it is unlikely to face relevant frictions to growth. Further, should sub-1GHz spectrum be essential to be credible, Everything Everywhere can be expected to place a high value on the 800 MHz as it currently does not hold spectrum below 1 GHz.
- 5.203 While we consider that Everything Everywhere is likely to be credible with its existing spectrum holdings (for the reasons set out in Section 4), if it did need to obtain sub-1GHz spectrum we consider that the risk that it would be unable to obtain it cannot be ruled out (because Vodafone and Telefónica may strategically invest to deny it access to 800 MHz).
- 5.204 However, we consider that Everything Everywhere is less likely to be the victim of strategic investment than a fourth national wholesaler. First, there is a material risk that a fourth national wholesaler has a lower intrinsic value than Everything Everywhere (which means a lower cost of strategic investment in that case). Second, the limited information available during the auction makes it difficult to target the strategic investment against a specific bidder which implies that when more than one wholesaler is potentially exposed to strategic investment the victim is likely to be the more vulnerable (e.g. with lower intrinsic value). Third, our analysis in Section 4 is that there are more likely technical and market conditions in which a fourth national wholesaler needs spectrum to be credible but Everything Everywhere does not.

Concern that Vodafone or Telefónica fails to acquire required spectrum to be credible national wholesaler or avoid disadvantage in competing across a wide range of services and customers

- 5.205 In the following paragraphs we discuss the risk of Vodafone and Telefónica not obtaining the spectrum in the auction they may require. We first consider the risk relating to the set of technical and market conditions in which Vodafone and Telefónica cease to be credible national wholesalers if they fail to acquire the required spectrum in the auction. Then, we briefly assess whether, and the extent to which, Vodafone and Telefónica may be put at a disadvantage in competing across a wide range of services and customers.

Intrinsic value

- 5.206 Like Everything Everywhere, Vodafone and Telefónica have a well established position in the market and should not face the frictions to growth that we identified were a possibility for a fourth national wholesaler.

5.207 In the applicable technical and market conditions (i.e. a need to deliver LTE services soon and a need for capacity) Vodafone and Telefónica should have a high intrinsic value for the relevant spectrum.

5.208 We therefore have no reason to expect that Vodafone and Telefónica would not be able to acquire the spectrum they need in the auction owing to a low intrinsic value compared to other bidders.

Strategic investment

5.209 Telefónica (or Vodafone) may nonetheless fail to obtain the required spectrum if Everything Everywhere, Vodafone (or Telefónica) and conceivably a fourth national wholesaler²¹² strategically invested to stop it from acquiring what it needs in the auction. In Section 4 we consider three different groups of alternative portfolios that might be needed for Vodafone and/or Telefónica to remain credible:

Group of smaller portfolios for Telefónica and/or Vodafone

| 800MHz | 1800MHz | 2.6GHz |
|--------|---------|--------|
| 2x5 | | |
| | | 2x10 |

Group of medium portfolios for Telefónica and/or Vodafone

| 800MHz | 1800MHz | 2.6GHz |
|--------|---------|--------|
| 2x10 | | |
| | 2x15 | |
| | | 2x20 |

Group of larger portfolios for Telefónica and/or Vodafone

| 800MHz | 1800MHz | 2.6GHz |
|--------|---------|--------|
| 2x10 | | 2x10 |
| | 2x15 | 2x10 |
| | | 2x30 |

5.210 In Section 4 we also identified variants of these. We therefore consider the following scenarios for what spectrum Telefónica and Vodafone need to be credible:

- Scenario A: any of the portfolios in the smaller portfolio group plus one portfolio from the middle group, namely: 2x15MHz of 1800MHz spectrum.²¹³
- Scenario B: any of the portfolios in the middle group;

²¹² For the same reasons we set out above when discussing the risk of Everything Everywhere being victim of strategic investment (see footnote 207), we consider it unlikely that a fourth national wholesaler would have incentive to engage in strategic investment to exclude Vodafone or Telefonica.

²¹³ As this portfolio is from the middle group of portfolios, it should give a greater degree of confidence that Telefónica and Vodafone will be credible than the portfolios in the smaller group (i.e. the other portfolios in Scenario A). Therefore if Telefónica or Vodafone obtained this portfolio they would be more likely to be credible than any of the portfolios in the smaller group. We do not need to include any of the other portfolios from the middle group, as they are all larger versions of the same spectrum in the smaller group.

- Scenario C: any of the portfolios in the larger portfolio group;
- Scenario D: Scenario A excluding the portfolio which only includes spectrum at 2.6 GHz;
- Scenario E: Scenario B, excluding the portfolio which only includes spectrum at 2.6 GHz;
- Scenario F: Scenario C, excluding the portfolio which only includes spectrum at 2.6 GHz;
- Scenario G: Scenario A with the addition of the unpaired 2.6 GHz spectrum as an alternative to the paired band;
- Scenario H: Scenario B with the addition of the unpaired 2.6 GHz spectrum as an alternative to the paired band;
- Scenario I: Scenario C with the addition of the unpaired 2.6 GHz spectrum as an alternative to the paired band.

5.211 We consider these scenarios in turn below.

Risk that Vodafone or Telefónica fails to acquire required spectrum to be credible national wholesaler

5.212 We first assess the risk of strategic investment by Everything Everywhere in the case of Scenario A. Hereinafter, for the sake of simplicity, we will refer to Telefónica as the potential target of the strategic conduct but, of course, the arguments apply similarly to Vodafone.

Scenario A: Telefónica (and/or Vodafone) not credible if it does not acquire at least 2x5 MHz of 800 MHz or 2x15 MHz of 1800 MHz or 2x10 MHz of 2.6 GHz

Feasibility

5.213 Outcomes that may result in Telefónica not obtaining any of the spectrum portfolios specified in Scenario A are rather limited as they involve cases in which Telefónica does not acquire (almost) any spectrum in the auction. Nonetheless, a possible outcome leading to Telefónica's exclusion would be, for example: Vodafone, Everything Everywhere and a fourth national wholesaler win 2x10 MHz of 800 MHz spectrum each, Vodafone or a fourth national wholesaler obtains the divested block at 1800 MHz, and Vodafone and Everything Everywhere win 2x20 MHz of 2.6 GHz with a fourth national wholesaler obtaining the remaining 2x30 MHz of 2.6 GHz.

Incentives

Payoffs of strategic investment

5.214 The benefits to the strategic investors from foreclosing Telefónica are likely to be broadly similar to those that would accrue to Telefónica or Vodafone if they squeezed out Everything Everywhere, though we may expect some difference depending on the specific characteristics of the wholesaler targeted by the strategic behaviour (e.g. the current market share, the actual and expected future competitive pressure that can exert on rivals, etc.).

Costs of strategic investment

- 5.215 Even though Everything Everywhere could relatively easily impede Telefónica accessing the 1800 MHz band by selling the divested spectrum in advance of the auction to Vodafone or a fourth national wholesaler, the costs of strategic investment in Scenario A would be very high. This is because of the large quantity of spectrum (of different frequencies) that the strategic investors would need to acquire in the auction to stop Telefónica obtaining even small amounts of spectrum, such as 2x5 MHz of 800 MHz or 2x10 MHz of 2.6 GHz. This is also shown by the large number of slots available in the auction that would permit Telefónica to obtain the spectrum it requires to be a credible national wholesaler (14).
- 5.216 Of course, the extra spectrum that the strategic investors would need to obtain in order to foreclose Telefónica depends on the spectrum that the other wholesalers would acquire based on their intrinsic values. For example, the larger the spectrum that Vodafone and a fourth national wholesaler would have obtained anyway, the smaller the quantity that Everything Everywhere would need to secure to exclude Telefónica. However, even so we consider that the strategic investors would likely have to acquire a large additional amount of spectrum. For example, even if Vodafone and a fourth national wholesaler acquired 2x15 MHz of 800 MHz each and Everything Everywhere sold the divested 1800 MHz in advance of the auction to either Vodafone or a fourth national wholesaler, the strategic investors would probably still need to prevent Telefónica from acquiring any one of seven 2x10MHz blocks of 2.6 GHz (it would be less likely that the intrinsic value of other national wholesalers would exceed Telefónica's if they managed to secure significant amount of spectrum in lower frequencies).
- 5.217 Also, the price premium that the strategic investors could have to pay for the extra spectrum is likely to be considerable. For example, under the technical and market conditions relevant to Scenario A (need for an early route to LTE and/or need for capacity), Everything Everywhere is expected to place a relatively small intrinsic value on the spectrum as its large holdings in the 1800 MHz band constitute suitable spectrum both for an early route to LTE and to provide capacity. Thus, the difference in intrinsic value between Everything Everywhere and Telefónica may be significant.
- 5.218 In the discussion above we focus on the victim being one national wholesaler, Telefónica or Vodafone. It is also possible in principle that strategic investment could lead to both of these national wholesalers being victims. For such a strategy the payoff resulting from the exclusion of two competing wholesalers might be significantly larger, but so also would be the costs. Indeed, unless a fourth national wholesaler is expected to acquire a large quantity based on their intrinsic values, Everything Everywhere would need to secure a considerable amount of spectrum to deny both Vodafone and Telefónica access to the spectrum they need to be credible, and this would result in large costs of strategic investment.
- 5.219 While technically not impossible, we do not consider it realistic that Telefónica and/or Vodafone would be the victim of strategic investment if the only spectrum either needed was 2x5 MHz of 800 MHz or the divested 1800 MHz or 2x10 MHz of 2.6 GHz.

Scenario B: Telefónica (and/or Vodafone) not credible if it does not acquire at least 2x10 MHz of 800 MHz or 2x15 MHz of 1800 MHz or 2x20 MHz of 2.6 GHz

- 5.220 Compared to Scenario A, the portfolios in Scenario B have more spectrum (except for the 1800 MHz band). In general terms, as the amount of spectrum that Telefónica

needs to secure to be credible rises, strategic investment becomes more likely as it is feasible in a larger number of auction outcomes and costs for the investors decrease. Also, given the spectrum requirement of Scenario B, the slots available to Telefónica would drop from 14 to 7.

- 5.221 However, we still consider it unlikely that Telefónica and/or Vodafone would be the victim of strategic investment given the rather wide set of options in terms of alternative spectrum holdings in Scenario B.

Scenario C: Telefónica (and/or Vodafone) not credible if it does not acquire at least (2x10 MHz of 800 MHz + 2x10 of 2.6 GHz) or (2x15 MHz of 1800 MHz + 2x10 MHz of 2.6 GHz) or (2x30 MHz of 2.6 GHz).

- 5.222 In addition to the previous Scenario, portfolios in Scenario C contain an additional amount of 2x10 MHz in the 2.6 GHz band. For the same reasons as strategic investment is more likely with Scenario B than with Scenario A, we consider the risk for strategic investment associated with Scenario C is higher than the corresponding risk raised by Scenario B. That is, the larger spectrum requirements of Telefónica enlarge the number of outcomes that are feasible for strategic investment, and more importantly tend to reduce the costs of strategic investment. Compared to Scenario B, the number of slots available to Telefónica would be further reduced (from 7 to 6).

- 5.223 Although strategic investment would be easier, we do not consider the outcome of Telefónica failing to obtain the required spectrum is very likely. First, the strategic investors would still need to acquire a relatively large amount of spectrum to deny the required spectrum to Telefónica. Second, under the technical and market conditions relevant for Scenario C Telefónica's intrinsic value is likely to be significantly higher than strategic investors' for the spectrum in question (other than Vodafone) as it would consider the spectrum essential to be credible and it would then value it accordingly.

Scenarios D, E and F

- 5.224 Scenarios D, E and F are equal to, respectively, Scenario A, B and C except for the fact that the former exclude portfolios with only 2.6 GHz spectrum. The risks of strategic investment implied by these Scenarios are, therefore, higher as the number of options available to Telefónica to acquire what it needs shrinks considerably when the 2.6 GHz spectrum is not a suitable alternative.
- 5.225 We also note that Scenario E coincides with Scenario B for a fourth national wholesaler being the potential victim of strategic investment. Under the technical and market conditions relevant to this Scenario, our view resembles that we expressed in that previous case (see paragraph 5.156), i.e. strategic investment aimed at preventing Telefónica from obtaining both the 800 MHz spectrum and the divested block at 1800 MHz would not be inconceivable.
- 5.226 Compared to Scenario E, portfolios in Scenario F contain an additional amount of 2x10 MHz in the 2.6 GHz band which tends to make strategic investment more likely. By contrast, Scenario D envisages lower spectrum requirement at 800 MHz than Scenario E. This would tend to reduce feasibility and increase costs of strategic investment, thereby resulting in a lower risk of strategic investment.

Scenarios G, H and I

- 5.227 Spectrum requirements in Scenarios G, H and I include the same spectrum as in Scenarios A, B, and C but for the possibility for Telefónica to rely on the unpaired 2.6 GHz band as an alternative to the paired spectrum.
- 5.228 The wider range of options for Telefónica to acquire the required spectrum renders strategic investment harder. The slots available to it would increase to 16, 8 and 7, respectively, in Scenarios G, H and I (two more in Scenario G than in Scenario A and one more each in Scenario H and I compared to Scenarios B and C).

Risk that Vodafone or Telefónica fails to acquire required spectrum to avoid disadvantage in competing across wide range of services and customers (although a credible national wholesaler)

- 5.229 Even if Vodafone and Telefónica are credible national wholesalers, they could be at a disadvantage in competing for certain types of customers or in offering some services if they lack suitable spectrum, making them potentially the target of strategic investment by rivals.
- 5.230 We consider that Vodafone and Telefónica could in principle be vulnerable in relation to three competition concerns: early route to LTE, large contiguous block for LTE and to some extent capacity. In these cases the costs of strategic investment for Everything Everywhere are probably lower compared to the costs it would face as discussed above (in relation to the spectrum being essential for Vodafone and/or Telefónica to be credible national wholesalers). This is because while the intrinsic value of the victim/s is smaller due to the fact that the relevant spectrum is not critical to them to remain credible, the intrinsic value of Everything Everywhere can be expected to be broadly similar as it already has the suitable spectrum. But the expected payoffs are also lower, as a smaller reduction in competitive pressures would be expected even if the strategic investment were successful. Overall the effect on incentives to strategic investment is unclear.

Provisional conclusion on risk that Vodafone or Telefónica fails to acquire required spectrum

- 5.231 Like Everything Everywhere, Vodafone and Telefónica have well established positions in the market and if they considered a specific amount or type of spectrum essential to remain credible national wholesalers we have no reason to expect that they would not be able to win that spectrum in the auction because of a low intrinsic value compared to other wholesalers.
- 5.232 We considered in Section 4 that there is some risk that Telefónica and Vodafone's existing holdings may not be credible in the longer term if LTE900 equipment is not available sufficiently quickly, or because of the relatively limited overall spectrum share they hold. If this were the case, in this section we have assessed whether either of them would be likely to be a victim of strategic investment.
- 5.233 Our provisional conclusion is that it would be unrealistic for strategic investment to prevent them from obtaining the group of smaller portfolios we identified in Section 4. If they needed a portfolio from the middle group we identified in Section 4 to be credible, we consider it unlikely that either of them could be the victim of strategic investment. Even if they required a portfolio from the larger portfolio group we considered in Section 4, we do not consider it very likely that strategic investment could prevent them from obtaining this.

5.234 However, if they needed a portfolio from the middle group that excluded 2.6GHz (i.e. if they needed 2x10MHz of 800MHz or 2x15MHz of 1800MHz), then we consider that strategic investment would not be as unlikely.

Concern that one national wholesaler obtains a very large share of spectrum

5.235 In Section 4 we set out a further competition concern that relates to the risk that one national wholesaler will hold a very large share of spectrum after the auction and, as a consequence, the other competitors, although they are credible national wholesalers, may exert a weaker competitive constraint than they could have done if spectrum holdings were distributed more evenly.

5.236 This risk is not specifically associated with one particular wholesaler as the outcome involves (at least) three wholesalers having a competitive disadvantage compared to the largest spectrum holder. This is why we assess the likelihood of such an outcome arising from the auction separately from the concerns discussed in the previous paragraphs.

5.237 In principle, all bidders could be in the position of having a significantly larger share than the other wholesalers if they managed to acquire the vast majority of the spectrum at auction, which corresponds to approximately 43%²¹⁴ of the total (paired) spectrum available for mobile use.²¹⁵ For example, even in the rather extreme scenario where a new entrant would obtain the entire spectrum, this would result in one wholesaler having a share of 43% with the second largest wholesaler (i.e. Everything Everywhere) holding slightly more than half of its share (around 24%).²¹⁶

5.238 In terms of the risk of strategic investment, the existing spectrum holdings of the national wholesalers have important implications as they affect both the feasibility and the incentives to engage in strategic investment. The larger the existing holdings, the smaller the additional amount that a strategic investor may need to secure in order to achieve a considerable gap between its share of spectrum and the share of the competing wholesalers. There would then be a larger number of auction outcomes that would result in the investor having a significantly bigger share than its competitors. For similar reasons, costs of strategic investment are likely to be lower when the additional amount of spectrum to be acquired is smaller. This would imply that Everything Everywhere has lower costs of strategic investment compared to Vodafone, Telefónica and a fourth national wholesaler as it starts from larger existing holdings.

5.239 The existing holdings may also affect, to some extent, the expected payoffs, though we consider that in general the payoffs will not be very high as the relevant outcome

²¹⁴ This assumes that the 1800 MHz spectrum that Everything Everywhere must divest will be available in the auction and excludes unpaired spectrum.

²¹⁵ The potential spectrum available for the purpose of this strategy could be lower than the total amount sold in the auction. In particular, this would be the case if one or more wholesalers need to acquire some spectrum in the auction to be credible national wholesalers. Since the competitive concern under examination relates to the situation in which the auction results in at least four credible national wholesalers, in principle we would ideally consider that part of the spectrum is already secured before this further concern comes into play (thereby reducing the scope for strategic investment). However, for simplicity in the following discussion we will abstract from this issue.

²¹⁶ See Figure 2.2 in Chapter 2 for the current spectrum shares of the wholesalers.

(by definition) would not jeopardize the credibility of the victims as national wholesalers. In the extreme scenario described above in which a new entrant acquires the entire spectrum available in the auction, the strategic investor would still face competitive pressure from Everything Everywhere which would retain a share of 24% as well as at least two other national wholesalers. By contrast, should Everything Everywhere obtain the entire spectrum its share would rise to about 68% with the second largest wholesaler (i.e. Vodafone) having 'only' 14%, so the latter may be able to exert a more limited competitive constraint. The payoffs for Vodafone, Telefónica and H3G would stand somewhere in between, as they might be able to achieve a larger gap between their share and those of their competitors compared to a new entrant but a smaller gap compared to Everything Everywhere. In other words, the larger the existing holdings, the larger the asymmetry between its share and those of the competitors that a strategic investor can induce by strategically investing in the spectrum.

5.240 Overall, even if it is not very likely, we cannot rule out the risk of an auction outcome that would result in one wholesaler having a very large share of the spectrum. The likelihood of strategic investment aimed at constraining the capacity of all the other competing wholesalers appears to vary according to the size of the strategic investor's existing holdings. Everything Everywhere is, therefore, potentially the wholesaler best placed to engage in such strategic investment, followed, first, by Vodafone and Telefónica (which currently have a broadly similar share of spectrum), second, by H3G and, last, by a new entrant.

Summary of competition concerns

5.241 In Section 4 we identified auction outcomes that could conceivably be detrimental to competition. Drawing on Section 4 above and the analysis in this Section, Figure 5.16 summarises our provisional view of the importance of the different competition concerns. By *importance* we mean the combined effect of three factors:

- likely magnitude of the competition concern from a specified auction outcome and the associated size of consumer detriment;
- likelihood of technical and market conditions being such that the detriment arises with that auction outcome; and
- likelihood of national wholesalers failing to acquire the required spectrum to avoid that auction outcome.

5.242 The first set of three competition concerns in Figure 5.16 (in the rows labelled 1 to 3) relate to the category of competition concern of fewer than four credible national wholesalers. The second set of competition concerns (in the rows labelled 4 to 8) relate to the risk that, even if there are four credible national wholesalers, one or more of them may be at a disadvantage in competing across a wide range of services and customers.

5.243 The 'importance of concern' column gives our current view on the importance of each of the eight competition concerns in the table, taking account of both the likelihood and the magnitude of the concern. In considering the likelihood of each concern we have considered the risk that auction outcomes would be detrimental to competition (in Section 4) and the risk that national wholesalers would fail to acquire the spectrum they require (in Section 5). In relation to the concern that there may be fewer than four credible national wholesalers, we consider whether the national

wholesaler already has suitable spectrum to be a credible national wholesaler. This is assessed in Section 4 and involves considering the technical capabilities of existing spectrum (taking account of frequency, quantity and international 'ecosystem') and also the market implication of the differences (e.g. considering the extent to which particular technical characteristics are valued by consumers and matter commercially). We also consider the likelihood of the national wholesaler failing to acquire in the auction the spectrum it may need. In relation to the second risk, we consider the intrinsic value of different bidders for the spectrum and the possibility of strategic investment in spectrum to reduce competition.

Figure 5.16: Summary of competition concerns without measures in the auction

| Competition concern | Comment | Importance of concern |
|--|--|-----------------------|
| Concern that fewer than four credible national wholesalers | | |
| 1. Fourth national wholesaler not credible because insufficient share of spectrum & no sub-1 GHz spectrum, & no spectrum for early route to LTE or high peak data rates with early LTE | This is our single largest concern. The potential magnitude of this concern is high, as there would be a risk of significant consumer harm with fewer credible national wholesalers. We consider there is a material risk in relation to this concern. This is because a fourth national wholesaler is likely to need more spectrum of the right type & amount to be credible, and it may not obtain it without measures in the auction, due either to lower intrinsic value or strategic investment by other bidders. | High |
| 2. Everything Everywhere not credible because no sub-1 GHz spectrum | While the potential magnitude of this concern is high (as with concern 1), we consider the likelihood is low. This is because of EE's large current holdings of 1800MHz and 2100MHz spectrum, which we consider mean it is likely to be credible even without spectrum in the auction. (But if it did need sub-1GHz spectrum to be credible, there is a risk that it could be the victim of strategic investment). | Low to Medium |
| 3. Telefónica/Vodafone not credible because no spectrum for early route to LTE, high peak data rates with early LTE or greater capacity | While the potential magnitude of this concern is high (as with concern 1), we consider the likelihood is low. This is because while there is some risk that Vodafone & Telefónica may not be credible in the longer term without spectrum in the auction, we consider they are likely to obtain the spectrum they need to be credible. If they are not credible with existing holdings, given the range of spectrum they could obtain to be credible (including 2x20MHz at 2.6GHz), we consider that strategic investment is unlikely. (But if technical/market conditions were such that Vodafone & Telefónica specifically needed 1800MHz or 800MHz spectrum to be credible, there is a risk that they could be the victim of strategic investment). | Low to Medium |
| Concern that even if at least four credible national wholesalers one or more wholesalers is at a disadvantage in competing across a wide range of services and customers | | |
| 4. Weaker competition because one or more competitors does not have sub-1GHz spectrum | Although there could be material consumer detriment, we consider that this is a lesser concern than not having four credible national wholesalers because it would not affect all customers and the degree of consumer impact would be lower if there are four credible national wholesalers. In addition, national wholesalers may be able to acquire this spectrum in the auction (although there is a risk they may fail to do so). | Low |
| 5. Weaker competition because one or more competitors does not have early route to LTE | This is a lower concern for the same reasons as concern 4. It is also a lower concern because it is temporary. In the longer term 900MHz and even 2.1GHz spectrum will be suitable for LTE. We are also not certain that LTE will offer significant competitive advantages over evolving HSPA standards. (Divestment of 2x15MHz of 1800MHz spectrum also clearly helps this concern and following concern. This divestment is happening anyway and is independent of the auction). | Low |
| 6. Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE | This is a lower concern for the same reasons as concern 4. We are also not certain how much high peak data rates matter to consumers (as opposed to average data rates), though it is possible that they may be more relevant to small cells where there is more likely to be a single user. | Low |
| 7. Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates | This is a lower concern for the same reasons as concern 4. | Low |
| 8. Weaker competition because one competitor has a very large share of spectrum | This is a lower concern for the same reasons as concern 4. | Low |

Section 6

Potential measures to promote national wholesale competition

Introduction and summary

- 6.1 This section considers in broad terms a range of measures that could be used to avoid the outcomes and competition concerns identified in Sections 3 and 4 that are detrimental to national wholesale competition.
- 6.2 The potential measures we consider are:
- spectrum caps;
 - spectrum reservations (or floors);
 - spectrum relinquishment to be eligible to compete for reserved spectrum;
 - bidder credits;
 - regulated wholesale access; and
 - non-spectrum related measures.
- 6.3 We provisionally conclude that spectrum reservation and spectrum caps (and also perhaps spectrum relinquishment) are more likely to be suitable types of measures to effectively address the outcomes and competition concerns identified in Sections 4 and 5. However, we are not ruling any of these measures out and welcome stakeholders' further views on them. In Section 8 of this Annex we evaluate specific options that include caps, reservations and spectrum relinquishment.

