



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

Annex 6: Competition Assessment

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Section 1

Introduction to competition assessment

Introduction

- 1.1 This Annex sets out the provisional competition assessment of mobile markets following the combined award of 800MHz and 2.6GHz spectrum that we are required to undertake under the Direction. Section 5 of the main consultation summarises this assessment, and also describes the relevant legal framework for the assessment.
- 1.2 In accordance with the Direction, our 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 combined award. It is therefore a forward looking assessment, based on our predictions 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.
- 1.3 This assessment is not a formal market review or assessment of Significant Market Power (SMP) under the Communications Act. The Direction expressly requires us, having assessed the markets to consider, if we think fit, to put in place measures to promote competition.
- 1.4 The time frame we have considered for our competition assessment is focussed on the next 5 to 10 years from the conclusion of the combined award. It is more difficult to consider a longer period because of the growing uncertainty the longer the time scale considered.
- 1.5 The competition assessment draws on the analysis and information gathered for our Mobile Sector Assessment, which we completed in December 2009, with our “Mobile Evolution” statement.¹ This found that the retail and wholesale mobile markets were effectively competitive at that time. This assessment was completed before T-Mobile and Orange merged.

Analytical framework

- 1.6 We first consider likely future competition in mobile markets. We consider the retail market first, and then the wholesale market. We consider how competitive a number of key elements of the mobile markets might be after the combined award, and the potential risks to competition. We assess this assuming we put in place no measures in the combined award to promote competition (in other words, an auction in which any bidder can bid for any amount of any spectrum, subject only to the technical licence conditions necessary to avoid harmful interference).
- 1.7 In light of the above assessment and our provisional conclusion that there are likely to be risks to future competition if we do not put in place measures to promote competition, we go on to consider whether there are any appropriate and proportionate measures that we should consider putting in place.

¹ http://stakeholders.ofcom.org.uk/binaries/consultations/msa/statement/MSA_statement.pdf

1.8 We have adopted the following analytical framework to assess whether we should put in place any measures to promote competition:

- What is the risk and likely magnitude of a market failure if we do not put a measure in place? By market failure we mean that markets (in the absence of measures) might not deliver the best outcome for citizens and consumers.
- What are the risks of regulatory failure if we take a measure? By regulatory failure we mean either that the regulatory intervention fails to achieve the outcome intended, or that there were unintended consequences. It can be thought of as the counterpart of market failure.
- What are the implementation costs and/or opportunity costs of the measure?

Structure of remainder of Annex

1.9 The rest of this Annex is structured as follows:

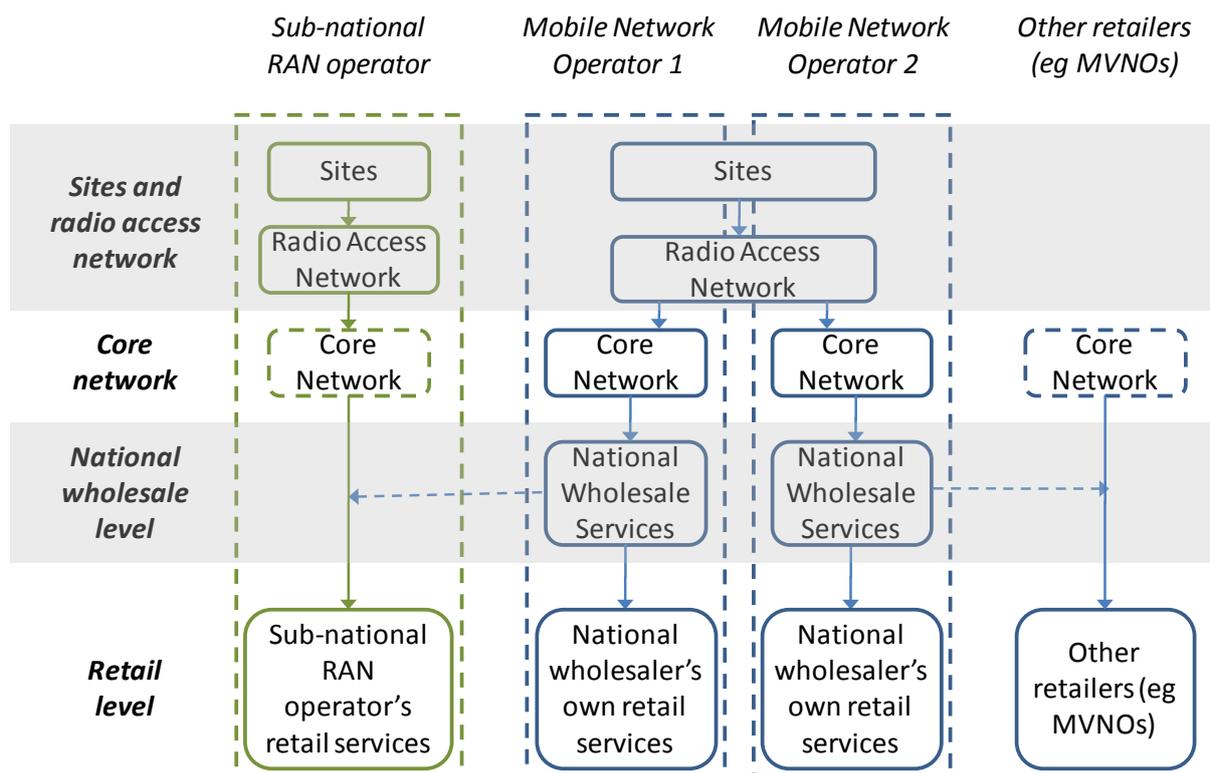
- Section 22 describes the mobile industry structure and the terminology we use in this competition assessment for different industry participants.
- Section 33 identifies possible candidate markets, which are considered in later sections.
- Section 44 considers competition in mobile markets currently and current trends.
- Section 55 assesses the likely future competition in markets after the combined award, on the assumption that we take no measures in the auction. It describes why we see the competition in the wholesale market as critical and why we consider that spectrum holdings are important for this. This section establishes that we have concerns that with no measures in the auction there is a material risk of a reduction in competition in wholesale and retail markets. The following sections then consider possible measures to address this concern and promote competition going forward.
- Section 66 considers potential measures to promote national wholesale competition. It provisionally concludes that it is likely to be appropriate and proportionate to put in place measures in the auction to ensure spectrum holdings for at least four competitors that enable them to be credible national wholesale competitors after the combined award. We propose to take measures in the auction relating to sub 1GHz and the overall quantity of mobile spectrum.
- Section 77 considers potential measures to promote national wholesale access. It provisionally concludes that it is unlikely to be appropriate and proportionate to intervene ex ante and impose an wholesale access condition.
- Section 88 considers potential measures to promote entry by sub-national radio access networks. It provisionally concludes that it is likely to be appropriate and proportionate to introduce a mechanism that aggregates low powered users' bids and allows competition between high and low powered bidders. There may also be a case for reserving some spectrum for shared low power use.
- Section 99 considers other powers that Ofcom has to promote competition, outside of the combined award.

Section 2

Mobile industry structure and terminology

2.1 This section describes the main parts of the vertical structure of the mobile industry and the terminology we use in this competition assessment.

Figure 2.1: Simplified mobile industry vertical structure



2.2 Figure 2.1 illustrates the main components of the vertical structure of the mobile industry.² The three types of entity we identify are:

- i) **Mobile Network Operators (MNOs)** who are the licensees of mobile spectrum and, in addition to having a core network, need access to:
 - **Sites:** In order to deliver services, mobile networks require suitable locations that can accommodate the infrastructure needed to house equipment. such as transmitters, and the backhaul needed to connect sites to the rest of the network.
 - **Radio Access Network (RAN):** The portion of a mobile network that utilises spectrum to establish connections between individual mobile devices and the core network.

² There are other parts to the mobile value chain which are not directly relevant to this analysis (e.g. content production) and other ways of classifying levels in value chains relating to other mobile services (e.g. in respect of mobile call termination).

MNOs have access to national RAN networks.³ They may share some network infrastructure, and for illustrative purposes, Figure 2.1 shows two MNOs sharing sites and RAN. MNOs provide their own retail services as well as providing national wholesale access services to other entities. In the UK today, there are currently four such MNOs: Everything Everywhere, H3G, O2 and Vodafone.

- ii) **Sub-national RAN operators** who have access to certain sites (which may mostly/only be indoors) and operate some radio access equipment (which may involve mostly/only pico-cells or femto-cells). They may also hold their own spectrum and may have their own core network. They are likely to use low powered cells with only very localised areas covered. They are able and likely to retail their own services and may be able to benefit from wholesale access to national networks, thereby achieving national coverage. Sub-national RAN operators exist today and relevant examples in the UK include networks using the so-called DECT guard band spectrum and WiFi networks using licence-exempt spectrum. We describe some of these existing sub national networks in section 4.12 below.
- iii) **Other retailers (e.g. Mobile Virtual Network Operators (MVNOs))** who purchase wholesale access to national networks and retail their own services without owning RANs. The ecosystem of these retailers encompasses a range of different companies with very different commercial models. At one end of the range, some are “pure resellers” in that they focus on developing their branding and pricing offer, but with the MNO providing access supplying the underlying service package in its entirety (including customer service and billing). At the other end, some operate their own customer relationship management systems, including all billing operations; and have their own number ranges, network code; core network infrastructure (e.g. switches) and SIM cards, having their customers roam onto their national wholesale partner’s network. They have the option of negotiating their own international roaming rates with foreign operators. Other levels in this ecosystem include Mobile Virtual Networks Enablers, who supply back office function (e.g. customer relationship management, and credit checks) and Mobile Virtual Network Aggregators, who aggregate demand from several MVNOs to negotiate with host MNOs, when MVNOs lack in scale to warrant having their own dedicated internal functions or to attract interest from potential wholesalers on their own.

2.3 Above we have used the term Mobile Network Operator in the way it is usually used, namely to refer to one of the four national mobile network operators. However, this could be misleading, as there is a sense in which the sub-national RAN operators are also mobile network operators, albeit on a much smaller scale. We also find the term unhelpful in the current context because a company could, in theory, be active at the wholesale level without necessarily itself “operating” a network on its own. It could instead contract for access to a network or share network infrastructure with another company.

2.4 For the purpose of this competition assessment, we therefore prefer the term **national wholesaler**, by which we mean a company that provides wholesale access for the supply of mobile services at a national level. This wholesale access service could be provided to the national wholesaler’s own retail business or also to other

³ In practice this means RAN networks that provide coverage to a significant portion of the country . Current levels of UK coverage are over 99% of the population for 2G services and in excess of 80%, with some variations between operators, for 3G services.

retailers. National wholesalers need access to spectrum and access to a network in order to wholesale mobile services. While national wholesalers clearly need access to a national RAN, they do not necessarily need to own it. It is possible for there to be fewer national radio access networks than there are national wholesalers because wholesalers may seek to share networks. The term national wholesaler allows us to more clearly recognise this. Currently, there are four national wholesalers in the UK (Everything Everywhere, H3G, O2 and Vodafone), but the industry is more concentrated at the network level. H3G and Everything Everywhere share a 3G RAN. O2 and Vodafone also have a site sharing agreement.

Section 3

Possible candidate markets

Section summary

3.1 In the previous section we distinguished between distinct vertically-related markets in the value chain. In this section, we consider the candidate markets that may be relevant to our competition assessment.

3.2 Given the forward looking nature of our competition assessment, we do not consider it useful to try to define markets in a definitive way. However, we believe it important to consider the most likely ways in which the market may develop. Our most important provisional conclusions on possible developments are:

- Mobile retail services are not currently competitively constrained by fixed services, and this is likely to remain the case for the period we are considering.
- Past assessments have found a single mobile retail services market and a single wholesale access and call origination market. They found a single mobile retail market because consumers typically buy a 'cluster' of services (including access, voice origination and data services) that are likely to face a common pricing constraint. In the future, the nature or importance of the different segments could change.
- In particular, data services are likely to continue to grow in importance.⁴ This is significant for this competition assessment because spectrum holdings can have a bigger impact on the quality of data services compared to the quality of voice services.
- The possible developments that could affect our competition assessment most would be the development of markets that required higher quality data services, such as:
 - A high quality data market associated with reliable indoor coverage for data services.
 - A separate market associated with higher data speeds and better latency (delivered by LTE) which is distinct from a market associated with lower data speeds (delivered by 2G and 3G).
 - A division of the retail market into services that had priority over other services (e.g. a highly reliable business service compared to a lower priority consumer service).

If markets were to develop in these ways then it could affect our competition assessment if not all providers were able to deploy services to serve all markets. In subsequent sections of this Annex we consider the implications of these candidate markets developing.

⁴ If VoIP services were to grow in importance, the distinction between voice and data service could become less relevant.

- The geographic scope of the retail and wholesale markets is likely to be the UK as a whole. We consider coverage issues separately in section 6 of the main consultation.

No definitive market definitions

- 3.3 We do not consider it useful to undertake a formal market definition exercise to reach a definitive view on future markets. While all market reviews are to some extent forward looking, the time period for this competition assessment does not begin until after the combined award, and it looks further into the future than is normally the case for a market review. We consider it is appropriate to consider a relatively long time frame for this review because we consider there are high barriers to entry to the wholesale market and that spectrum holdings have a significant impact on the wholesale market (for the reasons discussed in section 55). The award therefore has the potential to shape the competitive structure of the mobile sector for many years and as such provides an important opportunity to promote competition. We consider that it would be difficult for us to reach a definitive view of markets over a longer time frame, and there would be considerable scope for error if we tried to do so. This is because there is significant uncertainty about the future of mobile markets and their possible development, especially given current trends and uncertainty about the full implications for consumers of LTE networks being built in the future.
- 3.4 In addition, it is only necessary to consider market definition to the extent that it is likely to affect our analysis. Some distinctions (for example, whether business customers are in the same market as residential customers) may have no effect on our analysis. But other possible ways in which separate markets might develop could affect our analysis and we focus on these.
- 3.5 We first consider market definition at the retail level and wholesale level currently, and then consider possible future developments.

Current retail market product definition

Mobile services not competitively constrained by fixed services currently

- 3.6 In 2007, the European Commission issued a revised recommendation on relevant product and services markets susceptible to ex ante regulation.⁵ The accompanying Explanatory Note⁶ considered that fixed and mobile services would generally not be expected to be in the same market:

“In the initial Recommendation, a general division was made between services provided at fixed locations and those provided to non-fixed locations. Overwhelmingly, despite some moves towards hybrid or converged offerings, this distinction is considered to be still valid, because there is as yet insufficient evidence that the pricing of mobile services (to non-fixed locations) systematically constrains the pricing of services to fixed locations (or vice versa).”

⁵ Commission Recommendation of 17 December 2007 2007/879/EC, OJ L344, 28.12.2007, p.65: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2007/l_344/l_34420071228en00650069.pdf

⁶ Section 4.1 of http://ec.europa.eu/information_society/policy/ecomms/doc/implementation_enforcement/eu_consultation_procedures/sec_2007_1483_2.pdf

- 3.7 We have recently completed market reviews for the fixed narrowband services wholesale markets and the fixed wholesale broadband access markets. In looking at these wholesale fixed markets, we needed to consider whether at the retail level fixed and mobile services were in the same market.
- 3.8 In our 2009 reviews of the fixed narrowband services wholesale markets⁷ and the fixed narrowband retail services markets⁸ and our 2010 review of the wholesale fixed analogue exchange lines markets⁹, we concluded that mobile access and fixed access were in separate markets.
- 3.9 In these reviews, we noted that there was clear evidence of an increased level of competition between fixed and mobiles for call origination at the retail level.¹⁰ A high proportion of UK consumers have both mobile and fixed line access and so clearly have a degree of choice as to whether to make a call on their fixed line or mobile, at least when they are near their fixed line. While we concluded that mobile calls did not competitively constrain fixed narrowband calls, we recognised the growing constraint on fixed call origination from mobile call origination. However, the strength of any such constraint could be asymmetric. While mobile calls may be an increasing substitute for fixed calls, given the nature of mobile services, there will be circumstances when consumers are not near a fixed line, when fixed calls cannot substitute for mobile calls.
- 3.10 We considered the situation for access to be much more clear cut. We found that consumers currently generally regard mobile phone and fixed line access as complementary services rather than substitutes. While there was evidence that there was some substitutability between fixed and mobile access, the greater weight of evidence suggested that consumers predominantly view the two types of access as meeting different needs and have a strong preference to purchase both fixed and mobile access. Other evidence includes the trends in mobile versus fixed prices and variations in the number of mobile only households.
- 3.11 In our 2010 review of fixed wholesale broadband access markets, we found that broadband internet access services using mobile was in a separate economic market to fixed broadband internet access services. At the retail level, the evidence showed mobile broadband is largely seen as complementary to existing fixed broadband access, and the two services have different qualities.¹¹

⁷ http://stakeholders.ofcom.org.uk/binaries/consultations/wnmr_statement_consultation/summary/main.pdf

⁸ http://stakeholders.ofcom.org.uk/binaries/consultations/retail_markets/statement/statement.pdf

⁹ <http://stakeholders.ofcom.org.uk/binaries/consultations/review-wholesale-fixed-exchange/statement/statement.pdf>

¹⁰ This was partly because we considered it appropriate to take a conservative view of the market boundaries. The purpose of the market definition was to support the analysis of market power. The exclusion of mobile calls from the fixed call market set a higher hurdle in establishing that that market was effectively competitive, strengthening the robustness of our finding that there was no SMP for retail fixed narrowband calls in the UK (excluding Hull). See paragraphs 4.52 to 4.54 of the fixed narrowband retail services markets:

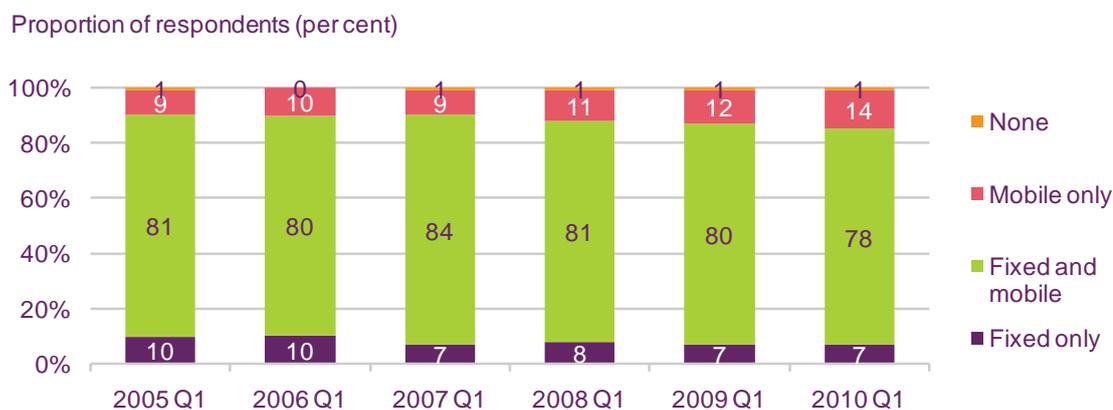
http://stakeholders.ofcom.org.uk/binaries/consultations/retail_markets/statement/statement.pdf

¹¹ See especially paragraphs 3.19 and 3.23 of the wholesale broadband access markets statement <http://stakeholders.ofcom.org.uk/binaries/consultations/wba/statement/wbastatement.pdf> and paragraphs 3.103 to 3.116 of the related consultation <http://stakeholders.ofcom.org.uk/binaries/consultations/wba/summary/wbacondoc.pdf>

3.12 We recognise that these market reviews considered whether mobile services constrain fixed services, whereas here we are interested in whether fixed services constrain mobile services. The absence of a constraint in one direction does not necessarily mean the absence of a constraint in the other direction. However, we consider that many of the arguments about the complementary nature of the two services are relevant for both directions.

3.13 Figure 3.1 below shows the take up of mobile and fixed service over time. The complementary take up of fixed and mobile services is illustrated by the fact that in Q1 2010 78% of households had both fixed and mobile access. The proportion of fixed only households has declined slightly over time, falling from 10% in 2005 compared to 7% in Q1 2010. There has been an increase in the proportion of mobile-only households, increasing from 9% in 2005 to 14% in Q1 2010. It was 12% in 2009 when we completed the review of the fixed narrowband services wholesale markets. There were, however, variations in these proportions by age and socio-economic group, with mobile only access being most prevalent in low income households and young households.¹²

Figure 3.1: Household penetration of fixed and mobile telephony



Source: Ofcom research
Base: All adults aged 15+

3.14 Given the complementary nature of fixed and mobile in the UK currently, we consider that mobile services are currently not competitively constrained by fixed services. We consider this is particularly the case for some aspects of service in the mobile market, such as mobile access.

3.15 Our provisional conclusion that fixed does not competitively constrain mobile is consistent with the European Commission's recent decision on the T-Mobile and Orange merger which considered the relevant retail market to be mobile telecommunication services to end customers.¹³

3.16 We recognise that in Austria the regulator (RTR) has found fixed and mobile broadband access to be in the same market for residential consumers.¹⁴ The

¹² See Figure 5.68 of Ofcom's Communications Market Report 2010 on the variations in these proportions by age and socio-economic group:

<http://stakeholders.ofcom.org.uk/binaries/research/cmr/753567/UK-telecoms.pdf>

¹³

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

¹⁴ See for example: <http://www.analysismason.com/about-us/news/Newsletter/Mobile-broadband-has-led-to-deregulation-in-the-Austrian-broadband-market/>

situation in Austria appears very different to that in most of the European Union, including the UK. Mobile broadband is used by a high percentage of residential customers, there are four extensive HSDPA networks, prices for fixed and mobile broadband connections move closely together, and 75% of residential mobile broadband customers used their connection mainly on a stand-alone basis, rather than coupled with a fixed connection. For business consumers, RTR found fixed and mobile broadband access to be in separate markets. As far as we are aware, the situation in Austria for residential customers is unique amongst Member States.

Currently may be a single retail product market

- 3.17 We have not formally assessed market definitions for mobile services since 2003. At that time we defined a market for mobile wholesale access and call origination, and found that this market was effectively competitive.¹⁵ As part of looking at the wholesale markets, we needed to consider the retail market. We found a single market consisting of a 'cluster' of services (including access, SMS and voice origination) that faced a common pricing constraint. We said it was unclear whether mobile internet services delivered through 3G technology was in the same market, because that had only very recently been introduced and the implications of it were unclear.
- 3.18 The European Commission's 2007 Explanatory Note considered that there is generally a "cluster" of mobile products (such as access, voice and SMS) which are normally sold together and can be regarded as a single market for retail mobile services.¹⁶
- 3.19 In its March 2010 decision on the T-Mobile and Orange merger, the European Commission considered that a single retail market was appropriate. It decided not to divide up the market by type of customer (corporate or private, post-paid subscribers or pre-paid customers) or type of network technology (2G/GSM or 3G/UMTS networks). The possible distinction by type of technology is most relevant to this assessment. The Commission said:

"... As far as distinguishing by type of customer is concerned, the respondents to the market investigation indicated that normally customer classification might involve a distinction between private and business customers and that tariff plans are different for pre-paid and post-paid. However, although business customers are considered "heavy users" as opposed to private customers who use mobile communication more scarcely, the service offered is substantially the same as the one offered to private customers. As for the distinction between pre-paid and post-paid, although the type of contracts have differentiated characteristics, the market investigation indicated that the distinction between the two segments is becoming blurred, because of the development of different types of offers.

Voice communications and data services, such as text messaging, access to e-mail services or general Internet access, can be

¹⁵ http://www.ofcom.org.uk/static/archive/oftel/publications/eu_directives/2003/mobileaco0803.pdf

¹⁶ Section 4.3 of http://ec.europa.eu/information_society/policy/ecommerce/doc/implementation_enforcement/eu_consultation_procedures/sec_2007_1483_2.pdf

provided on 2G or 3G networks. However, in the case of general Internet access, 2G networks provide a much lower speed. Other services require the faster transmission speed which only a 3G network can provide (video communication, mobile TV or other multimedia services). A network operator can provide to its customer access to voice communication and text messaging services indifferently on a 2G or a 3G network. On the other hand, only 3G networks provide greater network capacity which allows operators to provide more advanced, data intensive services.

The market investigation aimed at verifying whether the services offered on the two types of networks belong to separate markets. The majority of the respondents indicated that, although some MVNOs (Mobile Virtual Network Operators) tend to offer only voice/text messages, the borders between the two types of service are blurred and the larger part of the offers in the market generally includes both data and voice. Furthermore, the mobile communications market is facing an increasing demand for data services, which are normally coupled with effective voice communication and good coverage.

Therefore, for the purpose of this decision, the Commission considers that there is a single market for the provision of mobile communication services to end customers, in so far as they can be provided on both a 2G and a 3G basis.”¹⁷

- 3.20 Our competition assessment is about future markets rather than current markets, so it is not essential to reach a definitive view on current markets. It may be reasonable to assume a single product market for retail services currently. But even if there were different retail markets for different types of customer (e.g. corporate or private), it would be unlikely to affect our assessment. In terms of technologies, as described below, we consider possible future developments that could mean there were different retail markets related to different technologies in the future.

Current wholesale market product definition

- 3.21 At the wholesale level, past assessments by competition authorities have assumed a single wholesale access and call origination market. This is because both network access and call origination are typically supplied together by a national wholesaler to its own retail business or to independent retailers. For example, the European Commission assumed a single wholesale access and call origination market in the recent T-Mobile and Orange merger in the UK, and has adopted the same approach in other decisions. Again we do not need to reach a definitive view on the current wholesale market definition, as it is future markets that we are concerned with.

¹⁷ We have excluded the Commission’s footnotes from the extract above. See paragraph 21 to 24: http://ec.europa.eu/competition/mergers/cases/decisions/M5650_20100301_20212_247214_EN.pdf

Possible future developments and the potential importance of higher quality data services

Mobile services likely to remain unconstrained by fixed services

- 3.22 We recognise that there are some signs of growing substitution between some fixed and mobile services, especially for call origination. There are also some industry trends for fixed / mobile convergence that may in the future blur the distinction between fixed and mobile services.¹⁸ It is conceivable that in the future mobile and fixed may be in the same market.
- 3.23 We also recognise that if high quality indoor coverage were to become very important, it is possible that fixed services could act as more of a competitive constraint on some mobile use. This would depend in part on the value that consumers placed on being able to use a mobile connection indoors while away from where they had access to a fixed connection, for example when inside buildings other than their own home.
- 3.24 Also, even when inside buildings where they have access to a fixed service, some consumers may still value having mobile connectivity. This may be less likely for mobile broadband delivered using dongles and data cards, where the device connected is the same whether the connection is fixed or mobile. However, for mobile internet connections using smartphones,¹⁹ the functionality and use made of the devices may be more distinct from those associated with fixed services. It seems plausible that people would value having mobile services to devices such as smartphones even when they are in buildings where they also have access to a fixed broadband connection, especially as greater functionality is added to smartphones.
- 3.25 It is possible that mobile devices (such as smartphones) will increasingly connect with Femtocells or WiFi connections that rely on having a fixed service, and only use a macro cell mobile network when those types of connection are unavailable. However, if this were to happen, fixed networks and macro-site mobile networks could be complements rather than being substitutes in terms of providing services. Fixed services may still not competitively constraint mobile services.
- 3.26 For the timeframe of our competition assessment, we consider that it is reasonable not to rely on fixed services constraining mobile services (we do not need to consider whether there could be a constraint in the other direction). This is because in terms of access (as opposed to calls), there is currently considerable evidence that mobile services are not constrained by fixed access, and there is no obvious trend that fixed access will constrain mobile access more in the future. For example, the proportion of the population with only fixed lines (and no mobile access) has declined slightly over the last five years, which does not suggest fixed will become a greater constraint on mobile in the future.

¹⁸ See for example from paragraph 3.53 in our July 2009 'Mostly Mobile' consultation <http://stakeholders.ofcom.org.uk/binaries/consultations/msa/summary/msa.pdf>

¹⁹ Although there is no generally agreed definition of a smartphone, the use of an advanced operating system that facilitates the development and installation of third party applications is commonly accepted as differentiating smartphones from 'feature' phones. In most cases, smartphones have other characteristics such as a larger colour screen than a typical mobile phone, a touchscreen or full QWERTY keyboard, access to fast internet connection, and large memory storage.

There could be more retail markets and wholesale markets in the future

- 3.27 Although we consider there may currently only be a single retail market for the various retail services, we consider that in the future separate markets may develop at the retail level, and potentially at the wholesale level.
- 3.28 For example, there could be divisions connected with data and voice services. A separate market for data services delivered in isolation to voice services might develop. This would be associated with services delivered to dongles or data cards (which can be bought independently of other mobile services). It is also conceivable that there could be a further distinction between voice and data services delivered to integrated handsets that make heavy use of data services, and services to those consumers who predominantly just use voice services. The growth in smartphones and percentage of consumers using mobile internet (as discussed in section 4) may suggest that in the future most consumers will value voice and data services combined.
- 3.29 Any such future divisions of the mobile market may have little effect on competition if all providers were able to offer services to all future markets. However, if it were the case that only some providers were able to deliver services to some possible future markets, then this would affect the degree of competition for those services. We therefore focus on possible markets that might develop that could affect our competition assessment.
- 3.30 In particular, we focus on the possible emergence of markets that require higher quality data services that are not constrained by lower quality data services.²⁰ The three candidate markets for higher quality data services that we consider most likely to emerge are:
- A high quality market associated with reliable indoor coverage for data services. This could occur if low quality products (with poor indoor coverage) did not constrain the price of high quality products as consumers were not prepared to switch to low quality products. This might affect our competition assessment if reliable indoor coverage were only possible with access to sub 1GHz spectrum and if not all providers had access to sub 1GHz spectrum. This could have implications for all mobile services, if consumers tended to buy bundled offering that included access, voice and data.
 - A separate market associated with higher data speeds and better latency (delivered by LTE) which is distinct from a market associated with lower data speeds (delivered by 2G and 3G). It is possible that services delivered with large contiguous spectrum blocks using LTE are able to offer such superior quality that there is a break in the chain of substitution between low data speed services and higher speed services. This could affect our competition assessment if only some providers had access to large contiguous bandwidths of spectrum that could be used for LTE. Again, this could have implications for all mobile services if services tend to be bought in bundles.
 - A division of the retail market into services that had priority over other services (e.g. a highly reliable business service compared to a lower priority consumer

²⁰ Even if the low quality services did not constrain high quality services, it is possible that high quality services could constrain low quality services, meaning that there would be a single market if we were considering low quality services.

service). The use of LTE technology may make such segmentation easier to do. For there to be separate markets, there would need to be only a weak degree of substitution between the two types of service.

- 3.31 We recognise that it is not possible to know for sure whether such markets may develop. Our assessment is very forward looking and there are currently no services provided using LTE in the UK. While there is evidence that consumers currently value quality of service, and it seems very plausible that they would place higher value on data services that offered higher quality services, it is less clear this would mean that the higher quality services would be unconstrained by the lower quality services.
- 3.32 However, we consider it is possible that separate retail mobile markets may develop in the future, which might be accompanied by separate markets at the wholesale level. If not all providers were able to access some retail markets, this could impact on our competition assessment. We consider the implications of these three candidate markets in later sections of this Annex.
- 3.33 The possibility of a higher quality market developing is consistent with the European Commission's T-Mobile and Orange merger decision. While the European Commission assumed a single wholesale access and call origination market, it considered there was a possibility of a bifurcation of the market in the future. In particular, the European Commission was concerned about a possible division of the market between high quality services that could be only delivered by those providers with access to large contiguous blocks of spectrum (such as 2x20 MHz) for LTE and lower quality services offered by providers who did not have access to large contiguous blocks of spectrum for LTE.
- 3.34 Even in the scenario in which separate markets develop, there could still be material consumer harm from significantly weaker competition in higher quality or high speed or higher priority data services, given the expected importance of these services. The greater the extent to which these services tended to be bundled with voice services, the larger the affected markets would be, and the greater the potential harm that could result from weaker competitive intensity in the provision of the data services.

Single UK geographic market

- 3.35 Currently prices do not vary by geography and we are not aware of any plans or drivers for moving away from a national pricing structure. This suggests a single geographic market currently, for both retail and wholesale markets. We consider that the UK is currently the relevant geographic market and is likely to remain so for the period we are considering.
- 3.36 This is consistent with our 2003 assessment of mobile wholesale access and call origination and also with the much more recent European Commission merger decision.
- 3.37 While we propose to consider a single UK geographic market is appropriate, we do recognise the importance of rural coverage questions. We have considered these when we discuss coverage obligations in section 6 of the main consultation.

Other mobile markets not covered by assessment

Wholesale voice call termination

3.38 We do not consider wholesale voice call termination markets in this competition assessment. We have recently considered that market separately.²¹

Wholesale international roaming

3.39 We do not consider international roaming independently in this assessment. In 2009, the European Commission imposed wholesale and retail constraints on international roaming prices, and is currently reviewing the functioning of these regulations.

²¹ <http://stakeholders.ofcom.org.uk/consultations/mtr/statement>

Section 4

Current competition in mobile markets

Section summary

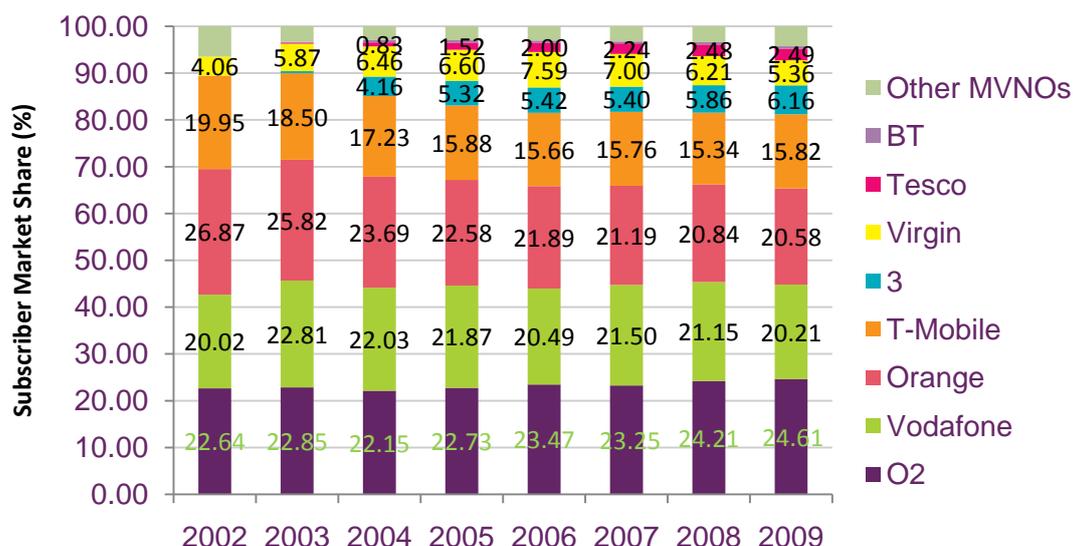
- 4.1 In this section we consider the current competitiveness in mobile markets, drawing on our Mobile Sector Assessment (MSA).
- 4.2 There are four national wholesalers in the UK: O2, Vodafone, Everything Everywhere and H3G. These companies together serve the large majority of the retail market. Everything Everywhere was formed in 2010 by the merger of T-Mobile and Orange in the UK. There are also a wide variety of retailers present in the UK market.
- 4.3 In the MSA, we considered that mobile markets were effectively competitive, and served consumers well.²² However, the MSA was completed before the merger of Orange and T-Mobile. Since the merger, we have seen no indication that competitive pressures have significantly reduced, but we recognise that the merger is relatively recent and there is currently little information on the period since the merger.
- 4.4 We also identify some of the current trends in the industry. A key trend in recent years is the increased usage of data services and the rapid growth of data traffic on mobile networks.

Current competitiveness of retail market

- 4.5 The UK retail market has a diverse range of firms supplying mobile services to consumers. These include the retail operations of the national wholesale competitors, sub-national RAN operators and a range of other retailers, such as MVNOs.
- 4.6 In the MSA, we found that in the retail market there were shifts in market shares, robust switching levels, new entry and evidence of innovation with new product and price options. Figure 4.1 below shows how market shares (in terms of subscribers) have changed over time, which is consistent with active competition between retailers.

²² *Mobile Evolution, Ofcom's Mobile Sector Assessment*
http://stakeholders.ofcom.org.uk/binaries/consultations/msa/statement/MSA_statement.pdf

Figure 4.1: Retail market share by number of subscribers



Source: Ofcom

- 4.7 Barriers to entry at the retail level appear relatively low, with many examples of entry occurring. Since the entry of Virgin Mobile in 1999, numerous retailers have entered the market, with around 25 currently operating. These include retailers in other sectors with established brands and distribution networks, such as Tesco Mobile in 2003 and Asda Mobile in 2007. Talk Talk entered the mobile retail market in 2010.²³ Other entrants include those who cater to more niche markets, such as ethnic communities, including Lebara Mobile in 2007²⁴ and Lyca Mobile in 2008.²⁵
- 4.8 However, it is possible that there are some barriers to growth in the retail market, particularly for those customer segments for which there are material customer acquisition costs. This would be consistent with the three national wholesalers who have been active in the retail market the longest (Everything Everywhere, O2 and Vodafone) being the three largest retail competitors. It may also be consistent with MVNO activity tending to be clustered around certain types of services and consumers, as we noted in the MSA. For example, MVNO are more likely to serve pre-paid rather than pay monthly accounts.
- 4.9 In the MSA, we also concluded that the mobile sector has served UK citizens and consumers well. Consumers have experienced sustained real price reductions and mobile penetration has continued to grow. We believe that competition has helped to deliver these benefits to consumers.
- 4.10 Since the MSA was published, the real price of a basket of mobile services has continued to fall, indicating that consumers continue to benefit from better value for money from mobile markets.

²³ <http://www.talktalk.co.uk/business/news/reuters/2010/07/30/talktalk-to-offer-mobile-on-vodafone39s-network.html>

²⁴ http://www.assets.lebara.com/medias/sys_master/8799861047326.pdf

²⁵ <http://www.lycamobile.co.uk/PDFs/Lycamobile%20launches%20low%20cost.pdf>

Figure 4.2: Real cost of a basket of mobile services

£ per month (2009 prices)



Source: Ofcom / operators

Note: Includes estimates where Ofcom does not receive data from operators; excludes non-geographic voice calls; adjusted for RPI; includes VAT

- 4.11 International comparisons suggest UK consumers enjoy mobile services that are priced competitively. Ofcom's comparative studies have found the UK to have the cheapest mobile services for a variety of usage baskets (covering both voice and data).²⁶
- 4.12 There are a few examples of sub-national RAN operators currently. They are all relatively small deployments and have very limited market shares. Current operations use picocells or other equipment to improve mobile coverage and reduce mobile call costs for their customers. These operators typically have a roaming agreement with national wholesalers, though we note that this is not always the case.
- 4.13 In 2006, Ofcom awarded twelve low power licences for shared use of a 2x3.3MHz strip of spectrum at the top of the GSM1800 band (the DECT guard band) suitable for 2G technology use²⁷. Several licensees are offering new services. Cable and Wireless, for example, offer a service allowing corporate customers to use a single mobile handset for all their calls, removing the need for a landline in addition to a mobile subscription. When in the office, users connect to their provider's low power cell. When out of the low-power provider's coverage, users roam onto a national network for wide area coverage. Teleware (through its subsidiary Private Mobile Networks) supplies picocell networks to some businesses and portable private mobile networks to the military and emergency services. Vectone Mobile operates urban picocell networks for ethnic communities.
- 4.14 Other sub national RAN operators do not use licensed spectrum but offer mobile services using Wi-Fi. A prominent example is BT Fusion which can use BT's Wi-Fi hotspots and a roaming agreement with Vodafone for wider coverage. The product was originally offered to residential consumers but was not commercially successful and has been withdrawn, although it remains available for business customers. An example of another type of network exists at New College Durham which operates a

²⁶ *The International Communications Market Report*, December 2010,<http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr10/international/>²⁷ http://stakeholders.ofcom.org.uk/spectrum/spectrum-awards/completed-awards/award_1781/

converged VoIP system over a campus wide Wi-Fi network that can be accessed with mobile handsets.²⁸

Current competitiveness of wholesale market

4.15 The MSA found that the wholesale market was competitive. Figure 4.3 below shows the market shares for total connections to the five national wholesalers that existed before T-Mobile and Orange merged. These figures include the subscribers of each wholesaler's own retail operations and the subscribers of MVNOs and resellers that use each wholesaler's network. It can be seen that the market shares have fluctuated over time between the different wholesalers.

Figure 4.3: Market shares for wholesale mobile connections



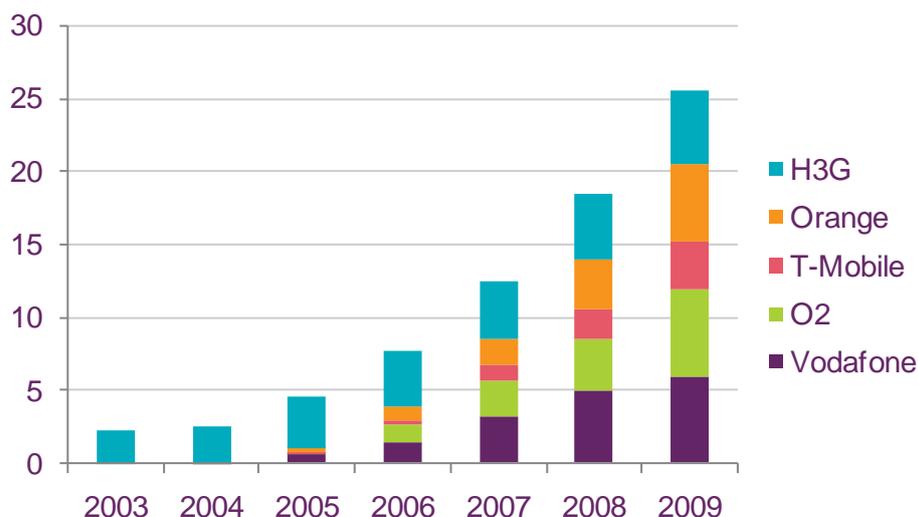
Source: Ofcom/operators

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

4.16 In this assessment, we are particularly interested in mobile data markets, where 3G technology is currently more important. Figure 4.4 shows only 3G subscriptions and how these have grown over time and how the relative position of the different wholesalers has changed. These subscription figures are for all 3G subscriptions, including both datacards/dongles and handsets.

²⁸ http://wbiaward.com/submission_photo/2008/40_photo1.pdf

Figure 4.4: 3G subscriptions

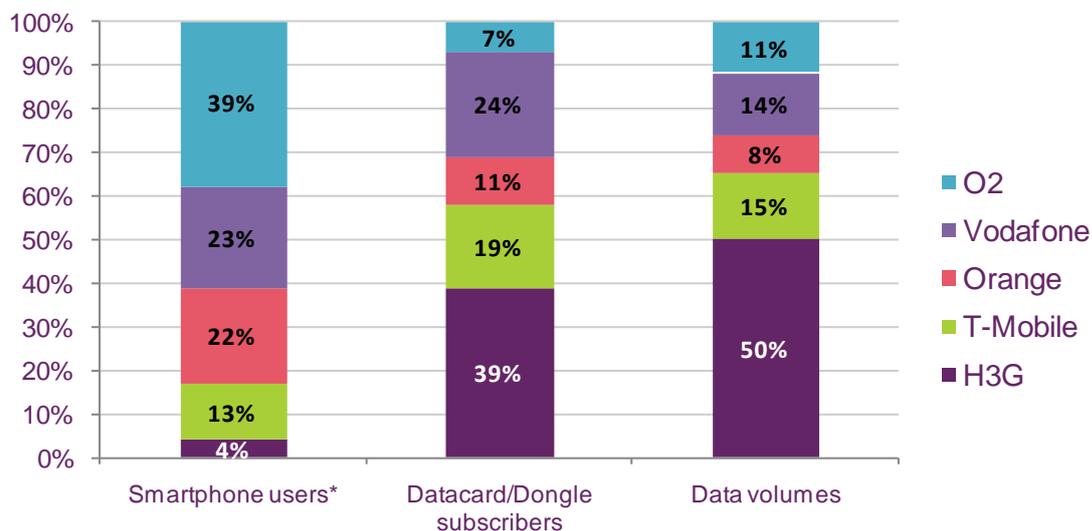


Source: Ofcom/operators

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

4.17 Figure 4.5 below, from Enders Analysis, shows market shares broken down by smartphone users, datacard/dongle subscribers and data volumes. These illustrate that the position of the different wholesalers varies considerably between the smartphone and datacard/dongle market segments. They also show that H3G has a relatively high share of data volumes, driven by datacard/dongle use.

Figure 4.5: UK market shares of subscribers and data volumes, Q4 2009



Notes: excludes MVNOs. * Based on Enders Analysis/BMRB survey in April 2010; includes Apple, RIM, HTC, Nokia N-Series and E-Series handsets

Source: Enders Analysis, European mobile market analysis, revenue and market trends to June 2010, with data drawn from company reports, Ofcom, Enders Analysis/BMRB survey

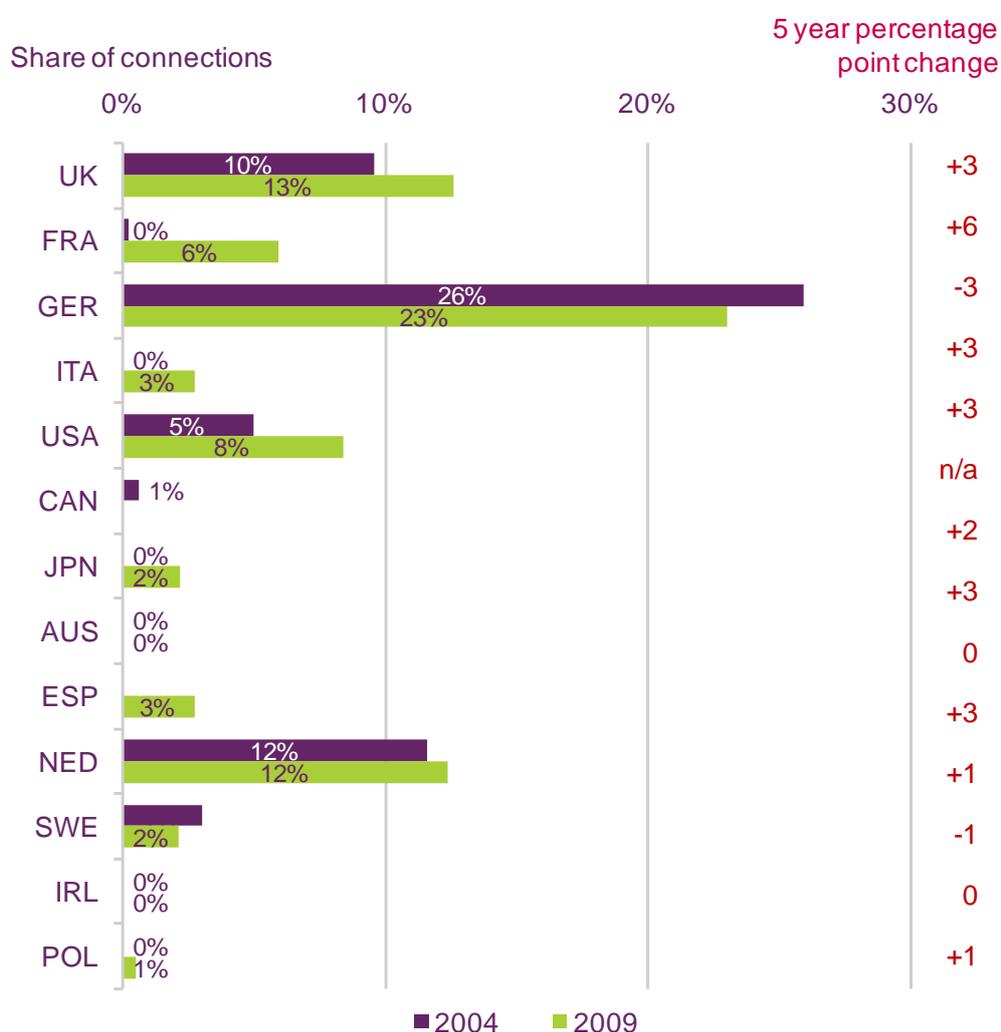
4.18 T-Mobile and Orange are shown as separate entities in the charts above, but have now merged into Everything Everywhere.

4.19 Entry at the national wholesale level has not occurred since H3G entered in 2003, following the award of 2.1GHz spectrum in 2000. As discussed in section 5, there are high barriers to entry at national wholesale level, the most important of which is access to suitable spectrum. As there has been no new release of spectrum suitable for providing credible national wholesale services since the 2000 award, it is not surprising that entry has not occurred since then.

National wholesale access provided to retailers

4.20 The significant presence of other retailers is consistent with effective wholesale market competition. Figure 4.6 below shows that the overall retail market share of other retailers is higher in the UK than many foreign markets despite there being no regulation of wholesale access in the UK.²⁹

Figure 4.6: Other retailers share of total mobile connections.



Source: IDATE / industry data / Ofcom

Note: UK and GER figures includes resellers' connections in addition to full MVNOs'

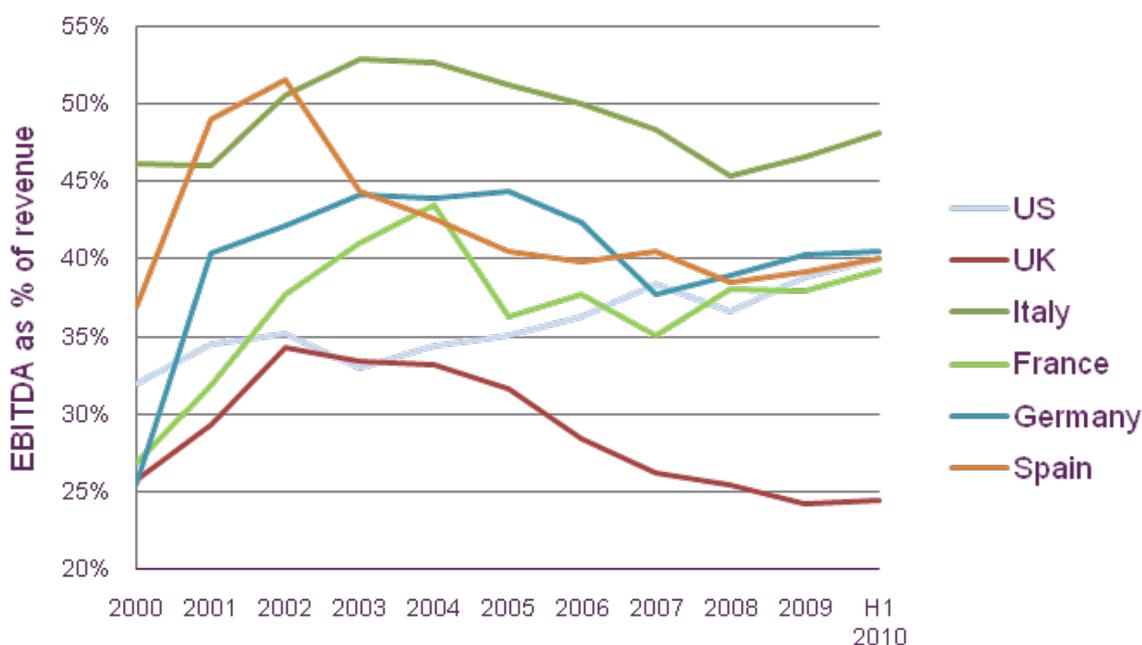
²⁹ The German spectrum licences contain obligations to provide wholesale services to resellers which positively influences the presence of MVNOs in that market

- 4.21 Around 25 other retailers are currently using wholesale access to provide retail services in addition to a small number of sub-national RAN operators. This suggests that competition in the national wholesale market has been sufficient to allow a wide range of different service providers to obtain national wholesale access.
- 4.22 In the MSA we noted that evidence on the ability of MVNOs to switch their host network was more limited. Switching wholesale relationships is more challenging. It is more common to observe MVNOs sourcing services from a new supplier for new customers than switching existing customers.

No evidence of excessive profits

- 4.23 Figure 4.7 below shows that the UK has been a less profitable market for national wholesalers compared to other developed economies. Coupled with evidence of lower prices, this provides evidence that there is strong competition.

Figure 4.7: EBITDA margins in selected European countries and the USA



Source: Ofcom

Note: Top 2 operators for each country

- 4.24 This view of the UK market as one of low margins with price competition is reflected by some investment analysts. For example, one analyst refers to the “stubbornly competitive and low margin UK market”, even in the context of the market after the Everything Everywhere merger.³⁰ Additionally, there is evidence that price competition is continuing in the post-merger environment, with another analyst stating that “the wording used by Hutch UK’s CEO to label the new offering [a new

³⁰ Barclays Capital Equity Research, “Everything Everywhere – can everyone win?”, 27 September 2010

sim-only price plan offered by H3G] ‘a game changer’, looks in our view, appropriate.”³¹

- 4.25 Evidence of competition between service providers is also notable in the case of smartphone provision. Some analysts hold the view that smartphone contracts may not greatly improve – and indeed actually risk degrading – service providers’ profit margins:

“Why do improving revenue trends increasingly correlate with deteriorating EBITDA margins? New pricing plans (used extensively for smartphones) may have contributed to this trend as they allow consumers to spread handset costs over time rather than pay for them upfront....However, when netted for that [the subsidy], the ARPU comes out lower than the level prevalent today in the marketplace.”³²

“Smartphones represent substantial additional costs...2004-2009 saw better handsets in customers’ hands for only similar outlay from operators....2009 onwards sees additional costs from smartphones....will some of this extra cost come from operator profit margins through the operation of competition?”³³

- 4.26 These views are consistent with active competition for customers.

Investment appears broadly in line with other countries

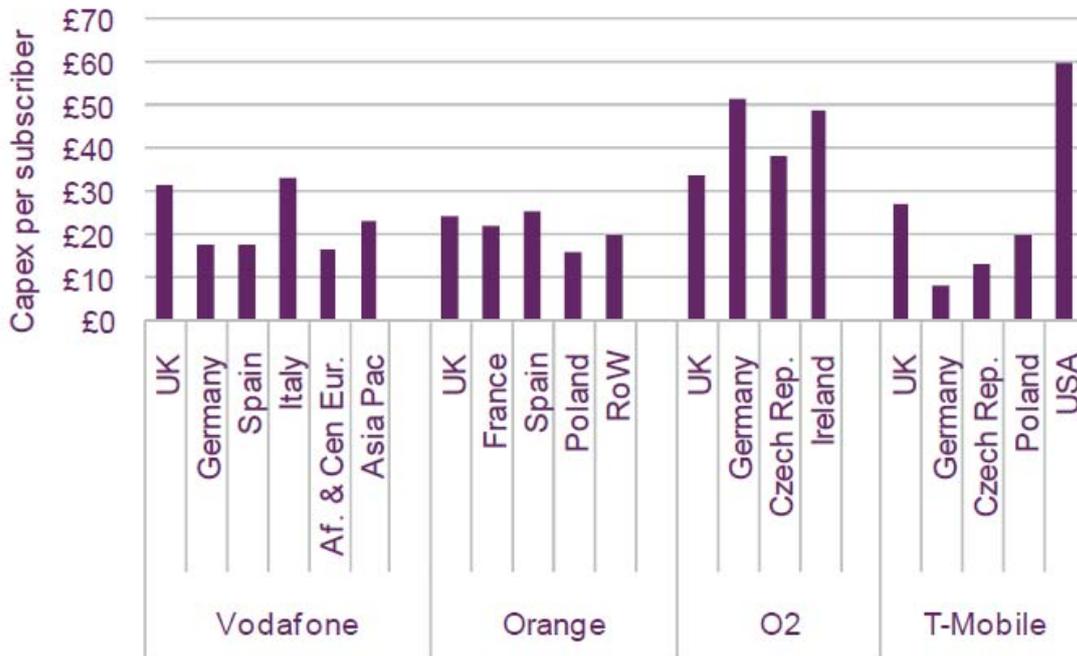
- 4.27 Despite lower profit margins, the evidence does not suggest that investment has been curtailed. We reproduce in Figure 4.8 an illustration of capital expenditure as measured on a per subscriber basis for 2008 that we compiled for the MSA. It suggests that capital expenditure per subscriber is broadly similar to that in comparable markets. This suggests that competition has not materially reduced the investment incentives.

³¹ Societe Generale Cross Asset Research, “Vodafone: Mind the pricing – Voice repricing has started in earnest; data pricing remains challenging”, 20 July 2010

³² Societe Generale, op. cit.