Assessment of measures and sets of measures

- 6.4 In our assessment of the effectiveness and proportionality of measures, and the sets of measures in Section 8, we consider:
- The advantages - how effectively the measure/option addresses the different competition concerns in light of our policy aim of promoting competition, bearing in mind that our analysis of the evidence suggests that some concerns are more important than others, depending on the likelihood and magnitude of each concern; and
 - The disadvantages - the risks of the measure/option causing spectrum inefficiency or weakening competition, whether the measure goes beyond what is required given the availability of other measures, and whether the measure/option is likely to result in other costs or unintended consequences.
- 6.5 This assessment is made in the context of the considerable uncertainties that are inherent given its forward looking nature.

Spectrum caps

- 6.6 There are a number of different types of spectrum cap, some of which were suggested in responses to our March 2011 consultation. One dimension of caps is the spectrum to which they relate. There could be, amongst other things:
- sub-1GHz spectrum cap;
 - 800MHz spectrum cap;
 - a cap on 800MHz and 1800MHz spectrum combined;
 - 2.6GHz spectrum cap; and/or
 - an overall spectrum cap.
- 6.7 Another factor is how tight the caps are. If the concern being addressed is that asymmetric distributions of spectrum are harmful to competition, then caps have the advantage of addressing this directly. However, if the concern being addressed is to ensure at least four national wholesalers have sufficient spectrum to be credible, then tight caps may have disadvantages, because they may be more restrictive than they need to be to achieve the aim.
- 6.8 We can illustrate this with a simple example, which abstracts from differences in frequency. Suppose we wanted to ensure that at least four national wholesalers had at least 10% of spectrum. This could be achieved by imposing caps of 30%. Assuming only four national wholesalers, this would limit the amount that three could obtain to 90% (=3x30%), leaving enough for the other national wholesaler to obtain 10%. However, it could be that this is unnecessarily restrictive in the sense that a reservation or 'floor' of 10% for the national wholesaler with the smallest holding may be sufficient and more effective. A potential disadvantage of tight caps is that there may be unnecessary risk of causing spectrum inefficiency through limiting the extent to which bidding in the auction determines the outcome. The other side of this is that tight caps ensure more symmetric holdings of spectrum, which might be an advantage if more symmetric holdings were important.
- 6.9 Alternatively, looser caps could be set. These might be effective in avoiding very asymmetric allocations of spectrum while keeping the risk of inefficient spectrum allocations lower than with tight caps. But loose caps are less likely to be effective in promoting at least four credible national wholesalers compared to some other measures.
- 6.10 Another possible factor in the design of caps is that they could be increasingly restrictive over time. For example, a sub-1GHz cap could become tighter over time. Such a cap might allow Vodafone and Telefónica to acquire 800MHz spectrum in the auction, but with the condition that they would have to relinquish some 900MHz spectrum at a specified future date, which could be some years later.
- 6.11 In the main options in Section 8 we consider caps on sub-1GHz and overall spectrum, and we also consider variations on these involving a cap on 800MHz and a cap on the combination of 800MHz and 1800MHz spectrum. However, we do not consider a 2.6GHz spectrum cap. Our provisional view is that a disadvantage of a 2.6GHz spectrum cap is that it restricts holdings of 2.6GHz spectrum without considering other spectrum holdings. For example, it would cap the amount of 2.6GHz spectrum that a new entrant could acquire at the same level as Everything

Everywhere despite its large current holdings at 1800MHz. Unless 2.6GHz spectrum were to give a particular advantage, it is not obvious what the rationale for such a cap would be.

Spectrum reservations (or floors)

- 6.12 Reserving particular spectrum (or a menu of suitable spectrum portfolios) for national wholesalers who need it to be credible has the advantage of potentially being more effective in meeting its aim of promoting competition. Because it is more targeted than caps, it may also reduce the disadvantage of potentially causing spectrum inefficiency. It is more targeted because it does not dictate how the remaining spectrum is divided, allowing this to be determined by competition in the auction.
- 6.13 But if the competition concern were to do with avoiding highly asymmetric outcomes, spectrum reservation may be less effective at addressing this.

Spectrum relinquishment to be eligible to compete for reserved spectrum

- 6.14 We could make eligibility to compete for reserved spectrum contingent on relinquishment of existing spectrum, depending on a national wholesaler's existing spectrum holding. This may have an advantage if we are concerned that national wholesalers may need particular spectrum, but that their overall share of spectrum (or of a type of spectrum) may become too large with that spectrum. For example, in its response to our March 2011 consultation, H3G suggested that for Everything Everywhere to be eligible to compete for the reserved spectrum, Everything Everywhere could be required to relinquish more 1800MHz spectrum. H3G suggested this could be on a 1:1 basis.
- 6.15 Where we consider relinquishment in the options in Section 8, it is on the basis of existing national wholesalers being given the option to relinquish in advance of the auction. If they were to choose the option to relinquish then they would become eligible to compete for the reserved spectrum. However, once they had committed to relinquish the spectrum they would have to relinquish it regardless of whether they actually obtained the reserved spectrum or not. This is because the auction process would be complex if they had the option of relinquishing the spectrum during the auction itself, and undue complexity in the auction risks an inefficient auction outcome.
- 6.16 The potential advantage of allowing relinquishment is that it might facilitate a better trade-off in terms of allowing one competition concern to be addressed without making another competition concern worse. However, relinquishment would also introduce significant complexity and scope for regulatory failure. The date for relinquishment would be important, and there would be considerable scope for regulatory failure over that date. We discuss this further in the options in Section 8.

Bidder credits

- 6.17 A 'bidder credit' would involve increasing the bids of some companies, either by a fixed sum of money or in percentage terms, when determining who wins spectrum in the auction.

- 6.18 The Federal Communications Commission (FCC) has used bidder credits for a number of its mobile spectrum auctions.²¹⁷ In the context of our auction, bidder credits might be of use if, for example, we considered that one or more national wholesalers were likely to be credible national wholesalers after the auction, and we wanted to assist the other national wholesaler(s) by adding a bidder credit to their bids.
- 6.19 Bidder credits could be used to try to strike an appropriate balance between the potential static inefficiency from spectrum being awarded to a party that had a lower intrinsic value and the potential benefits from competition from having at least four national wholesalers. The bidder credit could be set at an estimate of the benefits from competition, and whether or not it was in consumers' interests to have four credible national wholesalers would then be determined by the auction. But accurately quantifying the benefits from greater competition is difficult.
- 6.20 However, if one of the reasons for being concerned that there would be fewer than four credible national wholesalers is the threat of strategic investment in spectrum, then the bidder credit would also need to be set high enough to discourage strategic investment. In principle, it might be possible to set the bidder credit such that it would increase the cost of strategic investment by a sufficient amount to make it unprofitable. However, it would be challenging to determine the appropriate level of the bidder credit, as it would depend on a detailed quantification of the costs and payoff of strategic investment (and may require a view to be taken on the specific applicable technical and market conditions as these may affect the cost of strategic investment as discussed in Section 5). There would be significant scope for error in setting an appropriate bidder credit. Setting the bidder credit too low might fail to achieve the objective of making strategic investment unprofitable; and setting it too high might effectively pre-determine the outcome rather than it being decided through bidding in the auction.
- 6.21 Given the difficulties, we consider that bidder credits are likely to be inferior to other measures for dealing with the competition concern of fewer than four national wholesalers.

Regulated wholesale access

- 6.22 All the measures we are considering are ultimately about promoting competition at the retail level. But regulated wholesale access is different in nature to the other spectrum related measures discussed above. This is because it aims to promote retail competition through regulated access at the wholesale level. In contrast, all the other measures aim to promote retail competition by promoting competition at the wholesale level allowing the wholesale level to be unregulated. If competition at the wholesale level is successfully promoted, there should be no need for regulated wholesale access.
- 6.23 We consider that regulated spectrum access could be imposed:
- in addition to structural measures to ensure at least four credible national wholesale competitors;

²¹⁷ For example, in the 700MHz auction in 2008, the FCC included bidder credit provisions for some spectrum to promote participation from small and very small businesses and to promote service deployment in tribal lands that are unserved or underserved.

- as an alternative to those measures; or
 - in addition to those measures but only where fewer than four credible national wholesale competitors emerge from the auction.
- 6.24 In the March 2011 consultation, we considered whether it would be appropriate and proportionate to put in place regulated access conditions in order to promote competition in addition to the measures we proposed to ensure at least four competitors are capable of being credible national wholesalers. Our provisional views of regulated wholesale access are unchanged from the March 2011 consultation.²¹⁸
- 6.25 We distinguished between two possible forms of access condition:
- A “live” access condition – which would take effect immediately;
 - A “dormant” access condition – which would only take effect if certain criteria were met at a specified future date.
- 6.26 We also recognised that we could rely on our other competition powers, including under the Competition Act 1998 and Enterprise Act 2002. A further option might also be to undertake a review of the relevant market(s) under the Communications Act 2003.
- 6.27 Given we proposed to take measures to promote at least four national wholesalers, our view was that it was unlikely that intervening to put in place a “live” access condition would be appropriate and proportionate because we considered that the provision of national wholesale access services was likely to be competitive, if other measures are taken to promote at least four national wholesalers. We considered that the case for imposing a dormant access condition to address the residual risk that commercial access might not be provided in the future is not compelling given the regulatory uncertainty that would be likely to be created if the condition was to be effective.
- 6.28 Here we also consider whether it would be more effective and proportionate to promote retail competition through regulated wholesale access as an *alternative* to structural measures to promote four national wholesalers. For example, we could impose regulated wholesale access by attaching appropriate licence conditions to some of the spectrum in the auction.
- 6.29 We consider that there are likely to be significant advantages to one-off structural measures in the auction to promote competition between national wholesalers rather than on-going wholesale access regulation. Competition at the wholesale level involves competition over more of the value chain than competition just at the retail level. Also, key dimensions of quality are determined at the national wholesale level, such as data rates and coverage. Compared to regulation, the competitive process is likely to be far more effective at delivering quality levels that consumers want, and at delivering new and innovative services. In particular, there is potential for regulatory failure in setting a regulated price of wholesale access. If set too high, it would fail to promote retail competition. But if set too low, it could have the effect of chilling the incentives to invest of the regulated national wholesaler(s). In addition, other aspects of regulation could be inferior to the performance of wholesale

²¹⁸ See Section 7 of Annex 6 of our March 2011 consultation:
http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/Annex_6.pdf

competition, such as less flexibility in regulated access to adapt terms and conditions as between access seekers compared to commercially provided access.²¹⁹

- 6.30 We therefore consider that one-off structural measures in the auction to promote competition are more likely to promote consumers' interests than on-going wholesale access regulation. This is consistent with the strategic principle that Ofcom has used since the 2005 Telecoms Strategic Review of promoting competition at the deepest level of infrastructure at which it will be effective and sustainable.²²⁰
- 6.31 However, even if we take measures to promote competition between at least four credible national wholesalers, it is possible that four will not emerge from the auction. For the reasons set out from paragraph 7.17 below, we consider that there is a case for setting a reserve price by reference to the expected market value (but with a discount). This is to strike an appropriate balance between obtaining the potential benefits of competition whilst mitigating the risk of an inefficient spectrum allocation from the spectrum going to a company that has a low intrinsic value compared to other bidders. With this approach it is possible that fewer than four credible national wholesalers may emerge from the auction.
- 6.32 We also therefore consider whether we should impose regulated wholesale access if we put in place measures to promote at least four national wholesalers, but nevertheless fewer than four emerged from the auction. In this case we consider that the arguments for regulated wholesale access are stronger, compared to when regulated wholesale access is considered as an alternative to promoting competition with at least four national wholesalers. There is a significant risk that if fewer than four emerged from the auction competition would be weaker. This may argue for promoting retail competition through regulated wholesale access if fewer than four national wholesalers emerged from the auction.
- 6.33 However, even if competition is weaker if there are fewer than four, this does not necessarily mean that regulated wholesale access is preferable to that weaker competition without regulated access. Regulated access entails various risks of regulatory failure, as noted above and set out in the March 2011 consultation.
- 6.34 On balance, our provisional view is that even if fewer than four credible national wholesalers emerged from the auction and competition reduced, it may not be appropriate to impose regulated wholesale access conditions at that time. We could wait to see how the market evolved and use our competition or Communications Act powers if concerns arose. This might mean that wholesale regulated access could be introduced later, if justified following an investigation.

Non spectrum related measures

- 6.35 In Section 5 we noted that part of the reason for being concerned about the possibility of an outcome with fewer than four national wholesalers was that H3G or a new entrant may have a lower intrinsic value for spectrum, because of factors such

²¹⁹ For further discussion of regulatory failures, see for example paragraph 7.35 to 7.38 of Annex 6 of the March 2011 consultation.

²²⁰ For our 2005 Telecoms Strategic Review see:

http://stakeholders.ofcom.org.uk/consultations/statement_tsr/

For a more recent example of where we have used this principle see our Review of the wholesale broadband access markets, December 2010:

<http://stakeholders.ofcom.org.uk/binaries/consultations/wba/statement/wbastatement.pdf>

See also: <http://media.ofcom.org.uk/2011/11/08/competition-and-investment-in-superfast-broadband/>

as its existing position in the market. We noted in particular that national wholesalers with a smaller existing customer base may face delays and frictions in acquiring customers after acquiring new spectrum. One solution, therefore, may be to address these growth frictions directly through other measures.

- 6.36 These measures would also help mitigate concerns about strategic investment since anything that raises the intrinsic value of a fourth national wholesaler makes strategic investment more costly to carry out. However, that said, they cannot on their own eliminate strategic investment risk.
- 6.37 Ofcom has taken numerous measures in recent years to empower consumers across the communications sector by making switching easier. Our efforts to date have often focussed on fixed voice and broadband sectors, since the existence of an incumbent supplier there raises particular concerns, however where appropriate we have intervened in the mobile sector as well (for example regarding number portability²²¹). Ofcom will continue to take appropriate measures to support consumers' ability to switch supplier across all communications markets including the mobile sector.
- 6.38 However, many of the frictions we identified and the resulting advantages of an existing customer base are a simple fact of doing business and there are likely to be few (proportionate) measures that could be taken to eliminate them. A company will always have more information about its own customers and has scope to target marketing in one way or another at those most likely to upgrade their service (such as those approaching the end of an existing contract). Similarly, in terms of the search and switching costs for the consumer, upgrading a service with an existing supplier will inevitably be easier and less costly to some degree than switching supplier to do so. This is particularly true where the upgrade occurs within an existing minimum contract period, since only an existing supplier can waive any early termination charges. Consumers are also likely to view it as less risky since they have direct experience of their existing supplier.
- 6.39 Furthermore, even if further action were possible, there may be limits to what could be done in time to affect the auction. If a credible commitment to take future action were made this may still affect the forward looking intrinsic value of bidders with a smaller existing customer base. However, there would still be uncertainty and it may be difficult to take measures before the launch of new services using the awarded spectrum.
- 6.40 Finally, some of the factors affecting intrinsic value of spectrum cannot realistically be addressed by Ofcom, including the sunk costs a new entrant would need to incur or any differences in capabilities of the national wholesalers. In addition, part of our concerns relate to the risk of strategic investment which might not be eliminated by raising the intrinsic value of a fourth national wholesaler (though it could make strategic investment more expensive).
- 6.41 Overall, while we will continue to ensure reductions in harmful frictions to customer acquisition (that do not have countervailing benefits), we do not see such measures as being effective enough on their own to eliminate the competition concerns associated with the auction.

²²¹ <http://stakeholders.ofcom.org.uk/consultations/mnp/statement>

Section 7

Risks of regulatory failures

Introduction and summary

- 7.1 This section sets out the regulatory risks with taking measures and the uncertainties inherent in our assessment.
- 7.2 We consider potential sources of regulatory failure under the following three headings:
- Regulatory measures could lead to inefficient spectrum allocation or weaker competition;
 - Regulatory measures could be ineffective in achieving their aim; and
 - Regulatory measures could be unnecessary and not change spectrum allocation.
- 7.3 Thereafter we discuss the range of uncertainties in our forward looking competition assessment and illustrate how they interact with each other.

Regulatory measures could lead to inefficient spectrum allocation or weaker competition

Risk of inefficient allocation when bidder without highest intrinsic value obtains spectrum

- 7.4 Inappropriate regulatory measures could lead to spectrum inefficiency or even weaken competition.
- 7.5 Absent strategic investment, a well designed auction without measures is likely to result in the spectrum going to the bidder with the highest intrinsic value for the spectrum. In general, there are likely to be advantages for consumers from this. The bidder with the highest intrinsic value will expect to generate most profits from the spectrum which, if the degree of competition in the market remains unaffected, is likely to mean that it delivers the most benefits to consumers.
- 7.6 As set out in paragraphs 5.14 to 5.38, intrinsic values can differ between companies for a variety of reasons. For example, the intrinsic value a particular company places on spectrum could be affected by its existing spectrum holdings and network assets, its current customer base, its business plans and its capabilities including technical, strategic and organisational capabilities. There are therefore likely to be downsides to spectrum being acquired by a company with a lower intrinsic value because of measures in the auction.
- 7.7 However, if there are potential benefits from increased competition, this can outweigh the impact of a national wholesaler obtaining the spectrum when it had lower intrinsic value. This then could be a good outcome for consumers, and hence an efficient spectrum allocation.
- 7.8 Whether or not it is good for consumers and efficiency overall for the national wholesaler with lower intrinsic value to obtain the spectrum will depend on how large

the gap is between the intrinsic value of company that obtains the spectrum and that of the highest bidder, and how large are the benefits from having an extra competitor. The smaller the gap between the intrinsic value and the greater the benefits from an extra competitor, the more likely it will be that it is efficient for the spectrum to be acquired by the national wholesaler with lower intrinsic value.

7.9 We distinguish between the following ways in which measures could lead to inefficient spectrum allocation or weaker competition:

- We could take measures to pursue an outcome that fails to promote competition. For example we could focus on measures to promote at least four credible national wholesalers when it would be better for consumers if there were fewer national wholesalers (with more spectrum each on average); or
- Even though we are pursuing positive outcomes (e.g. it is consumers' interests to secure at least four credible national wholesalers), our chosen measures are inappropriate and cause an inefficient allocation of spectrum or even weaken competition.

7.10 We consider these in turn below.

Promoting at least four credible national wholesalers when fewer is in consumers' interests

7.11 In Section 5, we identified two different reasons why at least four credible national wholesalers may not obtain the spectrum they needed to be credible. These two reasons were that:

- **Lower intrinsic value:** a fourth national wholesaler (i.e. H3G or a new entrant) may have a lower intrinsic value for the spectrum than the other three existing national wholesalers (Vodafone, Telefónica and Everything Everywhere); or
- **Strategic investment:** Everything Everywhere, Vodafone and/or Telefónica may strategically invest in spectrum in order to prevent a fourth national wholesaler from winning sufficient spectrum to be credible. Or there may be strategic investment to deny Everything Everywhere, Vodafone or Telefónica spectrum, if one or more of them were to need spectrum to be credible.

7.12 We consider the implications for the risk of measures resulting in inefficient spectrum allocation or weaker competition are very different with these two reasons.

7.13 It is highly unlikely that it would be in consumers' interests for there to be only three or fewer credible national wholesalers after the auction if the reason for this was strategic investment. As discussed in Section 5, strategic investment can only change the outcome of the auction if the intrinsic value of the spectrum in question to the potential victim is higher than the intrinsic value to the potential strategic investor. If this is the reason why fewer than four national wholesalers are credible, then there is no trade-off between different effects of the measures. If successful, the measures would (i) simply ensure that the national wholesaler with the highest intrinsic value is the one that obtains the spectrum, and (ii) also help to promote competition.

Risk of regulatory failure when a fourth national wholesaler has lower intrinsic value

7.14 There is a risk of inefficient spectrum allocation or weaker competition if measures to promote at least four credible national wholesalers involve a national wholesaler with

lower intrinsic value obtaining the spectrum instead of another national wholesaler who placed higher intrinsic value on the spectrum.

- 7.15 As we said above, the smaller the gap between the intrinsic value and the greater the benefits from an extra competitor, the more likely it will be that it is efficient for the spectrum to be acquired by the national wholesaler with lower intrinsic value.
- 7.16 On the other hand, the larger the difference in intrinsic values and the smaller the competition gain, the more likely that there would be regulatory failure and the measures would be against consumers' interests. (This trade-off is also discussed from paragraph 7.37 below where we also describe how it interacts with the possibility of strategic investment). If we take measures, we propose to mitigate this risk of regulatory failure in the way we set reserve prices.

Reserve prices to mitigate regulatory failure

- 7.17 We are considering setting reserve prices by reference to expected market value, but with a discount, (however much higher than would be necessary to deter frivolous bidders, which was the approach in our previous spectrum auctions). Setting the reserve prices will involve balancing two risks. The higher the reserve price:
- the lower the risk of an inefficiency associated with a large difference in intrinsic values between the party who acquired reserved spectrum and the party that values it most highly; but
 - the greater the risk of fewer than four credible national wholesalers and hence the loss of competition benefits.
- 7.18 Conversely, a low reserve price may ensure at least four credible national wholesalers, but at the cost of a higher risk of a large difference in intrinsic values which may not be in consumers' interests.
- 7.19 Given that we consider the potential consumer detriment from a reduction in the number of national wholesalers is large (for the reasons set out in Section 2), this might argue for setting the reserve price at a discount to estimated market value. It would probably still be in consumers' interests to have at least four credible national wholesalers rather than fewer, even if a fourth national wholesaler had a lower intrinsic value. However, there is a limit to this. If a fourth national wholesaler were not prepared to pay the reserve prices even when set at a discount to estimated market value, there is a risk that the smaller profit it expected to earn might be associated with a smaller impact on competition. In this case, the competition benefits from having at least four national wholesalers are less likely to outweigh the risk of spectrum inefficiency from the spectrum not going to the party that has the highest intrinsic value.

Risk of delay in when spectrum can be used

- 7.20 There may be a further concern about regulatory failure with relatively high reserve prices, depending on the measures used. Especially with tight caps, relatively high reserve prices run the risk of some spectrum not being sold in the auction. This would result in a delay while the spectrum was re-awarded which is likely to delay when it could be used, which could be very inefficient.
- 7.21 This disadvantage does not apply to measures involving spectrum portfolios, where spectrum is potentially reserved for eligible bidders. If no eligible bidders valued it

sufficiently highly to pay the reserve price, they would not obtain it. In this event, the constraint of requiring at least four credible national wholesalers would then be removed, and the spectrum would then be awarded without any delay, with fewer than four credible national wholesalers emerging from the auction (though any other measures, such as safeguard caps, would still apply).

- 7.22 This means that even in the options in Section 8 where we propose to reserve spectrum, this would not guarantee that there would be at least four credible national wholesalers with sufficient spectrum holdings. Those eligible to compete for reserved spectrum would need to be prepared to pay the reserve price.

Reversibility of decision mitigates regulatory risk

- 7.23 Another factor that in our view mitigates the risk of regulatory failure from promoting an auction outcome with at least four national wholesalers when it would have been in consumers' interests to have fewer, is that this decision could be reversible. It would be possible to consider a spectrum trade or a consolidation after the auction. The balance between any efficiency benefits to the merging parties, effects on competition and benefits to consumers could be considered at that time.
- 7.24 Even though the decision to promote at least four national wholesalers may be reversible in this sense, we recognise that there could still be some costs to taking measures now to promote at least four. Taking measures now could at least delay any consolidation which could have costs. Taking measures could also result in a windfall gain to the company obtaining the reserved spectrum (as discussed further in paragraph 7.31 below).
- 7.25 Nevertheless, we consider that because it is reversible at a later date the potential cost of regulatory failure is reduced. In contrast, it is likely to be hard to increase the number of national wholesale competitors in the event that having only three did not result in a very competitive market.