³³ Morgan Stanley, “Telecommunications Services Glass Half Full”, 6 September 2010

Figure 4.8: Capital expenditure per subscriber (2008)

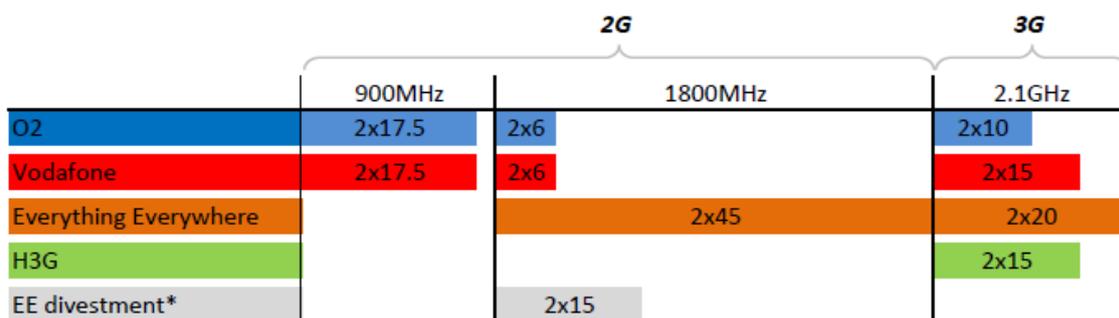


Source: Operator published accounts, Ofcom, Mobile Evolution, December 2009

Spectrum Holdings

4.28 Mobile services are currently provided on 3 spectrum bands: 900MHz, 1800MHz and 2.1GHz. The 900MHz and 1800MHz bands are predominantly used for 2G services and were allocated through comparative selection in the 1980s and 1990s. Spectrum in the 2.1GHz band is used for 3G services and was allocated in 2000 through auction.

Figure 4.9: Current spectrum holdings of UK national wholesalers



* Spectrum that Everything Everywhere must release as part of regulatory conditions on their merger

4.29 Previous awards of spectrum bands have led to only 2 operators with holdings of sub-1GHz spectrum. The issue surrounding sub-1GHz spectrum in particular will be discussed in further detail in later sections.

4.30 The combined award will make the 800MHz and 2.6GHz spectrum bands available for the provision of mobile communications services. Not only will this significantly

increase the overall amount of spectrum available, it will also almost double the quantity of sub-1GHz available.

Merger of T-Mobile and Orange

- 4.31 In September 2009, France Telecom and Deutsche Telekom announced their intention to merge their UK operations: Orange and T-Mobile respectively. This created the merged entity Everything Everywhere, reducing the number of UK national wholesalers from five to four.
- 4.32 The European Commission considered the merger. Following commitments offered by the merging parties, it concluded that the merger did not significantly impede effective competition and was compatible with the common market, and hence cleared it in March 2010.³⁴
- 4.33 The first set of commitments related to the European Commission's concerns about the implications of the merger for H3G. H3G depended on a roaming agreement with Orange to provide voice and text services on 2G bands and had a RAN sharing agreement with T-Mobile to expand its 3G network coverage. It was feared that the merged entity could marginalise or exclude H3G from these agreements in future, perhaps even forcing H3G to exit the market.
- 4.34 Everything Everywhere addressed these concerns by committing to the continuation of H3G's prior arrangements with both Orange and T-Mobile. Furthermore, Orange agreed to extend its 2G national roaming agreement with H3G at a reduced cost to H3G. The parties have subsequently agreed to incorporate Orange's sites into the sharing agreement, creating a shared Everything Everywhere/H3G network.
- 4.35 The second set of commitments related to the European Commission's concern that Everything Everywhere would be the only national wholesaler able to be able to deploy a full-speed national LTE network in the short to medium term, through its large holdings of contiguous spectrum. To allay these fears, Everything Everywhere agreed to divest 2x15MHz of its holdings in the 1800MHz band through release into the combined award or as a private sale before.
- 4.36 If Everything Everywhere maintains a market share (in terms of subscribers) that is equal to the sum of that of T-Mobile and Orange, then it would have the largest market share in terms of total subscriptions and also for 3G only subscriptions. This is illustrated in the table below.

Figure 4.10: Wholesale market shares based on 2009 subscriber numbers

	2G & 3G	3G only
T-Mobile and Orange	42%	33%
O2	28%	24%
Vodafone	23%	23%
H3G	6%	19%

³⁴

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

- 4.37 In the MSA (completed before the merger of Orange and T-Mobile), we considered that mobile markets were effectively competitive, and served consumers well.³⁵ Since the merger of Orange and T-Mobile, we see no indication that competitive pressures have significantly reduced, but we recognise that the merger is relatively recent and there is currently little information on the period since the merger.

Current trends in mobile markets

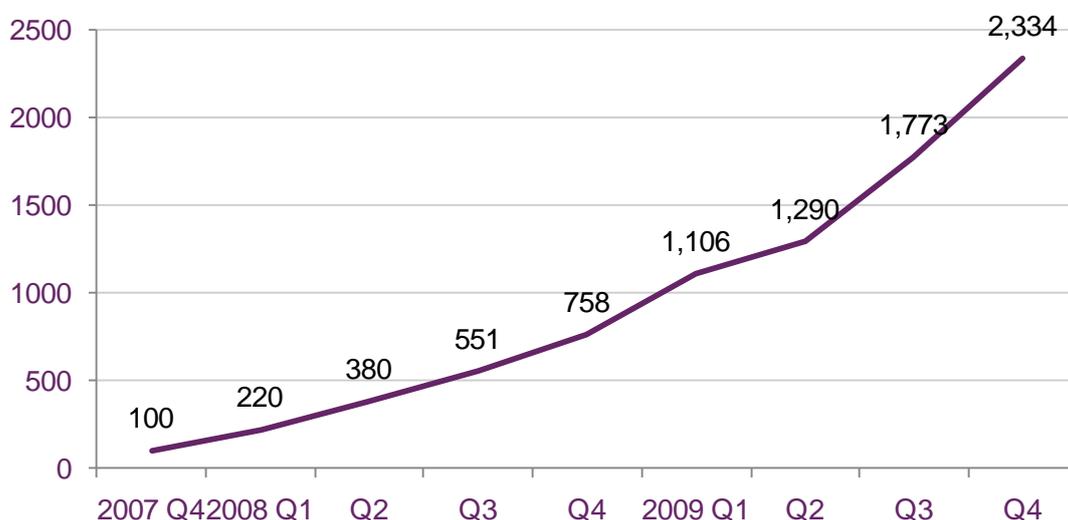
- 4.38 There are currently a number of important trends that may affect mobile competition in the future.

Data Growth

- 4.39 One of the key trends in the mobile sector in recent years is the strong growth of data services. This is illustrated in Figure 4.11 below.

Figure 4.11: Mobile data use

Index (2007 Q4=100)



Source: Ofcom / operators

Note: Includes estimates where Ofcom does not receive data from operators; data revenue is likely to be understated as it excludes any data element included within standard pay-monthly tariffs.

- 4.40 Continued rapid data traffic growth remains a dominant industry view, with a survey of forecasts by Real Wireless finding projections ranging from between 24% and 102% annual growth for the 2009-14 period.³⁶
- 4.41 We are aware that some hold the view that data traffic growth will slow in the next two to three years. Possible causes include: Wi-Fi offloading helping to shift the majority of indoor handset data traffic off mobile networks; and falling fixed broadband prices; and rising fixed broadband access speeds, and increased video

³⁵ *Mobile Evolution, Ofcom's Mobile Sector Assessment*
http://stakeholders.ofcom.org.uk/binaries/consultations/msa/statement/MSA_statement.pdf

³⁶ *Ofcom 4G capacity gains, Real Wireless*

use, constraining the growth of the kind of substitutive mobile broadband usage that currently accounts for a high share of total mobile data traffic.³⁷

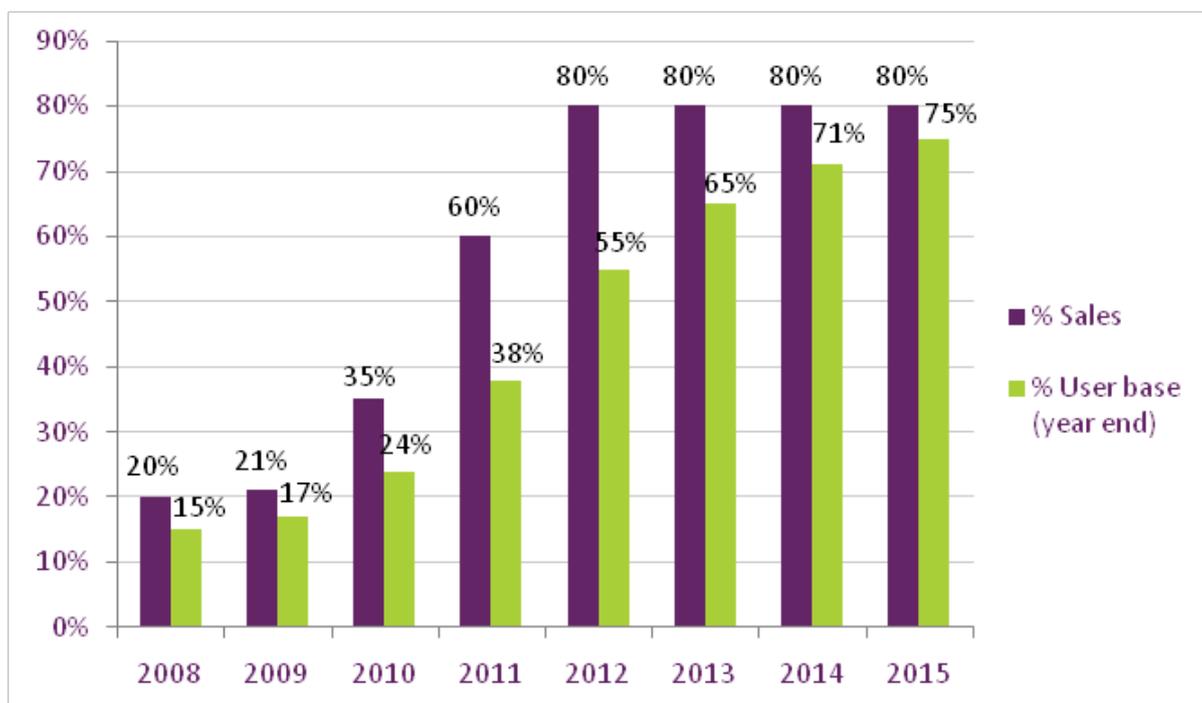
Growth of smartphones

- 4.42 Smartphone take-up has been very rapid in recent years. Ofcom's Consumer Market report 2010 found that in mid 2010, 26% of all mobile users claimed to have a smartphone – a more than doubling of the rate in only two years – whilst 73.5% of new contract handsets are classed as smartphones.³⁸
- 4.43 Smartphones are generally differentiated from 'feature' phones by their advanced operating systems that allow the installation of third-party mobile 'apps', which are commonly used to access internet content. Smartphones are also commonly equipped with advanced hardware such as touchscreens, large colour displays, large memory capacities and fast internet connectivity with Wi-Fi or 3G. Smartphones users are therefore able to generate much higher data traffic compared to users of 'feature' phones.
- 4.44 This trend of increasing smartphone adoption is expected to continue, with some analysts forecasting smartphones to dominate sales and the mobile user base in the coming years. Figure 4.12 shows projected figures from Enders Analysis suggesting that the majority of handsets could be smartphones within the space of the next year or two.

³⁷ Source: Analysys Mason

³⁸ See page 298 of Ofcom's Communications Market Report 2010

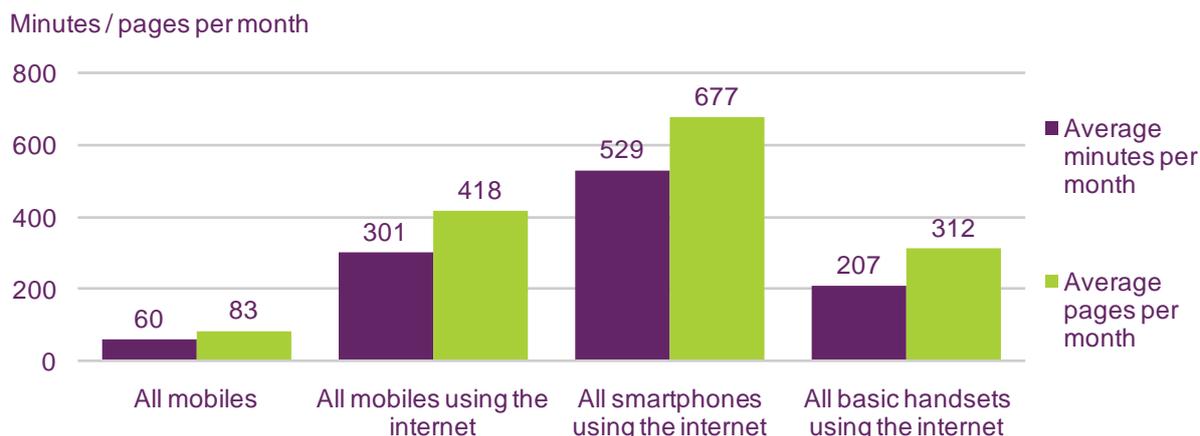
Figure 4.12: UK Smartphone share of sales and users



Source: Enders Analysis estimates³⁹

4.45 As shown in Figure 4.13 below, smartphone users are likely to generate much more data traffic compared to users of more basic handsets. Smartphone hardware is also becoming increasingly advanced, allowing the use of even more data intensive activities such as HD video streaming, P2P and tethering⁴⁰. Smartphones are likely to be a prominent source of data traffic growth in the near future.

Figure 4.13: Average internet use per mobile subscription



Source: GSMA Mobile Media Metrics

Note: Based on pre-production data for December 2009

³⁹ Enders Analysis, *Smartphones and mobile advertising*, Jan 2011

⁴⁰ Tethering is the practice of sharing a phone's data connection with a PC or laptop.

Growth of mobile broadband with dongles/datacards

- 4.46 Uptake of mobile broadband using devices such as USB dongles and datacards had been rapid with household penetration reaching 12% by March 2009. More recently the growth appears to have slowed. Around 15% of households had mobile broadband connection in Q1 2010.⁴¹ Compared with smartphones, data use per device for dongles/datacards is likely to be much higher, with evidence suggesting that individual connections are “around five times more data intensive as a typical smartphone and a hundred times as much as a normal handset.” Consequently, dongles/datacards account for a much higher proportion of overall data traffic volume than smartphones.⁴²
- 4.47 Research has shown that consumer satisfaction for mobile broadband services is strongly linked with network quality. Surveys conducted by YouGov showed customer satisfaction was closely correlated to network dependent attributes such as coverage, speed and reliability of connections. It also found that issues concerning connectivity and speed were among the most common reasons for consumers wanting to switch provider. There is evidence that consumers value network quality above other factors such as value for money and customer services, including data suggesting that customer satisfaction for MVNOs mirrors that of the national wholesaler whose network they have access to.⁴³
- 4.48 The study emphasised the importance of network quality to success in providing mobile broadband services, attributing the leading performance of H3G and T-Mobile down to the benefits from their shared network, stating “only until 2010 when the MBNL started to kick off did 3, followed by T-Mobile see improvements to satisfaction ratings”.

Growth of other mobile devices

- 4.49 In a dynamic and rapidly evolving market, we recognise that there is potential for other mobile devices to emerge that can have a material impact on data traffic.
- 4.50 One current example is the tablet, which has seen rapid adoption since introduction. Tablets are capable of all of the data intensive activities possible on smartphones. Indeed, their larger screens, more powerful hardware and superior battery life give the potential to generate higher data traffic per device compared to smartphones. For the iPad alone, some analysts estimate pre-Christmas sales of around 500,000 in the UK since its launch in May 2010 and further sales of several million in 2011.⁴⁴ Meanwhile, other manufacturers like Samsung and RIM have also released or are planning to release their own tablet devices.

⁴¹ See Section 5.1.5 of Ofcom’s Communications Market Report 2010

⁴² Source: Enders Analysis, *Mobile Data Economics: The Limited of the Unlimited, September 2010*

⁴³ YouGov, *Dongle Tracker Wave 11*, January 2011 and *Dongle Tracker Wave 9*, July 2010

⁴⁴ Source: Enders Analysis, *The mobile internet, apps and the route to market, Jan 2011*

Offloading mobile data may become increasingly important

- 4.51 In response to rapidly expanding demand for mobile data services, network operators are adopting strategies and technologies that allow the more efficient use of mobile spectrum and mobile networks. In the following paragraphs, we describe some of the solutions that may contribute to meeting this demand.
- 4.52 A significant portion of mobile data traffic is generated indoors, with two thirds of time spent accessing the internet with mobile services taking place at home or the workplace.⁴⁵ Indoor mobile usage can suffer from poor signal quality as signal strength degrades when passing through solid objects like walls to reach base stations. Indoor usage also increases traffic on existing networks which are already congested.
- 4.53 Femtocell technology can help to alleviate pressure on existing networks and improve quality and coverage. Femtocells are low-cost miniature base stations mounted within buildings, routing signals to core networks through fixed broadband connections. Vodafone Sure Signal is an early example of a consumer femtocell product in the UK.
- 4.54 Another way of offloading mobile data traffic is to take advantage of Wi-Fi infrastructure to offload traffic onto fixed networks. Wi-Fi connectivity is an established laptop standard and increasingly a standard feature for mobile devices such as smartphones and tablets. It is likely that a proportion of indoor mobile data use is already being routed over Wi-Fi as wireless routers are now relatively common.⁴⁶
- 4.55 Public Wi-Fi networks already exist, with operators such as BT Openzone⁴⁷ and BSkyB – through their acquisition of The Cloud – controlling access to thousands of hotspots around the country⁴⁸, mainly in public places such as shops, restaurants and bars. Others such as Virgin Media and O2 are also known to be considering investing in public access Wi-Fi networks.⁴⁹ ⁵⁰ A number of bilateral deals already exist between Wi-Fi operators and national wholesalers to include access to these Wi-Fi networks in the services that national wholesalers offer to their customers.
- 4.56 As the coverage of these Wi-Fi networks improve and mobile data traffic increases, access to these Wi-Fi networks may become more important components of the packages of mobile services that consumers demand.

⁴⁵ From *Cisco Visual Networking Index Global Mobile Data Forecast*. See page 351 of Ofcom's Communications Market Report 2010

⁴⁶ Research suggests 66% of UK homes use wireless routers in Q1 2010. See page 351 Ofcom's Communications Market Report 2010

⁴⁷ BT Openzone includes premium access hotspots in public locations and the BT Fon community, which allows BT's home broadband customers to share a small portion of their connection to obtain access to other members of the community.

⁴⁸ <http://www.thecloud.net/en/about-us/News-and-PR/The%20Cloud%20Says/The%20Cloud%20to%20become%20part%20of%20the%20BSkyB%20Group.aspx>

⁴⁹ <http://www.bbc.co.uk/news/technology-11827869>

⁵⁰ <http://mediacentre.o2.co.uk/Home-Page-Body-Announcement/O2-redefines-Wi-Fi-landscape-with-launch-of-O2-Wifi-2e9.aspx>

Deployment of LTE and other technologies

- 4.57 Long Term Evolution (LTE) technology refers to a new 4G mobile standard that offers significant benefits compared to existing 3G technologies.
- 4.58 LTE is able to provide higher quality mobile data services compared to 3G technologies. In particular:
- Higher speeds, improving the quality of activities such as streaming video and web surfing on mobile devices.⁵¹
 - Reduced latency, a key feature that improves the responsiveness of real-time services such as videoconferencing, VoIP and gaming.
 - Greater capacity compared to 3G networks, allowing larger numbers of customers to receive a given quality of service.
 - Greater spectral efficiency, allowing services to be delivered at a reduced cost per bit.
- 4.59 By LTE, we generally mean LTE FDD⁵². But we note that there is growing momentum behind LTE TDD⁵³ with some Chinese companies strongly promoting its use. We consider that it is possible that LTE TDD may also become an important technology in Europe, but that this is by no means certain currently.
- 4.60 Another mobile technology available for mobile data services is WiMAX. The technology has seen initial deployments in the US, by SprintNextel, and in South Korea (using the South Korean equivalent, WiBro).⁵⁴ However interest in WiMAX in the UK and Europe seems to have diminished substantially since 2009, when we previously intended to award the 2.6GHz spectrum.

Developments in use of spectrum bands

- 4.61 The recent 2G liberalisation means that 900MHz and 1800MHz spectrum can now be used for 3G.
- 4.62 We do not expect 1800MHz to be used for 3G services. We expect it to leapfrog 3G and to be used for LTE. There are already starting to be deployments of LTE at 1800MHz, such as in Poland. LTE has advantages in terms of higher speed, lower latency, increased network capacity and lower costs compared to 3G.
- 4.63 2.6GHz was the first band to see commercial deployment of LTE services, with networks using the spectrum deployed in several metropolitan areas in Scandinavia. In the UK, the 2.6GHz band is also likely to be one of the first bands in which LTE services are deployed.

⁵¹ See for example, UMTS forum white paper, *Towards Global Mobile Broadband: Standardising the future of mobile communications with LTE*, http://www.umts-forum.org/component/option,com_docman/task,doc_download/gid,1904/Itemid,12/

⁵² Frequency Division Duplex – A transmission method where the downlink/downstream path and the uplink/upstream path are separated by frequency.

⁵³ Time Division Duplex – A transmission method where downlink/downstream path and the uplink/upstream path are separated by time intervals.

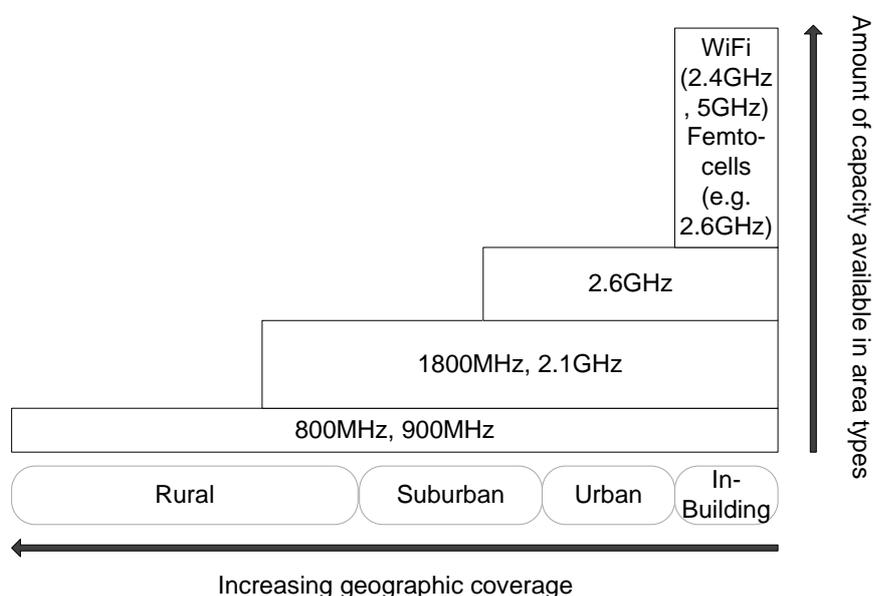
⁵⁴ Page 22, Ofcom, *Application of spectrum liberalisation and trading to the mobile sector*

4.64 The 800MHz band has also seen commercial LTE deployment in Germany.⁵⁵

Trend to using mix of frequencies and technologies

4.65 Given the different technical characteristics and availability of spectrum at different frequencies it is likely that future networks will use a range of frequencies to provide services. Figure 4.14 below illustrates how these properties of different spectrum bands make them suitable for providing coverage in varying locations. For example, sub-1GHz spectrum may be used to provide services in sparsely populated rural areas as it is more cost effective. On the other hand, in urban areas where traffic is likely to be heavy, services may be deployed in higher frequency bands, where more spectrum is available to provide the necessary network capacity.

Figure 4.14: Availability and coverage capabilities of spectrum bands



Radio Access Network sharing

4.66 Internationally, there is a general trend towards RAN sharing. The nature and depth of such agreements can vary substantially. In the UK, O2 and Vodafone have a site-sharing agreement, whereas H3G and T-Mobile have complete RAN sharing for their 3G networks.

4.67 As mentioned in section 5, the costs of constructing a network acts as a barrier to entry for national wholesalers. Network sharing deals may therefore help to lower these barriers as entrants can share the costs of obtaining access to a radio access network.

⁵⁵ See for example <http://www.mobilenewscwp.co.uk/2010/12/vodafone-germany-intros-lte-service-and-pricing/>

Section 5

Assessment of likely future competition in markets after the combined award

Section summary

- 5.1 In this section we assess likely future competition in mobile markets, assuming that we take no measures in the combined award to promote competition. We set out our provisional conclusions on the likely risks to competition in mobile markets. We do this in the context of the Direction to us to put in place measures to promote competition, if we think fit, in light of our assessment.
- 5.2 We first consider competition in retail markets, then wholesale markets.⁵⁶ A key risk to competition from sub-national RAN operators and other retailers is the ability to obtain wholesale access on reasonable terms. We therefore see competition in wholesale markets as critical to future competitiveness for retail as well as wholesale markets. We also consider there is a risk that sub-national RAN operators may not enter or expand in a way that would be beneficial for consumers, without measures to promote competition.
- 5.3 We then consider competition in wholesale markets. We describe the importance of national wholesalers for price and quality of service to consumers. It is national wholesalers who determine key aspects of quality of service, such as speed of data services and coverage.
- 5.4 We consider suitable spectrum holdings to be crucial for national wholesalers. Access to suitable spectrum is essential for providing a wholesale service, and is a key factor in determining the quality of the service offered. Because of its importance, national wholesalers are likely to want to hold the spectrum licences directly.
- 5.5 We consider that if there were any future network or spectrum sharing agreements it should be possible for them to be structured such that the sharers continue to compete as independent national wholesalers. 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.
- 5.6 We provisionally find that there is a material risk that the competitiveness in at least some possible retail and wholesale markets could be lower in the future compared either to today or to what it could be. This is because only some of the existing national wholesalers may currently have spectrum portfolios that enable them to provide the higher quality data services that are likely to be valued by consumers in the future.

⁵⁶ As we said in section 3 of this Annex3, we think that it is possible that different retail markets may develop for higher quality data services. While we do not take a definitive view on whether this would or would not happen, we refer throughout this section and later sections to retail markets in the plural. Similarly we refer to wholesale markets in the plural, though we do not take a definitive view on whether there may be more than one wholesale market in the future.

- 5.7 Our concerns relate to the nature of spectrum that might be necessary for any national wholesalers to compete on a credible basis in at least some possible wholesale markets after the combined award:
- A national wholesaler with a limited overall portfolio of spectrum suitable for LTE may be unable to profitably meet the increasing demand that we foresee for the forthcoming years; and
 - In particular, a national wholesaler without access to sub 1GHz may not be able to offer reliable indoor coverage for data services.
- 5.8 Those national wholesalers who currently have spectrum holdings that may enable them in the future to provide higher quality data services may have an incentive to pay more in the auction, in order to keep other national wholesalers from being able to match the services they can offer. Because of this, we consider there is a material risk that only three national wholesalers (or possibly even only two) may emerge from the combined award with spectrum portfolios that allow them an unmatched competitive advantage in the provision of higher quality data services that are likely to be valued by consumers.
- 5.9 We consider that if only three national wholesalers were to hold spectrum after the combined award that allowed them credibly to compete in the provision of higher quality data services, the degree of competitive intensity could be relatively weak compared to if there were more national wholesalers. This is especially the case given that there are high barriers to entry to the national wholesale market, including from the difficulty of obtaining access to suitable spectrum. The level of competitive intensity could be significantly less in the provision of higher quality data services compared either to today or to what it could be.
- 5.10 Relatively weak competitive intensity in at least some wholesale markets is also likely to reduce competition in retail markets. We consider that relatively weak competitive intensity in wholesale and retail markets could lead to higher prices and lower quality and innovation for UK consumers. We consider this could result in significant consumer detriment.
- 5.11 If some national wholesalers did not have spectrum portfolios that allowed them credibly to compete in the provision of higher quality data services, this could even lead to them to exit all wholesale markets. This might be the case if they were unable to be profitable without providing the higher quality data services. In this case any reduction in competitive intensity would affect all wholesale markets.
- 5.12 We therefore consider that we should go on to assess whether there are any appropriate and proportionate measures that we should put in place in the combined award to promote competition to address these concerns. Our assessment of potential measures is set out in sections 66 to 98 of this Annex.

Future competition and potential for new entry in retail markets

Ability to obtain commercial wholesale access

- 5.13 Provided it is possible for retailers to obtain wholesale access on reasonable terms in the future, we consider that the retail market is likely to be competitive in future. Barriers to entry appear relatively low at the retail level, and there have been many examples of entry occurring recently, as described in section 4.

- 5.14 However, if wholesale market(s) were to develop such that it was difficult for retailers to obtain wholesale access to national networks on reasonable terms, 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.
- 5.15 If separate retail markets associated with higher quality data services were to develop in the future, then it could be that separate markets would develop at the wholesale level. It is possible (for the reasons that we explore later) that the degree of competitive intensity may be different in these different wholesale markets. In particular, there is a risk that it would be less in markets associated with higher quality data services.

Entry for sub-national RAN operators may be harder than for other retailers

- 5.16 The barriers to entry for sub-national RAN operators may be higher than for some retailers (though much lower than for national wholesalers, as discussed later in this section). Sub-national RAN operators need to build some RAN infrastructure and may need to hold spectrum (if using licensed spectrum, as opposed to licence-exempt spectrum, such as that used to deliver Wi-Fi services). These fixed costs may make entry harder.
- 5.17 Entry or expansion by sub-national RAN operators could potentially have different kinds of competitive benefit compared to entry by other retailers. It may allow competition over more of the value chain, and may facilitate different types of business model and innovation in terms of retail offers. It could therefore be an important source of increased innovation and competitive pressure in the retail market, although the nature and scale of the benefits is uncertain. We consider there is a relatively high likelihood of sub-national RAN operators having a positive impact in terms of increasing competitive pressures in the retail market for specific or niche customer groups. We consider there is a smaller chance of a more radical effect on competition and consumers from entry by sub-national RAN operators with more unpredictable or paradigm-shifting commercial models – for example if “inside-out” models of network provision prove to be significantly more effective at providing high speed mobile broadband services.
- 5.18 Low powered use of (paired) 2.6GHz may be particularly attractive for sub-national networks, given that a wide variety of handsets may be able to use LTE at this frequency in the near future. It may be possible for a number of different companies to coexist by sharing access to the spectrum, as is currently the case with the DECT guard band spectrum. Shared low power use of some 2.6GHz by a number of different operators could be an effective and efficient use of spectrum. But potential entry using shared low-power use of spectrum may be more difficult if companies need to buy spectrum in the auction. This is because of the coordination problems involved with bidding for shared spectrum use. In particular:
- There is a risk that low powered users may not be able to acquire spectrum efficiently through a competitive award if they cannot coordinate effectively in an auction. In particular, it may be difficult to negotiate a joint bid between a number of sharers, and these difficulties are likely to increase the more sharers there are.
 - Also, even where individual bidders are able to coordinate and put forward an aggregate bid, there is a risk that the bid does not fully reflect the aggregate

value of the shared use. Depending on the precise arrangements, an individual low powered bidder may face two types of competition in the auction. First, if there is a limit on the maximum number of sharers (e.g. 10 users), there is competition against other low powered bidders to be in the top 10. Second, in conjunction with other low powered bidders (up to the limit of 10), there is competition against the high powered bidder with the highest bid to determine whether the winning bid(s) are for low powered or high powered use . Considering this second type of competition in the auction, the bids put forward by the potential users will only determine who will obtain access to the relevant spectrum. It will not determine how much spectrum they can secure (since for low powered users, the spectrum is shared). Therefore, given that there are multiple low powered bidders, individual bidders seeking to share spectrum may have an incentive to 'free-ride' by bidding less than their full value in order to pay less of the cost of outbidding the high powered bidder compared to other potential sharers. This risk will be greatest where the probability of being included in the top 10 bidders is high, i.e. where the first type of competition in the auction is relatively weak.

- 5.19 There may also be other market failures that mean that, even if the coordination failure were addressed, the outcome of the auction would not be optimal for consumers. For example:
- National wholesalers may have strategic incentives to secure more spectrum than may otherwise be profitable, in order to deter potential entry by sub national operators that might provide a competitive threat in the future.
 - Even absent any coordination failure or strategic incentives, the outcome of an unconstrained auction may not deliver maximum benefits for consumers. This is because the private valuations for spectrum by sub-national operators will reflect the profits they expect to earn following entry. They may not fully reflect the wider dynamic benefits to consumers that entry might generate, through increased competition and innovation.
- 5.20 Separate from 2.6GHz paired spectrum, sub national RAN operators might be able to use the unpaired 2.6GHz centre gap for TDD technologies. In auctions in some other European countries, new entrants have won unpaired 2.6GHz.⁵⁷ There are also some promising signs regarding the supply of equipment in this part of the 2.6GHz band. Sprint, the third largest US national mobile operator, already markets handsets that use WiMAX in an unpaired mode at 2.6GHz for high speed data services, in addition to several dongles and laptops. China Mobile, a Chinese mobile operator with over 575 million subscribers,⁵⁸ has been clear about its plans to develop and roll-out TD-LTE including at 2.6GHz.⁵⁹
- 5.21 Despite some promising signs, we consider that there remain doubts about the availability of a sufficiently large range of user devices using TD-LTE or WiMAX at 2.6GHz, especially in the short to medium term. A lack of suitable devices may make it difficult to offer a compelling retail product with unpaired 2.6GHz band (whether for

⁵⁷ For example in the Netherlands, Finland and Sweden new entrants bought unpaired 2.6GHz, though in Austria, Germany and Denmark this did not happen.

⁵⁸ See <http://www.chinamobileltd.com/ir.php?menu=11> as at 31 October 2010.

⁵⁹ See for example <http://www.rethink-wireless.com/2010/06/07/china-mobile-promises-td-lte-tests-abroad-year.htm>.

low or high powered use), reducing the benefits to consumers of entry with this spectrum.

- 5.22 Therefore, we consider that there is a risk that potential users of low powered shared spectrum may not be able to compete effectively in an award process without any measures to promote competition. This could potentially lead to material losses for consumers, particularly if entry by sub national operators provides competition over more of the value chain and facilitates different types of business models and innovation in terms of retail offers. However, the scale and nature of these benefits (over and above what other operators may deliver), as well as the extent of any market failures, is uncertain. Section 88 below considers whether there is a case for taking measures in the auction to promote competition by sub-national RAN operators.

Risks for future competition in retail market(s)

- 5.23 We therefore identify two potential risks to future competition in retail market(s):
- Firstly, there may be a risk to sub national RAN operators and other retailers arising from relatively weak national wholesale competition and an inability to obtain wholesale access on reasonable terms.
 - Secondly, there may be a risk to competition from sub national RAN operators who would rely on shared access to licensed spectrum, arising from coordination problems in the auction and the risk that any allocation of spectrum based on private valuations may not deliver maximum competition benefits for consumers, such that those operators may not gain access to the spectrum that they might need.
- 5.24 We therefore consider these potential risks and whether there are any appropriate and proportionate measures we should put in place to address them. We consider wholesale access in section 7 below, and in Section 8 consider whether there is a case for taking other in relation to retail competition.

Future competition and potential for new entry in wholesale markets

- 5.25 In the following sections we assess future competition and potential for new entry in wholesale markets. We begin by describing some of the key characteristics of the wholesale market:
- the importance of national wholesalers;
 - spectrum is a critical asset for national wholesalers;
 - it may be possible for national wholesalers to share assets; and
 - the high barriers to entry for national wholesalers.
- 5.26 We then explain why we consider that it is possible that there is a material risk of a lower level of competitive intensity in at least some wholesale markets compared to today and compared to what might be possible. We do this under the following headings:

- importance of holding suitable spectrum portfolios for providing higher quality data services;
- risk of lower competitive intensity in wholesale markets; and
- provisional conclusions on competition absent measures to promote competition.

Importance of national wholesalers

5.27 As well as being important to support competition in retail markets, competition between national wholesalers is important because it is at this level that many key aspects of quality of service are determined. The quality of the network and spectrum used by the national wholesaler determines:

- speed of data services, i.e. the throughput in Mbps that consumers can enjoy;
- capacity, i.e. the number of users that a network can support;
- breadth of coverage, i.e. what proportion of the country enjoys coverage for future mobile broadband services; and
- depth of coverage, i.e. how deep into buildings can consumers enjoy these services, when taking account of attenuation from walls and other structural elements.

5.28 The importance of national wholesalers is also illustrated by their central role in the value chain. For our August 2008 mobile sector assessment consultation⁶⁰, we commissioned Analysys Mason to survey the UK mobile sector. Analysys Mason reviewed the flow of funds within the mobile sector in order to calculate the 'retained value' for the main types of participant within the mobile value chain. The retained value is the share of revenues retained by a market participant after paying for or sharing the revenues with other participants.

5.29 Analysys Mason broke down the major functions provided by the vertically integrated MNOs into the network operator function (i.e. the holder of the network licence and spectrum rights) separately from the functions of service provision and distribution.

5.30 Analysys Mason looked at the flow of funds during the 2000-2002 and 2005-2007 periods. The results for the shares of retained value for the most important functional parts of the value chain for the 2005-2007 period are shown in Figures 5.1 below.⁶¹

⁶⁰ <http://stakeholders.ofcom.org.uk/binaries/consultations/msa08/summary/msa.pdf>

⁶¹ See Section 3.3 of the Analysys Mason for more details:

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

Figure 5.1 Retained value shares in the mobile value chain for 2005-2007⁶²

Value chain element	Description	Percentage of retained value
Network equipment vendors	This comprises the providers of network systems and sub-systems including radio and core access networks and IT platforms.	7.6%
Tower/transmission/backhaul	This comprises those organisations providing tower, transmission and backhaul services to network operators, including cell site providers (e.g. Arqiva) and telecoms service providers (e.g. BT)	2.5%
Network operator function	This comprises the holders of spectrum licences and operators of mobile networks, including the main national wholesalers and also smaller operators (such as UK Broadband)	42%
Service provision function	This is the retail function involving contracting with end users for the provision of mobile services, and includes service provision by both the MVNOs and national wholesalers	17.5%
Device vendors	This comprises the manufacturers of mobile handsets and other wireless devices (e.g. Nokia and Apple)	14.6%
Content providers	This includes content owners and content aggregators	1.2%
Distributors	This comprises the customer-facing distribution function and includes direct and online sales channels of the national wholesalers, MVNOs and independent retailers	13.5%

Source: *Analysys Mason*

- 5.31 The four current national wholesalers therefore control the network operator function, in that they hold the spectrum and own the national RANs. Figure 5.1 shows that this function comprises the largest single segment by retained revenue across all parts of the value chain, at 42 per cent. This was found to have been stable over a long time (i.e. since 2000). *Analysys Mason* considered that the network operators held considerable power relative to their suppliers and customers. The national wholesalers are also very large service providers and are also distributors. The share of retained value flowing to the national wholesalers is therefore very considerable.
- 5.32 We recognise that the above figures are now some years old and that the shares for different functions may have changed somewhat. For example, it is possible that content providers are more important than they were, given the growing importance of data. However, we consider that national wholesalers are still the centre of gravity for the mobile value chain.

⁶² The categories in Figure 5.1 do not correspond directly to the levels we set out in Figure 2.1. However, the network operator function broadly corresponds to the wholesale level plus the core networks and RANs owned by the national wholesalers (albeit indirectly in the case of EE and H3G's joint ownership of MBNL). The service provision function in Figure 5.1 broadly corresponds to the retail level in Figure 2.1. The sites in Figure 2.1 would be part of the tower/transmission/backhaul function in Figure 5.1. We did not include the other value chain elements (such as network equipment providers and content providers) in the simplified representation in Figure 2.1.

Spectrum is a critical asset for national wholesalers

- 5.33 Access to suitable spectrum is essential to provide a national wholesale service. It needs to be access to spectrum of the right quantity and frequency in order to be able to deliver national wholesale mobile services. It needs to be internationally harmonised spectrum for the national wholesaler to take advantage of cheaper network equipment and for there to be a wide range of higher quality and reasonably priced handsets. Such spectrum is scarce and valuable.
- 5.34 Because of its key importance, we consider that national wholesalers are likely to want to hold the spectrum directly. If they did not hold the spectrum directly, they would be likely to be in a weaker bargaining position than the person who held the spectrum they were seeking to access.
- 5.35 There could in principle be other strategic assets that could allow entities to leverage their position so as to obtain access to spectrum to allow them to have a position in the mobile value chain as important as a national wholesaler. Such strategic assets could include a portfolio of valuable sites, exclusive content, a large and loyal customer base, or a highly desirable end user device.
- 5.36 For example, there were press reports in the course of 2010 suggesting that Apple might attempt to take on a more significant position in the mobile value chain when commentators reported on plans to use a “soft” SIM approach.⁶³ This approach could have allowed Apple to have a direct relationship with end-users and to provide a mobile service effectively on the basis of wholesale agreements with national wholesalers. The assets that Apple might have used to achieve this position are its user devices such as the iPhone, the iPad and their likely successors, which have been very successful with higher spend mobile users. Subsequent reports indicate that Apple is not seeking to implement this strategy at this stage.⁶⁴
- 5.37 While in theory it is possible for a holder of another type of asset to attain a level of influence on the market comparable to that of a national wholesaler, we consider this unlikely in practice. As set out above, the current national wholesalers account for a very significant share of the retained value in the mobile value chain in the UK, consistent with them having a key role. Other companies in the value chain (e.g. providers of sites) are much less significant. Moreover, we are aware of no other country in which other asset holders have obtained a comparable influence on the degree of wholesale or retail competition as a national wholesaler directly holding spectrum. We are not aware of any obvious prospects for a company that did not hold spectrum to emerge in the UK as a powerful competitive stimulus at the national wholesale level. We therefore do not consider it prudent to rely on the emergence of such a company in this competition assessment.

It may be possible for national wholesalers to share assets

- 5.38 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 cost of end-to-end network competition.

⁶³ See for example “Apple versus operators”, Financial Times, Lex column, 19 November 2010.

⁶⁴ See for example “Telco Bullets: MOBILE DATA, VOD, VIV, THE CLOUD, APPLE, KPN”, Telecoms Research, Execution Noble, 22 November 2010.

- 5.39 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 be easier with LTE technology for national wholesalers sharing a network to maintain control over more dimensions of quality compared to 2G and 3G technology. It may also be possible for there to be spectrum sharing without compromising the independence of national wholesalers.
- 5.40 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.
- 5.41 We consider that as a result, we should focus in this competition assessment on ensuring effective competition in wholesale markets without taking a strong view on whether it may be in consumers' interests to have sharing arrangements. In the current context we focus on spectrum holdings. As described above, we see holding rights to use spectrum directly as crucial for national wholesalers, and this will be directly affected by the outcome of the combined award.
- 5.42 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 this would depend on the detail of the sharing agreements. Due to its specific technical characteristics, such as the ability to differentiate the quality of service different customers receive, it may be easier for wholesalers sharing an LTE network to maintain control over more dimensions of quality compared those sharing networks using 2G and 3G technology.
- 5.43 Negotiating a network sharing agreement is a complex process, and such agreements only normally involve two wholesalers. We consider that spectrum holdings could affect the ease with which wholesalers could negotiate sharing arrangements. In particular, it may be easier for a wholesaler with a strong spectrum portfolio to negotiate acceptable commercial terms, because with a strong spectrum portfolio there may be a credible fall-back option of operating a network independently. In contrast, with a weak spectrum portfolio such a fall-back option may be less credible (because, for example, a larger number of sites might be required rendering an independent network practically infeasible and/or resulting in an uncompetitive cost base). This could result in a weaker negotiating position for a holder of a weak spectrum portfolio.
- 5.44 We recognise that there is some risk for operators in bidding for spectrum without knowing whether they would be able to conclude network sharing negotiations. However, we consider that the current network and site sharing agreements illustrate that wholesalers are able to negotiate such arrangements. If there were advantages from network sharing, we would expect wholesalers to explore such arrangements (provided they remained compliant with competition law).
- 5.45 Any network or spectrum sharing arrangements would be subject to the requirements of competition law. The primary framework for considering the impact of RAN-sharing or network sharing agreements is UK or EU competition law. Under competition law, agreements between undertakings, decisions by associations of undertakings or concerted practices which have as their object or effect the prevention, restriction or distortion of competition are generally prohibited unless an exemption applies. It is for the parties to any of the above forms of agreements to assess whether their agreement is prohibited or exempt. As a concurrent competition authority, Ofcom is

empowered to conduct investigations and, where appropriate, to take steps to bring anti-competitive conduct to an end.

- 5.46 There are five main types of infrastructure and asset sharing arrangements that can take place between national wholesalers:
- i) No sharing. Each wholesaler has its own spectrum, sites, RAN and core network. They operate independently of each other at a commercial and operational level. This would result in the highest degree of network competition, assuming the resulting number of networks is sustainable. This is how UK operators ran their GSM networks for a period of time.
 - ii) Site sharing. Two or more wholesalers share the location of their radio network sites (and typically facilities such as power supply) but each wholesaler has its own spectrum, RAN and core network. This approach offers efficiencies and potential leverage in the process of securing access to sites, reducing timescales and unit costs per operator for these activities. This is the type of arrangement in place today between O2 and Vodafone. This is likely to result in both operators having the same coverage footprint (if the agreement covers all sites nationally), therefore reducing network competition on that particular aspect. However, they can still have different approaches to their RAN (e.g. technologies in use at a given site, number of spectrum bands in use and power levels).
 - iii) RAN sharing. In addition to site sharing, two or more wholesalers share the RAN infrastructure (such as towers, technology, rooftop structures, and antennas), but each wholesaler has its own spectrum and core network. This approach offers further unit cost reductions per operator for the establishment and operation of the shared RAN. This is the type of arrangement in place today between Everything Everywhere and H3G for their 3G RAN. The parties may still be able to differentiate certain aspects of their services that are controlled by the core network such as the provision of a given quality to certain user groups (e.g. higher speeds for premium users); they can decide how much of their respective spectrum resource they use at each site; and they retain sole management of commercially important information regarding the nature and extent of use of their spectrum resource.
 - iv) Spectrum sharing. In addition to RAN sharing, two or more wholesalers share their spectrum resources but retain separate core networks. This could risk further reduction of the commercial independence between the sharers, subject to the exact arrangements the parties put in place to manage the shared assets and associated company specific information. The parties also need to establish ways to arbitrate between conflicting demands on shared spectrum, for example which customers receive priority in case of congestion. At the same time, spectrum sharing allows potential quality gains by combining spectrum into large channels in a given band (e.g. of 2x10MHz or 2x20MHz) when the sharers have smaller holdings each and by serving demand more efficiently across a larger resource (e.g. if two potential sharers operated independently, one might experience congestion in a given location while the other had spare capacity). There are currently no examples of this type of sharing in the UK for national wholesalers.
 - v) Complete sharing. Two or more wholesalers share their spectrum, sites, RAN and core network. There are currently no examples of such deep sharing in the UK.

High barriers to entry for national wholesalers

- 5.47 There are high barriers to entry to wholesale markets. These barriers to entry are very significant for our competition assessment.
- 5.48 Firstly, access to spectrum of the right quantity and nature is necessary in order to be able to deliver wholesale services. Such spectrum is scarce and licences are currently held by only four firms. The 800MHz and 2.6GHz spectrum made available in the combined award may be a rare opportunity to obtain spectrum suitable for national mobile services⁶⁵ (other than through trading with an existing holder⁶⁶). The last entry to have occurred at the national wholesale level was when H3G entered following the 2000 spectrum award.
- 5.49 Secondly, a national wholesaler needs access to a radio access network. There are significant sunk costs involved in building a mobile network with national coverage. This acts as another barrier to entry. Acquiring access to new sites can be a lengthy and complex process because of the existence of a limited number of suitable locations for optimised outdoor coverage, the need for negotiations with landlords, potential planning requirements, potential works to host the network equipment and site engineering for interference management. While it may be possible to reduce the size of the costs that each wholesaler has to bear through a network sharing arrangement, there will still be a large fixed element to the costs.
- 5.50 The scale of the fixed costs will tend to limit the number of national wholesalers who can profitably survive in a competitive market. The Federal Communications Commission's Fourteenth Annual Report on the State of Competition in Mobile Wireless in the USA included a comparison of mobile market structure and performance in the United States, Western Europe and Asia-Pacific countries of comparable income levels. One of its findings was that the structure is converging to three or four national competitors per market in many countries.⁶⁷ This report drew partly on the Bank of America/Merrill Lynch's Global Wireless Matrix from Q4 2008.
- 5.51 The Bank of America/Merrill Lynch more recent Global Wireless Matrix reports also consider the number of competitors in different countries. In the Global Wireless Matrix for Q3 2010, the summary table shows mobile markets in 21 developed countries (in Asia-Pacific, Europe and North America). Of these, it reports that in 17 countries there were three or four competitors.⁶⁸ In one country (Norway) there were only two. The three countries reported as having five competitors were the UK, the USA and Canada. However, following the merger of T-Mobile and Orange, the UK now only has four. In the USA, the Global Wireless Matrix also said that there are only four competitors on a national scale. There are also a large number of regional and local mobile operators in the USA. In Canada, while more companies are trying

⁶⁵ It is also possible that other spectrum that may be suitable for mobile services, such as at 3.4 GHz, may be released by the public sector.

⁶⁶ Such trades may be affected by a range of factors, including the potential for existing national wholesalers to have weak incentives to sell to a new entrant, if by doing so it would increase competitive pressures in the market.

⁶⁷ See paragraph 364 to 367 of the FCC's Fourteenth Report (of 20 May 2010):

<http://www.fcc.gov/14report.pdf>

⁶⁸ Bank of America/Merrill Lynch's Global Wireless Matrix 3Q10. The 17 countries where there were 3 or 4 national wholesalers are: Australia, Japan, New Zealand, Singapore, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden and Switzerland. The number of national wholesalers is fairly consistent over time in most of these countries.

to enter the market, there are currently only three competitors at a national level.⁶⁹ We also note that in the recent German and Swedish awards, where four national wholesalers are active, there was no new entry.

- 5.52 While there are exceptions, we therefore consider that the norm in most developed countries is for there to be only three or four national wholesalers. It is possible that this may result from regulatory decisions, for example, on the number of spectrum licences. However, it may also reflect the difficulty of recovering fixed costs with a large number of national wholesalers.
- 5.53 It may also be more difficult for new entrants to achieve a sufficient market share to be profitable when they enter a market that is not growing rapidly. While a new national wholesaler could compete for the business of MVNOs, a large proportion of the retail market is held by the retail arms of existing national wholesalers. So a new national wholesaler may also need to win significant retail market share from the incumbents (either directly through its own retail business or indirectly via MVNOs expanding market share), with the associated costs of customer acquisition. Slowing growth in the number of mobile subscribers could therefore make entry more difficult.
- 5.54 However, as described above, in the UK entry at the retail level has continued to occur. This may suggest that this is not an insurmountable barrier to entry in itself, though it may be difficult for recent entrants to achieve a large market share.

Importance of holding suitable spectrum portfolios for providing higher quality data services

- 5.55 We consider that the importance of higher quality data services is likely to grow in the future. In section 33, we explained that we consider it is possible that separate markets might develop associated with higher quality data services. We described the following possible candidate markets that might develop in the future at the retail level:
- A high quality market associated with reliable indoor coverage for data services;
 - A separate market associated with higher data speeds and better latency (delivered by LTE) which is distinct from a market associated with lower data speeds (delivered by 2G and 3G); and
 - A division of the retail market into services that had given priority over other services (e.g. a highly reliable business service compared to a lower priority consumer service).
- 5.56 We considered that it is possible that these distinct retail markets could feed through to distinct wholesale markets. Even if separate markets do not develop, we consider that higher quality data services are likely to become more important in the future.
- 5.57 It may be difficult for national wholesalers to provide higher quality data services without access to suitable spectrum portfolios. For example, to provide high data speed services or prioritise some services, national wholesalers need access to spectrum that can be used for LTE services. To provide reliable indoor coverage, lower frequency spectrum may be required.

⁶⁹ For a short commentary on current developments in Canada see: http://www.economist.com/blogs/newsbook/2011/02/canadas_mobile-phone_market

- 5.58 It may be difficult for national wholesalers to obtain access to such spectrum unless they hold the licences themselves. As described above, if national wholesalers do not hold the spectrum directly, they may be in a weak bargaining position relative to those that do hold the spectrum licences. For example, if only one or two national wholesalers held spectrum that allowed them to compete in one of the possible wholesale markets above, they may have weak incentives to offer access to that spectrum to other potential national wholesalers. It is likely to be more profitable for them not to give other national wholesalers access.
- 5.59 We therefore consider that it may be difficult for national wholesalers to provide services to some of these possible future markets unless they directly hold spectrum portfolios that allow them to serve these markets.

Capacity, market share and profitability

- 5.60 The spectrum portfolio held by a national wholesaler can have a big influence over the quality of the services that can be delivered, and the number of people those services can be delivered to. It is not the only factor, as the number of macro sites deployed is also important as are arrangements to off-load data from the macrocell network, such as with WiFi or femtocell deployments.
- 5.61 In theory, deploying more sites could be used to add capacity instead of a greater quantity of spectrum. However, the higher the demand, the more sites would be required to match capacity and the less feasible it would be, both in terms of practicality and financial viability. We therefore consider that a national wholesaler's spectrum portfolio will have a significant influence over the capacity as well as the quality of service it can offer. As discussed below, if its portfolio does not include the right mix of spectrum, such as sub 1GHz, its quality of service may be limited. In addition, if its spectrum portfolio is small, it may have limited capacity.
- 5.62 A limit on a national wholesaler's capacity could limit the number of customers it could serve for any given quantity of spectrum. Given the significant fixed costs that are involved with achieving access to a network (even if these are shared), it may be necessary to have a large enough spectrum portfolio to have sufficient capacity to obtain a large enough customer base to be profitable. This is consistent with the observation that the mobile industry is characterised in most countries by a small number of national wholesalers (typically three or four). It may be hard for a national wholesaler with a small market share to survive given the fixed costs (even if these are shared through a network sharing arrangement). There may come a point at which if a national wholesaler does not hold a sufficient portfolio of spectrum it may struggle to be financially viable.
- 5.63 This does not mean that wholesalers need to have equal spectrum holdings or equal market shares for competition to be effective, but they all need to have sufficient portfolios to be sustainable. For example, we consider that H3G has had an important impact on the competitiveness of the UK market since its launch particularly for data services, despite a smaller market share than the other national wholesalers. H3G has, for example, led some pricing and service innovations, such as being the first to introduce a low cost, flat-rate mobile broadband package.⁷⁰

⁷⁰ This is consistent with the European Commission's view on H3G in its decision on the T-Mobile / Orange merger. The European Commission said that H3G "could be considered more as a 'maverick' in the market" and was "an important driving force for competition". The European Commission also

LTE, contiguous spectrum and data speeds

- 5.64 To provide some higher quality data services, it is likely to be necessary to use LTE technology. Some spectrum may be more suitable for this than other spectrum. For example, in section 46, we describe why we consider that 2.1GHz may be less likely to be used for LTE in the next 5 to 10 years.
- 5.65 Large blocks of contiguous spectrum holdings may also be important for the provision of some higher quality mobile services. UMTS only operates on 2x5MHz channels. In contrast, LTE is designed to operate using a variety of spectrum channel sizes, up to 2x20MHz. Higher peak data speeds can be obtained when larger contiguous spectrum is used for LTE. Large contiguous spectrum blocks are therefore likely to be more important for LTE than for UMTS.
- 5.66 The Commission also noted that “in order to deploy the most efficient and fastest download speed LTE technology, contiguous spectrum of 2x20 MHz is preferable, and necessary to achieve the maximum throughput possible (a speed of 100 Megabit per second – “Mbps”). While LTE can be launched also on 2x10 MHz or even smaller bands, the full speed will not be reached if this smaller amount of spectrum is used.”
- 5.67 While peak data rates are achieved with 2x20MHz of spectrum, the Commission considered that a contiguous block of 2x15MHz would allow the holder to compete on almost equal footing with a 2x20MHz contiguous block. The peak data rate relates to the speed a single user in a cell would receive in good conditions, such as being close to the base station. Typical throughput rates experienced by users will be much lower. For example, there will normally be many users simultaneously using any cell.
- 5.68 As well as higher peak data rates, contiguous spectrum also gives other benefits in terms of spectrum efficiency. For example, it allows better management of interference from other networks than if the same bandwidth of spectrum were split across non-contiguous parts.
- 5.69 In the future, technological developments might enable channel bonding that would allow contiguous and non-contiguous component carriers to be aggregated. This may reduce the advantage of contiguous spectrum, as non-contiguous spectrum could be used to increase peak data rates and achieve spectrum efficiency. However, this technology is not yet available for deployment and it is unclear when it might be. We consider it is likely that contiguous spectrum will offer advantages at least in the early part of the period we are considering. We consider there is some uncertainty about how large those advantages are.