Even though at least four credible national wholesalers would be in consumers' interests with appropriate measures, our chosen measures might cause an inefficient allocation of spectrum or weaker competition

- 7.26 Even though at least four credible national wholesalers may emerge from the auction, our measures could cause an inefficient allocation of spectrum or weaker competition. For example, this might be the case if we overestimated the amount or type of spectrum to be reserved to ensure a fourth national wholesaler was credible. This could mean some spectrum went to a fourth national wholesaler when one of the other national wholesalers could have used it more effectively. (We consider below the situation where we underestimate the amount of spectrum needed).
- 7.27 We consider these risks in more detail for each of the options in Section 8 of this Annex.

Regulatory measures could be ineffective in achieving their aim

- 7.28 Finally, even if we pursue an outcome that is in consumers' interests, there could be regulatory failure if the measures we adopt to pursue that outcome are ineffective in achieving it.
- 7.29 Our main concern is that there might be fewer than four credible national wholesalers after the auction. But we are not certain how much or what type of spectrum might be

needed by some national wholesalers to make them credible. There is therefore a risk that the measures we take are ineffective in promoting at least four credible national wholesalers. Different measures and sets of measures (and the extent of those measures) may reduce this risk, but this will generally be at the cost of increasing the earlier risks of regulatory failure. It is therefore difficult to reduce all risks of regulatory failure together, and there will generally be a trade-off between them.

- 7.30 In Section 8 we consider the effectiveness of various options in addressing our main competition concern that the auction results in fewer than four credible national wholesalers and our lesser concern that one or more national wholesalers are at a disadvantage in competing across a wide range of services and customers.

Regulatory measures could be unnecessary and may not change spectrum allocation

- 7.31 If regulatory measures made no difference to the resulting spectrum outcomes, the impact is likely to be that some national wholesalers would have paid less than would otherwise have been the case. We recognise that this could represent a material windfall gain to the beneficiary of the measure.
- 7.32 We considered whether such a windfall gain or asymmetric profit shock may give rise to a competitive distortion in our earlier work on 2G liberalisation.²²² We considered it would be possible for large asymmetric profit shocks to have an impact on competition if they were to lead to a national wholesaler exiting the market. In this case we consider this to be unlikely, because it would be an asymmetric profit *gain* for the party who won reserved spectrum. Given their spectrum holdings and position in the market, we would not expect other national wholesalers to exit as a consequence of such an asymmetric profit shock, which does not directly affect their financial position.
- 7.33 However, we considered that large asymmetric profit shocks resulting from regulatory policy could have a general detrimental impact on investment incentives in the sector, if they led to regulatory uncertainty which dampened incentives for investment. Concerns about regulatory uncertainty in this case should be mitigated by the fact that the auction is expected to be a major one-off event, due regulatory process and with a clear justification for intervention. Reserve prices set by reference to expected market value also mitigate this risk to some extent (see also paragraph 7.19 above in this regard).
- 7.34 Because we consider that asymmetric profit gains should not distort competition or have a large adverse effect on investment incentives in this case, we are less concerned about this type of regulatory failure.

²²² For more details see paragraphs 5.102 and A8.107 to A8.114 of our February 2009 Consultation: <http://stakeholders.ofcom.org.uk/binaries/consultations/spectrumlib/annexes/annex8.pdf>. See also paragraph 5.42 of our October 2010 Advice to Government on 2G liberalisation: <http://stakeholders.ofcom.org.uk/binaries/consultations/spectrumlib/annexes/government-advice.pdf> and paragraphs 8.46 to 8.54 of our September 2007 Consultation on 2G liberalisation: <http://stakeholders.ofcom.org.uk/binaries/consultations/liberalisation/summary/liberalisation.pdf>

Uncertainties in future mobile competition

7.35 In our assessment we recognise there is a range of inherent uncertainties to this forward looking assessment. For example, there are uncertainties over:

- the size of the potential consumer harm from a reduction in the number of credible national wholesalers;
- the size of the differences in intrinsic value between bidders;
- what spectrum a national wholesaler needs to be credible and how effectively different national wholesalers can compete across a wide range of services and customers, which depends in particular on:
 - when equipment is likely to be available in different bands for relevant technologies;
 - when it may be profitable to refarm spectrum from current uses to more advanced technologies;
 - how practical or costly it might be to employ different mixes of spectrum/network resources, including the effectiveness of different in-building technologies (such as Wi-Fi and femtocell);
 - what quality of service an operator might achieve with different mixes and amounts of spectrum/network resources;
 - whether and how much certain service characteristics are likely to matter to consumers in the medium term and the longer term; and
 - the nature and magnitude of transitional or longer term competitive advantages from certain service characteristics.

7.36 Our assessment is therefore concerned with balancing different risks in the presence of this uncertainty.

Illustration of interaction between uncertainties

7.37 Here we illustrate how the interaction of two uncertainties affects the assessment for a particular situation. We consider the situation where (1) Everything Everywhere, Telefónica and Vodafone are credible national wholesalers following the auction even without measures in the auction, but (2) a fourth national wholesaler (i.e. H3G or a new entrant) would not be credible without acquiring spectrum in the auction. As described in Section 5, a fourth national wholesaler may not obtain the spectrum it needs to be credible because of lower intrinsic value or strategic investment.

7.38 We abstract from issues about what sort of spectrum may be required in order to show the general relationship between two key uncertainties:

- Uncertainty over the size of the potential consumer harm from a reduction in the number of credible national wholesalers; and
- Uncertainty over the differences in intrinsic value between a fourth national wholesaler and other bidders.

7.39 First, if the reason for a fourth national wholesaler failing to acquire the required spectrum in the auction is its lower intrinsic value than other national wholesalers:

- Strategic investment is not necessary for this auction outcome to occur; and
- To justify promoting a fourth national wholesaler obtaining the spectrum, the expected competition benefits would need to be sufficiently large to more than offset the potential lower benefits for consumers reflected in its lower intrinsic value.

7.40 Second, if the reason for a fourth national wholesaler failing to acquire the required spectrum in the auction is strategic investment by other national wholesalers:

- a) There is a stronger case to promote a fourth national wholesaler obtaining the spectrum if:
 - i) Its intrinsic value is not much higher than the intrinsic value of others, which implies there is a lower cost of strategic investment; and/or
 - ii) Competition benefits are larger, which imply there is a larger payoff from strategic investment.
- b) Promoting a fourth national wholesaler obtaining the spectrum is potentially unnecessary if its intrinsic value is sufficiently higher than the intrinsic value of others (cost of strategic investment) and the competition benefits are sufficiently small (payoff) such that strategic investment is unprofitable. But it may still be justified, because there is a low cost of promoting a fourth national wholesaler obtaining the spectrum, because it is likely to be the efficient holder of the spectrum (as it has higher intrinsic value).

Section 8

Sets of measures to promote national wholesale competition

Introduction and summary

- 8.1 In this section we assess the effectiveness and proportionality of particular sets of measures for promoting competition, drawing on the provisional conclusions of Sections 3 to 7.
- 8.2 To reflect responses to the March 2011 consultation and facilitate engagement on the issues we have identified a wide range of options, although we have not attempted to set out an exhaustive list.
- 8.3 After considering each option individually, at the end of this section we compare options and their effectiveness and proportionality. Our favoured option is the following (Option 4 below):
- **Sub-1GHz safeguard cap** of 2x27.5MHz (as in the March 2011 consultation)
 - **Overall spectrum cap** of 2x105MHz (as in the March 2011 consultation)
 - **Reserve prices, set by reference to estimated market value with a discount**
 - **Reservation for a fourth national wholesaler of one of the portfolios shown in the rows in the following table:**

| 800MHz | 1800MHz | 2.6GHz |
|--------|---------|--------|
| 2x15 | | |
| 2x10 | | 2x10 |
| 2x10 | 2x15 | |
| | 2x15 | 2x10 |

- 8.4 This group of portfolios is on the assumption that the 2x15MHz of divested 1800MHz spectrum is in the auction (and would be adapted accordingly if this was not the case).

Options assessed

- 8.5 In the following sections, we assess:
- Option 1: No measures in the auction to promote national wholesale competition
 - Option 2: Safeguard caps
 - Option 3: Tight caps to promote at least four national wholesalers
 - Option 4: Reservation for a fourth national wholesaler and safeguard caps
 - Option 5: Reservations to ensure at least four national wholesalers when sub-1GHz spectrum essential, and safeguard caps

- Option 6: Reservations to ensure at least four national wholesalers when an early route to LTE is essential, and safeguard caps
 - Option 7: Reservations of spectrum to mitigate all risks to national wholesaler competition, and overall cap
- 8.6 For each option we provide a description, outline its rationale, and assess its effectiveness in addressing the potential competition concerns summarised at the end of Section 5 and its disadvantages. When we consider the effectiveness of the options at addressing competition concerns, we do this by comparison with Option 1 (taking no measures in the auction to promote national wholesale competition). We also identify some variations to each option.
- 8.7 Some of the options we consider include measures to address concerns that might be unnecessary if some of our provisional conclusions in Section 4 and Section 5 are correct. But we consider such options anyway recognising that our provisional conclusions could change following consultation having considered any further comments and evidence provided by stakeholders. For example, we provisionally conclude in Section 4 that sub-1GHz spectrum is likely not to be necessary to be a credible national wholesaler, if sufficient other spectrum is held. If that were the case, then Option 5 may be unnecessary to ensure at least four credible national wholesalers. Also, the second competition concern against which we assess each of the options (“Everything Everywhere not credible because no sub-1 GHz spectrum”) might be redundant. But we include it in this assessment because we are consulting on all of our provisional conclusions, and hence depending on consultation responses it may be the case that we ultimately decide that sub-1GHz spectrum is required to be a credible national wholesaler. Similarly Option 6 is unnecessary if the third competition concern (“Telefónica/Vodafone not credible...”) is of as low importance as in our current assessment. But we include it allowing for the possibility that Telefónica and Vodafone are either not credible with their existing holdings or are unlikely to obtain in the auction the spectrum they need to be credible.
- 8.8 Having considered each option in isolation, we then compare the options against each other, taking into account our analysis of the importance of each of the potential competition concerns as discussed in Sections 4 and 5 which arise out of our overall policy aim to promote competition in mobile markets, the range of measures in Section 6 and also our assessment of the possible regulatory failures in Section 7. From this comparison we draw our provisional conclusions on the option that we consider, based on the current evidence available to us, is most appropriate and proportionate to promote national wholesale competition. This assessment takes into account the requirement that any measures imposed in the auction should be no more onerous than is necessary to achieve our overall policy aim.

Option 1: No measures in the auction to promote national wholesale competition

- 8.9 Section 5 of this Annex considers the likelihood of the potential auction outcomes that could be detrimental to competition outlined in Section 4 in the absence of measures in the auction to promote national wholesale competition.
- 8.10 For the reasons set out in Section 5, our provisional view is that, with no measures in the auction to promote national wholesale competition, some of the competition concerns outlined in Section 4 would not be addressed, e.g. see Figure 5.28 at the end of Section 5.

Option 2: Safeguard caps

Description and rationale for option

- 8.11 Option 2 involves the use of ‘safeguard’ caps only. By this we mean caps set at a relatively high level. This option is designed to avoid very asymmetric spectrum outcomes where one national wholesaler obtains the majority of the spectrum, but limits the potential for causing an inefficient spectrum allocation by still allowing a considerable degree of freedom on different bidders to acquire spectrum.
- 8.12 We consider the following specific safeguard caps (as in the March 2011 consultation):
- **Sub-1GHz safeguard cap of 2x27.5MHz.**
 - **Overall spectrum cap of 2x105MHz.**²²³
- 8.13 We set out our view of the effectiveness of Option 2 in Figure 8.1 below. The last column summarises our view on the effectiveness of the option at addressing each concern. This is expressed independent of the importance we put on the concern.
- 8.14 In a market with four national wholesalers, caps at these levels could mean that one competitor obtained roughly 40%, either overall or of sub-1GHz, with the remaining 60% distributed between the other three competitors. This is not at a level that is too restrictive and so the risk of inefficiency is relatively low. Also, compared to larger safeguard caps it would exclude a range of more asymmetric distributions of spectrum.

²²³ We propose including the unpaired 2.6 GHz within the overall cap, as in the March 2011 consultation. For Everything Everywhere, the 2x15MHz of 1800MHz spectrum that it must divest is excluded when considering its compliance with the overall cap.

Figure 8.1: Effectiveness of ‘Option 2: Safeguard caps only’ in addressing competition concerns

| Competition concern | Comment | Effectiveness of option |
|--|---|-------------------------|
| Concern that fewer than four credible national wholesalers | | |
| 1. Fourth national wholesaler not credible because insufficient share of spectrum & no sub-1 GHz spectrum & also no spectrum for early route to LTE or high peak data rates with early LTE | The safeguard caps may mitigate this concern to some extent by making it more likely that a fourth national wholesaler will obtain spectrum it needs to be credible and by restricting the amount any one competitor can obtain (both of overall and sub-1GHz spectrum). However, we consider that the caps in this option would not mitigate this concern to a large extent, because of the level at which they are set. There remain many plausible auction outcomes where a fourth national wholesaler may not be credible. | Low |
| 2. Everything Everywhere not credible because no sub-1 GHz spectrum | This option improves the likelihood of Everything Everywhere obtaining sub-1GHz spectrum due to the sub-1GHz spectrum cap. But while it ensures that at least three national wholesalers have sub-1GHz spectrum, it does not ensure four, so Everything Everywhere may not obtain sub-1GHz spectrum. But as Everything Everywhere may have higher intrinsic value for the sub-1GHz spectrum than a fourth national wholesaler, we consider the sub-1GHz cap mitigates this risk to some extent. (We do not consider that the overall spectrum cap significantly impacts whether Everything Everywhere is credible given its existing high share of spectrum and the high level of the overall cap). | Medium |
| 3. Telefónica/Vodafone not credible because no spectrum for early route to LTE, high peak data rates with early LTE or greater capacity | This option mitigates the concern to some limited extent as the overall spectrum cap limits what Everything Everywhere can obtain. The sub-1GHz spectrum cap prevents Vodafone & Telefónica from obtaining 2x15MHz of 800MHz spectrum, so making it harder to obtain a large contiguous block for LTE. But we consider it unlikely that the sub-1GHz spectrum cap makes it materially harder for them to be credible because if they obtained the maximum allowed by the cap (2x10MHz of 800MHz spectrum) they would be likely to be credible. | Low |
| Concern that even if at least four credible national wholesalers one or more wholesalers is at a disadvantage in competing across a wide range of services and customers | | |
| 4. Weaker competition because one or more competitors does not have sub-1GHz spectrum | Sub-1GHz spectrum cap ensures at least three national wholesalers have sub-1GHz spectrum, but it does not ensure at least four. | Medium |
| 5. Weaker competition because one or more competitors does not have early route to LTE | Safeguard caps mitigate to limited extent by encouraging wider distribution of awarded spectrum (though set at high levels). Ensures at least two national wholesalers have 800MHz spectrum which provides an early route to LTE. (Divestment of 2x15MHz of 1800MHz spectrum also clearly helps this concern and following concern. But it could be bought by same party as buys 800MHz spectrum. As this divestment is happening anyway and is independent of the options, we do not mention this divestment in the tables on effectiveness of other options). | Low |
| 6. Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE | Overall cap mitigates to limited extent by limiting quantity of spectrum Everything Everywhere can acquire (though set at high level). But sub-1GHz spectrum cap prevents Vodafone or Telefónica from obtaining 2x15MHz of 800MHz spectrum. Overall effect unclear. | Low |
| 7. Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates | Safeguard caps mitigate to limited extent. By preventing any national wholesaler obtaining more than c40% of spectrum, others more likely to have more. But effectiveness limited as safeguard caps set at around 40% of total paired spectrum. | Low to Medium |
| 8. Weaker competition because one competitor has a very large share of spectrum | Safeguard caps mitigate by preventing any national wholesaler obtaining more than c40% of spectrum overall or of sub-1GHz spectrum. | High |

Risks of measures causing spectrum inefficiency or other disadvantages

- 8.15 These caps would prevent Vodafone and Telefónica from acquiring more than 2x10MHz of sub 800MHz, and also prevent Everything Everywhere buying large quantities of spectrum overall. Preventing them from obtaining that spectrum (if it were not outweighed by an increase in competitive intensity) could be detrimental to spectrum efficiency.
- 8.16 This option could weaken competition if large blocks of contiguous spectrum for LTE in 800MHz were important because it would prevent Vodafone or Telefónica from obtaining more than 2x10MHz of 800MHz.
- 8.17 Given the high levels of these caps, we consider that the risk of the measures leading to spectrum inefficiency is not high.²²⁴

Variations of option

- 8.18 The precise levels of the safeguard caps could be different.
- 8.19 In the March 2011 consultation we also consulted on an overall spectrum cap set at the higher level of 2x120MHz.²²⁵ Alternatively, the overall spectrum cap could be set at a tighter level than 2x105MHz, such as 2x95MHz (36%) of paired mobile spectrum. In general, the tighter the cap, the less the risk of a competition concern arising from an asymmetric spectrum holding, but the greater the risk of causing spectrum inefficiency.
- 8.20 Similarly the sub-1GHz spectrum cap could be set looser or tighter. In the March 2011 consultation we considered the level of 2x22.5MHz.²²⁶
- 8.21 The safeguard caps in the other options considered below could also be varied in the same way as for this option.
- 8.22 Option 3 below considers much tighter versions of the overall and sub-1GHz spectrum caps.

Summary of advantages and disadvantages

- 8.23 As can be seen from Figure 8.1 above, the safeguard caps mitigate some of the competition concerns. They are particularly effective at mitigating the last competition concern. They ensure that no one national wholesaler can hold a very large share of spectrum overall or of sub-1GHz spectrum.
- 8.24 For example, without the safeguard caps, it would in theory be possible for Everything Everywhere to obtain over 60% of paired mobile spectrum, or for one of Vodafone or Telefónica to obtain over 70% of sub-1GHz spectrum. We consider that such heavily skewed spectrum distributions would be likely to weaken the competitive structure in mobile markets and may undermine the credibility of other

²²⁴ We now propose to have 10 lots of 5MHz for the unpaired 2.6GHz spectrum rather than having it all in a single package. Subject to eligibility, bidders could bid for 2 lots of unpaired spectrum to all 10 lots. This could make it easier for Everything Everywhere to bid for some of the unpaired 2.6GHz spectrum and stay within the overall cap. This is different to the proposals in our March 2011 consultation where we proposed to auction the unpaired 2.6GHz spectrum as a single package..

²²⁵ See paragraphs 6.124 to 6.131 of Annex 6 of the March 2011 consultation.

²²⁶ See paragraphs 6.117 to 6.123 of Annex 6 of the March 2011 consultation.

national wholesalers. While such extreme outcomes are probably implausible even without measures in the auction, the safeguard caps ensure that they cannot occur and so hence help to reduce competition concerns.

- 8.25 We recognise that these caps could lead to spectrum inefficiencies and there is even a risk that the sub-1GHz spectrum cap could reduce competition. However, we consider that these risks are relatively low compared to the competition benefits of the safeguard caps, given that they are set at a relatively high level.
- 8.26 In other options, we consider the use of safeguard caps in combination with other measures. Our provisional conclusion is that these safeguard caps are likely to be more effective when combined with other measures.

Option 3: Tight caps to promote at least four national wholesalers

Description and rationale for option

- 8.27 Option 3 is intended to promote at least four national wholesalers through tight caps on spectrum holdings, both at sub-1GHz and overall. These caps ensure that at least four national wholesalers have access to some sub-1GHz spectrum.
- 8.28 We consider tight caps on overall spectrum and sub-1GHz spectrum holdings:
- **2x20MHz cap on sub-1GHz spectrum**
 - **2x80MHz cap on overall spectrum**
 - **Reserve prices, set by reference to estimated market value with a discount**
- 8.29 A new entrant would be able to acquire spectrum up to these caps. These caps would mean that the existing national wholesalers would face the following restrictions:
- Everything Everywhere would not be allowed to acquire more than 2x15MHz of spectrum, which could be made up of any combination of 800MHz or 2.6GHz.
 - Vodafone would not be allowed to acquire any 800MHz spectrum and would not be able to acquire more than 2x40MHz from the divested 2x15MHz of 1800MHz or 2.6GHz spectrum.
 - Telefónica would not be allowed to acquire any 800MHz spectrum and would not be able to acquire more than 2x45MHz from the divested 2x15MHz of 1800MHz or 2.6GHz spectrum.
 - H3G would not be allowed to acquire more than 2x20MHz of 800MHz spectrum or 2x65MHz of spectrum overall.
- 8.30 If there were no successful new entrant bidders in the auction, these caps effectively ensure that H3G has at least 2x15MHz of 800MHz spectrum.²²⁷

²²⁷ Of the four existing national wholesalers, only Everything Everywhere and H3G are eligible to obtain 800MHz spectrum. Everything Everywhere is restricted in the amount it can obtain to 2x15MHz by the overall cap, given it currently has 2x65MHz. Hence if there were only the four existing national

- 8.31 These caps represent around 30% of sub-1GHz spectrum and overall spectrum respectively. If only the four existing national wholesalers obtained spectrum in the auction, these caps would ensure that they all obtained spectrum (provided they were prepared to pay the reserve prices). The most uneven distribution that could result would involve H3G obtaining 10% of spectrum overall, and this would have to include 2x15MHz of 800MHz spectrum.
- 8.32 If a new entrant acquired spectrum, this may increase competition in the short term, as there would be five competitors. But in the longer term the spectrum holdings of the smaller holders may need to come together in some way for there to be at least four national wholesalers credible in the long term (see paragraph 8.52 below).

Reserve prices, set by reference estimated market value with a discount

- 8.33 This option includes setting reserve prices on a basis that would result in reserve prices at a much higher level than we have used in previous auctions, where we have set reserve prices merely to deter frivolous bidders. Reserve prices would be set by reference to estimated market value albeit with a discount to that value. Reserve prices would be set at this level so as to balance different risks, as discussed as paragraph 7.17 above.

wholesalers, H3G would be able to obtain 2x15MHz of 800MHz spectrum, provided it was prepared to pay the reserve price.

Figure 8.2: Effectiveness of ‘Option 3: Tight sub-1GHz spectrum caps’ in addressing competition concerns

| Competition concern | Comment | Effectiveness of option |
|--|--|-------------------------|
| Concern that fewer than four credible national wholesalers | | |
| 1. Fourth national wholesaler not credible because insufficient share of spectrum & no sub-1 GHz spectrum & also no spectrum for early route to LTE or high peak data rates with early LTE | Assuming only four national wholesalers, this option ensures that a fourth national wholesaler would be able to obtain at least 2x15MHz of sub-1GHz spectrum (subject to paying the reserve price). We consider that a fourth national wholesaler would be likely to be credible with 2x15MHz of 800MHz spectrum, but some small risk it may not be. If a new entrant obtained spectrum this may increase competition further in the short term, with a route to at least four credible national wholesalers in the long term. | High |
| 2. Everything Everywhere not credible because no sub-1 GHz spectrum | Assuming only four national wholesalers, this option ensures that Everything Everywhere would be able to obtain 2x15MHz of sub-1GHz spectrum. We consider that Everything Everywhere would very likely be credible if it obtained 2x15MHz of 800MHz spectrum. | High |
| 3. Telefónica/Vodafone not credible because no spectrum for early route to LTE, high peak data rates with early LTE or greater capacity | Neither Telefónica nor Vodafone could obtain 800MHz spectrum. But they would each be much more likely to be able to obtain 1800MHz or 2.6GHz spectrum due to the 2x80MHz overall spectrum cap. And even if one of them did not obtain spectrum, their competitors would be capped in the amount of spectrum they had. | High |
| Concern that even if at least four credible national wholesalers one or more wholesalers is at a disadvantage in competing across a wide range of services and customers | | |
| 4. Weaker competition because one or more competitors does not have sub-1GHz spectrum | This option ensures at least four national wholesalers with sub-1GHz spectrum, and if there are only four it ensures they would each have at least 2x10MHz of sub-1GHz spectrum. | High |
| 5. Weaker competition because one or more competitors does not have early route to LTE | This option ensures at least three national wholesalers have spectrum suitable for an early route to LTE, and makes it likely there would be four. | Medium to High |
| 6. Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE | This option makes it likely that a fourth national wholesaler would obtain 2x15MHz of 800MHz. The overall cap also makes it more likely that a number of national wholesalers would have large blocks of contiguous spectrum at some frequency. | Medium to High |
| 7. Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates | If the auction resulted in four national wholesalers, then the most uneven distribution of spectrum that can result from this option is three have 30% and one has 10%, so ensuring at least three have more than 20% of spectrum. The tight caps therefore contribute significantly to ensuring that competition is not weaker because some national wholesalers are capacity constrained. | Medium to High |
| 8. Weaker competition because one competitor has a very large share of spectrum | Tight caps prevent any national wholesaler obtaining more than c30% of spectrum overall or of sub-1GHz spectrum. | High |

Risks of measures causing spectrum inefficiency or other disadvantages

- 8.34 These caps are very restrictive. For example, they would prevent Vodafone and Telefónica from acquiring any 800MHz spectrum, and would severely limit the amount of spectrum that Everything Everywhere could obtain.
- 8.35 As set out in Section 7 above, there is a risk that measures may not be in consumers' interests because they could cause spectrum inefficiency or other disadvantages. In general, the more restrictive the measures, the greater is this risk. An example of how a restriction might lead to consumer detriment might be if one of Vodafone or Telefónica would have used 800MHz spectrum to deliver services that were more attractive to consumers than any other national wholesaler, but were prevented by this option from obtaining 800MHz spectrum. One of them might have been more effective at offering services because of a different business plan or if it were quicker and more effective to deploy LTE800 with an existing 900MHz network in place.
- 8.36 As mentioned in paragraph 7.20 above, a risk with this option is that the combination of tight caps and reserve prices set by reference to expected market value means that some spectrum is unsold even though some companies would have been prepared to pay the reserve price for the spectrum. For example, this could happen if a fourth national wholesaler were not prepared to pay the reserve price for 800MHz spectrum. This could result in unsold spectrum. There would be an inevitable delay before the spectrum could be re-auctioned. Given the value attached to 800MHz spectrum and to a lesser extent 2.6GHz spectrum, any such delay could be very inefficient.

Variations of option

- 8.37 Because of the potential disadvantage mentioned above of reserve prices when combined with a tight cap meaning the award of spectrum might be delayed, one variation of this option would be to have lower reserve prices. However, while this reduces the risk of a delay in the award of the spectrum, it would be at the cost of greater risk of the spectrum being allocated to a party that had much lower intrinsic value than the bidder with significantly higher intrinsic value, which might not be in consumers' interests (as discussed in paragraphs 7.17 to 7.18 above).
- 8.38 The levels of the overall and sub-1GHz caps could be changed, either to be even tighter or more relaxed. If they were made tighter, it would increase the risk that they could cause spectrum inefficiency or other disadvantages. If they were made significantly more relaxed, this option would become more similar to Option 2, i.e. safeguard caps.
- 8.39 To allow Vodafone and Telefónica to obtain 800MHz spectrum, this option could be modified to allow the relinquishment of 900MHz spectrum at a specified later date to allow Vodafone and Telefónica to compete for 800MHz spectrum. We discuss the possibility of relinquishment in more detail when we consider Option 7 below.

Summary of advantages and disadvantages

- 8.40 This option is effective at addressing most of the competition concerns, as shown in Figure 8.2 above. In particular, it is highly likely to result in at least four credible national wholesalers.
- 8.41 However, this comes at the cost of very restrictive measures in the auction. Very restrictive measures may not be in consumers' interests because they could cause

spectrum inefficiency or other disadvantages such as unsold spectrum, as discussed above.

Option 4: Reservation for a fourth national wholesaler and safeguard caps

Description and rationale for option

8.42 This option is designed primarily to ensure a fourth national wholesaler acquires the spectrum that enables it to be credible. It could be appropriate if (and is predicated on our assessment based on current evidence that) Everything Everywhere, Vodafone and Telefónica were likely to be credible with their existing spectrum holdings, or were likely to obtain what they need to be credible in the auction.

8.43 Option 4 involves:

- **Sub-1GHz safeguard cap of 2x27.5MHz** (as with Option 2)
- **Overall spectrum cap of 2x105MHz** (as with Option 2)
- **Reserve prices, set by reference to estimated market value with a discount** (as with Option 3)
- **Reservation for a fourth national wholesaler of one of the portfolios shown in the rows in the following table:**

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|---------------|----------------|---------------|
| Portfolio 14: | 2x15 | | |
| Portfolio 15: | 2x10 | | 2x10 |
| Portfolio 16: | | 2x15 | 2x10 |
| Portfolio 20: | 2x10 | 2x15 | |

Auction determines which portfolio selected

8.44 Exactly which of these portfolios was reserved for a fourth national wholesaler would be determined by the auction. The winning set of bids would be those that maximised value (as expressed in auction bids), subject to meeting the constraint of a fourth national wholesaler obtaining one of the possible portfolios (assuming a fourth national wholesaler were willing to pay the reserve price). This also allows competition between different eligible companies for the reserved spectrum. All bidders could therefore influence which portfolio was obtained to some extent.

8.45 This reduces the risk of inefficient spectrum allocation by allowing bidding in the auction to have a greater influence over the acquisition of spectrum. However, there would be a risk that if one of the portfolios were insufficient to ensure a fourth national wholesaler was credible, it might obtain that portfolio and there could still be fewer than four credible national wholesalers.

8.46 When we have a group of alternative portfolios for reservation in other options, we also envisage the auction determining which one is actually reserved.

Inclusion of portfolio 20

- 8.47 The group of portfolios above is based on the middle group of portfolios we consider in Section 4 to make a fourth national wholesaler credible. However, it also includes Portfolio 20 (i.e. 2x10MHz of 800MHz and 2x15MHz of 1800MHz) as this portfolio would also assist a fourth national wholesaler to be credible. Portfolio 20 was in the group of larger portfolios that we considered in Section 4 that might be required for a fourth national wholesaler to be credible. We consider that this portfolio gives a higher level of confidence that it would be sufficient to make a fourth national wholesaler credible, than the other portfolios included in the reservation (i.e. portfolios 14, 15 and 16). However, we consider it may not be possible to reduce portfolio 20 without giving a lower level of confidence than the other portfolios included. This is because 2x5MHz of 800MHz plus 2x15MHz of 1800MHz may give a lower level of confidence and it is not possible to reduce the size of the block containing 1800MHz (as the divested 2x15MHz of 1800MHz is to be sold as a single block). While this portfolio is therefore 'stronger' than the others, if it were the portfolio that maximised the value of the winning set of bids (given the constraints imposed by reservation), we consider it would be more efficient for it to be the portfolio reserved.
- 8.48 There is no need to include the other larger portfolios (i.e. portfolios 17, 18, 19 and 21 set out in Section 4), as they are all just larger amounts of the same spectrum in the portfolios above. This means that they could never be selected to be reserved because there is always a smaller portfolio (i.e. one of portfolios 14, 15 or 16) that would satisfy the constraint of one of the portfolios being reserved more easily. Portfolio 20 is different because it has a mix of spectrum that is different to portfolios 14, 15 or 16, and is not simply a larger version of one of them.

Same reservation for a new entrant as for H3G

- 8.49 For this option and such reservations in other options, we propose to have the same reservation for H3G or a new entrant. This is despite H3G already having 2x15MHz of 2.1GHz spectrum, and the above portfolios being formulated by considering them when added to H3G's 2x15MHz of 2.1GHz spectrum.
- 8.50 We have considered whether a group of larger portfolios should be specified for a potential new entrant than for H3G. This would not necessarily make it easier for the new entrant to obtain any reserved spectrum. As the winning set of bids would be those that maximised value (as reflected in auction bids), subject to meeting the constraint of one reserved portfolio going to either H3G or a new entrant, if the new entrant's group of portfolios were bigger than H3G's, in order to win it would need to outbid other bidders (including Everything Everywhere, Telefónica and Vodafone) for the additional spectrum. This could make it harder for the new entrant to obtain spectrum reserved for a fourth national wholesaler in competition in the auction against H3G. In other words, the new entrant would not have the option of only obtaining a small amount of reserved spectrum, and this might make it less likely to obtain a larger amount of reserved spectrum. Larger portfolios could therefore make it harder for the new entrant.
- 8.51 When the amount of reserved spectrum is the same for H3G and a new entrant, then the new entrant can compete on equal terms for the reserved spectrum and has the option of buying any additional spectrum it needs in the normal way in the auction. We would expect the reserved spectrum to be obtained by the eligible bidder with the highest intrinsic value. This seems appropriate as we do not have a prior preference

as between H3G or a new entrant obtaining the spectrum reserved for a fourth national wholesaler.

- 8.52 Moreover, to promote at least four credible national wholesalers, it may be excessive to reserve more spectrum than the minimum necessary to be credible when combined with H3G's 2x15MHz of 2.1GHz spectrum. It may be possible for a new entrant to buy the spectrum in one of the portfolios and to launch a successful LTE service soon after the auction. In the near term this could lead to stronger competition, as there would be five competitors. In the longer term, H3G and the new entrant may not each have sufficient spectrum to be credible. However, if necessary at that point, it might be possible for the two spectrum holdings to be brought together in some way, by network sharing, a trade or a merger, while still retaining at least four credible national wholesalers. In this way we consider that it may be possible for a new entrant to obtain only the reserved spectrum and to become credible in the longer term. We recognise that there could be a strategic incentive on Everything Everywhere, Telefónica or Vodafone to obtain one of these two spectrum holdings to prevent a fourth credible national wholesaler in the longer term. However, if this were through a spectrum trade, it would be subject to a competition assessment at that time.²²⁸
- 8.53 We recognise that if spectrum holdings were more dispersed there is some risk that they do not come together to enable at least four credible national wholesalers in the longer term. However, the risk of unnecessary restrictions on spectrum outcomes leading to an inefficient spectrum allocation is higher if we reserve more than the minimum necessary to enable at least four national wholesalers to be credible in the longer term.
- 8.54 On balance, we therefore consider it is likely to be sufficient for promoting at least four national wholesalers to set the same portfolios for H3G and a new entrant. This does not preclude a new entrant obtaining sufficient spectrum in the auction to be credible even in the longer term, but it may need to obtain more than the reserved spectrum (either in the auction or subsequently).

Other characteristics of option

- 8.55 This option involves higher reserve prices than has been the case in past auctions. This means that this option would only guarantee the reserved spectrum for a fourth national wholesaler if it were prepared to pay the reserve price. If a fourth player were not prepared to pay the reserve price, the constraint of the reservation would be removed and the only constraints in the auction would be the safeguard caps.

Divested 2x15MHz of 1800MHz spectrum

- 8.56 The above group of portfolios assumes that the 2x15MHz of 1800MHz is in the auction. If it had been divested in advance and is not acquired by H3G or a new entrant, then the portfolios that include the divested spectrum would need to be deleted and the group of portfolios would shrink to the following (i.e. portfolios 14 and 15).

²²⁸ See: <http://stakeholders.ofcom.org.uk/binaries/consultations/trading-900-1800-2100/statement/900-1800-2100-statement.pdf>

| 800MHz | 1800MHz | 2.6GHz |
|---------------|----------------|---------------|
| 2x15 | | |
| 2x10 | | 2x10 |

8.57 Alternatively, if the divested 2x15MHz of 1800MHz were obtained by H3G or a new entrant before the auction, then the group of portfolios would be as follows.²²⁹

| 800MHz | 1800MHz | 2.6GHz |
|---------------|----------------|---------------|
| 2x10 | | |
| | | 2x10 |

8.58 When combined with 2x15MHz of 1800MHz, these would provide portfolios 20 and 16 respectively (and portfolios 14 and 15 would go beyond the minimum requirement).

²²⁹ For similar reasons to those in paragraphs 8.49 to 8.54 above, we do not consider it essential that the divested 2x15MHz of 1800MHz spectrum is obtained by the same party as obtains the reserved portfolio.

Figure 8.3: Effectiveness of ‘Option 4: Reservation for a fourth national wholesaler and safeguard caps’ in addressing competition concerns

| Competition concern | Comment | Effectiveness of option |
|--|---|-------------------------|
| Concern that fewer than four credible national wholesalers | | |
| 1. Fourth national wholesaler not credible because insufficient share of spectrum & no sub-1 GHz spectrum & also no spectrum for early route to LTE or high peak data rates with early LTE | The option is designed to address this concern directly through a reservation for a fourth national wholesaler. The safeguard caps also help to mitigate this concern as described in Option 2. (However, the option may not eliminate the concern, because one of the portfolios may be insufficient to make a fourth national wholesaler credible. The effectiveness of this option for addressing this concern could be increased by increasing the spectrum reserved for a fourth national wholesaler. It is also possible that a fourth national wholesaler may not be prepared to pay the reserve price) | High |
| 2. Everything Everywhere not credible because no sub-1 GHz spectrum | This option has an ambiguous effect on whether Everything Everywhere is more or less likely to obtain sub-1GHz spectrum. While the sub-1GHz spectrum cap tends to mitigate the concern that Everything Everywhere does not obtain sub-1GHz spectrum by limiting how much each of Telefónica and Vodafone can acquire, the possible reservation for a fourth national wholesaler of sub-1GHz (if a portfolio with sub-1GHz spectrum was acquired by a fourth national wholesaler) tends to increase the concern because there would be less left for others. We discuss this further below. | Low (may worsen) |
| 3. Telefónica/Vodafone not credible because no spectrum for early route to LTE, high peak data rates with early LTE or greater capacity | There are effects in both directions, but on balance this option may worsen this concern. The overall spectrum cap limits what Everything Everywhere can obtain, tending to mitigate the concern. But the reservation for a fourth national wholesaler increases this concern, as it limits the amount of spectrum suitable for an early route to LTE they can compete for. (As for Option 2, we do not think the sub-1 GHz spectrum cap worsens this concern). We discuss this further below. | Low (may worsen) |
| Concern that even if at least four credible national wholesalers one or more wholesalers is at a disadvantage in competing across a wide range of services and customers | | |
| 4. Weaker competition because one or more competitors does not have sub-1GHz spectrum | Possible reservation of sub-1GHz spectrum for a fourth national wholesaler and sub-1GHz spectrum cap mitigate concern, by ensuring at least three have sub-1GHz spectrum. But this option does not ensure at least four national wholesalers. | Medium |
| 5. Weaker competition because one or more competitors does not have early route to LTE | Reservation for a fourth national wholesaler and safeguard caps mitigate to some extent. | Low to Medium |
| 6. Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE | Safeguard caps have ambiguous effect (as in Option 2). Possible reservation for a fourth national wholesaler could make it easier for a fourth national wholesaler to obtain 2x15MHz of some frequency. | Low |
| 7. Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates | Mitigated to some extent by safeguard caps (as for Option 2) and by portfolio for a fourth national wholesaler, which boosts the spectrum holdings of the party with the smallest share | Medium to High |
| 8. Weaker competition because one competitor has a very large share of spectrum | Substantially the same as for Option 2. | High |

- 8.59 If Everything Everywhere needed sub-1GHz spectrum to be credible, there could be a danger of it being the victim of strategic investment. We discussed this situation when there were no measures in paragraphs 5.180 to 5.204 above. This option has an ambiguous effect on whether it is more or less likely that Everything Everywhere could be a victim of strategic investment compared to no measures. On one hand, the sub-1GHz spectrum cap tends to mitigate the concern that Everything Everywhere does not obtain sub-1GHz spectrum by limiting how much each of Telefónica and Vodafone can acquire to 2x10MHz. On the other hand, if a portfolio with sub-1GHz spectrum was reserved for a fourth national wholesaler, this would mean there was less left for others and could make this concern worse.²³⁰ On balance, we consider that the net effect on Everything Everywhere is not completely clear, but this option may worsen this concern.
- 8.60 If Vodafone and Telefónica needed spectrum for an early route to LTE, there may be a concern that one of them could be a victim of strategic investment, as discussed from paragraph 5.205 above. By reserving spectrum (for a fourth national wholesaler) that could otherwise provide an early route to LTE by Vodafone or Telefónica, this option reduces the spectrum available for them, which may worsen the concern, as discussed below.
- 8.61 Similarly, reserving 2x10MHz of 2.6GHz spectrum for low powered use – a possible measure which we consider in Section 9 - could affect the incentives of some national wholesalers to strategically invest to reduce competition to a limited extent. It would not affect the risk that Everything Everywhere could be a victim of strategic investment if sub-1 GHz spectrum were essential, but could increase the risk that Telefónica, Vodafone or H3G could be a victim of strategic investment in some circumstances. First, as a baseline we consider the effect on the risk of strategic investment without any other measures in the auction (i.e. reservation of 2x10MHz of 2.6GHz spectrum for low powered use combined with Option 1). Then we consider the effect on strategic investment when reservation of 2.6GHz spectrum for low powered use is combined with Option 4.
- 8.62 If there were no other measures in the auction, there would still be 2x60 MHz of 2.6 GHz available for high power use in macrocell networks, so any effect on the risk of strategic investment is likely to be small.
- 8.63 The risk of Telefónica and/or Vodafone being the victim of strategic investment could nonetheless be higher if spectrum was reserved both for a fourth national wholesaler and for low power use. The table below shows the quantity of spectrum that would be left for others in the auction in this case (this varies according to the reserved portfolio that a fourth national wholesaler would acquire as a result of the auction). The total amount of spectrum available would range from 2x90 MHz with Portfolio 14 to 2x80 MHz with Portfolios 16 and 20.

²³⁰ The situation would be analogous to that considered in paragraph 5.191 above (in which we consider the implication of a fourth national wholesaler having a higher intrinsic value for 2x10MHz of 800MHz, which reduces the amount of spectrum strategic investors would need to acquire to exclude Everything Everywhere from 2x10MHz of 800MHz).

Table 8.1: Remaining spectrum after reservation of 2x10MHz of 2.6GHz for low power use and for fourth national wholesaler with portfolio shown

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|---------------|----------------|---------------|
| Portfolio 14: | 2x15 | 2x15 | 2x60 |
| Portfolio 15: | 2x20 | 2x15 | 2x50 |
| Portfolio 16: | 2x30 | - | 2x50 |
| Portfolio 20: | 2x20 | - | 2x60 |

- 8.64 In Section 4 we set out that if Vodafone and Telefónica needed spectrum to be credible, 2x10 MHz of 800 MHz or 2x15 MHz of 1800 MHz or 2x20 of 2.6 GHz are likely to be sufficient. Given these rather limited requirements the spectrum available in the auction even after accounting for the portion reserved for a fourth national wholesaler and to low power use would still leave a wide set of alternatives for Vodafone and Telefónica to obtain what they need (also considering that the overall cap of 2x105MHz sets a limit of 2x40 MHz on what Everything Everywhere can acquire in the auction). Overall, while the risk of Vodafone and/or Telefónica being victim of strategic investment could be higher in this case we still consider that it is not very likely that they would fail to acquire the spectrum they need to be credible national wholesalers.
- 8.65 Spectrum reservation for a fourth national wholesaler could significantly increase the risk of strategic investment to foreclose Vodafone and Telefónica if Vodafone and Telefónica require some sub 2 GHz spectrum to be credible (either 2x10 MHz of 800 MHz or 2x15 MHz of 1800 MHz). However, as we set out in Section 4, our view is that these conditions are not likely to arise.

Risks of measures causing spectrum inefficiency or other disadvantages

- 8.66 The safeguard caps have similar risks of spectrum inefficiency and weakening competition as with Option 2.
- 8.67 There is a risk that a fourth national wholesaler obtains spectrum through the reservation when it has a lower intrinsic value than other national wholesalers and this is against consumers' interests. This would not be the case however if the potential benefits from increased competition outweigh the impact of a national wholesaler obtaining the spectrum when it had lower intrinsic value. We consider this risk is mitigated by the way reserve prices are set and by the possibility of future trading or consolidation. This is discussed further in section 7 above under regulatory failures.
- 8.68 If Everything Everywhere, Vodafone or Telefónica were not credible with their existing spectrum holdings, there is a risk that this option would make it harder for one or more to acquire the spectrum they need in the auction, especially if the portfolios go beyond the minimum required for a fourth national wholesaler to be a fourth national wholesaler.
- 8.69 There is a risk that we reserve more spectrum than is necessary for ensuring a fourth national wholesaler remains in the market as a credible competitor. If this were to happen the spectrum that was more than necessary to make a fourth national wholesaler credible might be inefficiently allocated, as it might have been more efficient for it to go to the bidder with the highest intrinsic value. The less spectrum that is reserved for a fourth national wholesaler, the lower this risk will be. (The opposing risk is that insufficient spectrum is reserved to ensure a fourth national

wholesaler is a credible national wholesaler and the measures are ineffective at ensuring at least four credible national wholesalers).

- 8.70 Another risk is that there are other portfolios that would be sufficient for a fourth national wholesaler to become credible. This might result in a fourth national wholesaler obtaining this spectrum when it would have been more efficient for it to have become credible by obtaining different spectrum. In the variations below we consider other possible portfolios.

Variations of option

- 8.71 We recognise that the precise type and amount of spectrum a fourth national wholesaler needs to be credible is, to a degree at least, uncertain. Above we have assumed the middle group of the three groups we considered in Section 4 that could make a fourth national wholesaler credible. Implicitly we have assumed that this is the only spectrum available in the auction that would be sufficient. There are a range of variations depending on exactly what spectrum is included in the group of portfolios for reservation.
- 8.72 One possible variant would be to add the portfolio of 2x5MHz of 800MHz plus 2x20MHz of 2.6GHz spectrum. This would be justified if we concluded that this portfolio was sufficient to make a fourth national wholesaler credible. If so, the risk of strategic investment would decrease slightly because the potential strategic investors would need to acquire more spectrum to prevent the fourth national wholesaler from obtaining the spectrum it needs to be credible. However, the plausible focal point for coordination of strategic investment discussed in Section 5 (i.e. 2x10MHz of 800MHz acquired by each of Vodafone, Telefónica and Everything Everywhere) would also prevent a fourth national wholesaler from acquiring 2x5MHz of 800MHz. In addition, there could be a concern that the fourth national wholesaler might not obtain the portfolio because of lower intrinsic value.

Group of smaller portfolios for fourth national wholesaler

- 8.73 Another variant would be to reserve a group of smaller portfolios. In Section 4, we set out the following group of portfolios which may be sufficient to ensure a fourth national wholesaler is credible.

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|---------------|----------------|---------------|
| Portfolio 12: | 2x10 | | |
| Portfolio 13: | | 2x15 | |

- 8.74 If the divested 1800MHz spectrum were traded in advance and were obtained by a fourth national wholesaler, then this variant would imply that there would be no reservation in the auction as a fourth national wholesaler would have sufficient spectrum. If it were acquired by Vodafone or Telefónica, then the only portfolio in this group would be 2x10MHz of 800MHz spectrum.
- 8.75 We consider this group of portfolios is at the lower end of the plausible range for what is required to make a fourth national wholesaler credible, as discussed in Section 4. The risk of causing an inefficient spectrum allocation as a result of reserving more than necessary for a fourth national wholesaler is lower with this group, but this is at the cost of an increase in risk that the competition concern will not be addressed, and that a fourth national wholesaler would not be credible even with this spectrum. It would be open to a fourth national wholesaler to compete in the auction for more

spectrum, but there would be a risk that it would fail to acquire such spectrum either because of lower intrinsic value or strategic investment by other national wholesalers.

Group of larger portfolios for fourth national wholesaler

8.76 We could also consider the group of larger portfolios to make a fourth national wholesaler credible that were considered in Section 4. This group is towards the upper end of the plausible range for what is likely to be required to make a fourth national wholesaler credible.

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|---------------|----------------|---------------|
| Portfolio 17: | 2x20 | | |
| Portfolio 18: | 2x15 | | 2x10 |
| Portfolio 19: | 2x10 | | 2x15 |
| Portfolio 20: | 2x10 | 2x15 | |
| Portfolio 21: | | 2x15 | 2x15 |

8.77 These portfolios would significantly reduce the concern that a fourth national wholesaler would have insufficient spectrum to be credible, but would increase the risk of causing an inefficient spectrum allocation as a result of reserving more than necessary for a fourth national wholesaler.

8.78 If H3G obtained some of these portfolios, its spectrum holding would be above those of Telefónica's current holdings. However, there might still be circumstances in which measures that resulted in this outcome were justified – for example, if we considered that Telefónica was likely to obtain spectrum in the auction, but we were concerned that a fourth national wholesaler would not obtain what it needed to be credible because it was likely to have lower intrinsic value.

8.79 If the 2x15MHz of 1800MHz was not in the auction because it had been divested in advance to a party other than H3G or a new entrant, then the group would consist only of the top three portfolios in the table above (i.e. Portfolios 17, 18 and 19).