Particular importance of sub 1GHz spectrum for coverage and quality of services

800MHz and 900MHz broadly equivalent

- 5.70 By sub 1GHz spectrum we mean the 800MHz and 900MHz bands. In terms of physical properties, the two bands are similar. While all our technical modelling has

noted that H3G “is considered by several market players as an important competitive force in the UK market and to be the most innovative MNO in the market”. See in particular paragraphs 49, 62, 63 and 107 of the European Commission’s Decision:
http://ec.europa.eu/competition/mergers/cases/decisions/M5650_20100301_20212_247214_EN.pdf

been for LTE at 800MHz, we consider that the results would be similar for LTE at 900MHz.

- 5.71 Following 2G liberalisation, the 900MHz band is likely to be used increasingly for 3G in the short term. This is because of the wide and growing range of handsets and devices capable of using UMTS900. If the provision of higher quality data services with LTE becomes important for consumers, we would expect the holders of 900MHz spectrum to have an incentive to de-fragment that spectrum and re-farm it for LTE in the longer term. It may be easier and cheaper to change networks to new technologies in the future, because of more flexible base station equipment that can simultaneously support different standards and is easier to upgrade. We expect the 800MHz to be used for LTE as soon as the spectrum becomes available.
- 5.72 We therefore consider that the 800MHz and the 900MHz are broadly equivalent and we treat them the same in our analysis. (We discuss temporary differences between the bands from paragraph 6.132 in the next section).

Distinction between matchable and unmatchable advantages

- 5.73 We consider that sub 1GHz has technical advantages over higher frequencies in terms of the quality of coverage that can be provided, particularly for 3G and LTE networks. So for two networks with the same number of sites, the quality of a network with sub 1GHz spectrum will generally be higher than one with higher frequency spectrum.
- 5.74 However, there is less agreement over whether these advantages are ‘matchable’ with higher frequencies. By matchable, we mean that wholesalers without sub 1GHz spectrum are still able to develop their networks to offer services sufficiently similar to wholesalers with sub 1GHz spectrum to avoid a material competitive disadvantage. Services could be matchable because:
- Either, it is technically and practically⁷¹ feasible for a wholesaler with higher frequency spectrum to offer the same higher quality services by using a more extensive network, and it is profitable to deploy or obtain access to that more extensive network (thereby avoiding an unmatchable technical advantage);
 - Or, while some wholesalers do not offer as high a quality services by using a more extensive network, the differences in quality are not valued by consumers highly enough for this to have a material impact on competition (thereby avoiding an unmatchable competitive advantage).
- 5.75 In contrast, if the higher quality cannot be delivered, and consumers place sufficient value on the difference in quality, the advantage of lower frequency spectrum would be unmatchable.

Potential unmatchable technical advantage of sub 1GHz spectrum

- 5.76 Sub 1GHz spectrum gives advantages over higher frequencies in terms of coverage. It allows a significantly greater geographical area to be served than higher frequency bands would, for the same number of sites (because signals travel further at lower frequencies). It also tends to provide substantially better signal quality and higher

⁷¹ There may be practical limits on the sites that can be built due, for example, to planning restrictions.

download speeds (throughput) within buildings than higher frequencies since lower frequency signals are better at penetrating solid objects. This is provided that demand in a particular area is not so high that interference between users begins to limit network performance.

- 5.77 In our technical analysis we have considered whether a national wholesaler without any sub 1GHz spectrum, but with higher frequency spectrum, is likely to be able to build an LTE network whose performance matches that of a national wholesalers using an LTE network with 2x20MHz of sub 1GHz spectrum. We have concentrated on exploring the advantages of sub 1GHz spectrum in terms of indoor coverage. This is because we consider this likely to be more important than any advantages in rural areas given the geographic distribution of existing mobile use. The results of this technical work are shown and explained in more detail in Annex 7.
- 5.78 We consider three metrics of performance:
- Coverage – the proportion of the population within an area to which it is technically possible to deliver a service indoors with a particular downlink speed (if all the resources of the serving cell were dedicated to a single customer), as a function of the number of network sites (and in some cases the loading on the network)⁷²;
 - Speed – for a given number of sites and network loading, the proportion of the population within an area to which it is possible to deliver a particular downlink data-rate (if all the resources of the serving cell were dedicated to a single customer)⁷³;
 - Capacity – for a given downlink speed and network loading, the number of sites needed to provide enough capacity to simultaneously serve a certain proportion of the population within an area with the given downlink speed.
- 5.79 We compare the modelled performance of three LTE networks, using in each case the same bandwidth of spectrum (2x20MHz contiguous), but at different frequencies: 800MHz, 1800MHz and 2.6GHz.
- 5.80 We summarise some of the results of our technical modelling below. Annex 7 contains a fuller description and interpretation of the results.
- 5.81 Looking first at coverage, we find that for any given number of sites and guaranteed downlink data rate, the model predicts that a network operating at 800MHz will be able to reach a consistently higher proportion of the population⁷⁴ than networks operating at 1800MHz or 2.6GHz. This is illustrated in Figure 5.2 below. This shows the proportion of the population in the sample area that can receive a guaranteed

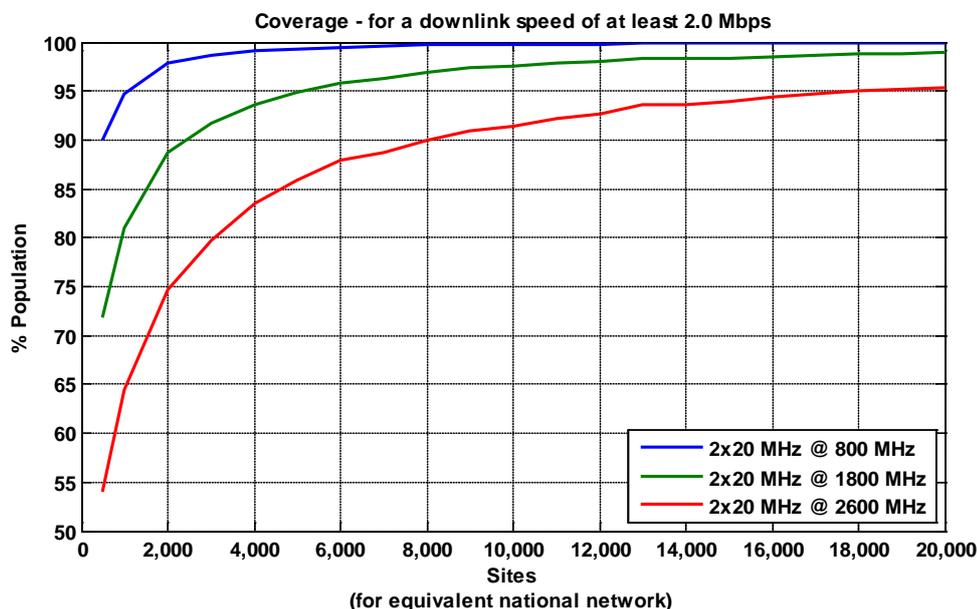
⁷² Note that this measure is of coverage and not capacity. In order to serve a customer at the very edge of coverage of a cell, the network will have to dedicate all of the resources of that cell to that single customer and will not be able to serve any other customers simultaneously in the same cell.

⁷³ Again, this is a measure of what is technically possible, not of the capacity of the network. In order to deliver the given speed to a customer at the edge of coverage (for that speed), the network will have to dedicate all of the resources of the cell serving that customer to that single customer, and will not be able to serve any other customers simultaneously in the same cell.

⁷⁴ Note that the model looks at the quality of service provided indoors (inside buildings) rather than outdoors, since there is evidence that most mobile broadband usage occurs indoors rather than outdoors.

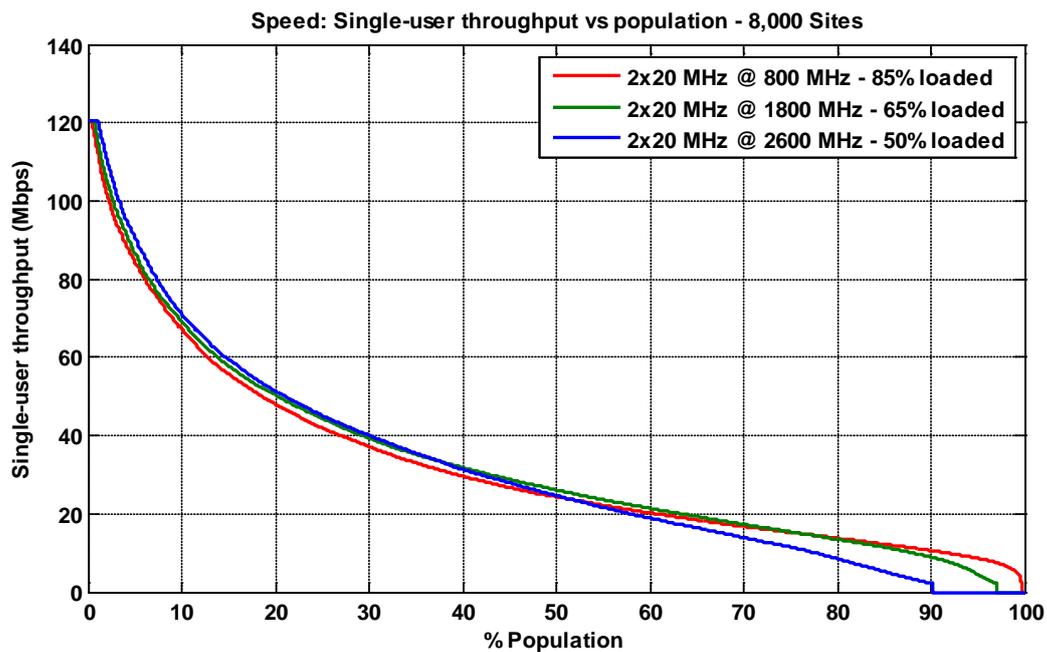
download data rate of at least 2 Mbps for various numbers of site for the different frequencies.

Figure 5.2



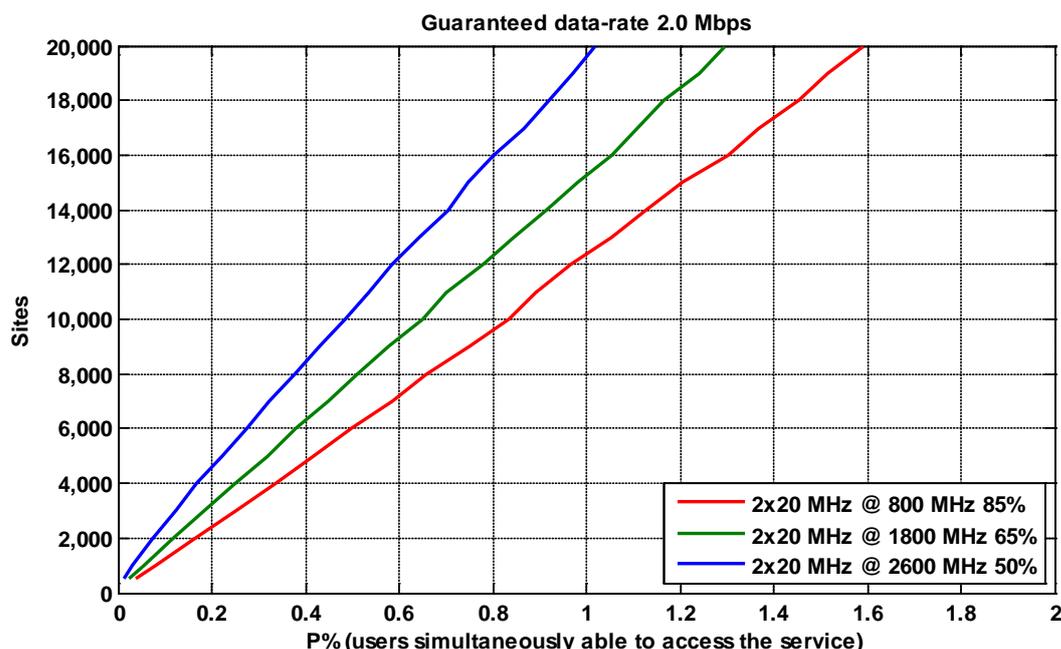
- 5.82 Looking at these graphs in another way, we see that the predicted number of sites needed to achieve a given level of coverage, is consistently higher for networks using 1800MHz or 2.6GHz than for a network using 800MHz. For lower levels of coverage, below 90%, the difference in the number of sites required is perhaps moderate, in particular in respect of 1800MHz spectrum. However, for higher levels of coverage the gap is wider, and for 2.6GHz in particular the number of sites required to provide coverage above say 95% starts to look unfeasibly large.
- 5.83 In Annex 7, we show the results for other guaranteed downlink data rates and find a similar pattern. The predicted gap in coverage between networks using different frequencies widens somewhat as the guaranteed downlink data rate increases.
- 5.84 In terms of speed (single-user throughput), the results in Annex 7 show that the model predicts quite a big difference in the maximum speed that can be provided to any given proportion of the population between a network using 800MHz spectrum (highest speed) and one using 2.6GHz spectrum (lowest speed) if the networks are lightly loaded (15% loaded). However, the speed advantage offered by an 800MHz network, whilst not disappearing completely, becomes relatively less for most customers as the networks become more heavily loaded.
- 5.85 The model suggests therefore that the operator of a higher frequency network might be able to match the speed offered by a lower frequency network by operating at a somewhat lower loading (albeit this would have consequences for the capacity of the network unless the operator either had more spectrum or more sites) – for example a 2.6GHz network operated at 50% loading is predicted to achieve a similar maximum speed for most customers as does an 800MHz network operated at 85% loading.

Figure 5.3



- 5.86 What the model results show clearly however is that even with a reduction in loading there remains a gap between the performance of an 800MHz network and a network using a higher frequency (whether 1800MHz or 2.6GHz) at the edge of coverage, with this gap being wider in the case of 2.6GHz than in the case of 1800MHz spectrum.
- 5.87 Finally, comparing the predicted capacities of the three networks, we see that the 800MHz network has somewhat higher capacity than either the 1800MHz or 2.6GHz networks. This is illustrated in Figure 5.4 below for a guaranteed data-rate of 2 Mbps. The difference is almost constant in relative terms over a range of network sizes and downlink data rates (as shown in the further results in Annex 7). For a guaranteed data-rate of 2 Mbps, to match the capacity obtained with 2x20MHz of 800MHz with 8,000 sites, a network with 2x20MHz of 2.6GHz would need to have around 13,000 sites.

Figure 5.4



- 5.88 In summary therefore, we find that the model predicts a difference in coverage between networks using different frequencies with the same number of sites. In some circumstances it may be possible to match the coverage of an 800MHz network when using higher frequencies through the deployment of more sites, but in other circumstances this may be impractical. To the extent that 800MHz provides a speed advantage over higher frequencies, this may be matched for the majority of customers by operating a higher frequency network at lighter loading, but the model predicts that such matching will not be possible at the edge of coverage given equal numbers of sites.
- 5.89 The circumstances in which it might be feasible to match the coverage of an 800MHz network using higher frequencies with more sites will depend on the practicalities and financial cost of building more sites. The evidence available does not allow us to take a definitive view on this. Directly assessing financial viability is difficult for two reasons. First, there are many uncertainties about how and when wholesalers with higher frequency spectrum would deploy more sites in order to match, hence estimating the cost differences of using different spectrum bands is unlikely to be robust. Second, there is considerable uncertainty over the impact on revenues of not matching. It depends on potential mobile broadband revenues and the proportion of consumers sensitive to differences in quality which are both in turn highly uncertain.⁷⁵

⁷⁵ We have considered whether using forecasts of differences in auction prices for sub 1GHz and higher frequency spectrum (e.g. from international auctions) could allow us to assess whether quality differences are matchable with more sites. In principle, if differences in auction prices reflected differences in spectrum value and these were less than the additional cost of building more network to match the level of quality, then we could conclude that quality differences were unmatchable. However, there is considerable uncertainty over assessing the cost differences of the two networks. There are uncertainties over the cost of deploying an LTE network, and we do not know how wholesalers with low frequency spectrum would deploy it, so do not know how many extra sites would be need to match what the low frequency would deliver. This makes even a rough assessment of the network cost differences difficult and potentially unreliable. To draw a robust conclusion, it would also

- 5.90 Our technical analysis is based on macro site networks. It therefore does not take account of other ways of improving indoor coverage. Other ways of providing indoor coverage could include with in-building repeaters, WiFi technology and femtocells. We described in section 4.4.5.1 above the trend towards increasing use of data off-loading technologies, such as WiFi.
- 5.91 These other techniques for providing indoor coverage could help reduce the coverage gap between sub 1GHz and higher frequency spectrum to some extent in terms of in-building coverage. However, we remain doubtful whether femtocells or other in-building solutions could be used to eliminate differences in quality between sub 1GHz and higher frequency macro networks. This is partly because this would likely require installation of 'open access'⁷⁶ femtocells or similar systems in a very large number of locations.
- 5.92 We therefore consider that sub 1GHz spectrum may give an unmatched technical advantage in terms of coverage.

Potential unmatched competitive advantages of sub 1GHz spectrum

- 5.93 Just because sub 1GHz has an unmatched technical advantage in terms of coverage does not necessarily mean that this advantage will result in an unmatched competitive advantage. It is also necessary for consumers to place sufficient value on the differences in technical quality for the difference to matter commercially and affect competition.
- 5.94 This will depend on how sensitive consumers are to differences in coverage, especially indoors. As we discussed in section 4.3, there is considerable uncertainty over future demands and how consumers may value differences in quality, not least because LTE services do not yet exist in the UK. However, we know that a lot of mobile broadband use today is indoors. We consider that consumers are likely to value better quality indoor coverage and that the differences could therefore be important.
- 5.95 We consider there is a risk that consumers would place sufficient value on this difference in indoor coverage that national wholesalers with a large amount of sub 1GHz spectrum would have an unmatched competitive advantage over national wholesalers without any sub 1GHz frequencies, at least for any markets associated with reliable indoor coverage for higher speed mobile broadband services.
- 5.96 Whilst our technical modelling also predicts some difference in capacity between networks using different frequencies, we do not consider this necessarily gives an unmatched competitive advantage. First, a wholesaler could increase its capacity by adding sites or by adding spectrum, such as at higher frequencies, i.e. above 1 GHz. If higher frequency spectrum is less useful than other spectrum (e.g. for coverage), then we would expect it to be priced more cheaply. Second, we do not consider competitors need to have the same capacity in order to be able to compete. This is provided that wholesalers with smaller capacity still have sufficient to provide

be necessary to establish whether the differences in auction prices between different frequencies were related to differences in spectrum value or materially affected by other factors (such as the design or competitiveness of the auction).

⁷⁶ Initial deployments of femtocells usually restrict usage to a whitelist, e.g. the subscriber and members of their household. Use of femtocells in so-called 'open access' mode means that all subscribers can use the device. One possible issue with this is that the owner would have to share their broadband connection with others.

a competitive force. We therefore do not see differences in capacity as necessarily creating unmatchable competitive advantages.

Advantages of sub 1GHz spectrum recognised by other regulators

5.97 Our view of the importance of sub 1GHz is consistent with the position taken by other European regulators in recent and upcoming awards:

- In Germany's recent spectrum auction of the 800MHz, 1800MHz, 2.1GHz and 2.6GHz bands, the regulator imposed caps which effectively limited two wholesalers (T-Mobile and Vodafone) to 2x22.4MHz and all other potential bidders to 2x20MHz of sub-1GHz spectrum. In contrast, it did not impose any caps on the higher frequency spectrum in the auction, indicating their greater concerns regarding excessive concentration in the sub-1GHz bands.⁷⁷
- Sweden's regulator cited the sub-1GHz spectrum as being "well suited for area coverage and indoor coverage" and imposed 2x10MHz caps in its recently completed 800MHz auction.
- In Ireland's upcoming auction of the 800MHz, 900MHz and 1800MHz bands, the regulator has proposed a sub-1GHz cap of 2x20MHz.⁷⁸ It identified sub-1GHz spectrum as "particularly important for competition in a service market such as this" and cited a technical study which identified the significantly fewer number of sites needed a 900MHz network needed to achieve the same service level as a network using higher frequency spectrum.⁷⁹
- In its upcoming auction of all mobile spectrum bands, Switzerland's regulator has proposed a sub-1GHz cap of 2x30MHz, highlighting its relative importance by citing the bands' "good propagation characteristics".⁸⁰ The 800MHz band is the only new spectrum band that has caps imposed on it, with the 2.6GHz band having no caps.
- Spain's regulator has proposed a 2x20MHz sub-1GHz cap for its upcoming auction of all mobile spectrum bands.

5.98 Figure 5.5 below summarises specific measures regarding sub-1GHz in recent and upcoming European auctions. Notably, all of the regulators concerned have put in place measures that at least maintain the current number of sub-1GHz wholesalers, whilst in the case of Ireland and Spain, efforts have been made to ensure sub-1GHz spectrum will be available to all national wholesalers.

⁷⁷ <http://www.cullen-international.com/report/5350/t4049>

⁷⁸ <http://www.comreg.ie/fileupload/publications/ComReg1071.pdf>

⁷⁹ <http://www.comreg.ie/fileupload/publications/ComReg0914a.pdf>

⁸⁰ <http://www.news.admin.ch/NSBSubscriber/message/attachments/21307.pdf>

Figure 5.5: Summary of sub-1GHz measures in other auctions

	Number of incumbent national wholesalers	Number of incumbents with sub-1GHz	Sub-1GHz cap in auction	Minimum no. of guaranteed sub-1GHz wholesalers after auction
Germany	4	4	2x20MHz (2x22.4MHz Vodafone and T-Mobile)	4
Ireland	4	3	2x20MHz	4
Switzerland	3	3	2x30MHz	3
Sweden	4	4	2x10MHz (800MHz band only)	4
Spain	4	3	2x20MHz	4

Ability to negotiate potential network sharing agreement

5.99 Having a reasonable overall spectrum portfolio may have another commercial advantage. It may improve the negotiating position for a national wholesaler if it were seeking to agree a network sharing agreement with another national wholesaler. This is because it is much more credible for a national wholesaler to 'go it alone' if it has a portfolio of spectrum that makes it plausible that they could operate on a stand-alone basis.

5.100 Having some sub 1GHz spectrum may be particularly important in this regard. It is possible to provide some coverage over the large majority of the population with a relatively small number of sites with sub 1GHz spectrum. This makes it much cheaper than with higher frequencies to build a network that provides some basic level of national coverage. Having a reasonable overall portfolio of spectrum makes it more likely that the fixed costs of the network can be recovered, making it more credible that a national wholesaler will build its own network if it could not agree acceptable terms for network sharing.

Provisional conclusions on spectrum holdings needed to be a credible national wholesaler

5.101 For national wholesalers to be credible competitors in terms of providing higher quality data services, we consider it likely that they need to have a spectrum portfolio that includes at least:

- a reasonable overall portfolio of spectrum suitable for LTE that allows them to offer higher quality data services and is of sufficient size for them to be able to cover the fixed costs of being a national wholesaler; and
- in particular, we consider that a national wholesaler is likely to need to have some sub 1GHz spectrum to be able to credibly offer higher quality data services, particularly indoors.

Risk of lower competitive intensity in wholesale markets

- 5.102 Currently there are only two national wholesalers who have spectrum portfolios that include sub 1GHz spectrum, that is, Vodafone and O2. Everything Everywhere has a relatively large quantity of spectrum and the largest site base, but does not have sub 1GHz spectrum. H3G has 2x15MHz of 2.1GHz and no sub 1GHz spectrum.
- 5.103 We therefore consider that, depending on the outcome of the combined award, there is a material risk of a lower number of competitors providing higher quality data services, compared to the number of competitors in the wholesale market today and compared to what might be possible. For example, if Vodafone and O2 won access to all of the 800MHz spectrum, they would hold all of the available sub 1 GHz spectrum, and might therefore be the only national wholesalers capable of providing reliable higher quality data services, particularly indoors.
- 5.104 Especially given the high barriers to entry, we consider that if there were only two or, if only one other competitor were to acquire sub-1 GHz spectrum, three competitors in the provision of higher quality data services, this could result in a lower level of competitive intensity compared to a situation where there were more national wholesalers. Competition pressure in the provision of higher quality data services might be less than in the wholesale market today where there are four competitors.
- 5.105 We consider the possible impact of the number of national wholesalers on competitive intensity in more detail in section 66 below, but our provisional conclusion is that if there were only three national wholesalers there would be a material risk of limited competitive intensity compared to if there were more national wholesalers. We also set out in section 66 that if there were more national wholesalers this does not necessarily involve a large risk of inefficiency, particularly in comparison to the competition benefits they may bring.
- 5.106 While decreasing competitiveness is one possible outcome of the combined award, there are others. If a new entrant were to enter, and all existing wholesalers were to win access to spectrum portfolios that enabled them credibly to offer higher quality data services, competitive intensity in wholesale markets could increase.
- 5.107 However, if it were possible for only two or three national wholesalers to win access to spectrum portfolios that would allow them to offer higher quality data services, they may have a strategic incentive to bid to achieve this. Expected profits would tend to be higher as a result of lower competition. This could mean that two or three national wholesalers would have an incentive to pay more for the spectrum in order to restrict competition and the number of national wholesalers having such spectrum portfolios. In this case, the concentrated spectrum outcome would not reflect a socially optimal allocation of the spectrum. Rather it would reflect likely lower competition in the case where there were only two or three credible national wholesalers. These strategic bidding incentives could make an outcome of the combined award with fewer national wholesalers holding credible spectrum portfolios for offering higher quality data services more likely.

Provisional conclusions on future competition absent measures to promote competition

- 5.108 The key risk to competition in retail market(s) will in our view be the ability for retailers to obtain wholesale access on reasonable terms. We therefore consider competition in wholesale markets to be critical to future competitiveness for retail

markets. However, we also identify a potential risk to competition at the retail level such that sub-national RAN operators may not gain access to spectrum when it could be beneficial for consumers that they could do so. This risk arises from coordination problems in the auction and the risk that any allocation of spectrum based on private valuations may not deliver maximum competition benefits for consumers.

- 5.109 We consider that directly holding a suitable portfolio of spectrum is likely to be crucial for national wholesalers to be credible competitors in the provision of higher quality data services. We consider such a portfolio is likely to need to include:
- a reasonable overall portfolio of spectrum suitable for LTE that allows them to offer higher quality data services and is of sufficient size for them to be able to cover the fixed costs of being a national wholesaler; and
 - in particular, we consider that a national wholesaler is likely to need to have some sub 1GHz in order credibly to be able to offer higher quality data services, particularly indoors.
- 5.110 Currently only two national wholesalers may have such spectrum portfolios. We consider that if we put in place no measures in the combined award to promote competition, there is a material risk that only three wholesalers (or possibly even only two) might emerge from the combined award with spectrum portfolios that would allow them credibly to serve the possible higher quality data markets that may develop.
- 5.111 We consider that if only two or three national wholesalers were to hold spectrum after the combined award that enabled them to provide higher quality data services, the degree of competitive intensity could be weaker than if there were more national wholesalers. This is especially the case given that there are high barriers to entry to the national wholesale market, including from the difficulty of obtaining access to suitable spectrum.
- 5.112 Relatively weak competitive intensity at the wholesale level, at least in the provision of higher quality data services, would also be likely to reduce competition in retail markets. We consider that relatively weak competitive intensity in wholesale and retail markets could lead to higher prices and lower quality services and innovation for UK consumers. We consider this could result in significant consumer detriment.
- 5.113 If some national wholesalers did not have spectrum portfolios that allowed them credibly to compete in the provision of higher quality data services, this could even lead them to exit all wholesale markets. This might be the case if they were unable to be profitable without providing the higher quality data services. In this case any reduction in competitive intensity would affect all wholesale markets.
- 5.114 We therefore consider that we should go on to assess whether there are any appropriate and proportionate measures that we should put in place to promote competition to address these concerns.
- 5.115 Because of the way competition in wholesale markets affects retail markets, we begin by considering potential measures to promote competition in wholesale markets. Our assessment of potential measures in wholesale markets is set out in sections 66 and 77, we then consider potential measures in retail markets in section 88 below.

Section 6

Potential measures to promote national wholesale competition

6.1 In the previous section we provisionally concluded that if we were to hold an auction with no measures in place to promote competition, there is a material risk that the level of national wholesale competition would be lower than it is today or what it could be. Hence, in this section we consider whether there are any appropriate and proportionate measures which we should put in place to promote competition in the future at the national wholesale level.

Section summary

- 6.2 We assess whether there are any appropriate and proportionate measures we should consider putting in place to promote effective competition at the national wholesale level.
- Our provisional conclusion is that some measures to ensure that at least four competitors are capable of being credible national wholesale service providers after the combined award are likely to be appropriate and proportionate, and we think we should put such measures in place.
- 6.3 We then consider the options for implementing such measures, including the possible use of spectrum caps (restrictions on the total amount of spectrum any competitor can hold) and spectrum floors (guaranteeing that at least four competitors have the minimum necessary amount of spectrum by putting restrictions on the auction outcomes we would accept).
- 6.4 We provisionally conclude that the most appropriate and proportionate option for achieving our above objective is to specify spectrum floors in the auction, together with “safeguard caps” to guard against the risk of future competition problems arising from very asymmetric distributions of mobile spectrum.
- 6.5 The spectrum floors would involve a specified set of spectrum portfolios intended to represent the minimum spectrum portfolios needed to provide higher quality data services in a profitable way. Only auction outcomes that ensured that at least four national wholesalers had spectrum holdings at least as large as the set of minimum portfolios would be accepted. In our preferred option, we consider that set of portfolios would be:
- 2x5MHz of sub 1GHz spectrum and 2x20MHz or more of 2.6 GHz
 - 2x5MHz of sub 1GHz spectrum and 2x15MHz or more of 1800MHz; or
 - 2x10MHz of sub 1GHz spectrum and 2x10MHz or more of 1800MHz; or
 - 2x10MHz of sub 1GHz spectrum and 2x15MHz or more of 2.6GHz; or
 - 2x15MHz or more of sub 1GHz spectrum.

- 6.6 Finally we consider whether there are any other appropriate and proportionate measures which we should consider putting in place to address any temporary competitive advantages that could arise.
- We provisionally conclude that no action is likely to be necessary given our current view on market developments and the availability of 800MHz and 2.6GHz spectrum, but we would keep the matter under review if expectations changed.
 - We also believe that it would be in consumers' interests to liberalise spectrum for new technologies as soon as the European Commission varies the relevant RSC Decisions accordingly.

Relevant factors affecting national wholesale competition

- 6.7 In the previous section we set out our view that absent measures in the auction to promote competition, future national wholesale competition might be less than it is now and/or less than it could be. As a result the interests of consumers might not be as well served as they could be. This is because there may be strong incentives to concentrate spectrum into the hands of a few competitors in order to exploit the competitive advantages this could give.
- 6.8 We recognise that, besides the number of competitors in the market, there are a number of other factors that may influence the level of national wholesale competition. These include:
- Barriers to entry – as set out in section 5 we think that barriers to entry in national wholesale are high due to: the scarcity of mobile spectrum, a key input for national wholesale mobile services; the fixed costs of deploying a national radio access network (RAN) and the difficulties for a new entrant to achieve an effective scale in a maturing mobile market. Where the number of competitors in a market is limited, high barriers to entry are likely to increase the ability of those competitors to exploit their market positions.
 - Differences between market competitors – the more asymmetry in market shares and cost structures, the harder it should be for competitors to identify strategies for tacit collusion (e.g. it should be harder for firms to work out their rivals' pricing strategies), potentially increasing the intensity of competition.
 - Asymmetry due to new entry may increase competition because new entrants may compete aggressively to capture market share and act as mavericks bringing innovative and disruptive strategies to the market. H3G was a much later entrant to the wholesale market and the EC acknowledged that it may have played the role of a maverick in the UK in its decision on the T-Mobile / Orange merger. If firms have different technologies, competition may increase as they may seek to exploit the competitive advantage it gives them.
 - Whether users have countervailing buyer power – While individual retail customers may not have a large enough share of mobile broadband demand to have significant buyer power, this may be true for larger wholesale customers and may therefore limit the extent to which national wholesalers could restrict competition.
- 6.9 Ofcom cannot directly influence many of these factors and, even if we could, would not be well placed to try to influence some of them. These factors may also change over time independently of any action we may take. One factor that Ofcom can

however influence through the combined award is the number of competitors who have access to sufficient spectrum to be credible national wholesalers. As far as we can identify other stable effects, we will use these to inform our competition assessment.

The number of credible national wholesalers may be key to promoting competition in the relevant markets

- 6.10 We consider that the number of competitors who are capable of being credible national wholesale competitors is likely to be a key factor in how competitive mobile markets are in the future, and so most likely to further the interests of consumers. This is because, as set out above in section 5, the relevant markets are characterised by particularly high barriers to entry including due to the scarce supply of spectrum, a key asset necessary to be an effective national wholesale competitor.
- 6.11 Whilst in the future, we expect all mobile spectrum to be tradable, we do not consider that we can rely on this solely to ensure that markets are competitive – if spectrum is a scarce strategic asset that can give some competitors an unmatched competitive advantage, there may be incentives not to trade spectrum in order to retain such advantages, which could then restrict the intensity of competition.
- 6.12 We have therefore considered whether, in order to promote competition at the national wholesale level, we should put in place measures to ensure that a minimum number of competitors have sufficient spectrum at the end of the combined award to become credible national wholesalers, and if so, what that minimum number should be.
- 6.13 In considering this question, we note that (a) we are only considering a potential minimum, and do not rule out the possibility that the combined award may result in a greater number of credible national wholesale competitors, and (b) we recognise that future changes in the market (for example consolidation or spectrum trading) may mean that the position changes after the combined award: we are not seeking to guarantee a particular ongoing market structure, but are instead considering whether and, if so, how to put in place measures which are capable of ensuring an environment in which competition is promoted.
- 6.14 As a rule of thumb (and in most economic models), more competitors tend to make a market more competitive. In previous consultations on the award of the 2.6GHz band (April 2008)⁸¹ and on mobile spectrum liberalisation (February 2009)⁸² similar issues arose and we set out why we considered that the number of competitors could have a major effect on the intensity of competition. We have not found any compelling evidence since then to change this view.⁸³
- 6.15 In light of our considerations above and particularly in light of the high barriers to entry resulting from the scarcity of relevant spectrum for these purposes, our provisional view is that we should consider putting in place measures to ensure that at the end of the combined award a minimum number of competitors have sufficient

⁸¹ <http://stakeholders.ofcom.org.uk/consultations/2ghzrules/statement/statement/>

⁸² <http://stakeholders.ofcom.org.uk/binaries/consultations/spectrumlib/summary/spectrumlib.pdf>

⁸³ We recognise that there are some economic models (such as Bertrand competition with homogenous products) where it is possible that even with more competitors the intensity of competition may not increase substantially. However, we consider that these models are unlikely to be relevant to the mobile wholesale market where significant service differentiation may be possible.

spectrum to become credible national wholesalers in the provision of higher quality data services.

What is the minimum number of competitors that we should seek to ensure have sufficient spectrum at the end of the combined award?

- 6.16 We start by considering the case for ensuring that at least three, four or five competitors are capable of being credible national wholesale competitors after the combined award. Given that we provisionally conclude that we should ensure at least four, we have not considered the case for less than three or more than five. We consider that the arguments for less than three would be weaker than the arguments for three, and the arguments for more than five would be weaker than for five. In any event given existing spectrum holdings, we would reasonably expect at least two such competitors to emerge from the combined award, even if we put in place no measures to promote competition.
- 6.17 We also note at the outset that we are concerned with putting in place measures to enable entities to be credible national wholesale competitors; we cannot guarantee that holders of spectrum will in fact become national wholesale competitors (though this may be the most valuable use of the spectrum) nor that they remain in the market indefinitely if they do so.
- 6.18 We group our discussion of the arguments for and against the different minimum number of competitors under the following headings:
- **Competition** and the associated benefits for consumers e.g. lower prices, higher usage, better quality and choice.
 - **Efficiency** including in terms of spectrum use and of overall industry fixed costs.
 - **Broader social value** for consumers and citizens, in terms of widespread coverage of mobile broadband networks.
- 6.19 We assess our three proposed options for the number of wholesale competitors against the issues above in the round.

Competition

- 6.20 If there were only three national wholesalers after the combined award, this would be fewer than the number of national wholesalers in the current wholesale market. Other things being equal, only three competitors would be likely to mean lower competitive intensity in the market compared to four, which in turn would be likely to lead to lower competitive intensity compared to five.
- 6.21 The specific evidence we have considered (set out below) suggests that, although we cannot be certain that competition would be limited if there were three or fewer credible national wholesale competitors for mobile broadband (particularly since other factors may also affect the level of competition) there is a material risk that competition would be limited.
- 6.22 Lower competitive intensity in wholesale markets is also likely to reduce competition in retail markets. We consider that relatively weak competitive intensity in wholesale and retail markets could lead to higher prices and lower quality and innovation for UK consumers. We consider this could result in significant consumer detriment.

- 6.23 Our analysis suggests that, if there are at least four credible national wholesale competitors, the risk of limited competition is significantly reduced. We consider that a five competitor market (or more) may be more competitive still. However we are not aware of any stakeholder interest in entering the market as a fifth national wholesaler.
- 6.24 The following have informed our assessment of how the intensity of competition may vary with the number of national wholesale competitors.
- Regulatory decisions in mobile markets in other countries.
 - Ofcom's decisions in relevant fixed telecoms markets.
 - The EC's analysis of the T-Mobile Orange merger.
 - Relevant academic research.
- 6.25 Experience in other EU mobile markets suggests that there is a risk that competition will not be effective if there were three or fewer credible national wholesale competitors, though it does not suggest that competition concerns would arise in every market where this is the case. We consider the evidence from the mobile sector in other EU countries is particularly relevant because it is specific to the mobile sector.
- In some EU mobile markets where there were three national wholesale competitors, regulators either found joint dominance or reached an initial view that anti-competitive behaviour was present, particularly in terms of refusal to supply wholesale service.⁸⁴
 - In Spain, a market review returned a finding of joint dominance on the then three national wholesalers, citing refusal to supply wholesale access, evidence of retail pricing alignment and very limited pass through of cost reductions to consumers. The regulator felt it necessary to impose a wholesale access obligation on the three incumbents.
 - In France in 2005, investigations were launched into possible abuse of dominance and collusive practices. These were not concluded and the authorities focused on promoting market entry by re-awarding the 3G licence, unsold in 2002, and reserving it specifically for a new entrant. The incumbents had to relinquish some 900MHz spectrum to the new entrant (Free Mobile) and a licence was granted in January 2010.

⁸⁴ SMP on individual operators was found in Cyprus and Slovenia, but this related to the position of the historic monopoly operator so it does not address the same issue we are considering. In nine EU markets with three wholesalers, there have not been conclusive findings of competition concerns. The cases are heterogeneous; In some of the nine competition is judged to be strong and there may be healthy MVNO competition, e.g. Belgium. In other markets either investigations have been launched with no conclusion yet, e.g. Portugal.

- In Italy, three incumbents were investigated in 2007 for abuse of collective dominance, with the regulator deciding against further action after the subsequent conclusion of several wholesale access agreements for MVNOs⁸⁵.
- Concerns were also raised in Poland in 2006. A market review finding a lack of effective competition in the access market and designating the three incumbents as having a joint SMP position reached the draft stage. The regulator also considered imposing an access condition, though, ultimately, no action was taken.
- The treatment of mergers in EU mobile markets over the last decade also suggests that there may be concerns in mobile markets with only three credible competitors, although concerns do not arise in every case because the structure and dynamics of the markets in question are also important.
 - In the pan-Nordic Telia / Sonera (fixed and mobile) merger in 2002, the parties had to offer commitments for the merger to be approved. In Finland, it would have led to three competitors after the merger, and MVNO activity at the time was limited. The combined business had to commit to: divest Telia's retail business in Finland; provide national roaming if the purchaser did not have a GSM network; and separate legally its mobile (and fixed) network business from its retail business for the merger to proceed⁸⁶.
 - The T-Mobile Austria / Tele.ring merger in 2004, could be seen as a four to three merger in terms of credible competitors (since the smallest operator had not then reached scale⁸⁷). MVNO presence was also limited. Commitments on competitors' access to the combined entities' sites needed to be given, for the merger to proceed⁸⁸.
 - In contrast, in the T-Mobile / Orange merger in Netherlands in 2007⁸⁹, no competition concerns were raised for this four to three competitor merger, partly because MVNOs had captured a significant retail market share – 17%.
 - Also, the merger of TIM Hellas and Q-Telecom in Greece in 2005, was judged to not impede competition as the two operators were the smallest two in the Greek market and would remain the smallest after the merger.⁹⁰

6.26 We consider that experience in fixed telecoms markets, though different to mobile markets, can also inform this issue. Ofcom has reviewed a number of relevant markets under the Communications Act, assessing whether any operators have significant market power in a relevant market. They suggest that there may be risks where there are three or fewer credible wholesale competitors. Although this competition assessment is focusing on the promotion of future competition we think these market reviews still provide useful supporting evidence.

⁸⁵ Whilst 3 Italia was also active in the Italian market in 2007, its limited network could have limited its ability to be a credible competitor for national wholesale services.

⁸⁶ http://ec.europa.eu/competition/mergers/cases/decisions/m2803_en.pdf

⁸⁷ A fact that was specifically noted and taken into consideration by the EC in their investigation of the merger.

⁸⁸ http://ec.europa.eu/competition/mergers/cases/decisions/m3916_20060426_20600_en.pdf

⁸⁹ http://ec.europa.eu/competition/mergers/cases/decisions/m4748_20070820_20310_en.pdf

⁹⁰ http://ec.europa.eu/competition/mergers/cases/decisions/m4036_20060113_20310_en.pdf

- 6.27 For example, in our 2008 review of the fixed wholesale broadband access market⁹¹, we found that wholesale access was only likely to be competitive in those local markets or areas where there were four (or more) wholesale operators. Our December 2010 market review⁹² broadly confirms that there are risks to competition with three or fewer credible wholesale operators (actual or forecast). However, it also suggests that the detailed market structure is important and that three competitor markets where the formerly dominant firm, BT's, market share has fallen to below 50% are also effectively competitive.
- 6.28 Our 2008 business connectivity market review⁹³ found a difference in competition in markets with two versus three wholesale competitors. However, this only applied to a small geographic market we defined called the Central and East London Area (CELA) comprising the London congestion charging zone and Docklands. Specific conditions in this market, such as lower barriers to entry than the rest of the UK due to a higher density of consumers, led us to find that no operator had SMP in this market. Hence we do not consider that this review should be taken as a general rule for the relationship between the number of firms and competition.
- 6.29 In approving the merger of T-Mobile and Orange in the UK, the EC considered that the UK national wholesale market was likely to be competitive, given four credible competitors, subject to the commitments given by the merging parties and the specific market conditions in the UK. This suggests that four competitors may be sufficient for effective national wholesale competition in the UK, but does not prove it more generally.
- 6.30 One of the EC's concerns regarding a merger without the commitments related to T-Mobile's RAN sharing agreement with H3G. The EC was concerned that H3G's competitive position could be undermined. It regarded this as potentially significant for the intensity of competition. It said:
- "The possible disappearance of 3UK or the degradation of its competitive position could consequently have a serious impact on the UK retail mobile communication market and would mean that the merger could in a worst case scenario lead to a concentration from 5 to 3 players"
- 6.31 This suggests that the EC considered that only three national wholesalers in UK mobile markets would be a source of concern.
- 6.32 Academic research is a useful supplement to the above evidence. We must interpret it carefully however, because research based on markets with certain characteristics may not translate directly to those with different characteristics.
- Research on the impact of mergers on competition, e.g. by Coates⁹⁴ supports our view that markets with fewer competitors may be less competitive and finds that generally, market with three competitors have been seen by the US Competition Authority as carrying a more significant risk to competition than markets with four competitors.

⁹¹ <http://stakeholders.ofcom.org.uk/binaries/consultations/wbamr07/statement/statement.pdf>

⁹² <http://stakeholders.ofcom.org.uk/binaries/consultations/wba/statement/wbastatement.pdf>

⁹³ <http://stakeholders.ofcom.org.uk/binaries/consultations/bcmr08/summary/bcmr08.pdf>

⁹⁴ Counting Rivals or Measuring Share: Modelling Unilateral Effects for Merger Analysis, December 2010, <http://ssrn.com/abstract=1722846>

- More theoretical research, such as Selten⁹⁵ and Philips⁹⁶, also supports our view that as the number of firms in a market falls, there is a critical threshold below which markets are not competitive. They both find a threshold of five, but this depends heavily on their modelling assumptions and may not be directly transferrable to mobile broadband.

Efficiency

6.33 We consider the impact of measures to ensure a minimum number of national wholesalers on efficiency under the following headings:

- efficient use of the spectrum;
- spectrum fragmentation;
- economies of scale in networks; and
- efficient investment and innovation.

Efficient use of the spectrum

6.34 If we put in place measures in the combined award to promote competition, some companies that acquire spectrum may not otherwise have done so. There is a risk that the reason those companies would not otherwise have acquired spectrum is because they will not use it as efficiently as those who would have bought it.

6.35 For example, it might be bought by a company that will struggle to be effective as a national wholesaler because it will not be effective at providing services consumers want. There is a subsidiary risk that such a company will look to Ofcom for ongoing regulatory measures to assist it. Any such assistance could be counterproductive. It could induce inefficient bidding in the combined award. After the combined award, any on-going assistance could undermine normal competitive dynamics (including changes in management or mergers) that are likely to work in consumers' interests. We consider that we can mitigate this subsidiary risk by making clear in advance that the measures we are proposing to put in place in the combined award are one-off structural interventions. In particular, we do not envisage providing any on-going assistance in the event that any companies winning spectrum are commercially weak. However, this does not remove the underlying risk that a company that wins spectrum may not use it efficiently.

6.36 Another example of a possible inefficient use might be that the spectrum is won by a company that does not attempt to become a national wholesaler. For example it might be acquired by a company that only wishes to use the spectrum for mobile services in particular locations.

6.37 We consider that the risks of inefficient use are higher, the higher the minimum number of competitors we try to ensure. We do not currently have clear evidence of interest from stakeholders in becoming a fifth national wholesaler. This may suggest that the risk of inefficient use could be significant if we tried to ensure at least five compared to trying to ensure at least four.

⁹⁵ A Simple Model of Imperfect Competition where 4 are Few and 6 are Many, International Journal of Game Theory (1973)

⁹⁶ Competition Policy: A Game-theoretic Perspective (1995)

- 6.38 However, it is important to stress that if the number of national wholesalers is greater than it would otherwise have been as a result of our measures, this is not necessarily inefficient. The reason a small number of national wholesalers may emerge from a combined award without measures to promote competition may be due to that small number of national wholesalers having an incentive to pay more for the spectrum in order to restrict competition, by restricting the number of national wholesalers having credible spectrum portfolios. In this case, putting in place measures to ensure a minimum number of national wholesalers that is in fact greater than might otherwise have resulted, would be likely to *increase* efficiency.
- 6.39 Also, the risk of inefficiency is far less relevant if the number of national wholesalers would have emerged even without measures in the combined award to promote competition.

Spectrum fragmentation

- 6.40 As regards the risk of inefficiently fragmenting the spectrum, our main concern is over the likelihood that each competitor can enjoy the benefits of holding large blocks of contiguous spectrum. In particular a 2x20MHz contiguous block allows LTE technology to deliver maximum end-user speeds (which is only one key measures of quality alongside coverage and capacity). For higher frequency, above 1GHz, spectrum we think that there is unlikely to be a problem because the large amount of spectrum available greatly increases the chances that every national wholesaler could get a sufficient amount of spectrum regardless of whether there were three, four or five competitors.
- 6.41 However, for sub 1GHz spectrum there is only around 2x65MHz of spectrum available, and some of that is only likely to be used for LTE in the longer term. Hence, with four or five competitors, the likelihood of competitors obtaining 2x20MHz of *contiguous* sub 1GHz spectrum is much lower than compared with three.
- 6.42 We nevertheless consider that there is still some risk of losing some of the benefits of contiguous spectrum that can be obtained by LTE if we put in place measures in the combined award to ensure a minimum number of competitors. This risk is greater the higher that number is.
- 6.43 To some extent this risk may be mitigated by using small amounts of sub 1GHz spectrum with higher frequencies. Our technical research shows (see Annex 7) that it may be possible for a national wholesaler to largely match the benefits of a 2x20MHz block of contiguous sub 1GHz spectrum with a combination of a smaller block of sub 1GHz spectrum and 2x15MHz or 2x20MHz of contiguous higher frequency spectrum.
- 6.44 The risk of inefficient spectrum fragmentation may also be mitigated if spectrum sharing is possible (although this may have an impact on competition if parties sharing spectrum become less independent).

Economies of scale in networks

- 6.45 There are economies of scale in the access network, as evidenced by the network sharing agreements we see currently between Everything Everywhere and H3G and the site sharing agreement between Vodafone and O2. Some market analysts suggest it may be efficient to have very few networks in view of the economies of scale.⁹⁷
- 6.46 There is a risk that measures to ensure more national wholesalers than would emerge without measures might increase the overall fixed costs of the industry, if it resulted in more networks.
- 6.47 However, while we would not prejudge how many networks are efficient, we consider that network sharing could allow three, four and possibly five wholesale providers to operate a smaller number of networks (perhaps two or three) effectively. If this were possible, it may mitigate or eliminate the risk of higher overall fixed costs. However, negotiating a network sharing agreement is a complex process, and such agreements only normally involve two wholesalers. There may be an upper limit on how many wholesalers can effectively share one network. Any agreement would have to be considered on its merits at the time as detailed in section 55.38 above.

Efficient investment and innovation

- 6.48 We consider that there is little compelling evidence that differences in the number of national wholesale competitors (between three, four and five) would have a significant difference on investment incentives.
- 6.49 It is possible that competition could increase investment. Even if it does not increase investment, we consider that there is evidence suggesting that competition is unlikely to lead to lower investment:
- In our mobile sector assessment⁹⁸ we found that levels of investment in the UK mobile sector have been comparable to those in other European countries, including those where there were fewer credible wholesalers than in the UK (see paragraph 4.27 above).
 - In our research on coverage (not-spots)⁹⁹, we found that UK 3G coverage levels were second only to Italy of the countries compared, exceeding those of several Member States with fewer operators.
 - The launch dates of 3G technologies, both UMTS and its upgrade HSDPA, compare favourably in the UK to other European member states.¹⁰⁰

⁹⁷ For example, "3G-infrastructure sharing: the future for mobile networks" Analysys Mason (2008)

⁹⁸ See section 5 of the July 2009 'Mostly Mobile' consultation
<http://stakeholders.ofcom.org.uk/consultations/msa/>.

⁹⁹ See figure 4 of the November 2010 update on our mobile not spot research at
<http://stakeholders.ofcom.org.uk/market-data-research/telecoms-research/mobile-not-spots/not-spots>

¹⁰⁰ See for example, selected 3G launches <http://www.cet.co.uk/3G%20Licensing%20Final.pdf>;
Government leaflet highlighting H3G's European first with the launch of 3G
(<http://webarchive.nationalarchives.gov.uk/tna/+http://www.dti.gov.uk/bestpractice/assets/3g.pdf/>);
operators launching 3G services in the UK and other countries at very similar times
(http://www.o2.com/media_files/O2_AReport_web_p04-05.pdf,
http://www.o2.com/media/press_releases/press_release_281.asp,

- 6.50 Academic and empirical research¹⁰¹ also supports the view that greater sustainable competition could lead to increased investment and innovation, although these findings are not conclusive.

Provisional conclusions on efficiency

- 6.51 We consider that if more companies win spectrum as a result of measures we put in place in the combined award there is a risk of some inefficiency. We consider that this risk may be significantly higher if we were to try to ensure five national wholesalers compared to if we tried to ensure four national wholesalers.

Broader social value

- 6.52 The main way that national wholesalers might contribute to promoting broader social value would be through providing widespread coverage to mobile broadband services.
- 6.53 It is possible that a larger number of national wholesale competitors may improve coverage. Competitive intensity is likely to be higher with a larger number of national wholesale competitors. Increased competitive intensity may mean that national wholesalers compete to provide the best coverage, tending to improve coverage.
- 6.54 However, this is not certain. This is partly because there are fixed costs involved in networks, and this might tend to reduce coverage when there are more competitors. But if network sharing is possible, it may be possible for national wholesalers to share networks, at least in some areas.
- 6.55 We discuss the arguments for imposing a coverage obligation on some spectrum licences in section 6 of the main consultation. We believe that we can consider the case for coverage obligations independently of whether we should take measures to ensure a minimum number of national wholesalers.

Summary and provisional conclusion

- 6.56 Figure 6.1 below summarises our assessment of the three options.

http://www1.orange.co.uk/documents/about/3g_press_release.pdf, http://online.vodafone.co.uk/dispatch/Portal/appmanager/vodafone/wrp?nfpb=true&pageLabel=template09&pageID=PAV_0015&tabIndex=1, <http://www.t-mobile.co.uk/business/services/about-t-mobile/our-company/milestones/>) or the GSA's report on timing of launches worldwide which show that the UK has been at the forefront of developments (<http://www.gsacom.com/news/statistics.php4>).

¹⁰¹ See for example P. Aghion et al. "Competition and Innovation: An Inverted-U Relationship", Quarterly Journal of Economics, May 2005, Vol. 120, No. 2, Pages 701-728.

Figure 6.1 Summary of assessment of the minimum number of credible wholesale competitors

	Measures to ensure a minimum of three wholesale competitors	Measures to ensure a minimum of four wholesale competitors	Measure to ensure a minimum of five wholesale competitors
Competition	Material risk of limited competitive intensity	Little evidence of a risk to competitive intensity	Likely to be even more competitive than with four
Efficiency	Good. Risks of inefficient use, fragmenting spectrum and increasing overall fixed costs are low	Fairly good. Compared to three, greater risks of inefficient use of spectrum, fragmenting spectrum and increasing overall fixed costs than with three operators. The risk of increasing overall fixed costs may be mitigated through network sharing	More significant risk of inefficient use of spectrum, spectrum fragmentation and increasing overall fixed costs. Network economies of scale may be more difficult to achieve
Broader social value	Uncertain. Lower competitive intensity from only three national wholesalers may reduce coverage, but this is far from certain	Uncertain. Increased competitive intensity compared to three national wholesalers may improve coverage, but this is far from certain	Uncertain. Even higher competitive intensity than four national wholesalers may improve coverage further, but this is far from certain
Initial conclusion	May not be in the best interests of consumers and citizens because of the material risk to competition, which could potentially lead to material consumer detriment.	Likely to be good for consumers and citizens	Has advantages but greater risk to efficiency and commercial interest in a fifth national competitor is unclear

6.57 In light of the above considerations, we propose putting in place measures to ensure a minimum number of credible national wholesale competitors after the combined award.

6.58 We provisionally consider that those measures should aim to ensure at least four competitors are capable of being credible national wholesalers. We consider that taking measures to ensure at least four national wholesale competitors is unlikely to involve a large risk to efficiency, particularly in comparison to the competition benefits they may bring. We consider there may be a beneficial effect from ensuring at least four on broader social value, but that this is not certain.

6.59 With measures to ensure at least three national wholesalers, the risks to efficiency are lower, but we do not think they outweigh the potential downsides to competition.

6.60 With measures to ensure at least five national wholesalers, we consider that there could be greater benefits to consumers and citizens through increased competitive intensity. However, the potential incremental competition benefits from having five

competitors rather than four are likely to be less than the benefits from having four rather than three.¹⁰² We also consider that the potential benefits are unlikely to outweigh the increased risks to efficiency from measures to ensure at least five national wholesalers. We consider these risks are significantly greater than for measures to ensure at least four. This is partly because we do not currently have clear evidence of interest from stakeholders in becoming a fifth national wholesaler.

- 6.61 We consider that we may be able to mitigate the risk of inefficiency from ensuring at least four national wholesalers to some extent by having higher reserve prices. We discuss this in section 8 of the main consultation.
- 6.62 We also consider that there is another reason for favouring measures to ensure at least four rather than at least three. It is likely to be easier in the future for the number of national wholesalers to go down, rather than up.
- While we believe it unlikely, it could transpire in the future that three credible national wholesalers brings greater benefits to consumers and citizens than four. This could be the case if, for example, we have underestimated the benefits of contiguous spectrum and if spectrum sharing proves difficult in practice. In this case, consolidation in the market could occur in the future, subject to competition law.
 - On the other hand, if only three credible national wholesalers emerged following the combined award, it would be hard to increase the number of national wholesalers in the future if it transpired that competitive intensity was weak with only three and there were not strong efficiency benefits from only having three. While it may be possible to use ex post competition powers to do that, it is likely to take considerable time and be very disruptive. During this period, the benefits foregone, though greater competition, could be substantial. In contrast, market consolidation is arguably faster and less disruptive.
- 6.63 We therefore consider that the risk of regulatory failure is lower with the promotion of at least four national wholesalers compared to at least three.
- 6.64 This argument about asymmetric risk may also suggest going further and taking measures to ensure at least five rather than at least four. However, for the reasons set out earlier, we do not consider the case for at least five is strong overall.
- 6.65 We make no assumptions about the identity of the competitors concerned. They could be the four existing national wholesalers or a combination of some of them and new entrants.
- 6.66 It is also important to note that if we were to put in place measures to ensure 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.