8.80 Alternatively, if the divested 1800MHz were obtained by H3G or a new entrant before the auction, then the group of portfolios would be as follows.

| 800MHz | 1800MHz | 2.6GHz |
|---------------|----------------|---------------|
| 2x10 | | |
| | | 2x15 |

Sub-1 GHz spectrum

8.81 If we concluded that a fourth national wholesaler would not be credible without sub-1GHz spectrum, we would remove the portfolios that did not contain sub-1GHz spectrum.

8.82 This option could then involve reserving sub-1GHz spectrum for a fourth national wholesaler, but not for Everything Everywhere. This could be appropriate if we considered that:

- Everything Everywhere was credible with its existing spectrum holdings because of the large size of those holdings, with 2x45MHz of 1800MHz and 2x20MHz of 2.1GHz; but

- reserving some 800MHz was the only likely way of making a fourth national wholesaler credible with the spectrum in the auction.

2.6GHz spectrum only

- 8.83 If we considered that a fourth national wholesaler needed no spectrum at 2.1GHz and below (or in the case of H3G, no more spectrum at these frequencies), we could add portfolios with only 2.6GHz spectrum, e.g. 2x30MHz (or 2x20MHz or 2x40MHz in the groups of smaller and larger portfolios respectively).

Non-paired 2.6GHz spectrum

- 8.84 If we considered that in the longer term the non-paired 2.6GHz spectrum was likely to be a reasonable substitute for paired 2.6GHz spectrum, then we could add portfolios that allowed unpaired 2.6GHz spectrum where there was currently paired 2.6GHz spectrum. This would then increase the number of alternative portfolios that could be reserved in the auction. We would treat 20MHz of unpaired spectrum to be equivalent to 2x10MHz of paired spectrum.

Summary of advantages and disadvantages

- 8.85 We consider that reservation for a fourth national wholesaler is a targeted way of addressing the first competition concern (of a fourth national wholesaler not being credible). This option could be appropriate if we were primarily concerned about the first competition concern, and were less concerned about the other competition concerns.
- 8.86 A key issue in the assessment of this option is whether the amount and frequency of the spectrum reserved for a fourth national wholesaler is sufficient to ensure it is credible. The smaller the amount reserved, the larger the residual concern that a fourth national wholesaler may not be credible.
- 8.87 There is a risk that reserving spectrum for a fourth national wholesaler results in an inefficient spectrum allocation, if the fourth national wholesaler has lower intrinsic value. We consider this is mitigated by the way we propose to set the reserve price. This risk is greater the more spectrum that is reserved, as we may reserve more than is necessary to ensure at least four credible national wholesalers.
- 8.88 One way to consider the magnitude of the restrictions imposed is to consider how much of the spectrum in the auction is being reserved. With the middle group of portfolios, 13% to 22% of the total spectrum being auctioned is reserved. With the group of smaller portfolios this would only be 9-13%, whereas with the group of larger portfolios it would be 17-30%.
- 8.89 The group of portfolios considered in the main option (when considered combined with 2x15MHz of 2.1GHz spectrum) will be broadly comparable in the longer term to the holdings of Telefónica, which has the third smallest share of spectrum of the existing national wholesalers.²³¹ If this were not enough to be credible it would therefore be equally placed to other national wholesalers in terms of spectrum to

²³¹ For example, Portfolio 14 would be 2x15MHz of 800MHz plus 2x15MHz of 2.1GHz, compared to Telefónica's 2x17.4MHz of 900MHz plus 2x10MHz of 2.1GHz and 2x5.8MHz of 1800MHz. The amounts of sub-1GHz spectrum are roughly equal and the amounts of 1800/2100MHz spectrum are roughly equal.

compete for further spectrum in the auction. Even if the portfolios were not sufficient, the reservation of part of the spectrum might make strategic investment more difficult because the fourth national wholesaler might only need to obtain a little more to be credible (perhaps at any frequency) and it might be difficult to prevent this. However, there may still be some risk of it not obtaining the spectrum it needs to be credible if it has a lower intrinsic value.

8.90 This option does not address some of the other potential competition concerns particularly well, as shown in Figure 8.3 above. Although it may make the second and third competition concerns worse, as discussed above, it is not clear that any such effect would be significant.

Option 5: Reservations to ensure at least four national wholesalers when sub-1GHz spectrum essential, and safeguard caps

Description and rationale for option

8.91 This option is designed to ensure at least four credible national wholesalers by ensuring at least four have sub-1GHz spectrum. It involves reservation for a fourth national wholesaler broadly as set out for Option 4, except that portfolios without sub-1GHz are excluded. It also involves reservation specifically of sub-1GHz for a different competitor, other than the two national wholesalers who already have sub-1GHz spectrum (i.e. Vodafone and Telefónica). This option would be effective in addressing competition concerns based on the view that sub-1GHz spectrum was essential to be a credible national wholesaler and if we thought that fewer than four would have sub-1GHz without measures in the auction, due to strategic investment.

8.92 Specifically, Option 5 involves:

- **Sub-1GHz safeguard cap of 2x27.5MHz** (as with Option 2)
- **Overall spectrum cap of 2x105MHz** (as with Option 2)
- **Reserve prices, set by reference to estimated market value with a discount** (as with Option 3)
- **Reservation for a fourth national wholesaler of one of the portfolios shown in the rows in the following table:**

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|---------------|----------------|---------------|
| Portfolio 14: | 2x15 | | |
| Portfolio 15: | 2x10 | | 2x10 |
| Portfolio 20: | 2x10 | 2x15 | |

- **Reservation of 2x10MHz of 800MHz spectrum for a different party who does not currently hold any sub-1GHz spectrum**

8.93 As with Option 4, the auction would determine which portfolio was reserved and for whom. The rationale for the portfolios for the fourth national wholesaler is the same as for Option 4, except that the portfolio without sub-1GHz has been removed.

8.94 This option is similar to our preferred proposal in our March 2011 consultation, in that it involves reserving 800MHz spectrum for two national wholesalers who currently do not have it. However, the amounts and details of the portfolios are different. In

particular, the amount of 800MHz spectrum reserved for each in this option is 2x10MHz rather than 2x5MHz in the March 2011 consultation.

- 8.95 One way these conditions could be satisfied is by a fourth national wholesaler obtaining one of the portfolios above and Everything Everywhere obtaining 2x10MHz of 800MHz spectrum. But other options are possible, for example, a new entrant could obtain the spectrum reservation in the table and H3G could obtain 2x10MHz of 800MHz to satisfy the final condition.
- 8.96 If a new entrant obtained 2x10MHz of 800MHz, then it could be that neither it nor Everything Everywhere would be credible in the longer term. In this case, it might be possible for the two spectrum holdings to be brought together in some way, for example by network sharing, a trade or a merger, while still retaining at least four credible national wholesalers (see above from paragraph 8.49).
- 8.97 In the event that two new entrants acquired reserved spectrum, then one would obtain 2x10MHz of 800MHz and one would obtain the larger reserved holding. The auction would determine who obtained which, depending on which was prepared to pay more for the larger reserved holding.
- 8.98 If two national wholesalers obtained at least 2x10MHz of reserved sub-1 GHz, then the sub-1GHz safeguard cap would be redundant. But it is included in this option because there are circumstances in which it could become relevant. In particular, if only one party were prepared to pay the reserve price for the reserved spectrum, then one of the reservation constraints would be removed. In this situation, the sub-1GHz safeguard cap could become relevant.

Figure 8.4: Effectiveness of ‘Option 5: Reservations to ensure at least four national wholesalers when sub-1GHz spectrum essential, and safeguard caps’ in addressing competition concerns

| Competition concern | Comment | Effectiveness of option |
|--|--|-------------------------|
| Concern that fewer than four credible national wholesalers | | |
| 1. Fourth national wholesaler not credible because insufficient share of spectrum & no sub-1 GHz spectrum & also no spectrum for early route to LTE or high peak data rates with early LTE | Substantially the same as for Option 4, though the reservations with this option would only include sub-1GHz spectrum, potentially reducing the concern that the reservation may be insufficient to ensure that a fourth national wholesaler is credible. | High |
| 2. Everything Everywhere not credible because no sub-1 GHz spectrum | The option is designed to ensure at least four national wholesalers have sub-1GHz spectrum. Assuming Everything Everywhere is one of them, we consider it would address this concern. | High |
| 3. Telefónica/Vodafone not credible because no spectrum for early route to LTE, high peak data rates with early LTE or greater capacity | This option may make this concern worse. While the overall spectrum cap may help mitigate the concern, the reservation of 800MHz for two others reduces the amount of 800MHz spectrum they could compete for. On the other hand our current view in Section 4 is that it would probably be sufficient for them to obtain an early route to LTE in 1800MHz or 2.6GHz spectrum. We discuss this below. As for Option 2, we do not think the sub-1 GHz spectrum cap worsens this concern. | Low (may worsen) |
| Concern that even if at least four credible national wholesalers one or more wholesalers is at a disadvantage in competing across a wide range of services and customers | | |
| 4. Weaker competition because one or more competitors does not have sub-1GHz spectrum | Reservation of sub-1GHz spectrum for two national wholesalers ensures that at least four have sub-1GHz spectrum, removing this concern. | High |
| 5. Weaker competition because one or more competitors does not have early route to LTE | While overall safeguard cap may help to some extent, concern may be worsened because likely that Everything Everywhere would obtain the reserved 2x10MHz of 800MHz spectrum (though a new entrant could also obtain it), leaving less 800MHz spectrum for those without an early route to LTE. However, our current view is that it would probably be sufficient for them to obtain an early route to LTE 1800MHz or 2.6GHz spectrum. | Low (may worsen) |
| 6. Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE | Overall spectrum cap mitigates to limited extent (as in Option 2). Reservation of at least 2x10MHz of 800MHz for a fourth national wholesaler could make it easier for it to obtain 2x15MHz of 800MHz spectrum, but reservation for other party may make this more difficult. Overall effect unclear. | Low |
| 7. Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates | Mitigated to some extent by safeguard caps (as for Option 2) and by portfolio for a fourth national wholesaler, which boosts the spectrum holdings of the party with the smallest share. However, reservation likely to be obtained by Everything Everywhere increases the spectrum share of the party with the largest existing share, reducing spectrum available for others, tending to worsen this concern | Medium |
| 8. Weaker competition because one competitor has a very large share of spectrum | Substantially the same as for Option 2. Likely reservation for Everything Everywhere increases the spectrum share of the party with the largest existing share, but Everything Everywhere's share still well below level of overall cap (before taking account of any further spectrum it may acquire). | High |

- 8.99 If Telefónica or Vodafone needed 800MHz or 1800MHz to be credible, there could be a danger of one of them being a victim of strategic investment. We discussed this situation when there were no measures from paragraph 5.205 above. Depending on the relative sizes of the pay-offs and the costs (which will depend on the intrinsic values the different parties put on the spectrum) Everything Everywhere and/or a fourth national wholesaler could have an incentive with this option to acquire the unreserved 2x10MHz of 800MHz to squeeze out one of Telefónica or Vodafone (assuming that the other obtained 2x15MHz of 1800MHz spectrum). If it were necessary to obtain 2x10MHz of 800MHz for Vodafone or Telefónica to be credible, then Everything Everywhere or a fourth national wholesaler would only need to obtain 2x5MHz more than the reserved 2x10MHz of 800MHz spectrum to stop one of them being credible.
- 8.100 These possibilities of strategic investment are consistent with this option potentially worsening the third and fifth competition concerns.

Risks of measures causing spectrum inefficiency or other disadvantages

- 8.101 The overall spectrum cap prevents any national wholesaler holding more than 2x105MHz of spectrum. But we consider the risk of this causing spectrum inefficiency to be relatively low given the cap is set at a relatively high level.
- 8.102 This option has many of the same risks as Option 4 but potentially magnified because of the greater extent of reservation. For example, it might reserve spectrum for a fourth national wholesaler and one other when this was not in consumers' interests. It could reserve more spectrum than is necessary for ensuring national wholesalers remain in the market as credible competitors. And we may fail to specify all the portfolios that would be sufficient for national wholesalers to become credible. These risks are explained more fully under Option 4.
- 8.103 By reserving sub-1GHz spectrum to a company other than Telefónica or Vodafone, this option could deprive Telefónica or Vodafone of 800MHz spectrum when they would have valued it most highly. This could potentially weaken competition if an early route to LTE in 800MHz or 1800MHz spectrum was important. This option also introduces the risk that spectrum is reserved for a second national wholesaler (either a new entrant or Everything Everywhere) when it does not need that spectrum to be credible.
- 8.104 Assuming Everything Everywhere outbids others to obtain a reservation of 2x10MHz of 800MHz spectrum, this option could involve an increase in the share of spectrum for the national wholesaler that already has the largest share.
- 8.105 This is illustrated in Figure 8.5 below. The first row shows the shares of spectrum that Everything Everywhere currently holds (excluding the 2x15MHz of 1800MHz that it must divest). The second row shows what the shares would be if Everything Everywhere obtained the reserved 2x10MHz of 800MHz. This shows that as a result of regulatory measures, Everything Everywhere's share of spectrum at 2.1GHz and below could rise to 38%, compared to 33% currently. And its share of total paired spectrum could be 28% compared to 24% currently.

Figure 8.5: Shares of paired spectrum for Everything Everywhere

| | Sub-1GHz spectrum | 2.1GHz and below | Total paired |
|--|--------------------------|-------------------------|---------------------|
| Everything Everywhere currently (excluding divested 1800MHz) | 0% | 33% | 24% |
| Row above plus 2x10 of 800MHz | 15% | 38% | 28% |

8.106 For Everything Everywhere’s share of spectrum to increase as a result of regulation may be detrimental to spectrum efficiency if Everything Everywhere has a lower intrinsic value for a large share compared to others, and could be detrimental to competition as it reduces the opportunities for others to increase their spectrum shares.

Variations of option

Variations in the group of portfolios reserved for fourth national wholesaler

8.107 As with Option 4, a difficulty with this option is assessing what type and amount of spectrum a fourth national wholesaler needs to be credible. Above we have assumed the middle of the three groups we considered in Section 4 that could make a fourth national wholesaler credible, except that the group above only includes portfolios that include at least 2x10MHz of 800MHz spectrum. One possible variation would be to include the portfolio with 2x5MHz of 800MHz and 2x20MHz of 2.6GHz spectrum, if we consider that this was sufficient for a fourth national wholesaler to be credible.

8.108 We could also consider smaller and larger portfolios that may be sufficient to make a fourth national wholesaler credible. We consider that all the variations considered in Option 4 are relevant for the reservation for a fourth national wholesaler, except that for this option any portfolios without sub-1GHz spectrum would be removed.

Variations in the 2x10MHz of 800MHz spectrum reserved for second company

8.109 We consider the combination of the reserved 800MHz spectrum and Everything Everywhere’s current spectrum holdings, because it might be possible to combine these two holdings in the future and still have at least four credible national wholesalers.

8.110 In Section 4, we considered three possible amounts for how much sub-1GHz spectrum Everything Everywhere might need if technical and market conditions were such that it needed some sub-1GHz spectrum to be credible. Above we considered the middle amount of 2x10MHz, but variations might be 2x5MHz or 2x15MHz. It also could be appropriate to reserve less sub-1GHz for Everything Everywhere than a fourth national wholesaler, if the large amounts of 1800MHz and 2.1GHz spectrum that Everything Everywhere has mean that it requires less sub-1GHz spectrum to be credible.

2x10MHz cap on 800MHz spectrum

8.111 Option 5 is similar in some respects to that in our March 2011 consultation, in that it means Everything Everywhere and H3G would be eligible for reserved spectrum involving sub-1GHz. In their responses to the March 2011 consultation, Vodafone and Telefónica raised the concern that Everything Everywhere may strategically invest in more 800MHz spectrum so as to prevent others having an early route to LTE and to obtain highest peak data rates possible with LTE with sub-1GHz

spectrum. One variant of this option would be to prevent this with a 2x10MHz cap on 800MHz spectrum.

Requirement on Everything Everywhere to relinquish to be eligible for reserved spectrum

8.112 H3G's response to the March 2011 consultation suggested that to be eligible to compete for the reserved spectrum, Everything Everywhere could be required to relinquish more 1800MHz spectrum. H3G suggested that Everything Everywhere could be required to relinquish 1800MHz on a 1:1 basis for the 800MHz reservation it wished to be eligible for. We consider how relinquishment arrangements might work in Option 7 below. A similar arrangement could be made for Everything Everywhere to be eligible for reserved 800MHz spectrum in this option. This would avoid regulatory intervention being the cause of a more asymmetric spectrum distribution.

Summary of advantages and disadvantages

8.113 This option could be appropriate if we considered that sub-1GHz spectrum was necessary to make a national wholesaler credible, that 800MHz and 900MHz spectrum were broadly equivalent, and we were concerned that Everything Everywhere may not obtain any sub-1GHz spectrum because of strategic investment.

8.114 A particular risk with this option is that it may weaken competition by concentrating on one competition concern, when other competition concerns matter more. For example, if Everything Everywhere did not need 800MHz to be credible and instead what was important was an early route to LTE with 800MHz or 1800MHz spectrum, then this option could lead to an inefficient spectrum allocation and make competition weaker rather than stronger.

8.115 Another potential disadvantage of this option is that the regulatory intervention would potentially reserve spectrum for Everything Everywhere when it already holds the largest share. This could be detrimental to spectrum efficiency if Everything Everywhere has a lower intrinsic value for additional spectrum due to its existing large share compared to others, and could be detrimental to competition as it reduces the opportunities for others to increase their spectrum shares.

Option 6: Reservations to ensure at least four national wholesalers when an early route to LTE is essential, and safeguard caps

Description and rationale for option

8.116 This option is designed to ensure at least four credible national wholesalers when an early route to LTE is important to being a national wholesaler. It involves reservation for a fourth national wholesaler and reservation of spectrum suitable for an early route to LTE for two other competitors, other than Everything Everywhere which already has an early route to LTE. This option would be effective in addressing competition concerns if an early route to LTE were particularly important and if we thought that fewer than four would obtain this without measures in the auction, due to strategic investment.

8.117 Option 6 involves:

- **Sub-1GHz safeguard cap of 2x27.5MHz** (as with Option 2)

- **Overall spectrum cap of 2x105MHz** (as with Option 2)
- **Reserve prices, set by reference to estimated market value with a discount** (as with Option 3)
- **Reservation for a fourth national wholesaler of one of the portfolios shown in the rows in the following table:** (as with Option 4)

| | 800MHz | 1800MHz | 2.6GHz |
|---------------|---------------|----------------|---------------|
| Portfolio 14: | 2x15 | | |
| Portfolio 15: | 2x10 | | 2x10 |
| Portfolio 16: | | 2x15 | 2x10 |
| Portfolio 20: | 2x10 | 2x15 | |

- **Reservation for two other companies other than Everything Everywhere of one of the portfolios shown in the rows in the following table:**

| | 800MHz | 1800MHz | 2.6GHz |
|--------------|---------------|----------------|---------------|
| Portfolio 6: | 2x10 | | |
| Portfolio 7: | | 2x15 | |
| Portfolio 8: | | | 2x20 |

- 8.118 The reservation for a fourth national wholesaler is as in Option 4, and is intended to ensure that a fourth national wholesaler would be credible.
- 8.119 Two further companies (which could be new entrants, Telefónica or Vodafone) would then be eligible for reservations as in the table above (i.e. one of Portfolios 6, 7 or 8).
- 8.120 In the event that two (or even three) new entrants acquired reserved spectrum, then one (or two) would obtain one of the smaller holdings in the second table (Portfolio 6, 7 or 8) and one would obtain the larger reserved holding in the first table (Portfolio 14, 15, 16 or 20). The auction would determine who obtained which portfolio, depending on who was prepared to pay more for the larger reserved holding. It might be possible for any new entrant's spectrum holdings to be brought together with an existing national wholesaler's spectrum holdings in the future, for example by network sharing, a trade or a merger, while still retaining at least four credible national wholesalers.

Second group of reserved portfolios

- 8.121 The second group of reserved portfolios above is based on the middle group of portfolios we consider in Section 4 as being sufficient to make Telefónica or Vodafone credible, in the event that they were not credible with their existing holdings.

Divested 1800MHz spectrum not in auction

- 8.122 If the divested 1800MHz spectrum were not in the auction because it had already been acquired by another party, then that party would already have an early route to LTE. In this case, this option would ensure that two other parties had an early route to LTE. The spectrum reservation for a fourth national wholesaler would change as in Option 4, depending on who obtained the spectrum. If it was Telefónica or Vodafone that obtained the divested spectrum, then the group of reserved portfolios in the first table for a fourth national wholesaler would exclude portfolios 16 and 20 which

contain 1800MHz spectrum; and the spectrum in the second table (Portfolio 6 or 8) would only be reserved for one other company rather than two. These modifications would still allow at least four national wholesalers to have an early route to LTE and sufficient capacity.

Figure 8.6: Effectiveness of ‘Option 6: Reservations to ensure at least four national wholesalers when an early route to LTE is essential, and safeguard caps’ in addressing competition concerns

| Competition concern | Comment | Effectiveness of option |
|--|---|-------------------------|
| Concern that fewer than four credible national wholesalers | | |
| 1. Fourth national wholesaler not credible because insufficient share of spectrum & no sub-1 GHz spectrum & also no spectrum for early route to LTE or high peak data rates with early LTE | Substantially the same as for Option 4. | High |
| 2. Everything Everywhere not credible because no sub-1 GHz spectrum | This option has an ambiguous effect on whether Everything Everywhere is more or less likely to obtain sub-1GHz spectrum. The sub-1GHz spectrum cap tends to mitigate the concern that Everything Everywhere does not obtain sub-1GHz spectrum by limiting how much each of Telefónica and Vodafone can acquire. But the possible reservations of sub-1GHz for other parties may make it harder for Everything Everywhere to obtain any, especially if it could be the victim of strategic investment. | Low (may worsen) |
| 3. Telefónica/Vodafone not credible because no spectrum for early route to LTE, high peak data rates with early LTE or greater capacity | By reserving a quick route to LTE for at least three national wholesalers, this option significantly reduces this concern. | High |
| Concern that even if at least four credible national wholesalers one or more wholesalers is at a disadvantage in competing across a wide range of services and customers | | |
| 4. Weaker competition because one or more competitors does not have sub-1GHz spectrum | Possible reservations of sub-1GHz spectrum and sub-1GHz spectrum cap mitigate concern, by ensuring at least three have sub-1GHz spectrum. But does not ensure at least four national wholesalers. | Medium |
| 5. Weaker competition because one or more competitors does not have early route to LTE | Reservations ensure that at least four have an early route to LTE, removing this concern. | High |
| 6. Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE | Overall spectrum cap mitigates to limited extent (as in Option 2). Reservation of at least 2x10MHz of 800MHz for a fourth national wholesaler could make it easier for it to obtain 2x15MHz of 800MHz spectrum, but reservations for other parties may make more difficult. Overall effect unclear. | Low |
| 7. Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates | Mitigated to some extent by safeguard caps (as for Option 2) and by portfolio for a fourth national wholesaler, which boosts the spectrum holdings of the party with the smallest share. | Medium to High |
| 8. Weaker competition because one competitor has a very large share of spectrum | Substantially the same as for Option 2. Reservations for national wholesalers other than Everything Everywhere also reduce scope for Everything Everywhere to obtain a large share. | High |

Risks of measures causing spectrum inefficiency or other disadvantages

- 8.123 The safeguard caps have similar risks of spectrum inefficiency and weakening competition as with Option 2.
- 8.124 This option has many of the same risks as Option 4, but magnified by the larger amount of spectrum that is reserved. These risks are explained more fully under Option 4.
- 8.125 This option could involve reserving more than 2x10MHz of 800MHz spectrum for companies other than Everything Everywhere. This could make it more difficult for Everything Everywhere to obtain 800MHz spectrum when it valued it most highly. This could weaken competition if holding sub-1GHz was important to competition and Everything Everywhere did not obtain it because of this option. In the extreme, Everything Everywhere could cease to be credible as a result of these measures.

Variations of option

Variations in the group of portfolios reserved for fourth national wholesaler

- 8.126 As with Option 4, the groups of portfolios reserved for a fourth national wholesaler could be varied, with the aim being to set the amount needed to make a fourth national wholesaler a credible national wholesaler. We consider that all the variations considered in Option 4 are relevant to this option.