¹⁰² Our analysis set out earlier suggests that if there are four credible national wholesale competitors, the risk of limited competition is significantly reduced compared to if there are three. While there are likely to be some additional benefits from five compared to four, we consider that the incremental benefits are likely to be lower. This is consistent with most economic models that generally suggest a reduction in the incremental benefit of an additional competitor the more competitors there are.

Possible measures to promote national wholesale competition

- 6.67 Next we consider what specific measures could be taken to ensure that there are at least four competitors capable of being credible national wholesale competitors. However, we discuss detailed auction rules for such measures in section 9 of the main consultation.
- 6.68 As we provisionally concluded in section 55 above, for national wholesalers to be credible competitors in terms of providing higher quality data services, we consider they are likely to need to have a spectrum portfolio that includes:
- a reasonable overall portfolio of spectrum suitable for LTE that allows them to offer higher quality data services and is of sufficient size for them to be able to cover the fixed costs of being a national wholesaler; and
 - in particular, we consider that a national wholesaler is likely to need to have some sub 1GHz in order to be able to credibly offer higher quality data services, particularly indoors.
- 6.69 In the next section we consider what type of measures we could put in place in the combined award to ensure that at least four national wholesalers hold at least a minimum portfolio of spectrum necessary to be a credible national wholesaler, before setting out our assessment of the specific options that we think may achieve this.

Options for implementing proposed measures to ensure at least 4 holders with a minimum spectrum portfolio

- 6.70 The basic tools we have in combined award are as follows:
- Spectrum caps – we could set caps on the amount of spectrum that bidders could hold following the combined award in relation to sub 1GHz and other spectrum. So, if there were a specific sub 1GHz cap for example, bidders would be able to buy in the auction an amount of 800MHz spectrum equal to the cap minus any 900MHz spectrum it held going into the auction. Variants of this type of restriction have been used in some recent awards, e.g. the German 800MHz auction.
 - Spectrum floors – we could set a restriction on the outcome of the auction such that only those outcomes where at least four competitors held a minimum portfolio of spectrum were acceptable outcomes (we would pre-specify the minimum portfolios). Hence, we would reject any set of bids that would result in only three or fewer competitors holding (at least) one of the pre-specified minimum portfolios.¹⁰³
 - Safeguard cap – this would only be used in combination with a spectrum floor. If we put in place a spectrum floor, it is still possible that the distribution of spectrum after the auction could be very asymmetric, because the floor would not limit the maximum amount of spectrum that could be held (once minimum requirements were satisfied). Although a spectrum floor could be sufficient to address currently predictable risks to competition, we could not rule out risks to future competition

¹⁰³ If this condition could not be satisfied, e.g. in the unlikely event of there being only three competitors in the auction, we would adjust the spectrum floor to recognise that only three competitors could meet the condition. We would not keep back any spectrum for re-award to a future 4th competitor.

because future market and technology developments are uncertain. Hence a safeguard cap would aim to prevent very asymmetric outcomes and could be proportionate if it could do so without imposing substantial costs.

The choice between spectrum caps and spectrum floors

- 6.71 We think a spectrum floor and safeguard cap is likely to be a better option than a spectrum cap. This is because a spectrum cap is likely to impose greater costs because it would go beyond the minimum that we consider to be necessary for competition. It would place more restrictions on what competitors could acquire in the auction than a spectrum floor.
- 6.72 For example, in order to ensure, through a spectrum cap, that at least four competitors hold sub 1GHz spectrum, we would need to set a cap of 2x20MHz (or lower), because:
- Any higher cap, e.g. 2x22.5MHz, would not ensure that at least four competitors held sub 1GHz spectrum – given that Vodafone and O2 each hold already 2x17.5MHz of 900MHz spectrum and that there is 2x30MHz of 800MHz spectrum¹⁰⁴.
- 6.73 A sub 1GHz cap could, therefore, limit the ability of Vodafone and O2 to acquire sub 1GHz spectrum, beyond what was needed to promote competition (to ensure at least four players with enough sub 1GHz spectrum in their portfolio to be credible national wholesalers) – if, for example, either 2x5 or 2x10MHz of sub 1GHz spectrum was necessary¹⁰⁵. A floor would impose fewer restrictions on what competitors could buy in the auction as it only ensures that at least four players have the minimum amount of spectrum needed to compete. A floor is better targeted on the desired outcome and hence the adverse impact of a cap on efficiency is likely to be greater than that of a spectrum floor.
- 6.74 We recognise that it may be efficient for firms to acquire more than the minimum spectrum portfolio, but the floor would not prevent this as our objective in setting the floors would be not to specify what a desirable spectrum portfolio would be but rather to identify the minimum amount that would be required to allow a wholesale operator to be credible, either as a standalone business or as a partner in a network sharing or other similar arrangement. Provided all national wholesalers hold sufficient spectrum to be financially viable, it may even help competitive intensity to have a range of different cost structures, as discussed in paragraph 6.86.8 above.
- 6.75 As a result, we consider that a spectrum floor approach is likely to be more proportionate than a spectrum cap approach. Any concerns of the impact of very asymmetric outcomes on future competition could be dealt with through an additional safeguard cap. We discuss options for how spectrum floors can be implemented in the auction design in section 9 of the main consultation.

¹⁰⁴ Vodafone and O2 could each acquire 2x5MHz of 800MHz spectrum in addition to their 900MHz spectrum, and another player could acquire all the remaining 2x20MHz of 800MHz spectrum, which would result in only three players holding sub 1GHz spectrum.

¹⁰⁵ It could also impose other costs because Vodafone and O2 may not be able to acquire any 800MHz spectrum in the auction without relinquishing some 900MHz spectrum. This also has a cost.

Minimum spectrum portfolio necessary to be a credible national wholesaler

6.76 In this section, we assess the minimum portfolios of spectrum that may be necessary to be a credible national wholesaler, and discuss two alternative sets of minimum portfolios.

6.77 Figure 6.2 below presents the two alternative sets of minimum spectrum portfolios that we consider could be necessary to be a credible national wholesaler.

Figure 6.2

SPECTRUM FLOORS THAT SPECIFY A MINIMUM SPECTRUM PORTFOLIO									
OPTION 1				OPTION 2					
<i>Each wholesaler must hold one of the following (or more):</i>				<i>Each wholesaler must hold one of the following (or more):</i>					
	800MHz/ 900MHz	1800MHz	2.6GHz	Total		800MHz/9 00MHz	1800MHz	2.6GHz	Total
a)	2x5MHz	2x15MHz		2x20 MHz	a)	2x10MHz	2x15MHz		2x25MHz
b)	2x5MHz		2x20 MHz	2x25 MHz	b)	2x10MHz		2x20MHz	2x30MHz
c)	2x10MHz	2x10MHz		2x20 MHz	c)	2x15MHz	2x10MHz		2x25MHz
d)	2x10MHz		2x15 MHz	2x25 MHz	d)	2x15MHz		2x15MHz	2x30MHz
e)	2x15MHz			2x15MHz	e)	2x20MHz			2x20MHz

6.78 We have attempted to define these minimum spectrum portfolios by assessing what combinations of spectrum could match the quality that may be provided by an operator with a larger holding of sub 1 GHz spectrum, while still providing a reasonable level of capacity.

6.79 As in Section 55, we consider three metrics of performance:

- Coverage – the proportion of the population within an area to which it is technically possible to deliver a service indoors with a particular downlink speed (if all the resources of the serving cell were dedicated to a single customer), as a function of the number of network sites (and in some cases the loading on the network);
- Speed – for a given number of sites and network loading, the proportion of the population within an area to which it is possible to deliver a particular downlink data-rate (if all the resources of the serving cell were dedicated to a single customer);
- Capacity – for a given downlink speed and network loading, the number of sites needed to provide enough capacity to simultaneously serve a certain proportion of the population within an area with the given downlink speed.

- 6.80 We have assessed portfolios of spectrum against the coverage and speed that a network using 2x20MHz of sub 1GHz with a loading of around 85%. We consider that this is a reasonable benchmark because low frequency spectrum has the best signal propagation and because 2x20MHz of contiguous spectrum is the maximum size of block in which LTE operates.
- 6.81 It is not clear that a national wholesaler needs to achieve the same capacity as 2x20MHz of sub 1GHz. This is because we do not consider that competitors need to have the same capacity in order to be able to compete. Rather they need to have enough capacity to be a competitive constraint¹⁰⁶ on other competitors in the market and to be able to serve a large enough customer base to cover fixed network costs.
- 6.82 We do not consider that it is necessarily essential to completely match the technical performance of a 2x20MHz carrier of sub 1GHz spectrum on speed and coverage in order to match from the point of view of the impact on competition. But speed and coverage need to be sufficiently similar. How close this is would depend on how consumers value the differences in technical quality.

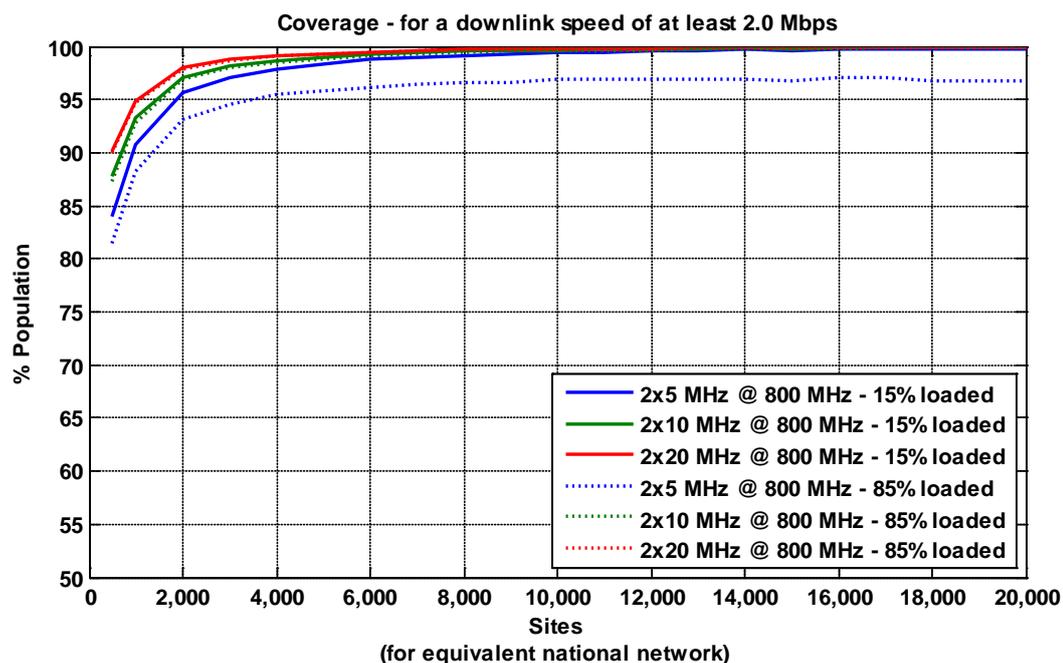
Ability to compete with 2x20MHz of sub 1GHz by combining sub-1GHz spectrum with higher frequency spectrum

Technical matching

- 6.83 We have considered the technical aspect of these questions in Annex 7 and only summarise some of the technical results below. See Annex 7 for a fuller description of results. In these technical results we modelled 800MHz as the sub 1GHz frequency, but we consider the results would be very similar if we had modelled 900MHz.
- 6.84 As shown in Figure 6.3, for a guaranteed downlink data rate of 2Mbps or less, there is very little difference in the coverage provided by a network with 2x5MHz, 2x10MHz or 2x20MHz of 800MHz spectrum, especially when the 2x5MHz is lightly loaded.

¹⁰⁶ Currently in EU mobile markets there are effective competitors with materially lower market shares than average.

Figure 6.3



6.85 In Annex 7 we show that even for a downlink data rate of 4Mbps the difference in coverage is quite small provided that the 800MHz layer of the multi-frequency networks is only lightly loaded. It is only when we look at higher guaranteed downlink data rates, such as 8Mbps, that we start to see a significant difference in coverage between the networks, irrespective of the network loading, with the network having only 2x5MHz of 800MHz spectrum struggling to provide this sort of speed to much more than 80% of the population irrespective of loading.¹⁰⁷

6.86 Moving on to consider maximum speed (single-user throughput), we find that a network layer of lightly loaded higher frequency combined with a lightly loaded lower frequency can broadly match what a national wholesaler with 2x20MHz of 800MHz spectrum could achieve. This is through the combination of the higher frequency spectrum and the lower frequency spectrum in a 'doughnut' arrangement.¹⁰⁸

6.87 Here we consider two multi-frequency networks:

- 2x5MHz of 800MHz and 2x15MHz of 1800MHz,
- 2x10MHz of 800MHz and 2x15MHz of 1800MHz.

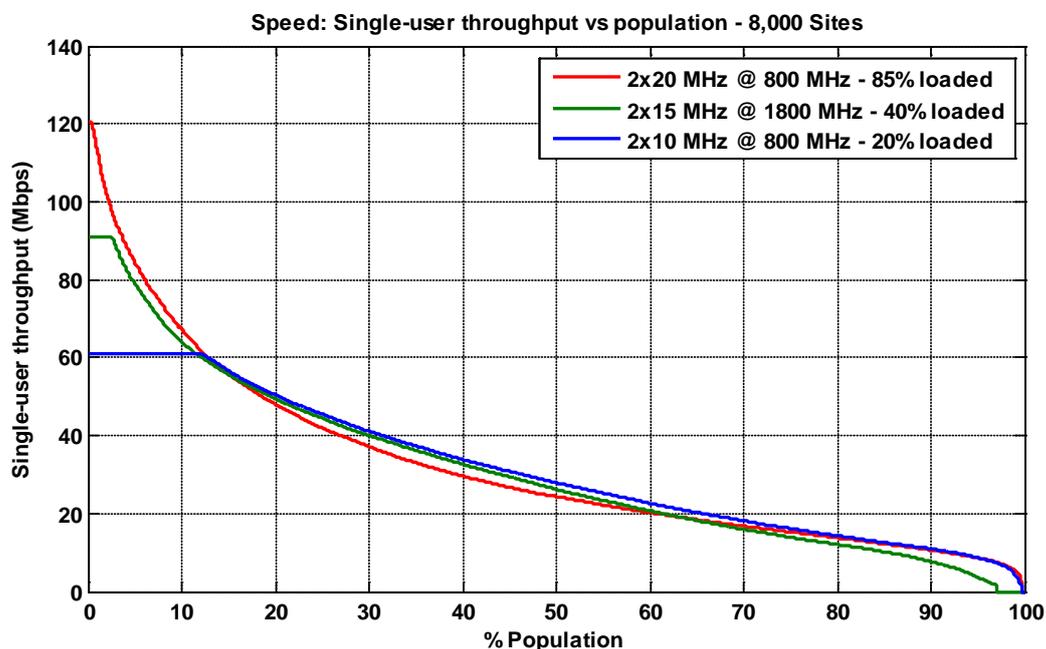
6.88 Figure 6.4 shows that combining the use of 1800MHz spectrum and 800MHz spectrum is predicted to allow a national wholesaler with 2x10MHz of 800MHz spectrum plus 2x15MHz of 1800MHz spectrum to pretty well match the speed that a

¹⁰⁷ We note that the model is looking at indoor coverage; outdoor coverage should be significantly better than this.

¹⁰⁸ Using the larger bandwidth of higher frequency spectrum to serve customers near the centre of each cell and the smaller bandwidth of lower frequency spectrum to serve customers nearer the edge of each cell.

national wholesaler with 2x20MHz of 800MHz spectrum can provide over almost the entire area, if the 800/1800MHz multi-frequency network is more lightly loaded.¹⁰⁹

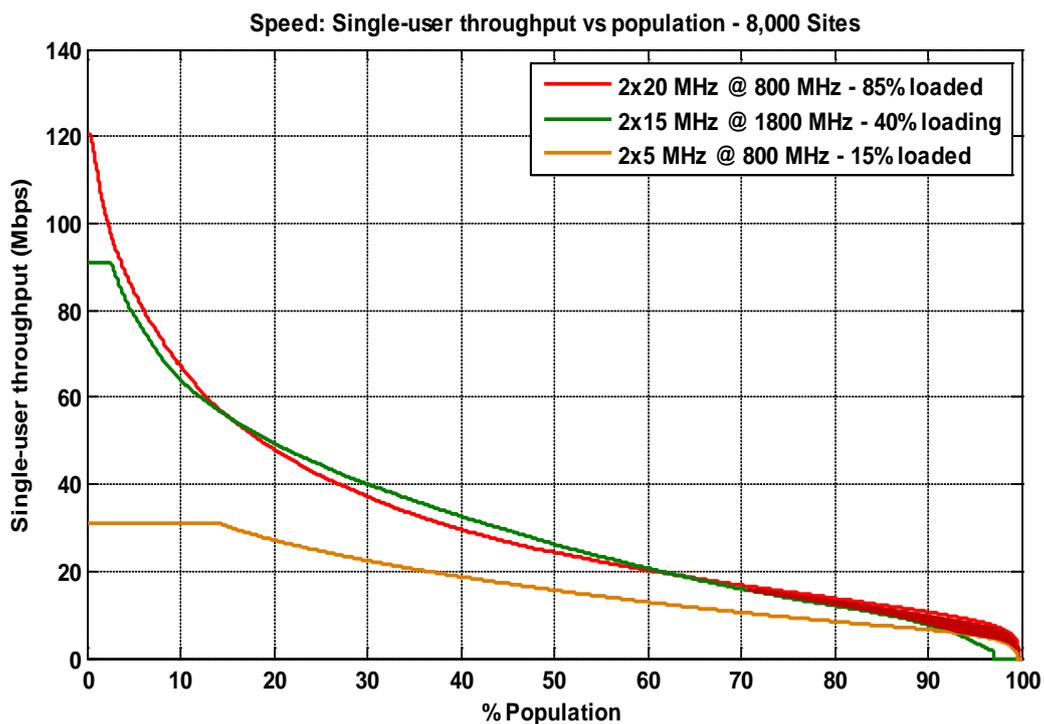
Figure 6.4



- 6.89 In the case of a network with only 2x5MHz of 800MHz spectrum, even if lightly loaded, there remains some gap in the maximum speed that the network can deliver to customers at the edge of coverage, but the network can, none the less, deliver a service with a reasonable downlink data rate to almost the same set of customers as the network with 2x20MHz of 800MHz spectrum. When combined with 2x15MHz of 1800MHz, it is predicted to give near comparable maximum speeds to most customers, but with some drop off in speed at the very edge of coverage (shown in dark red in Figure 6.5 below).

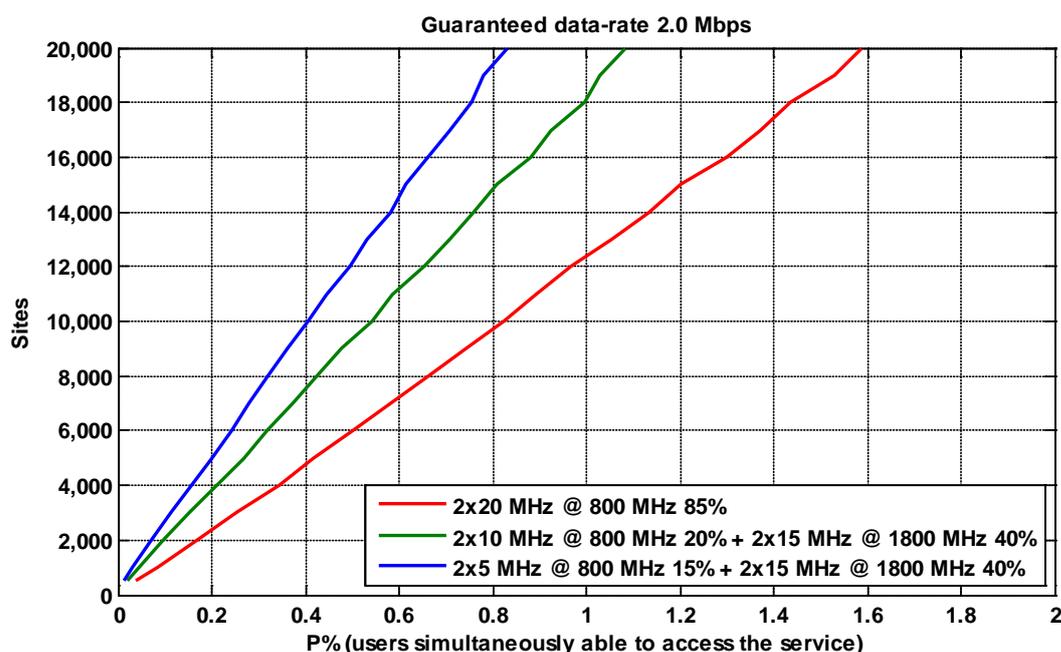
¹⁰⁹ The performance of the multi-frequency network should be read as the envelope of the curves for 2x10MHz @ 800MHz and 2x15MHz @ 1800MHz

Figure 6.5



6.90 Looking at the capacity of these different networks we see that, unsurprisingly, the 2x20MHz 800MHz network operating at 85% loading has a rather higher capacity (ability to simultaneously serve customers for a given number of sites) than do either of the two multi-frequency networks we are showing results for here. National wholesalers of such multi-frequency networks would therefore be more constrained in their ability to simultaneously serve large numbers of customers if the modelled spectrum was all that they had available to them, and they were to operate with a similar number of sites as any national wholesaler with 2x20MHz of sub-1GHz spectrum.

Figure 6.6



- 6.91 In summary therefore, multi-frequency networks with a limited amount of sub-1GHz spectrum and also a limited amount of above-1GHz spectrum can go a long way towards matching the coverage and maximum speed deliverable by a network with only sub-1GHz spectrum using the same number of sites, provided that the multi-frequency networks are not loaded to the same extent as the sub-1GHz only network. This requirement for lighter loading does however mean that, all other things being equal, such multi-frequency networks may not be able to serve the same number of customers as a sub-1GHz only network with a similar amount of spectrum.
- 6.92 In Annex 7 we also explore the option of combining of 800MHz with 2.6GHz spectrum. We find similar results as for 1800MHz spectrum, except more 2.6GHz spectrum (i.e. 2x20MHz) would be required to allow the multi-frequency network with only 2x5MHz or 2x10MHz of 800MHz to match the coverage and speed of a network of 2x20MHz of 800MHz.

Competitive matching

- 6.93 Whether a national wholesaler with only 2x5MHz of 800MHz spectrum (together with higher frequencies) would be at a material competitive disadvantage (relative to a national wholesaler with 2x20MHz of 800MHz) would depend on whether consumers placed a high value on the differences in speed at the edge of coverage.
- 6.94 We have considered two options, as set out in Figure 6.2 above. In Option 2, the minimum sub 1GHz holding is 2x10MHz and the technical matching is very close. We therefore consider that it should allow competitive matching. In Option 1, the minimum sub 1GHz holding is 2x5MHz, and the technical matching is not as close, but may be close enough for a national wholesaler with one of these spectrum portfolios not to be at a competitive disadvantage compared to a national wholesaler with 2x20MHz of 800MHz.

- 6.95 We recognise that the minimum spectrum portfolios in Option 2 would lead the sub 1GHz floor to account for a substantial proportion of the 800MHz spectrum and significantly larger than in Option 1. The bidding in the auction would therefore have materially less influence over the auction outcome and regulation would have a greater influence. The risk of regulatory failure would therefore be lower with Option 1. We are therefore minded to favour Option 1. This is however a matter on which we are particularly keen to receive views and evidence from stakeholders in response to this consultation.
- 6.96 We recognise that the capacity that could be provided by some of the multi-frequency portfolios may be less than could be provided with, for example, 2x20MHz of sub 1GHz, assuming the same number of sites. However, with access to more spectrum than the minimum we have modelled or if it were feasible to operate with a larger number of sites than a competitor with 2x20MHz of sub 1GHz spectrum or use of technologies such femtocells and WiFi to off load data from macro cell networks, then the capacity of the multi-frequency network could be increased.
- 6.97 We do not consider it is necessary for all national wholesalers to have the same capacity in order for there to be effective competition. Rather, all national wholesalers need to have sufficient spectrum to be able to serve a large enough customer base for them to provide a competitive constraint.
- 6.98 As discussed in section 8 of the main consultation, some of the obligations and restrictions that are likely to apply to some parts of the 800MHz band may be relatively material. As a result, it could be risky to consider that these parts of the band are suitable to support a credible national wholesale competitor. We therefore anticipate that some blocks in the 800MHz band may not be suitable to count towards the minimum spectrum portfolio for national wholesale competitors.

Bands considered for the minimum portfolios of spectrum

- 6.99 We have not considered 2.1GHz as part of the minimum spectrum portfolios. This is because we consider that it may be difficult to launch an LTE service at 2.1 GHz in the relevant period of time. This band appears less likely to be used for LTE services in Europe than other bands within the timescales of our competition assessment. 2G, 3G and LTE technologies may co-exist for some time and it is not clear whether 2G and 3G services would be a constraint on LTE services in the future. The use of the different bands may depend on the availability of equipment for different technologies, the current technologies deployed, and the ease of migrating the usage of the band from 2G/3G to LTE use. We consider the 2.1GHz band to be the one where there is most uncertainty over whether LTE equipment will be available within the timescales that we are focussing on in this assessment (the five to ten years from the conclusion of the combined award) and the one where it is likely to be most difficult to migrate current usage to LTE.
- 6.100 We have also excluded the unpaired 2.6GHz from counting towards the minimum portfolios of spectrum. This is because of doubts about the availability of a sufficiently large range of user devices using unpaired 2.6GHz (see also section 5 above).

Assessment of specific options for a spectrum floor

- 6.101 In this section, we assess whether it would be appropriate and proportionate to ensure that at least four players hold at least a minimum portfolio (for the two sets of alternatives described above in Figure 6.2) by putting in place spectrum floors.

Risk and magnitude of possible problem without intervention

6.102 If we did not put in place measures to ensure that at least four competitors had a minimum portfolio of spectrum following the combined award, we consider that there would be a material risk that after the award, there would be fewer than this number of competitors. This is because bidders would have incentives to bid strategically in the auction to acquire more spectrum than they otherwise might in order to gain a higher profit from being one of two or three competitors in the market. For the reasons set out above, we consider that if there were less than four credible national wholesalers, there would be a material risk of reduced competitive intensity, to the detriment of consumers.

Potential regulatory failure: failure to achieve outcome

6.103 There is a risk that the minimum portfolios of spectrum that we have proposed turn out to be insufficient for firms to be credible national wholesalers and this risk is greater for the portfolios in Option 1 than Option 2. As a result we may fail to promote competition as much as we intend. There could be implications for efficiency too, because some operators may not be able to provide as high a quality of service as they could with a larger spectrum portfolio.

6.104 This risk is likely to be mitigated by the following:

- First, our proposed measures only specify a minimum spectrum portfolio and competitors will have the opportunity to acquire more than this in the combined award.
- Second, if there were two operators with insufficient spectrum portfolios, it would, subject to trading rules and competition law, be open to them to share spectrum, although sharing itself could reduce the intensity of competition depending on the degree of coordination and cooperation it involved.

Potential regulatory failure: unintended consequences

6.105 There is a linkage between the minimum spectrum portfolios we consider are likely to be needed to be a credible national wholesaler and two other parts of our proposals for promoting competition. Hence there is a risk that, if our analysis on the minimum spectrum portfolios turns out to be inaccurate, our other proposals may not be as effective or may be costlier than we have anticipated.

6.106 First, if more sub 1GHz spectrum were necessary to be a credible competitor than in either of our options, it might not be possible for four competitors to have the minimum portfolio given the scarcity of sub 1GHz spectrum. Hence the potential efficiency losses from ensuring at least four players capable of being credible competitors could be greater than in our current assessment and packages of measures associated with a smaller number of credible competitors could be more proportionate.

6.107 This risk is mitigated by the possibility that spectrum sharing could allow four competitors to have access to the minimum spectrum portfolio in this situation. We also think that the depth of our technical analysis and the fact that other countries, e.g. Germany and Sweden have imposed similar measures in their 800MHz awards also reduce this risk of regulatory failure. For example, the German regulator imposed a cap on sub-1GHz spectrum of around 2x20 MHz whilst Sweden imposed

a cap on 800MHz spectrum of 2x10MHz. Ireland, Switzerland and Spain all propose to have caps on sub 1 GHz spectrum in their forthcoming auctions. The caps vary in different countries between 2x10 MHz to 2x30 MHz (depending partly on whether they apply to all sub 1 GHz or just to 800MHz).