Variations in the group of portfolios reserved for two other companies other than Everything Everywhere

- 8.127 In Section 4 we considered what spectrum Telefónica and Vodafone might need if it were the case that they needed more capacity and perhaps an early route to LTE to be credible. We identified three possible groups of portfolios from smaller to larger size. In this option we have considered the middle group. This is because this option is designed to ensure at least four credible national wholesalers have an early route to LTE and we consider the middle group is likely to contain portfolios with sufficient spectrum to launch a credible LTE service. Variations of this option could involve the other groups considered in Section 4.

Cap on 800MHz and 1800MHz spectrum combined

- 8.128 A concern with this option is that if it were important to have sub-1GHz spectrum, then the option might make strategic investment to prevent Everything Everywhere obtaining sub-1GHz spectrum easier. One way of preventing this would be to cap the amount of 800MHz and 1800MHz spectrum that could be obtained. For example, there could be a cap of either 2x10MHz of 800MHz spectrum or 2x15MHz of 1800MHz spectrum. However, this would be restrictive and unnecessary unless sub-1GHz were essential for Everything Everywhere to be credible.

Requirement on Vodafone and Telefónica to relinquish to be eligible for reserved spectrum

- 8.129 A concern with this option is that it could result in more sub-1GHz spectrum being reserved for Telefónica and Vodafone when they currently are the only national wholesalers with sub-1GHz spectrum (albeit at 900MHz rather than 800MHz which provides the early route to LTE). This option could be varied so that Telefónica and Vodafone were only eligible to compete for the reserved spectrum if they commit to

relinquish some 900MHz spectrum at a specified later date. This may allow Telefónica and Vodafone to have an early route to LTE while also ensuring that regulatory measures do not make the distribution of sub-1GHz spectrum too asymmetric. We consider how relinquishment arrangements might work in more detail in Option 7 below. Those arrangements could be adapted for this option.

Summary of advantages and disadvantages

- 8.130 This option could be appropriate if we consider that an early route to LTE is the key competition concern.
- 8.131 A particular risk with this option is that it may concentrate on one competition concern when other competition concerns were more important. For example, if Telefónica and Vodafone did not need an early route to LTE to be credible, but having sub-1GHz spectrum was important for competition, then this option could lead to an inefficient spectrum allocation and make competition weaker rather than stronger.

Option 7: Reservations of spectrum to mitigate all risks to national wholesaler competition, and overall cap

Description and rationale for option

- 8.132 This option is designed to mitigate all the main risks to national wholesale competition that we have identified. In particular, it ensures that at least four national wholesalers have sub-1GHz spectrum, the type of spectrum that gives an early route to LTE and sufficient share of spectrum. This option could be attractive if there were a high level of concern about all the competition concerns for why there might be fewer than four national wholesalers, including the possibility of needing sub-1 GHz spectrum and an early route to LTE to be credible.
- 8.133 Option 7 involves:
- **Overall spectrum cap of 2x105MHz** (as with Option 2)
 - **Reserve prices, set by reference to estimated market value with a discount** (as with Option 3)
 - **Reservation for a fourth national wholesaler of 2x10MHz of 800MHz and 2x10MHz of 2.6GHz**
 - **Reservations for at least three other companies such that they have spectrum holdings satisfying both the following conditions:**
 - **2x10MHz of sub-1 GHz spectrum, and**
 - **2x10MHz of 800MHz or 2x15MHz of 1800MHz spectrum**
- 8.134 Option 7 assumes that the 2x15MHz of divested 1800MHz spectrum is either in the auction or if it has been sold, it was obtained by Vodafone or Telefónica. This option as currently specified would not be possible if someone other than Vodafone or Telefónica obtained the divested spectrum.
- 8.135 The reservation for a fourth national wholesaler is the only portfolio considered in Option 4 (i.e. portfolio 15) that is possible given the other components of this option.

8.136 The final part of this option could be satisfied in the following ways by different national wholesalers:

- If one new entrant obtained the reservation for a fourth national wholesaler, then a second new entrant or H3G could satisfy both conditions for the second reservation by obtaining 2x10MHz of 800MHz spectrum.
- Everything Everywhere would satisfy the first condition by obtaining 2x10MHz of 800MHz in the auction. (This would also satisfy the second condition, though Everything Everywhere already satisfies the second condition given its large holdings of 1800MHz spectrum).
- Vodafone and Telefónica already satisfy the first condition so would only need to satisfy the second condition. One of them could do that with 2x10MHz of 800MHz spectrum and the other through obtaining 2x15MHz of 1800MHz spectrum. Given these constraints, one of Vodafone and Telefónica would effectively be guaranteed 2x15MHz of 1800MHz spectrum (subject to being prepared to pay the reserve price and outbidding new entrants).

Figure 8.7: Effectiveness of ‘Option 7: Reservations of spectrum to mitigate all risks to national wholesaler competition, and overall cap’ in addressing competition concerns

| Competition concern | Comment | Effectiveness of option |
|--|--|-------------------------|
| Concern that fewer than four credible national wholesalers | | |
| 1. Fourth national wholesaler not credible because insufficient share of spectrum & no sub-1 GHz spectrum & also no spectrum for early route to LTE or high peak data rates with early LTE | Substantially the same as for Option 4. | High |
| 2. Everything Everywhere not credible because no sub-1 GHz spectrum | Substantially the same as for Option 5. | High |
| 3. Telefónica/Vodafone not credible because no spectrum for early route to LTE, high peak data rates with early LTE or greater capacity | Substantially the same as for Option 6. | High |
| Concern that even if at least four credible national wholesalers one or more wholesalers is at a disadvantage in competing across a wide range of services and customers | | |
| 4. Weaker competition because one or more competitors does not have sub-1GHz spectrum | This option ensures four national wholesalers with at least 2x10MHz of sub-1GHz spectrum, removing this concern. | High |
| 5. Weaker competition because one or more competitors does not have early route to LTE | This option ensures four national wholesalers with an early route to LTE, removing this concern. | High |
| 6. Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE | Overall spectrum cap mitigates to limited extent (as in Option 2). Three lots of 2x10MHz on 800MHz spectrum prevents anyone from obtaining 2x15MHz of 800MHz spectrum. | Low |
| 7. Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates | Mitigated to some extent by safeguard caps (as for Option 2) and by portfolio for a fourth national wholesaler, which boosts the spectrum holdings of the party with the smallest share. However, reservation likely to be obtained by Everything Everywhere increases the spectrum share of the party with the largest existing share, reducing spectrum available for others, tending to worsen this concern | Medium to High |
| 8. Weaker competition because one competitor has a very large share of spectrum | Substantially the same as for Option 2. Likely reservation for Everything Everywhere increases the spectrum share of the party with the largest existing share, but Everything Everywhere's share still well below level of overall cap (before taking account of any further spectrum it may acquire). | High |

Risks of measures causing spectrum inefficiency or other disadvantages

8.137 This option is very restrictive in the outcomes it allows:

- The 800MHz spectrum must be sold in blocks of 2x10MHz to three different parties. So no party could obtain 2x5MHz, 2x15MHz or 2x20MHz of 800MHz. This includes preventing a fourth national wholesaler (i.e. those with low share of spectrum or no spectrum currently) obtaining more than 2x10MHz of 800MHz spectrum.
- This option effectively prevents one of Vodafone and Telefónica from obtaining any 800MHz spectrum.
- Because there are only three lots of 2x10MHz of 800MHz spectrum, one of Vodafone and Telefónica would be guaranteed to obtain the 1800MHz spectrum as they are the only parties (other new entrants) that can ensure that four national wholesalers emerge from the auction satisfying the above conditions. This effectively prevents a fourth national wholesaler from obtaining the 1800MHz spectrum in the auction.
- This option probably makes it more difficult for there to be five national wholesalers because of the interplay between the various constraints. For example, it would not be possible for a potential fifth national wholesaler to have 2x10MHz of 800MHz spectrum and 2x15MHz of 1800MHz spectrum.

8.138 This option also has the same risks as Option 4 but substantially magnified because of the extent of reservation across national wholesalers that is determined by regulation. These risks are explained more fully under Option 4.

8.139 Assuming Everything Everywhere obtains a reservation of 2x10MHz of 800MHz spectrum, this option could involve an increase in the share of spectrum for the national wholesaler that already has the largest share. This could be detrimental to spectrum efficiency if Everything Everywhere has a lower intrinsic value for a large share compared to others. It could also be detrimental to competition as it reduces the spectrum available for those with small shares, tending to worsen competition concern 7 in the table above (though on balance we consider that this option is quite effective at addressing that concern because there are also reservations for three others).

Variations of option

Variations in the group of portfolios reserved for fourth national wholesaler

8.140 The amount of 2.6GHz spectrum in the portfolio reserved for a fourth national wholesaler could be varied, either increased to 2x20MHz or reduced to zero. This would be consistent with the groups of portfolios considered in Option 4, except that the portfolios that are not consistent with the other parts of this option are excluded.

Relinquishment by Everything Everywhere

8.141 As noted above, this option could involve regulatory measures increasing the share of spectrum for Everything Everywhere which already has the largest share.

8.142 This option could be varied by requiring Everything Everywhere to relinquish spectrum in order to be eligible for reserved spectrum. For example, before the

auction, Everything Everywhere would need to choose whether or not to relinquish more 1800MHz spectrum in return for being eligible to compete for the reserved spectrum.²³²

- 8.143 If this were on a 1:1 basis (as proposed by H3G in its response), then 2x10MHz of 1800MHz spectrum would then be included in the auction, though the spectrum would not be available for use until it was relinquished at a specified future date. Having made this commitment, Everything Everywhere would have to relinquish this 1800MHz spectrum, even if it did not obtain any reserved spectrum, unless it was to win back the 1800MHz spectrum in the auction. Another variation might be to require Everything Everywhere to relinquish more than 2x10MHz of 1800MHz spectrum in order to obtain 2x10 of 800MHz spectrum. This would recognise that low frequency spectrum is more valuable than higher frequency spectrum.
- 8.144 The date for relinquishment of the 1800MHz spectrum would be important. The later the date, the longer Everything Everywhere would have increased capacity as a result of regulatory measures and the later the acquirer would be able to use the spectrum. The earlier the date, the more challenging for Everything Everywhere to relinquish the spectrum, and the greater the risk that Everything Everywhere might not realistically be able to obtain 800MHz spectrum. Some of the considerations on when might be a reasonable date for refarming are set out in Annex 8. While Everything Everywhere has a large amount of spectrum overall, it is already required to divest 2x15MHz of 1800MHz spectrum, making any additional relinquishment harder. On balance, we consider that some point beyond 2016 would probably be appropriate.

Relinquishment by Vodafone or Telefónica

- 8.145 This option could involve regulatory measures that would increase the share of sub-1GHz spectrum for Vodafone or Telefónica. This could be detrimental to spectrum efficiency if Vodafone or Telefónica had a lower intrinsic value for large shares of sub-1GHz spectrum compared to others, and could be detrimental to competition as it reduces the opportunities for others to increase their shares of sub-1GHz spectrum.
- 8.146 This option could be varied by requiring Vodafone or Telefónica to relinquish some 900MHz spectrum in order to be eligible for reserved spectrum. For example, before the auction, Vodafone or Telefónica could be given the choice of whether or not to relinquish 2x10MHz of 900MHz spectrum in return for being eligible to compete for reserved spectrum. Having made this commitment, they would be required to relinquish the 900MHz spectrum, regardless of whether they obtained reserved spectrum, unless they won back the 900MHz spectrum in the auction.
- 8.147 The date for relinquishment for the 900MHz spectrum would be important. The considerations would be similar as for Everything Everywhere above. We consider that some point beyond 2016 would probably be appropriate. Another variant would be to have a smaller relinquishment to be eligible, of 2x5MHz, although there would be a significant risk that this smaller amount of 1GHz spectrum would be insufficient for the acquirer.

²³² This commitment would need to be given before the auction because the auction process would be complex if Everything Everywhere had the choice of relinquishing spectrum during the auction itself. Undue complexity in the auction risks an inefficient auction outcome.

Summary of advantages and disadvantages

- 8.148 This option reduces the risks that there would be fewer than four credible national wholesalers by reserving spectrum for all four.
- 8.149 This option addresses effectively the concerns of one or more national wholesalers being at a disadvantage because of lack of sub-1GHz spectrum and an early route to LTE.
- 8.150 The key disadvantage of this option is that it is highly restrictive in the outcomes it allows.

Overall comparison of options

- 8.151 In this final sub-section we compare the options introduced above and consider their relative effectiveness and proportionality. We start by summarising our main competition concerns, drawing on earlier sections.
- 8.152 As we described in Section 2, our policy aim in the auction is to promote competition in markets for the provision of mobile services. We have identified that there is a concern that those markets would be significantly less competitive with fewer national wholesalers than now (i.e. fewer than four). Any such reduction in competition is likely to be long lasting, as the auction is likely to be the last realistic chance to obtain prime new mobile spectrum for the foreseeable future. We therefore consider the magnitude of potential consumer harm from only three credible national wholesalers emerging from the auction is significant.

Main competition concern relates to a fourth national wholesaler not being credible national wholesaler

- 8.153 For the reasons set out in Section 4 and Section 5, we consider:
- H3G's existing spectrum holdings are likely to be insufficient for it to remain a credible national wholesaler if it does not obtain more spectrum in the auction, and spectrum at 2.6GHz would be insufficient to make H3G credible.
 - A new entrant would obviously need to acquire spectrum in the auction to be a credible national wholesaler.
 - It is possible that a fourth national wholesaler (i.e. H3G or a new entrant) may obtain the spectrum it needs to be a credible national wholesaler in the auction without measures, but there is a material risk that it may not.
- 8.154 Given the material risk that we identify in relation to a fourth national wholesaler, we think that in order to ensure at least four credible national wholesalers it is necessary to implement measures in the auction to ensure that a fourth national wholesaler will obtain the spectrum in the auction that it needs to be credible in the future.

Concerns that fewer than four national wholesalers because Everything Everywhere, Vodafone or Telefónica are not credible national wholesalers

- 8.155 For the reasons set out in Section 4 and Section 5, we consider:

- Everything Everywhere is likely to remain a credible national wholesaler even if it does not obtain any sub-1GHz spectrum in the auction, given its large amount of 1800MHz and 2100MHz spectrum.
- Telefónica and Vodafone's existing holdings are likely to be sufficient for them to be credible in the near term, for at least as long as HSPA900 is competitive with LTE. But there is some potential risk of them not being credible in the longer term if LTE900 equipment is not available soon thereafter, or because of the relatively limited overall spectrum share they would hold if they did not win spectrum in the auction. However, they are likely to be able to obtain what they need to be credible in the auction, for example at 2.6GHz.

8.156 Although we consider that there are potential competition concerns that Everything Everywhere, Vodafone or Telefónica may not be credible national wholesalers after the auction without winning new spectrum in the auction, these concerns are of low likelihood, for the reasons given in Sections 4 and 5. However, the potential magnitude of these concerns if they were to arise is high, because we consider there could be significant consumer harm from fewer than four national wholesalers.

8.157 We therefore consider the desirability of options that also mitigate these concerns, taking into account the potential costs such as the risk of causing spectrum inefficiency.

Lesser concern that even though four credible national wholesalers, one or more is at a disadvantage in competing across a wide range of services and customers

8.158 Even if there were four credible national wholesalers, one or more of them could be at a disadvantage in competing across a wide range of services and customers, at least for some temporary period. We regard this as less important than promoting four credible national wholesalers. This is because most or even all consumers may be affected by whether or not there are four credible national wholesalers, whereas if some of them are unable to compete across the full range of services this will only affect particular customer or service segments. However, there could still be material consumer harm from significantly weaker competition in any such segments.

8.159 In Sections 4 and 5, we identified five competition concerns related to one or more national wholesalers being at a disadvantage in competing across a wide range of services and customers, as shown in concerns 4 to 8 in Figure 8.8 below.

8.160 Again, we consider the desirability of options to mitigate these concerns, taking into account the potential costs.

Comparison of options

8.161 In order to reach a provisional conclusion as to which option we consider is the most effective and proportionate to address our overall aim of promoting competition, we have assessed the options on the basis of:

- which are effective to achieve the policy aim identified above;
- for those options that are effective at addressing those concerns, which is the least onerous one required to achieve that policy aim; and

- whether the least onerous option identified produces adverse effects arising which are disproportionate to the aim pursued.

8.162 In comparing the options, it is important to stress that we are comparing options in the presence of considerable uncertainty. We consider that uncertainty is an inevitable aspect of our competition assessment, given its forward-looking nature and the potential for rapid and unexpected developments in technology, mobile services and consumer demand. These uncertainties mean that making decisions on the relative importance of the different competition concerns involves a measure of judgment, but one informed by our analysis of the available evidence.

Comparison of effectiveness of options to achieve the policy aim identified

8.163 Figure 8.8 below brings together the effectiveness of the options from the earlier tables. This assessment is for the main option considered and not for the variations that were also considered for each option.

8.164 The final column shows our view of the importance for each concern (as explained in Section 5). The final row summarises our view of how restrictive each option is (relative to Option 1, no measures).

Figure 8.8: Comparison of effectiveness of options

| | Effectiveness of Option in addressing competition concerns compared to Option 1 (no measures) | | | | | | Importance of concern |
|---|---|----------------|------------------|------------------|------------------|----------------|-----------------------|
| | Option 2 | Option 3 | Option 4 | Option 5 | Option 6 | Option 7 | |
| Concern that fewer than four credible national wholesalers | | | | | | | |
| 1. Fourth national wholesaler not credible because insufficient share of spectrum & no sub-1 GHz spectrum & no spectrum for early route to LTE or high peak data rates with early LTE | Low | High | High | High | High | High | High |
| 2. Everything Everywhere not credible because no sub-1 GHz spectrum | Medium | High | Low (may worsen) | High | Low (may worsen) | High | Low to Medium |
| 3. Telefónica/Vodafone not credible because no spectrum for early route to LTE, high peak data rates with early LTE or greater capacity | Low | High | Low (may worsen) | Low (may worsen) | High | High | Low to Medium |
| Concern that even if at least four credible national wholesalers one or more wholesalers is at a disadvantage in competing across a wide range of services and customers | | | | | | | |
| 4. Weaker competition because one or more competitors does not have sub-1GHz spectrum | Medium | High | Medium | High | Medium | High | Low |
| 5. Weaker competition because one or more competitors does not have early route to LTE | Low | Medium to High | Low to Medium | Low (may worsen) | High | High | Low |
| 6. Weaker competition because one or more competitors does not have 2x15 or 2x20 contiguous block for LTE | Low | Medium to High | Low | Low | Low | Low | Low |
| 7. Weaker competition because one or more competitors does not have enough spectrum for capacity and average data rates | Low to Medium | Medium to High | Medium to High | Medium | Medium to High | Medium to High | Low |
| 8. Weaker competition because one competitor has a very large share of spectrum | Medium to High | High | Medium to High | Medium to High | Medium to High | Medium to High | Low |
| Restrictiveness of option | Low | High | Low to Medium | Medium | Medium | High | |

8.165 For ease of reference, we repeat the option names below:

- Option 1: No measures in the auction to promote national wholesale competition
- Option 2: Safeguard caps
- Option 3: Tight caps to promote at least four national wholesalers
- Option 4: Reservation for a fourth national wholesaler and safeguard caps
- Option 5: Reservations to ensure at least four national wholesalers when sub-1GHz spectrum essential, and safeguard caps

- Option 6: Reservations to ensure at least four national wholesalers when an early route to LTE is essential, and safeguard caps
- Option 7: Reservations of spectrum to mitigate all risks to national wholesaler competition, and overall cap

8.166 Given that we judge the first competition concern (i.e. a fourth national wholesaler not being credible) as the single most significant competition concern relevant to our policy aim of promoting competition in future mobile markets, it follows that:

- Option 1 (No measures) is not effective because it fails to address this competition concern at all, and does not address any of the other concerns.
- Option 2 (Safeguard caps only) is unlikely to be effective since it does not in our view address this key concern sufficiently; and
- Options 3 to 7 all appear effective since they potentially address our key competition concern to a sufficient degree.

8.167 In relation to Options 1 and 2, we note that in principle, while they are not likely to be effective in addressing our concerns, they could nevertheless be the most appropriate and proportionate options if the costs of the other options proved to be too high. However, as we explain below we believe there is an option (Option 4) which is effective at addressing our concerns and which does not have particularly high costs and so overall is better than these first two options.

Comparison of magnitude of restrictions imposed by options to assess which option is the least onerous required to achieve our policy aim

8.168 Given our provisional view that options 3 to 7 all appear, at least to some degree, effective in addressing our main competition concern relevant to achieving our policy aim, it is necessary to consider the proportionality of imposing each of these options by assessing which option is the least onerous required to achieve our policy aim. In undertaking such an assessment, we have taken into account the considerable uncertainty around each option which is an inevitable aspect of our competition assessment.

8.169 There are two rather different responses we could adopt to this uncertainty:

- attempt to mitigate as many risks as possible; or
- favour approaches that address the key competition risks but involve making fewer and more limited regulatory judgements.

8.170 These different responses have fundamentally different implications.

8.171 The first response implies a highly interventionist approach in which regulation determines major aspects of the allocation of the spectrum to be awarded. For instance, Option 3 (tight caps) and Option 7 (mitigate all risks) address all the more important competition concerns about ensuring at least four credible national wholesalers well. They also address reasonably well many of the lesser competition concerns (about ensuring that one or more wholesalers are not at a disadvantage in competing across a wide range of services and customers).

- 8.172 However, this comes at the cost of being highly restrictive in terms of the outcomes they allow from the auction. This increases the risk of an inefficient spectrum outcome. We consider these options are likely to be disproportionate, given our view of: (i) the relatively low likelihood that the competition concerns will materialise; and/or (ii) the extent of uncertainty about their significance; and (iii) the difficulty of being sufficiently confident that the extensive detailed judgements made in these options about how much spectrum particular national wholesalers are likely to require are correct.
- 8.173 Option 5 (concerned with sub-1GHz reservation) and Option 6 (concerned with an early route to LTE) are focussed on particular competition concerns. These suffer from similar disadvantages to Options 3 and 7 but in some sense are more risky because they rely on a particular view that certain competition concerns are more important than others. While we are confident that we can make such a judgement in relation to our first concern (relating to a fourth national wholesaler) we are much less confident we can make such relative judgements about the other concerns. The downside is that if the concerns that Options 5 and 6 focus on prove not to be well founded or important, then these options may worsen the position in relation to some of the other competition concerns we have identified.
- 8.174 The second response to uncertainty implies a much less interventionist approach allowing competition in the auction to determine the acquisition of spectrum to a large extent, constrained only by targeted measures such as to focus on the competition concern of greatest significance as in Option 4 (reservation for a fourth national wholesaler). This is effective in addressing the competition concern at which it is targeted and carries a much lower risk of regulatory failure, but it does not address (or may even worsen) other competition concerns which are currently assessed as being of lower significance.
- 8.175 On balance, we favour the second response. This is because we are concerned that attempting to mitigate as many risks as possible will lead to disproportionate intervention, given that the costs of such an interventionist approach may lead to our intervention being more onerous than is required to achieve our policy aim. It therefore, follows that we are currently of the view that it would not be proportionate to put in place restrictions in the auction which would attempt to mitigate more or all of the competition concerns regardless of their importance (i.e. Options 3, 5, 6 and 7).
- 8.176 This does not mean however that there should be no measures in the auction to promote national wholesale competition where the competition concern is sufficiently important. In our analysis, despite the uncertainty, the evidence supports the view that the category of competition concern regarding there being fewer than four national wholesalers falls into this category. In addition, taking into account existing spectrum holdings, we consider it is clear that the risk of failing to be a credible national wholesaler is significantly greater for a fourth national wholesaler than for the other current national wholesalers. These considerations point towards Option 4 (reservation for a fourth national wholesaler) as being the most appropriate and proportionate measure.
- 8.177 That said, we do not believe we should disregard the other potential competition concerns completely and propose to impose safeguard caps on both sub-1 GHz and overall spectrum as a way to mitigate some of them. The costs and risks associated with these caps are likely to be low as they do not tightly prescribe what bidders may win and so we consider them to be proportionate. We propose the same levels for these caps as we suggested in the March 2011 consultation.

Possibility of producing adverse effects which are disproportionate to the aim pursued

- 8.178 It is also necessary to consider more generally whether our proposed option produces adverse effects which are disproportionate to the aim pursued.
- 8.179 We consider that the main risks of potential regulatory failure with measures in the auction designed to achieve the desired objective of promoting competition by securing at least four credible national wholesalers in the future are the risks of (i) unintentionally weakening competition or (ii) causing spectrum inefficiency. We consider that the extent of these risks is dependent on the particular spectrum reservation and we have considered these risks above.
- 8.180 We do not consider the effects of Option 4 are disproportionate to the aim pursued. There are two scenarios to consider: first where a fourth national wholesaler would have obtained the spectrum reserved for it any case even in the absence of the measures; and second where it obtains the spectrum as a result of the reservation. In the first scenario the cost of the measure is clearly low. In the second scenario there may be costs of spectrum inefficiency associated with the fourth national wholesaler acquiring the spectrum when it had a lower intrinsic value. However, we consider it likely that the benefits to consumers from the greater intensity of competition from seeking to ensure at least four credible national wholesalers outweigh such cost. Finally, the risk of regulatory failure associated with promoting at least four national wholesalers in the auction is mitigated since, if the market evolves in a way that means it would in fact have been in consumers' interests to have fewer national wholesalers, this can be addressed later through, for example, market consolidation, subject to scrutiny under merger control at that time as appropriate. By contrast if measures are not put in place in the auction to promote four national wholesalers such that only three national wholesalers emerge and this is shown not to be in consumers' interest, then it would be much more difficult to change this position to increase the number of national wholesalers in the future.
- 8.181 We therefore provisionally consider that it is appropriate to put in place some measures in the auction to address our single largest competition concern relevant to achieving our policy aim of promoting competition to the benefit of consumers, i.e. that a fourth national wholesaler may not emerge from the auction as a credible national wholesaler. We consider that Option 4 (with Group 2 portfolios) is the most proportionate way in which to address this risk.
- 8.182 Accordingly, our provisional view is that Option 4, including a reservation of spectrum to promote the credibility of a fourth national wholesaler and safeguard spectrum caps is the least onerous option required to achieve our policy aim.

Section 9

Potential measures to promote retail competition

Introduction and summary

- 9.1 As set out in Section 2 of this Annex, our view is that competition between national wholesalers promotes retail competition, to the benefit of consumers. In the light of our proposals to take measures to promote competition in wholesale markets, this section considers whether we should take any further measures, to promote competition in retail markets.
- 9.2 In our March 2011 consultation, we considered that market entry by sub-national RAN operators – using shared spectrum for low-powered cells that cover small areas – could potentially deliver innovative services to consumers, and increase competition. This is the only form of potential entry that stakeholders have identified to date.²³³ However, there was a concern that such entry, even if socially beneficial, would not occur without our support.
- 9.3 We identified three reasons for this concern:
- a) Coordination problems could occur between low power users when bidding for shared spectrum;
 - b) The private value of the spectrum to low power users might not reflect the full social value their collective use could generate, for example through dynamic competition benefits (i.e. the introduction of innovative services); and
 - c) National wholesalers, anticipating the impact of such increased competition, could bid strategically against low power users.
- 9.4 We provisionally concluded there was a strong case for aggregating bids amongst low power users for 2.6 GHz spectrum to ameliorate coordination problems.²³⁴ However, we recognised that this might not be enough to secure new entry.
- 9.5 We considered going further by reserving spectrum for low power use. We said that there might be a case for reserving 2x10 MHz, but reserving 2x20 MHz exclusively for low power use was unlikely to be proportionate.
- 9.6 We also considered that if low power users had access to a 2x10 MHz block, a “hybrid” solution could allow standard power and low power users to share a further 2x10 MHz block. However, we said that this was subject to further technical work.
- 9.7 In response to our March 2011 consultation, BT and another potential low power bidder argued that aggregation was not sufficient to ensure entry, and that reservation was necessary. BT said this was because: (a) national wholesalers would

²³³ Although our proposals for promoting national wholesale competition allow for a new entrant being a fourth national wholesaler under a spectrum floors approach.

²³⁴ By aggregating bids, we mean summing the value of all bids for low power use, and, if this exceeds the highest bid for standard power use, assigning that lot to low power use bidders.

have an incentive to bid strategically in order to exclude competition; (b) low power users would have strong incentives to free-ride, which would prevent them from bidding their full value; (c) low power bidders would express private values in the auction which would not incorporate the additional consumer benefits arising from more effective wholesale competition; and (d) low power users' willingness to bid would be reduced by uncertainty about their ability to negotiate roaming agreements with wide area cellular operators.

- 9.8 BT said that the shared low power spectrum should be a block of 2x20 MHz, to enable the fastest broadband services to be provided and interference between multiple licensees to be more easily managed. It added that 2x10 MHz shared standard power and low power (i.e. hybrid solution), plus 2x10 MHz exclusive low power use, was the next best alternative, but was much less attractive, while 2x10 MHz was less useful still. Another potential low power bidder argued that with 2x20 MHz low power users could offer high data rates with high reliability, so 2x20 MHz should be reserved. However it said that 2x10 MHz of reserved spectrum and 2x10 MHz of low/standard shared used could be sufficient.
- 9.9 National wholesalers generally supported, or did not object to, aggregation of bids for low power use. However they argued against reservation. They said that the potential benefits from low power use were uncertain, and the opportunity cost of reservation – preventing standard power use of the spectrum – was high.
- 9.10 For the reasons set out below we provisionally conclude that shared power use of 2.6 GHz might constitute an opportunity for disruptive entry into the mobile market, and that this could bring significant benefits to consumers, which could be greater than the value that might be generated by national wholesalers. While it is possible that such entry could occur without reservation we have identified that there is some risk that it might not. We are minded to favour reservation of 2 x 10 MHz of 2.6 GHz spectrum but we would welcome more evidence on the costs and benefits of such an action which we recognise is a difficult judgement.
- 9.11 Given this uncertainty, and particularly the high opportunity cost of reservation, we consider that reservation of 2x20 MHz of 2.6 GHz spectrum is unlikely to be proportionate.
- 9.12 We are also consulting on whether a sufficiently high reserve price could ensure the opportunity cost of reservation would be proportionate to the expected benefits.
- 9.13 We provisionally conclude that hybrid use of 2.6 GHz spectrum, shared between low power and standard power users, is unlikely to be an effective measure. However, we have set out an option of having one 2x10 MHz block split between two predefined geographic areas (broadly speaking, one 'urban' and one 'rural') , and allowing bids in each area for either shared low power use or a standard power network. We are consulting on whether there is interest in low power use of the spectrum to provide local urban service, and whether this proposed approach would facilitate such provision.

Assessment of the case for reservation

- 9.14 Our policy aim in the context of this competition assessment is the promotion of competition in markets for the provision of mobile services (see Section 2 above). In addition to those measures proposed at the wholesale level, we consider that competition will be promoted by the entry of sub-national RAN operators. In

particular, such entry could allow competition over more of the value chain than entry at the retail level, and facilitate innovative business models.

- 9.15 A decision to reserve spectrum for low power use would need to be based on an expectation that:
- a) Market entry by sub-national RAN operators would be a better outcome of the auction for consumers and competition than no such market entry – i.e. the benefits of such entry are likely to exceed the opportunity cost; and
 - b) There is a significant likelihood that such entry would not occur in the absence of reservation.
- 9.16 We consider these points in turn, beginning with an assessment of the potential benefits of entry, and the potential costs of reserving spectrum to ensure such entry.

Assessment of benefits and costs

Benefits of sub-national RAN entry

- 9.17 Market entry by sub-national RAN operators using low power networks could deliver substantial benefits to consumers. Through the deployment of ‘inside-out’ networks (i.e. adding mobile services to a fixed high speed broadband network) they could potentially offer improved indoor coverage, high data rates, and LTE services. Higher data allowances and speeds could be achieved by sub-national RAN operators than on mobile networks, due to data being handled over a fixed connection most of the time, and devices being closer to the base station. This could allow sub-national RAN operators to compete directly with national wholesalers, both in the market generally and for specific or niche customer groups.
- 9.18 There is also the possibility that sub-national RAN operators could introduce paradigm-shifting business models, for example from being able to integrate fixed and mobile delivery of TV, broadband and telephony services on multiple devices.
- 9.19 Two potential low power bidders have presented details of their plans for this spectrum. One argued that the success to date of Wi-Fi based services demonstrates the commercial viability of the small cell model and the consumer benefits they can deliver, but that the advantages of femtocells over Wi-Fi will make them increasingly important as the growth in demand for mobile data continues.
- 9.20 These potential low power bidders also argued that the deployment of low power cells would allow a seamless broadband user experience, with fast speeds and good coverage for indoor use. They said that this would introduce disruptive competition to the current mobile industry and represented the only way of introducing further infrastructure competition (beyond the existing national wholesalers).
- 9.21 Our analysis is that low power entry may bring about greater competition. Competition in the wholesale market could effectively be limited to four national wholesalers in a market in which barriers to entry are high. In this context, entry by sub-national RAN operators could lead to a more competitive outcome. For example:
- a) As the market matures, there is some risk that the degree of competitive intensity between the four national wholesalers will tend to decline. For example, if a fourth national wholesaler reached a point where it had a similar market share to the other three operators, this could blunt its incentive to act as a disruptive

competitive force (see the discussion of symmetry in paragraph 2.63). In this case, the presence of sub-national RAN operators, seeking to grow their market share, could help to sustain competition in the market.

- b) In particular, sub-national RAN operators could act as a competitive fringe which would tend to undermine any coordinated outcome between national wholesalers (such as tacit collusion to delay innovation or raise prices).
- 9.22 It is also possible that sub-national operators will introduce innovative services or business models, which will act as a disruptive competitive force in the market, leading to better consumer outcomes
- 9.23 Arguing against the potential benefits, national wholesalers said that the DECT guard band model was the closest equivalent to our proposals for shared low power use of 2.6 GHz. Everything Everywhere said that of the 12 DECT licences awarded in 2006, it was only aware of three licensees who were using the spectrum for that purpose. National wholesalers said that the failure of this model placed doubts on the benefit of reserving spectrum for shared low power use, or at best provided no evidence in support of such an approach.
- 9.24 Whilst the DECT guard band has in fact been used to deliver services,²³⁵ we do not consider that it is necessarily a good analogy to the present case, notwithstanding some technical similarities. The 2006 auction of the DECT guard band gave 12 licensees concurrent access to 2 x 3.3 MHz of spectrum, a much smaller bandwidth than we are considering here. Also, the DECT guard band is suited for GSM-based voice services. In contrast 2.6 GHz spectrum would allow the provision of LTE-based data services,²³⁶ allowing entrants to compete for a growing area of the market. It is by no means clear that the experience of the DECT guard band can be generalised to the present case.

Cost of reserving spectrum for low power entry

- 9.25 National wholesalers said that this spectrum was valuable for standard power use, so reservation for low power had a high opportunity cost. H3G said that prices for 2.6 GHz FDD spectrum in previous European auctions were consistent with a value of £450 million for a 2x20 MHz block in the UK, but did not provide a source for this estimate. Everything Everywhere said that prices in these auctions were consistent with a value of £60 million for 2x10 MHz in the UK. Everything Everywhere cites Table 8.1 of our March 2011 consultation (page 103), which shows prices in previous European auctions. These results are set out in Figure 9.1, updated with results from more recent auctions.
- 9.26 Figure 9.1 shows both minimum and average winning prices (converted to £ and adjusted for population differences with the UK).²³⁷ While winning prices in Spain, Germany, Austria, Norway and Portugal were around £25 million for a 2x10 MHz lot,

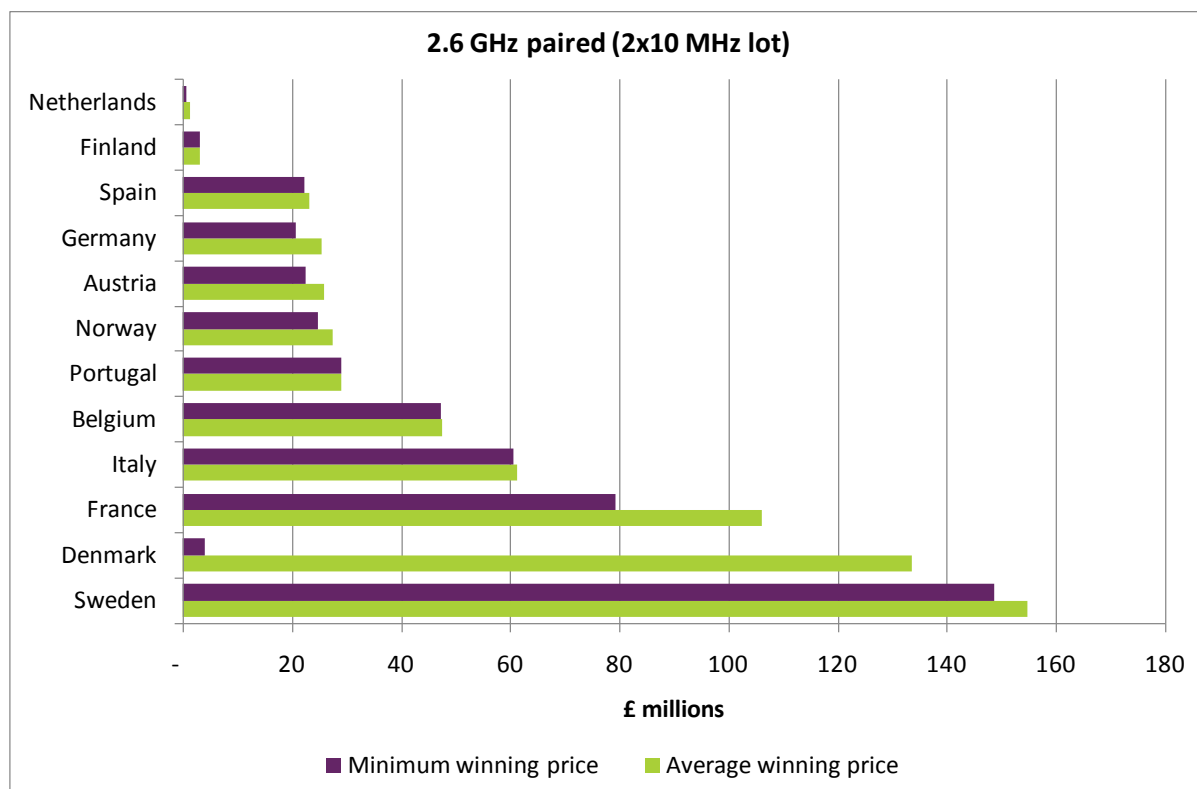
²³⁵ For example, C&WW has used the DECT guard band to provide local mobile services inside offices and in campus environments, including provision of mobile services to Tesco employees in all Tesco supermarkets, depots and offices – see Ofcom briefing for analysts, April 2011, page 20: <http://media.ofcom.org.uk/files/2011/04/Telecoms-analyst-briefing-transcript-April-2011.pdf>

²³⁶ Real Wireless, March 2011, pages 33 – 34: <http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/real-wireless-report.pdf>

²³⁷ In Denmark, Hi3G's bid was less than 5% the size of the next lowest bid, possibly due to binding caps on other bidders.

in certain countries – notably France, Denmark and Sweden – these lots went for the equivalent of over £100 million on average. With some exceptions, the minimum winning price was close to the average winning price – i.e. there was not much difference, within a given auction, in the price per MHz for winning prices.

Figure 9.1 Approximate UK equivalent auction prices (population adjusted)



Source: Ofcom

Notes:

- (1) Average values per lot for Austria and Denmark are pro-rated from the overall band value assuming 40 MHz of fully useable spectrum in the 2.6 GHz lot.
- (2) The minimum winning prices for Austria and Denmark are averages of prices for paired and unpaired 2.6 MHz spectrum by the lowest bidder.

9.27 While there is some concern that reserving spectrum for low power use would have a high opportunity cost, we could mitigate this risk in setting a reserve price. We consider this point further below.

Net benefits

9.28 In conclusion, reservation could potentially lead to sub-national RAN operators offering new services. However, the scale, innovation, and ultimate success of such new services are necessarily subject to a degree of uncertainty. As such, their benefit to consumers and their impact on competition are also uncertain. Evidence of previous auctions suggests that the opportunity cost of reserving 2x10 MHz may be

between £25 million and £150 million. The opportunity cost of reserving 2x20 MHz would be at least twice as high.²³⁸

- 9.29 While the sums involved are significant, they should be seen in the context of the overall scale of the market for mobile services, which has annual retail revenues of £15.1 billion.²³⁹ Although large benefits are uncertain, an innovative service which substantially improved consumer outcomes in this market, or even a segment of it, over a five or ten year period could be worth tens or hundreds of millions in consumer value. However, we recognise that the opportunity cost is more certain than the scale of the potential benefits.

Likelihood that sub-national RAN entry would occur without our support

- 9.30 We consider that there are three principal reasons why aggregated bids by sub-national RAN operators for low power use could, in principle, be lower than bids for standard power use by national wholesalers:

- a) Free riding effects;
- b) Lower intrinsic value; or
- c) Strategic investment.

- 9.31 We assess each of these in turn.

Free riding

- 9.32 Aggregating bids is subject to a free riding problem, in that there is in principle a potential for a low power bidder to increase its profits by bidding less than its valuation, if it expects that the sum of aggregated bids for low power use will be greater than those for standard power use. In other words, each low power bidder prefers for other low power bidders to bear the cost of outbidding standard power bidders (whilst still obtaining the benefits).
- 9.33 However, low power users cannot simply rely on others to win the spectrum for low power use, because they need to bid at least enough to ensure that they are one of the limited number of low power licensees that would be allowed. In addition, they face a strong likelihood of the spectrum going to standard power use if they underbid. If the number of low power bidders is small (a possibility discussed at paragraph 9.43 below), the former effect will not be relevant, but the latter effect is likely to provide a strong constraint on incentives to free-ride.
- 9.34 A 2009 Federal Communications Commission (FCC) paper²⁴⁰ considered this point in a slightly different context, noting that shared bidding for low power use can be distinguished from other public good problems, in that there is a “provision point”, i.e. a minimum aggregate contribution that firms must collectively make in order for any given firm to obtain value from its contribution. It notes that the likelihood of significant free riding is less because the contribution made by a bidder only reduces

²³⁸ For example, suppose that in an unrestricted auction the lowest successful bid for 2x10 MHz would be £50 million, while the second-lowest successful bid would be £51 million. A 2x10 MHz reservation would have an opportunity cost of £50 million, while a 2x20 MHz reservation would have an opportunity cost of £101 million.

²³⁹ See Figure 5.1 in Ofcom’s Communications Market Report, August 2011

²⁴⁰ *Efficiency gains from using a market approach to spectrum management*, FCC, December 2009.

its payoff if the sum of aggregated bids exceeds the provision point – otherwise the payoff is zero, regardless of the sum bid by that bidder.

Provisional conclusion on free riding

- 9.35 On balance, we consider that if we introduce a mechanism to aggregate low power bids, free riding is unlikely, in itself, to have a significant impact on the ability of low power users to compete effectively with standard power users.

Differences in intrinsic value

- 9.36 In the absence of other market failures, all bidders will bid for spectrum up to their intrinsic value, i.e. the present value of their additional expected profits from using the spectrum compared to not having the spectrum (in the absence of any strategic considerations to obtain spectrum to reduce competition in mobile services from the existing level). It is possible that the sum of the intrinsic values of the low power bidders will be less than that of the highest-value standard power bidder.
- 9.37 An auction outcome would be socially sub-optimal if:
- a) the total benefits of low power use (including both intrinsic value, *and* the benefits to consumers and competition, which are not captured by low powered users²⁴¹) are greater than the opportunity cost (which arises because the spectrum is not being used by a standard power user), so that low power use of the spectrum would be socially optimal; *but*
 - b) low power bidders will fail to win spectrum because they have a lower intrinsic value than a standard power bidder.
- 9.38 In our assessment of measures to promote national wholesale competition, we consider whether there may be reasons for differences in intrinsic value between different current and potential national wholesalers. In the present case, low power users may have a substantially different business model, or models, from national wholesalers, as discussed above, which makes comparisons of relative intrinsic value more difficult. We now discuss reasons why low power users may have a higher or a lower intrinsic value.

Reasons low power use may have a higher intrinsic value

- 9.39 The arguments that potential low power bidders have put forward as to the likely demand for services they will be able to offer by using this spectrum, and the cost savings they will be able to achieve, suggest that their intrinsic value for the spectrum will be substantial.
- 9.40 It could be argued that the value of the spectrum to a standard power user will be limited by the customer base it can reasonably hope to serve with this spectrum, either as a retailer or wholesaling its network capacity to MVNOs. This will depend on its potential future share of the mobile retail and wholesale markets. In contrast, a group of up to ten low power users could collectively serve the large majority of UK adults (at least in principle). In principle, a national wholesaler which won the spectrum could, in addition to using it for standard power use, potentially also use it

²⁴¹ In excess of any benefits to consumers and competition from use of the spectrum by a standard power user

for low power use. As a single firm, it may be able to avoid some of the coordination problems that arise with multiple users of the same spectrum. If so, it could potentially offer low power-based services to end users, or to intermediaries through a wholesale arrangement. However, in practice some network coordination problems may remain, even with a single operator. Furthermore, a national wholesale operator may be unwilling to make capacity available to others for services that could cannibalise its standard power and low power-based services.²⁴²

- 9.41 Paired 2.6 GHz spectrum is likely to have different intrinsic values for different national wholesalers. For example, a national wholesaler which already has LTE spectrum in other frequency bands, and is using 2.6 GHz spectrum to expand its LTE capacity, may have a lower valuation of the spectrum than a national wholesaler for whom 2.6 GHz allows earlier introduction of LTE, and/or is the main source of LTE capacity in the longer term. In order to win (say) 2x10 MHz of 2.6 GHz spectrum, low power bidders would not need (collectively) to have a greater valuation of 2.6 GHz spectrum than any national wholesaler. This is because there is more than 2x10MHz of this spectrum for sale. For example, suppose that the highest valuation of a national wholesaler was £100 million for a 2x10 MHz lot, and the highest valuation for a further 2x10 MHz (by the same, or another, national wholesaler) was £90 million, and the highest residual valuation continued to decline in £10 million increments for each additional lot. In that case, and if for the moment we assume there is no strategic investment, then low power bidders would only have to have a higher intrinsic value than any national wholesaler for the seventh lot – i.e. in the present example they would need to have an intrinsic value above £40 million.

Reasons low power use may have a lower intrinsic value

- 9.42 The evidence from recent European auctions suggests that the intrinsic value to national wholesalers of 10 MHz of this spectrum is likely to be above £25 million, and may be over £100 million. While the intrinsic value of the spectrum for low power use is highly uncertain, it would clearly have to be a significant sum – at least tens of millions of pounds, in order to exceed that of standard power use. Even so, the scale of the market affected (see paragraph 9.29) may suggest that innovative services delivered via low power use of this spectrum could potentially deliver such an outcome.
- 9.43 Even if low power users could, in principle, serve a larger combined customer base than would be served by a single standard power user, they may not do so in practice:
- a) Only a small number of parties have expressed a strong interest in low power use, and it is not clear that many more will emerge. Each potential low power user will have, independently, to make the decision to participate in the auction, and some may decide not to do so because of the resource costs of participation (which are duplicated by each bidder), or firm-specific factors. For example, one operator which expressed an interest in bidding as a low power user has since ruled this out.²⁴³

²⁴² See the discussion of cannibalisation from paragraph 5.102 above.

²⁴³ It is possible that some firms will rule out bidding because they are unable to use the spectrum to deliver a service that would be valued by customers – in which case their non-participation could not be seen as a market failure.

- b) If there is only a small number of low power bidders, it is possible that a single standard power user could achieve a comparable or larger customer penetration. Of course, the value per customer/household may differ between low power and standard power users.

9.44 As noted above, BT has argued that low power users may need to negotiate wholesale access to mobile networks, and that this uncertainty as to the terms of such access will pose a significant disincentive to investment by low power users. This might lead them to take a cautious view of their expected profits, i.e. reduce their intrinsic value. BT even suggested that it would deter potential new entrants from participating in the award.

Provisional conclusion on intrinsic value

9.45 In conclusion, arguments can be made in both directions as to the relative intrinsic value of low power and standard power use. We are unable to conclude at this stage that low power operators have a lower intrinsic value for this spectrum but it remains a possibility. Leaving aside strategic investment, a case for reserving spectrum would require that, even if there were lower intrinsic value from low power use, we would expect it to lead to greater benefits for consumers than standard power use.

Strategic investment

- 9.46 Even if low power bidders (in aggregate) have a higher intrinsic value than standard power bidders (for at least 2x10MHz of 2.6GHz), they could fail to win the spectrum in the auction due to strategic investment²⁴⁴. As discussed above, there is a possibility that low-power use of the spectrum will enable both the provision of services that will compete with those offered by national wholesalers, and potentially disruptive innovation. While we see this as an opportunity, from the perspective of national wholesalers it is a threat, and they may have an incentive to include a strategic value in their bids against low power bidders to prevent such an outcome.
- 9.47 National wholesalers will only strategically invest in spectrum if the expected payoff from doing so exceeds the cost. The payoff to national wholesalers would be in avoiding the threat of increased or disruptive competition. The cost of strategic investment would be in paying more than their intrinsic value for the spectrum.
- 9.48 The cost of strategic investment to national wholesalers depends on a number of factors:
- a) To exclude low power bidders from 2x10MHz of 2.6GHz spectrum, the national wholesalers would need collectively to acquire 2x65MHz (or 2x55MHz to prevent low power bidders acquiring 2x20MHz). For example, two national wholesalers each acquiring 2x20MHz, a third 2x15MHz and a fourth 2x10MHz.
 - b) If the intrinsic value of the spectrum to national wholesalers were broadly similar to that of low power users, the former might not have to bid much more than their intrinsic value to eliminate low power users, so – other things being equal – strategic investment might not be very costly. However, if national wholesalers

²⁴⁴ As explained above in relation to national wholesale competition, in considering strategic investment in this way, we are not suggesting that any bidder, either individually or collectively, would act or intend to act in any prohibited manner. Our concern is to consider whether such behaviour by one or more bidders might result in an outcome that made the market less competitive, such that it posed a risk to our policy objective to promote competition through the auction.

had a much lower intrinsic value, and were only buying the spectrum to keep low power users out, strategic investment might be costly.

- c) Standard power lots of 2.6 GHz spectrum (in packages of 2x5MHz – see Section 7 in the main Consultation) are proposed to be generic, meaning that national wholesalers will have to outbid low power users simultaneously in (almost) every 2x5MHz lot. If doing so required national wholesalers to bid above their intrinsic value in every lot, or in a number of lots, it would push up the cost of strategic investment. Alternatively, if, say, national wholesalers had a higher intrinsic value than low power users for six blocks of 2x10 MHz spectrum, and only had to bid strategically in the seventh block, the cost of strategic investment might be lower (although it would be borne entirely by the successful bidder for the seventh lot – see next point).
- d) In deciding whether to bid strategically above its intrinsic value in any given lot, a national wholesaler will always prefer to allow another national wholesaler to win the lot and bear the cost of exclusion, whereas the benefits of excluding low power users will be shared across all national wholesalers – i.e. there is a free rider effect which could lead to a coordination problem for the strategic investors:
- For example, suppose a standard power user (“Firm X”) values a lot at £50 million, but believes that low power users will bid up to £59 million for it. Suppose that keeping low power users out of the market is worth £10 million to Firm X. Firm X has a unilateral incentive for strategic investment, i.e. its payoff is sufficiently large that it is incrementally profitable for it to bid above its intrinsic value and exclude low power users. Even so, it would prefer another national wholesaler to bid £60 million, as this would allow to avoid a £10 million cost of strategic investment. However, in doing so, it faces the risk that other national wholesalers will fail to bid the required amount to exclude lower power users, in which case Firm X would be worse off.
 - A more serious coordination problem could arise for national wholesalers, if the cost to, for example, Firm X of excluding low power users was greater than the payoff – so that an exclusionary strategy would only be profitable if the cost could be shared between national wholesalers. Suppose, for example, that there were three different blocks of 2.6GHz on which strategic investment is required²⁴⁵, and that Firm X would, if acting alone, have to bid £10 million more than its valuation in *each* of these lots in order to exclude low power use. The cost to Firm X (£30 million) would exceed the payoff (£10 million) from excluding low power users. In this case, an exclusionary strategy would only be profitable if there was coordination between Firm X’s strategic investment and similar bidding by other strategic investors.

9.49 The intrinsic value of this spectrum to national wholesalers (as evidenced above by previous European auctions) tends to suggest that strategic behaviour might not be very costly to national wholesalers,²⁴⁶ unless low power users have a much higher valuation for the spectrum.

²⁴⁵ For example, if there were seven blocks and standard power bidders had the highest intrinsic value for four blocks, but would have to invest strategically in the remaining three.

²⁴⁶ Of course, strategic investment would not be necessary if national wholesalers could exclude low power users simply by bidding their intrinsic value.

- 9.50 The difficulties of coordination may depend on the ease or difficulty for the strategic investors in identifying a focal point. In 2.6 GHz auctions in Germany, Spain and Sweden, three national wholesalers won 2x20 MHz and a fourth (or several others in the case of Spain) won 2x10 MHz. This suggests that such an outcome may not be too difficult for strategic investors to identify as a focal point (although there may still be room for disagreement about which national wholesalers should acquire the larger and which the smaller amounts of 2.6GHz). However, coordination could also be difficult if national wholesalers were also seeking to exclude one another from the 2.6 GHz band.
- 9.51 Coordination is easier, or even not needed, if three national wholesalers have higher intrinsic value than the (aggregate of) low power bidders and only one has lower intrinsic value and this is common knowledge among the national wholesalers (e.g. we discussed in Section 4 the different requirements for spectrum capacity of the existing national wholesalers based on their current spectrum holdings).

Provisional conclusion on strategic investment

- 9.52 In summary, strategic investment would require national wholesalers to perceive a threat of increased competition due to low power entry, and to conclude that it is both feasible and cost-effective to coordinate on a strategy of excluding entry. While there is not clear evidence on the incentives of national wholesalers to pursue such a strategy and the issues of coordination, we do not consider that we can rule it out. For example, it is possible that national wholesalers' intrinsic value exceeds the value in aggregate of low power bidders for much of the 2.6GHz paired spectrum, in which case strategic investment might not be very costly; and that, for the remaining spectrum, national wholesaler(s) have unilateral incentives for strategic investment.

Reserve prices

- 9.53 If we were to reserve 2x10 MHz of spectrum for low power use, the concern that this would entail a disproportionate opportunity cost could be mitigated through the level at which we set a reserve price.
- 9.54 In order to have this effect, a reserve price would need to be high enough to ensure that the spectrum is not dedicated to low power use if this is of much lower value than could be achieved by a national wholesaler. However, a reserve price that was too high would deter low power bidders, so the purpose of reserving spectrum – i.e. promoting competition to the benefit of consumers – would not be achieved.
- 9.55 We could set the reserve price based on an expectation of what the minimum successful bid would be (in the absence of reservation) for 2x10 MHz of spectrum, on the basis that this would indicate the opportunity cost based on the value of the spectrum to the marginally successful bidder for standard power use. This could be informed by successful bids in previous auctions (as set out in Figure 9.1 above).
- 9.56 But in considering the appropriate level of the reserve price, we need to take into account the market failures which we considered above when assessing whether low power bidders would be outbid by standard power bidders.
- 9.57 If we set the reserve price at the estimated market value of the spectrum, then low power bidders would only meet the reserve price if they had a greater aggregate intrinsic value than any standard power bidder (and were not prevented from acting on this intrinsic value by free riding). On the strong assumption that we could accurately foresee standard power bidders' intrinsic valuations, reserving spectrum

for low power use at this reserve price would be effective in ruling out strategic investment by standard power users. This is because such strategic investment would raise the price *above* the intrinsic value to standard power users.²⁴⁷

- 9.58 However, setting a reserve price at the intrinsic value for standard power use would not reflect the possibility, discussed above, of greater benefits to competition and consumers from low power use than from standard power use. If intrinsic value for low power use were less than for standard power use, then low power users would not meet a reserve price which was set equal to the (expected) value for standard power use. This would be an unfavourable outcome if the total benefit (including benefits to competition and consumers) were greater for low power use than for standard power use.²⁴⁸
- 9.59 To the extent that the estimated benefits to competition and consumers are larger if low power users acquire the spectrum, it is appropriate for reserve prices to be set at a discount on the estimated market value of the spectrum.

Provisional conclusion on the need for reservation

- 9.60 The evidential base for reserving 2.6 GHz spectrum for low power use is mixed. There is a reasonable likelihood that a reservation would lead to the introduction of new services based on low power use.²⁴⁹ However, the extent and success of such services, and their impact on competition and consumer welfare, are uncertain at this stage.
- 9.61 In addition, the evidence as to whether entry by low power users would occur without spectrum reservation is not clear-cut:
- a) Our view is that there is a low risk that free riding among low power users will have a significant effect on auction outcomes;
 - b) The intrinsic value to national wholesalers of this spectrum is indicated by recent auctions in other European countries, and it is possible that low power bidders have a lower intrinsic valuation of this spectrum than national wholesalers. On the other hand, if low power users believe this spectrum could allow them to have a market-changing impact, and compete successfully against national wholesalers, one might expect their intrinsic value to be high.
 - c) While national wholesalers engaging in strategic investment would face some costs and coordination might be needed, we cannot rule out the possibility of strategic investment taking place to exclude low power bidders.

²⁴⁷ For example, suppose a standard power user valued the spectrum at £50 million, but would strategically bid £60 million, while low power users would pay up to £59 million for it. In an unreserved auction, the low power bidders would be excluded by strategic investment. If the spectrum were reserved for low power use, with a reserve price of £50 million, low power users would acquire it,²⁴⁸ As regards free riding, a reserve price would act as a “provision point” of the kind described in paragraph 9.34 above. As discussed there, we expect free riding to be limited in the present case because (a) bidders will only have to pay their bids if the provision point is met (i.e. if the sum of low power bids exceeds the reserve price), and (b) if the reserve point is not met, low power bidders will have no access to this spectrum, so free riding is risky (although free riding may be less risky, and therefore more likely, for a lower reserve price).

²⁴⁹ Two potential low power bidders have described their plans for this spectrum, although a third prospective bidder, who expressed an interest in response to our March 2011 consultation, has since told us that it does not plan to bid.

- 9.62 Because of the intrinsic value of the spectrum to national wholesalers, the opportunity cost of reserving 2x10 MHz of spectrum could be more than £100 million. An outcome in which some low power users are occupying, but under-using, reserved 2.6 GHz spectrum may also be difficult to reverse through trading or revoking of licences. As discussed above, we could mitigate this concern in setting a reserve price, by reference to the expected market value of the spectrum, but with a discount.
- 9.63 We also note that a reservation of the kind considered here has not, to our knowledge, been implemented or seriously contemplated in other countries that have auctioned 2.6 GHz spectrum.
- 9.64 On the other hand, reservation of some 2.6 GHz spectrum is the only way of ensuring that the auction creates an opportunity for market entry in a harmonised band. Creating such an opportunity for entry would be consistent with the requirement under the Government's Direction for us to consider the potential for new entry, and our duty regarding desirability of encouraging investment and innovation.
- 9.65 As noted above, low power entry may bring about greater competition by sustaining competition in the market or acting as a disruptive competitive force (see paragraph 9.15 above).
- 9.66 The 2x10 MHz of spectrum we are considering reserving could also be used by a national wholesaler to provide a more efficient service, and in a competitive market we would expect these efficiencies to be reflected in lower prices and/or a better service to customers.²⁵⁰ However, this should be seen in the context that national wholesalers will already hold significant amounts of spectrum (including the large majority of 2.6 GHz spectrum). In particular, 2x10 MHz of spectrum represents less than 4% of total paired mobile spectrum and national wholesalers may hold all or the vast majority of the remaining 96%.
- 9.67 While it is possible that low power entry could occur without reservation we have identified that there is some risk that it might not. Given these risks and the potential benefits to consumers of this entry we are minded to favour reservation of 2 x 10 MHz of 2.6 GHz spectrum but we would welcome more evidence on the costs and benefits of such an action which we recognise is a difficult judgement.
- 9.68 However, we have not seen compelling evidence that there is a much greater benefit in reserving 2x20 MHz for low power use, rather than 2x10 MHz, while reserving 2x20 MHz would be likely to at least double the opportunity cost. We therefore remain of the view that reservation of 2x20 MHz is unlikely to be proportionate.
- 9.69 We invite interested parties to provide evidence as to:
- Whether entry by sub-national RAN operators would have greater benefit to consumers than use of this spectrum by national wholesalers, and in particular evidence as to whether such entry would have a substantial impact on competition – for example whether entrants would be effective as a competitive fringe, and further evidence as to the scope for such entry to lead to the introduction of innovative services;

²⁵⁰ In Section 8, we consider how the risk of strategic investment would be affected if we were both to reserve spectrum for a fourth national wholesaler and reserve spectrum for low powered use.

- Whether, in the light of the potential for low power entrants to have a disruptive impact on competition, their intrinsic value of this spectrum is likely to be higher or lower than that of national wholesalers;
- The scope for effective strategic investment by national wholesalers against low power entrants; and
- Whether the risk of inefficient entry by low power users can be reduced by setting an appropriate reserve price.

Assessment of options for hybrid or split licences

Background

- 9.70 The hybrid approach was originally proposed in the technical report²⁵¹ on low power applications which Real Wireless prepared during the development of our March 2011 consultation. It was put forward as a new option that would combine elements of dedicated spectrum and full underlay spectrum.
- 9.71 The second technical report²⁵² undertook further development and analysis of the hybrid option. In particular, the report considered what technical measures would need to be implemented by a low power base station operating in hybrid spectrum. The June 2011 consultation²⁵³ on Technical Licence Conditions set out some tentative options based on the alternative approaches of spectrum sensing and geolocation, i.e. minimum separation distance.
- 9.72 The technical report that we published alongside the June 2011 consultation focussed on spectrum sensing and analysed in detail what measures a low power base station would need to take to manage the interference into a standard power network. It was based on the use of existing 3GPP reports and knowledge of options available in the 3GPP specifications.

Our position now

- 9.73 A hybrid approach for low power licensing is theoretically possible. As we outlined in the second technical report, spectrum sensing could be employed to minimise the cases of desensitisation of base stations and interference zones in the standard power network. The spectrum sensing approach would depend on a range of reporting and measurement capabilities being built into low power base stations, as well as implementation of particular formulae for calculation of base station power back-off and terminal power caps.
- 9.74 Our assessment is that the specific measurement and reporting capabilities are not embedded into standards to the extent that we can rely on their implementation across the low power networks. We understand that some of these capabilities appear as features in 3GPP specifications but that their implementation in base station products is optional.

²⁵¹ <http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/real-wireless-report.pdf>

²⁵² <http://stakeholders.ofcom.org.uk/binaries/consultations/tlc/annexes/report.pdf>

²⁵³ <http://stakeholders.ofcom.org.uk/consultations/technical-licence-conditions/summary>

- 9.75 Most countries will not be implementing hybrid shared spectrum. In the context of the European equipment market, this implies that most models of low power base stations will not implement the particular measurement and reporting capabilities required of the sensing approach. In addition, the specification of the particular formulae for base station power back-off and terminal power caps would be dependent on decisions about acceptable degradation in the standard power network. In the absence of other countries working with us to develop a common approach to hybrid sharing, the formulae would be a UK-specific equipment implementation. The timescale to deliver such a solution is unpredictable.
- 9.76 The specific implementation of a hybrid approach by measurement, reporting and calculation depends on the terminals being able to decode information broadcast by the standard power network. As a result, the spectrum sensing approach that we outlined would depend on the standard power network and all low power hybrid systems using LTE technology. However, in line with the technical conditions in Commission Decision 2008/477/EC we have developed proposals for licence conditions on the basis that we do not specify a permitted technology for standard power or low power licences. Including a technology-specific hybrid approach in licences would introduce a risk for licensees because they could not guarantee that other networks in the shared portion of spectrum would use that technology.
- 9.77 Spectrum sensing approaches have been analysed extensively during the study of white space technologies for UHF. In our September 2011 Statement²⁵⁴ on Implementing Geolocation, we concluded that in the short- to medium-term, geolocation would be the most important mechanism, given the expected cost and complexity of making white space devices that are sufficiently sensitive to sense the very low level signals of licensed users. We therefore did not propose to include sensing in our enabling measures for TV white space spectrum. Although the work on white space has concentrated on possible implementation in UHF TV spectrum, we have every reason to believe that the same conclusions for sensing would apply at 2.6 GHz.
- 9.78 For a hybrid approach based on geolocation, i.e. setting a minimum distance between each standard power base station antenna and the nearest low power base station that can use hybrid spectrum, we observe that there are again similarities with the work on implementing geolocation for white space in the UHF TV band, where activities are continuing. In order to proceed with development of technical licence conditions for 2.6 GHz hybrid based on geolocation, we would therefore need to consider mechanisms to arrange for management of the database of standard power base stations and the procedure for low power base stations to query it. We would also need to develop proposals for the minimum separation distance between low power and standard power base stations, and the accuracy of location information for low power base stations, bearing in mind that some could be self-install units with a similar form factor to a Wi-Fi access point. Since the standard power network would be progressively rolling out, we would also need to set requirements on how frequently the low power base stations would need to recheck the database.
- 9.79 Other European countries are not introducing geolocation approaches in 2.6 GHz so generally available low power base stations would not include any functionality for querying a geolocation database. Inclusion of this capability would require a UK-specific equipment implementation and the timescale for delivery is unpredictable.

²⁵⁴ <http://stakeholders.ofcom.org.uk/consultations/geolocation/statement/>

- 9.80 The difficulties with geolocation that are outlined above concern the particular implementation as a minimum separation distance from installed base stations of a network that is progressively rolling out. This means that the permitted area for the low power networks is only defined by reference to the base station sites of the standard power network, and that this area will change dynamically as the standard power network operator installs new base stations.

Provisional conclusion on hybrid licences

- 9.81 In view of the considerations set out above, we have provisionally decided not to proceed with the hybrid approaches with sensing or minimum separation that we outlined in the March 2011 consultation.²⁵⁵

Proposal for geographically split licences

- 9.82 Instead of the hybrid approach, we are now considering a different method of making additional low power spectrum available, in which one 2x10 MHz block is dedicated for either the low power networks or a standard power network in predefined geographic areas may be of interest to stakeholders. The model that we are considering is a geographic division between rural and non-rural areas. In the Information Memorandum and the licences we would define:
- a) the set of rural areas where low power networks may establish base stations using the shared 2x10 MHz block in addition to their dedicated 2x10 MHz block, and
 - b) the set of non-rural areas where the standard power network may establish base stations using the shared 2x10 MHz block in addition to its other 2.6GHz spectrum.
- 9.83 Under the geographic division approach that we are considering, the standard power licensee would not be permitted to establish base stations in rural areas in the shared 2x10 MHz block, and would be restricted to its dedicated block. Similarly, outside the defined rural areas, low power operators would only be able to use their dedicated 2x10 MHz block. The standard power operator and low power operators would be required to develop a coordination agreement to manage interference between low power and standard power networks in the vicinity of the boundary between rural and non-rural areas.
- 9.84 For example, this could lead to a particular block of 2x10MHz being licensed for standard power use (by one licensee) in urban locations, and for low power use (by, say, ten licensees) in rural locations.
- 9.85 Such a geographic split is, in itself, unlikely to facilitate entry by operators wishing to provide a national service via low power use – for example BT – as such operators are likely to place higher value on the urban area, which would also be of greatest interest to bidders for standard power use.
- 9.86 Rather, we would expect any consumer benefit from allowing a geographic split to arise from creating an opportunity for providers who wished to provide a specifically

²⁵⁵ This is consistent with our position on enabling measures for TV white space spectrum, as set out in our September 2011 Statement on Implementing Geolocation.

rural service. We are interested in receiving comments from stakeholders on whether this approach would be of interest

Measures on which we are consulting

- 9.87 Measures to facilitate the entry of low power users of 2.6GHz spectrum could take different forms depending on:
- Whether we support low power users in bidding for 2x10MHz or 2x20MHz of 2.6GHz paired spectrum.
 - Whether we achieve this by reserving spectrum, aggregating bids from licensees, or both (e.g. reserving for 2x10MHz and aggregating bids for a further 2x10MHz).
 - Whether support for low power use bids relates to national licences, or geographically-split licences, or both (e.g. aggregating bids for national use of 2x10MHz and for geographically split licences in a further 2x10MHz).
 - The reserve price for any spectrum which is reserved for low power use.
- 9.88 This range of factors gives rise to a variety of options, set out in Figure 9.2 below. The Figure does not attempt to list every possible permutation – it excludes possible options which we consider unlikely to be desirable in practice.
- 9.89 First, Figure 9.2 illustrates options for a 2x10 MHz band of spectrum. Such a band could be reserved nationally, or a rural licence could be reserved in a national split; alternatively we could allow aggregated low power bids for national use of the band, or aggregate rural and urban bids separately (options I to IV respectively).
- 9.90 If we were to support low power bids in two 2x10 MHz bands, we could do so either by reserving one band and aggregating another, or by aggregating both bands. We would not propose to reserve more than one 2x10 MHz band. In either case, licenses could be national, or split geographically into urban and rural licenses, and the possible combinations are set out in options V to X.

Figure 9.2: Options for supporting bidders for low power use of 2.6GHz

| Options for 2x10MHz | | | |
|--|--------------------|--|--------------------|
| Reserve | | Aggregate | |
| (I) National | | (III) National | |
| (II) Reserve rural licence in geographic split | | (IV) Aggregate bids on both urban and rural licences in geographic split | |
| Options for 2x20MHz (two separate 2x10 bands) | | | |
| Reserve one band and aggregated one band | | Aggregate both bands | |
| Reserved band | Aggregated band | First band | Second band |
| (V) National | + National | (VIII) National | + National |
| (VI) National | + Geographic split | (IX) National | + Geographic split |
| (VII) Rural licence in geographic split | + Geographic split | (X) Geographic split | + Geographic split |

- 9.91 As noted above, a geographic split of the kind we have proposed is, in itself, unlikely to facilitate entry by operators wishing to provide a national service via low power use. If we were supporting low power use in only one band, we would therefore propose to do so on a national basis, rather than with a geographic split (as in options II and IV). If we were supporting low power use in two bands, we would expect that at least one of these would be national – i.e. options VII and X are unlikely to be appropriate.
- 9.92 As discussed above, we propose that any measure including a reservation of spectrum for low power use should include reserve prices based on market value, with a discount to reflect the potential for greater benefits to competition and consumers from low power use.
- 9.93 Based on the reasoning set out above, and in the absence of arguments in favour of a geographically split licence, we consider that of the ten options set out in Figure 9.2, one of the following four is likely to be appropriate:
- a) Aggregating bids for national low power use in one 2x10 MHz band **(III)**.
 - b) Reserving 2x10 MHz for national low power use **(I)**.
 - c) Aggregating bids for national low power use in one 2x10 MHz band and, separately, in a further 2x10 MHz band **(VIII)**.
 - d) Reserving 2x10 MHz for national low power use and aggregating bids for a further 2x10 MHz for national low power use. **(V)**.
- 9.94 Taking each of these in turn:
- a) Aggregating in one 2x10 MHz band would be the least interventionist way of supporting national entry. However there is a possibility that it would not be effective, either because low power bidders are outbid by a standard power bidder, or because 2x10 MHz is not sufficient for low power use.

- b) Reservation removes the possibility of a standard power bidder outbidding low power users, but might not be the most efficient use of the spectrum, and again, there remains a possibility that 2x10 MHz will not be sufficient for low power use.
 - c) Aggregating bids in two 2x10 MHz bands creates some scope for low power users to win 2x20 MHz, if that is needed. However, the possibility remains that aggregation will not lead to low power users winning the spectrum, in one or both bands.
 - d) Reservation of 2x10 MHz and aggregating bids for a further 2x10 MHz ensures that low power users will have access to at least some 2.6 GHz spectrum, with an option to bid for more if there is strong enough demand. However, as discussed above, reserving spectrum carries an opportunity cost.
- 9.95 If this consultation reveals a strong demand for a geographically split licence, we consider that the following are most likely to be preferred options:
- a) Aggregating bids for national low power use in one 2x10 MHz band and aggregating bids for urban low power use and (separately) for rural low power use (i.e. allowing geographically split licences) in a further 2x10 MHz band **(IX)**. This remedy combines a minimal support for national entry by low power users, but also creates an opportunity for entry in rural provision of mobile services, while allowing the same spectrum to be used by a standard power user in urban areas.
 - b) Reserving 2x10MHz for national low power use, and aggregating low power bids for geographically split licences in a further 2x10MHz **(VI)**. This remedy ensures national access to spectrum by low power users, while creating an opportunity for rural provision.
- 9.96 We are consulting on whether we should support the use of 2.6GHz spectrum by low power users and, if so, which of the options set out above is appropriate. We are also consulting on which of the two proposals for implementing a geographic split is better.