- 6.108 The second linkage is with our discussion of whether to reserve spectrum for sub national RAN operators which are discussed in section 88. If we underestimate the amount of spectrum needed to be a credible national wholesaler, our assessment of whether to reserve above 1GHz spectrum may overstate the case for reserving spectrum particularly because we would have underestimated its opportunity cost.
- 6.109 However, given the options we consider in section 8 for reserving spectrum for new entrants involve relatively small quantities of the total amount of spectrum available, we think that the risk of regulatory failure is likely to be low.

Cost of implementation and/or opportunity cost

- 6.110 An opportunity cost would arise if some firms were willing to pay more for some extra spectrum than someone else was willing to pay for spectrum they actually won in the auction. The opportunity cost may be higher for Option 2 than for Option 1, simply because the amounts of spectrum in the portfolios in Option 2 are larger than those in Option 1 and hence regulation has a greater influence on the outcome. This is part of our reason for preferring Option 1.
- 6.111 We note there is a risk that the optimal amount of spectrum for a firm may be more than either of the sets of minimum spectrum portfolios we have set out. However, spectrum floors allow bidders in the auction to win more spectrum than the minimum. Hence, we consider that the impact on efficiency is relatively limited because we have focused on the minimum needed to achieve our aims, whilst allowing bidders to win more, subject to any spectrum caps that we may put in place.

Provisional conclusions on spectrum floor

- 6.112 It is our provisional view, therefore, that a combined award with no measures to promote competition could lead to a material detriment to national wholesale competition in respect of the possible distribution of spectrum. Further, we consider that measures in the combined award to ensure that at least four competitors hold a minimum portfolio of spectrum needed to be a credible national wholesaler as set out in Figure 6.2 above would be appropriate and proportionate. We are minded to prefer Option 1, for which regulation has a smaller influence over the auction outcome. But we recognise there are arguments to support Option 2 and would welcome stakeholders views in this area.

Avoiding overly concentrated or very asymmetric distributions of spectrum

- 6.113 Although we propose to use a spectrum floor rather than a cap to ensure that there are at least four competitors with sufficient spectrum to be credible national wholesalers, there may be a different role for a cap of another sort – a safeguard cap.
- 6.114 Safeguard caps could be used to guard against longer terms risks to competition from very asymmetric holdings of spectrum. While we do not think that spectrum needs to be held equally for there to be effective competition or equality of

opportunity to compete, we do think that there could be a risk if some national wholesalers held a very large share of mobile spectrum.

- 6.115 While it is difficult to speculate about future possible developments, we consider it is possible that in the longer term there could be technological (e.g. beyond LTE) or market developments that meant that very asymmetric holdings of spectrum represented a risk to competition, especially for sub 1GHz spectrum. For example, if there were very unequal holdings of spectrum it might be easier for those with relatively large spectrum holdings to refarm that spectrum to use for a future technology that may replace LTE. Because we are concerned about the implications from possible future developments, the justification for safeguard caps does not relate directly to our technical analysis of LTE.
- 6.116 The safeguard caps we propose still allow significant spectrum holdings, which are unlikely to preclude national wholesalers from obtaining efficient spectrum portfolios. Therefore, whilst the benefits of the safeguard caps are uncertain, the costs are likely to be relatively small.

Proposals for a sub 1GHz spectrum safeguard cap

6.117 The options we consider are:

- Having no cap;
- A safeguard cap of 2x27.5MHz; and
- A safeguard cap of 2x22.5MHz.

- 6.118 If we put in place no safeguard cap, we consider that there would be a risk (of uncertain size and likelihood at the moment) that competitive intensity in the future might be lower than it could be. Although we may be able to address this using our other competition powers, we consider that the potential regulatory failures of such an approach are likely to be more significant than imposing a safeguard cap now. This is because using our other powers, including ex post competition law powers, is likely to take considerable time and be very disruptive. During this period, the benefits foregone, though greater competition, could be substantial.
- 6.119 We consider that a safeguard cap of 2x22.5MHz may impose significant costs because it could significantly constrain some competitors' ability to acquire sub 1GHz spectrum and hence limit the optimal use of the spectrum. For example, a cap of 2x25MHz could mean that Vodafone and O2 (if they were to participate in the combined award) could only win 2x5MHz of 800MHz spectrum. If it were more efficient to have a 2x10MHz channel of sub 1GHz, their only option would be to consider spectrum sharing or to re-farming part of their 900Mhz holdings, which they may prefer to use for other services.
- 6.120 A safeguard cap of 2x27.5MHz would prevent any one bidder from winning all of the 800MHz spectrum. We think that the cost of this option is likely to be relatively low as it places fewer restriction on the ability to acquire spectrum than the other option (although some firms could still be restricted). For example, Vodafone and O2, if they participate in the auction, would be able to bid for up to 2x10MHz of 800MHz spectrum in addition to their 900MHz spectrum.

- 6.121 Another desirable feature of a safeguard cap of 2x27.5MHz of sub 1GHz spectrum is that it gives broadly equal opportunity to all existing and potential national wholesalers in terms of the amount of sub 1GHz spectrum they could hold following the combined award. In particular, for the set of spectrum floor portfolios we are minded to favour, it would be possible for there to be four national wholesalers and still be possible for any company that does not currently satisfy the floor to win 2x25MHz of 800MHz. This would only be slightly less than the maximum sub 1GHz spectrum that Vodafone and O2 could hold following the combined award.
- 6.122 On balance, our provisional view is that a safeguard cap of 2x27.5MHz of sub 1GHz spectrum is likely to be the best option. It strikes an appropriate balance between not unduly limiting the spectrum that firms could reasonably hold and limiting the asymmetry of the sub 1GHz holdings after the combined award.¹¹⁰
- 6.123 We do not propose to allow any relinquishment in the combined award. This is partly to avoid auction complexity and partly because we consider our safeguard caps are set at a relatively high level. See Section 8 of the main consultation for more details on relinquishment.

Proposals for an overall spectrum safeguard cap

- 6.124 As this safeguard cap is intended to prevent advantages in the longer term, we consider it appropriate to include in the overall safeguard cap the unpaired 2.6 GHz and paired 2.1GHz spectrum. In the longer term, we consider these may be useful for LTE services or subsequent technologies. We therefore propose to include all mobile spectrum in the overall spectrum safeguard cap.¹¹¹
- 6.125 We consider the following options for an overall safeguard cap are:
- Having no safeguard cap;
 - A safeguard cap of 2x105MHz; and
 - A safeguard cap of 2x120MHz.
- 6.126 Similarly to sub 1GHz spectrum, if there were no safeguard cap on overall spectrum, there is a risk (of uncertain size and likelihood at the moment) that competitive intensity in the future might be lower than it could be. As before, we could rely on our other powers, including ex post competition law powers. However, we consider that the likely risks and costs of regulatory failures are likely to be lower using a safeguard cap.
- 6.127 A safeguard cap of 2x105MHz size would allow:
- Everything Everywhere to acquire up to 2x40MHz of spectrum, for example 2x20MHz of 800MHz and 2x20MHz of 2.6GHz spectrum.
 - Other competitors substantial scope to acquire spectrum. For example, a new entrant would have the opportunity to acquire up to 2x25MHz of 800MHz

¹¹⁰ We propose to include all of the 800MHz band in the sub 1GHz safeguard cap, even if the obligations and restrictions on some of it were relatively material.

¹¹¹ Paired spectrum in the 800MHz, 900MHz, 1800MHz, 2.1GHz and 2.6GHz bands, and unpaired spectrum in the 2.6GHz band (but excluding unpaired 2.1GHz).

spectrum and up to 2x70MHz of 2.6GHz spectrum. Alternatively a new entrant would have the opportunity to acquire 2x105MHz overall by acquiring the unpaired 2.6GHz¹¹² and 2x85MHz of paired spectrum. H3G would have the opportunity to acquire up to 2x90MHz of paired spectrum, such as 2x20 of 800MHz and 2x70MHz of 2.6GHz spectrum. Vodafone would have the opportunity to acquire up to 2x10MHz of 800MHz and up to 2x50MHz of 2.6GHz spectrum, and O2 would have the opportunity to acquire up to 2x10MHz of 800MHz and up to 2x60MHz of 2.6GHz spectrum.

6.128 A safeguard cap of 2x120MHz size would allow:

- Everything Everywhere to acquire up to 2x55MHz of paired spectrum, for example, 2x25MHz of 800MHz and 2x30MHz of 2.6GHz spectrum.
- Other competitors substantial scope to acquire spectrum. For example, a new entrant could acquire all of the 2.6GHz (paired and unpaired) and up to 2x25MHz of 800MHz spectrum. H3G would have the opportunity to acquire up to 2x25MHz of 800MHz and all 2x70MHz of paired 2.6GHz spectrum. Vodafone and O2 would each have the opportunity to acquire up to 2x10MHz of 800MHz and all 2x70MHz of 2.6GHz spectrum.

6.129 We consider that a safeguard cap of 2x105MHz is likely to be the best option. We think that the costs of both options are likely to be low because competitors would still have ample scope to acquire spectrum in the auction. However, in our view, this option strikes a good balance between not unduly limiting the spectrum that firms could reasonably hold and limiting the potential asymmetry of spectrum holdings after the combined award.

6.130 In contrast, a safeguard cap of 2x120MHz would give firms greater flexibility, in particular to hold more 2.6GHz spectrum, but with a risk that one player could acquire all of the 2.6GHz spectrum. Even though the risk may be small because of the amount of 2.6GHz spectrum available, if this scenario did happen, it is possible that it could lead to a material reduction of competition in the future.

6.131 An overall safeguard cap would help in terms of providing greater equality of opportunity. A safeguard cap of 2x105MHz would allow a new entrant to acquire up to 2x95MHz of paired spectrum, or to acquire 2x105MHz by acquiring the unpaired 2.6GHz. A safeguard cap of 2x120MHz would allow a new entrant to acquire up to 2x115MHz by acquiring all the spectrum that would be available, assuming that only 2x5MHz of 800MHz spectrum was needed by another national wholesaler to satisfy the floor requirement. The lower 2x105MHz safeguard cap would go further to providing equality of opportunity than the 2x120MHz safeguard cap, especially if the unpaired 2.6GHz were not regarded as being as valuable as paired spectrum, even in the longer term.

Liberalisation of 900 MHz, 1800 MHz and 2.1GHz spectrum for LTE and WiMAX

6.132 The 2.1 GHz spectrum is currently licensed for use in the UK for the provision of UMTS services and 900MHz and 1800MHz spectrum is currently licensed for both

¹¹² We consider the unpaired 2.6GHz would be equivalent to 2x20MHz in terms of its impact on the overall safeguard cap.

UMTS and GSM services. Technical work has been undertaken in Europe on the use of these frequencies for LTE and WiMAX which is now complete. We understand that the Commission is considering whether to amend the existing RSC Decision relating to 900 MHz and 1800 MHz spectrum to include a requirement to liberalise that spectrum for these additional technologies. Consideration is also being given to the position of 2.1 GHz spectrum that is not within the scope of that Decision.

- 6.133 We consider below the impacts of varying the current restrictions on the use of that spectrum to allow LTE and WiMAX services in addition to UMTS and GSM in terms of the likely effects on consumers and on competition of liberalisation of these spectrum bands.
- 6.134 We consider that allowing 900MHz, 1800MHz and 2.1GHz spectrum to be used to deliver LTE mobile services is likely to bring significant benefits to consumers. In particular, LTE has advantages in terms of higher speed, lower latency, increased network capacity and lower costs compared to 3G (section 4 sets out the benefits of LTE in more detail). WiMAX technology may also offer similar advantages, though it seems unlikely, given current stakeholder plans, it will be deployed using this spectrum. Nevertheless we would expect our liberalisation to be as technology neutral as possible and so allow licensees the greatest scope possible on technology choice. As noted earlier in this section, 2.1GHz is less likely to be used for LTE services in Europe than 900MHz and 1800MHz in the short term. The benefits associated with liberalisation of 2.1GHz are therefore likely to be longer term.
- 6.135 We recognise that it is possible that liberalisation of 900MHz and 1800MHz spectrum for LTE services could provide holders of that spectrum with a temporary advantage over others. However, given the current distribution of 2.1GHz and the likelihood that LTE services will not be launched at 2.1GHz in the short term, we do not consider that liberalisation of this spectrum is likely to create any short term advantages. We consider the possible short term advantages from LTE liberalisation of 900MHz and 1800MHz below.

Possible short term advantages from LTE liberalisation

- 6.136 One possible example of a temporary advantage might be that Everything Everywhere (and whoever acquires the divested 2x15MHz of 1800MHz) may be able to deploy LTE at 1800MHz with a large contiguous bandwidth before LTE services can be launched in other bands, if 1800MHz were liberalised for LTE. If deployed throughout Everything Everywhere's extensive network, it is possible that LTE1800 may be more attractive to some consumers than services provided using UMTS2100 or UMTS900.
- 6.137 It was partly because of the concern that Everything Everywhere could launch LTE at 1800MHz with a large contiguous bandwidth before other operators that the European Commission accepted commitments from Everything Everywhere's parent companies to divest some of Everything Everywhere's 1800MHz spectrum. Given those commitments, we do not consider it necessary to take any further measures before liberalising 1800MHz for LTE. Furthermore, once 2.6GHz becomes available, wholesalers will be able to deploy LTE in large contiguous bandwidths. When deployed in combination with sub 1GHz spectrum, the advantages of 1800MHz over 2.6GHz are likely to be matchable.
- 6.138 It is possible that the 900MHz spectrum could be liberalised for LTE use before the 800MHz spectrum is awarded and available for use on a wide scale basis. This

might give holders of that spectrum a temporary advantage over holders of other spectrum. However, we don't consider that particularly likely given the information currently available to us on the timing for the development of LTE 900 equipment and the other availability of other spectrum, such as 800MHz, for the deployment of LTE.

Other possible temporary advantages

- 6.139 Even without liberalisation of 900MHz and 1800MHz for LTE, different national wholesalers may have temporary advantages over others at particular points in time due to their different spectrum portfolios.
- 6.140 There is a possibility that Vodafone and O2 might have a short term advantage with UMTS900 until LTE800 deployments constrain UMTS900's advantage. The risk of this was considered and taken into account by the Government in advance of its making the Direction to Ofcom. This was in line with Ofcom's October 2010 Advice to the Government on 2G liberalisation.¹¹³ We do not consider this further here, save to note that if there were to be a material delay to when LTE800 could act as a constraint on UMTS900, we retain the ability to reconsider this issue as necessary at the time.
- 6.141 Once LTE is deployed at 800MHz, operators offering LTE800 may have an advantage over others. This is because LTE may be more attractive to some consumers than UMTS and because of the better indoor coverage of sub 1GHz spectrum. Again, we consider that this advantage (if any) will be temporary. At some point, LTE900 is likely to be deployed that will be very similar to LTE800, but it seems likely that user equipment for LTE900 will only be available later than for LTE800, meaning that 900MHz might be used for 2G and UMTS services for some time.¹¹⁴
- 6.142 We consider below whether we should put in place any measures which would be appropriate and proportionate to address any temporary advantages.

Possible measures to address temporary advantages

Risk and magnitude of potential problem without intervention

- 6.143 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 operators 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 outcome of the competitive process, can offer significant benefits to consumers and would not normally be a cause for concern.
- 6.144 It is not obvious that temporary advantages should necessarily lead to market failures. However, if such advantages were unmatchable¹¹⁵, it could be argued that a market failure could arise. In that situation, competitive forces might be weaker than might otherwise be possible. This could tend to lead to higher prices and poorer quality for consumers. However, the magnitude of the market failure is limited by the period of time to which it relates.

¹¹³ <http://stakeholders.ofcom.org.uk/consultations/spectrumlib/advice-to-government/>

¹¹⁴ This potential temporary advantage does not disadvantage Vodafone or O2, because they have the option of buying 800MHz in the auction.

¹¹⁵ See Section 5 above for an explanation of an 'unmatchable' advantage.

Potential regulatory failure and costs of intervention

- 6.145 Designing measures to address temporary competitive advantages would be difficult. One possible such measure would be to delay liberalisation or attach conditions to the liberalisation of a particular band for a new technology, if only some national wholesalers had that band and we were concerned it would give a temporary unmatched competitive advantage. We would need to consider the risk of regulatory failure from any such intervention. We consider that there would be a large risk of potential significant regulatory failure.
- 6.146 Regulatory interventions that resulted in delaying the liberalisation of a band could reduce consumer benefits by denying consumers the benefits of the new technology.
- 6.147 Regulatory interventions could reduce the incentives on firms to innovate and try to get ahead of rivals. Or for firms that might suffer a disadvantage without regulatory intervention, it could dilute the incentives on them to strive to do all they can to catch up or minimise the impact of any temporary disadvantage. This potential weakening of the competitive process could have significant detrimental consequences for consumers.

Provisional conclusions

- 6.148 In summary, we consider that liberalising 900MHz and 1800MHz spectrum in the hands of the existing licensees is likely to bring significant benefits consumers. We consider that the possible magnitude of any market failure resulting from a temporary advantage in this case is likely to be limited. Moreover, we would not want regulatory interventions to slow the introduction of new technology (and the benefits to consumers of that new technology) just because temporary competitive advantages could result. We therefore expect that it would be in consumers' interests to liberalise spectrum for new technologies as soon as the European Commission varies the relevant RSC Decision.
- 6.149 We consider that it is unlikely that regulatory intervention would be justified to address the types of temporary advantages described above, and we do not therefore propose to put in place any measures at this stage to address any potential advantages that might arise.

Section 7

Potential measures to promote national wholesale access

Section summary

- 7.1 We consider that national wholesale access (whether commercial or regulated) is very important for:
- Sub national RAN operators who could enter by acquiring new spectrum in the forthcoming combined award and deploy new, possibly LTE, technologies – e.g. an indoor femtocell network requiring a national access service to provide comprehensive outdoor coverage¹¹⁶.
 - Other retail competitors whose services may be similar to the wholesale competitors' own retail services but do not have access to any RAN infrastructure of their own – as mentioned in section 2, these can range from traditional MVNOs such as Tesco Mobile and Virgin, to providers who operate their own switches (and may have limited networks), such as Mundio Mobile.
- 7.2 We specify some of the features of a potential regulated access requirement first. In particular we distinguish 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.
- 7.3 We assess whether it would be appropriate and proportionate to put in place regulated access conditions in order to promote competition given our proposals in the previous section to ensure that at least four competitors are capable of being credible national wholesale competitors.
- 7.4 Our initial views are that:
- It is unlikely that intervening to put in place a “live” access condition would be appropriate and proportionate because we consider that the provision of national wholesale access services is likely to be competitive, given our proposals to ensure that at least four competitors are capable of being credible national wholesale competitors.
 - We consider 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.

¹¹⁶ Not all sub national RAN operators may necessarily require roaming agreements. An example of such an exception might be an airport only wireless connectivity network, concentrated on providing international roaming services to travellers within a limited geographic area.

- Further, we retain the ability to exercise our other powers including our competition law powers, in the future as appropriate.

Nature of regulated access

7.5 Regulated access could be introduced in many different ways. We therefore first seek to narrow the potential options, focusing on what might best promote competition and so further the interests of consumers and citizens. We divide the issues into two groups:

- The nature of a regulated access service (e.g. roaming, access to spectrum); and
- How regulated access could be applied.

Nature of a regulated access service

7.6 In our view, where regulated access is to be required, it is generally likely to be in the best interests of consumers not to pre-specify the type of access that should be provided. This is so as to allow the market to reach the best agreement and avoid unnecessary restrictions. If the absence of agreement on the form of access, Ofcom has dispute resolution powers to resolve certain disputes.

7.7 Nonetheless, we have considered the types of access that we could specify if we decided to put in place measures to require access. We consider that a number of factors are relevant in this regard:

7.8 First, we consider that there is a trade-off between basing an access service on (i) existing commercial agreements such as roaming (more suited to alternative network entrants and retailers with their own network infrastructure) and MVNO access and (ii) the limited scope for differentiation that roaming and MVNO access allow compared to other forms of access less tried and tested in the mobile sector. An example may be the mobile equivalent of Virtual Unbundled Loop Access in the fixed network which allows some flexibility to build service features on top of the basic access service.

7.9 We consider that it is likely to be better that access is based around roaming and MVNO access if we have to intervene. This is because we consider that this is likely to make access much quicker to implement and more effective, and this is likely to outweigh the downsides of the more limited ability to differentiate.

7.10 Another important element of the nature of a regulated access service is the basis on which prices are calculated. For instance, retail minus pricing allows companies to compete on similar terms to the access provider, but does not give much flexibility beyond that for competition at a deeper level e.g. through innovation and new services. On the other hand, cost based access pricing might lead to deeper competition, but with a greater risk of creating disincentives for access providers to roll out new networks or comply with access regulation because of the greater competitive threat that access might bring.

7.11 Although it would be necessary to decide which method to implement before the combined award if we were to impose access, we leave the question open for the purposes of this assessment since both methods can promote competition.

Applying regulated access

7.12 The main dimensions within which regulated access could be applied are:

- On new networks or existing networks
- On one or all networks
- Live (comes into force immediately) vs. dormant (comes into force only if and when pre-specified triggers are met)

New networks vs. existing networks

7.13 Retailers (sub-national RAN operators and other retailers) may require access to both existing and new networks to compete effectively. Access to existing networks would allow a retailer to provide mobile broadband services immediately using 3G. But they might not be able to compete in markets where quality was important, once wholesalers had deployed LTE networks.

7.14 Access to new networks (LTE or other 4G technologies) would allow firms to provide the highest quality mobile broadband services, but they would only be able to offer a nationwide service once new networks had been deployed.

7.15 As we are primarily concerned with considering what, if any, measures to put in place in relation to the combined award, we focus on the potential measures we could take to promote national wholesale access in relation to new networks deployed using the spectrum which is being made available in the auction.

7.16 We have considered whether we should propose to require existing national wholesalers to provide access to their current networks, but we do not consider that this is necessary at this stage. As we have set out above^{4.21}, retailers such as MVNOs have to date been able to agree access agreements with national wholesalers without such access being mandated by regulation. We do not therefore presently see a strong need to require such access.

One vs. all networks.

7.17 We consider that imposing access on all new networks is unlikely to be proportionate. First, putting an access condition on all licensees could mean that all licensees bear the potential costs of imposing regulated access. We discuss the costs of access in more detail when we discuss our preferred form of access below.

7.18 Second, there are likely to be significant similarities to the benefits from imposing regulated access on one compared to all licensees. This is because once a downstream competitor has access through one national wholesale competitor, it can compete with all the national wholesale competitors' own retail operations. Hence, all national wholesalers may have an incentive to compete in providing wholesale access services to gain wholesale revenues, if regulated access has been successfully imposed on one wholesale provider.

7.19 We do not consider that putting in place an access condition in one (or a subset) of the new licences would be discriminatory because all bidders will have the opportunity to factor the effects of the access condition on the value of the licence into their bids, and of course have a choice as to whether they bid at all.

Live vs. dormant condition

- 7.20 A “live access condition” would be effective immediately. In contrast a “dormant access condition” would only require access to be provided *if* pre-defined criteria had been met at some future point.
- 7.21 In our view, both a “dormant” and a “live” access option could potentially promote competition in national wholesale access (to the extent that any problems would arise with four credible national wholesale competitors). Hence we consider each in turn in this section.

Summary

- 7.22 We have summarised our view on the most ideal form of a regulated access requirement in the table below. We cannot reach a view on the live vs. dormant dimension in advance of assessing the costs and benefits, so we propose to assess two options in light of this. We recognise that if we were to include an access condition we would need to consult further before the combined award on the areas where we have not yet put forward definitive proposals.

Figure 7.1 Potential proposals for regulated access.

Issue	Proposals	Rationale
Form of access: roaming or basic access	Not specified unless no agreement then roaming / MVNO access	Only roaming and MVNO access have existing commercial equivalents, hence lower implementation risk
New or existing licences	New licences	Do not consider necessary to require access to existing networks, as provided commercially
One or all new licences	One network	Extra benefit of applying to all licences is small compared to extra cost
Live or dormant	Assess both variants	Difficult to judge which is better a priori
Cost based or retail minus pricing	Uncertain – assess both at later stage (if relevant)	Choice has limited impact on overall assessment

Assessment of regulated access against no additional intervention

- 7.23 This section compares the costs and benefits of imposing a regulated access requirement of the type set out above against the option of doing nothing beyond the measures we would impose to promote national wholesale competition (which we refer to as “no additional intervention”). We first consider imposing a live access condition, then consider the option of a dormant access condition.

Framework for analysing benefits and costs

- 7.24 The potential benefits of regulated access arise from the extent to which it allows greater and more effective competition from retailers and alternative entrants. This in

turn may lead to benefits for consumers in the form of lower prices, better quality and output, greater choice and more innovation.

- 7.25 These benefits must be considered against the alternative of what would happen if we did not impose regulated access – i.e. the likelihood of commercial access services arising, given our proposal to ensure that at least four firms are capable of being credible national wholesale competitors as a result of the auction.
- 7.26 Sub national RAN operators and other retailers may be in different positions with regard to national wholesale access. For example, sub national RAN operators' services are more likely to compete more directly and may even be disruptive forces in the market, hence increasing the potential competitive threat to the wholesale competitors. For this reason we assess the benefits of regulated access separately for sub national RAN operators and other retailers.
- 7.27 On the cost side, we consider both the direct and indirect costs likely to be incurred in regulated access. The direct costs relate to the additional equipment and operating costs of setting up and providing regulated access (assuming commercial access would not have been provided if it had not been imposed). Indirect costs can arise from regulatory failure, both the failure to achieve the intended objectives and the unintended negative consequences of regulation. The costs of regulated access are likely to be similar for sub-national RAN operators and other retailers as they mainly relate to the wholesale providers, so we assess them together.

Assessment of benefits and costs for a live regulated access condition

Risk and magnitude of possible problem without intervention

- 7.28 Our view is that if no wholesale access was provided by the national wholesalers, the magnitude of the impact on consumers could be material. However, in our view, the risk of a possible problem without intervention is likely to be low for access to new networks if we put in place measures to ensure that at least 4 firms were capable of being credible national wholesale competitors after the auction. The provision of wholesale access to existing 3G networks appears to be effective currently and incentives for providing access to new networks for retailers should in our view be similar.
- 7.29 We believe this is supported by experience to-date in the UK and in other relevant markets. For example:
- Many downstream competitors have been able to get national access services in the UK without regulatory intervention (though some negotiations have been protracted) and MVNOs represent a significant share of the UK retail market, 13% in 2009, which compares well to most other European countries (see paragraph 4.20 above).
 - International experience suggests that where wholesale access has been competitive, national access services have been provided. As we previously mentioned in paragraph 6.25, the cases where regulators / competition authorities have intervened or considered action to enable national wholesale access have been in markets where there have effectively only been three credible national wholesale competitors – in Italy, Poland and Spain.

- We suggested in our Mobile Sector Assessment Statement: “Mobile Evolution”¹¹⁷ published December 2009, that the national wholesale market was reasonably competitive – at the time, prior to the T-Mobile Orange merger, there were five national wholesale competitors. Responses to the consultation were mixed¹¹⁸. Cable and Wireless suggested that there was no need for intervention given the level of competition in wholesale access.¹¹⁹ However, BT argued that access agreements might be inadequate as wholesalers might be in a stronger bargaining position than their downstream competitors.¹²⁰
- In its final decision on the T-Mobile, Orange merger, the European Commission concluded that the wholesale national access market was likely to remain competitive after the merger, given the commitments made by the merging parties to H3G such as to guarantee their existing access agreements with H3G. Further, the European Commission did not consider that the wholesale providers would be likely to try to restrict wholesale capacity after the merger – e.g. it noted that the merged entity might have greater spare capacity than before the merger which might lead it to compete more aggressively for wholesale business. Some independent commentators consider that the national wholesale market may have become more competitive since the merger¹²¹.

Sub national RAN operators

- 7.30 Potentially, the incentive for national wholesale competitors to provide access for sub-national RAN operators is weaker than for other retail competitors since sub national RAN operators may pose a greater competitive threat, particularly if they are pursuing more radical strategies.
- 7.31 The more national wholesalers, the more likely it is that wholesale access will be provided commercially. If there is a risk that the sub national RAN operators will be able to obtain wholesale access and anyway enter the retail market, each wholesaler may have an incentive to sell wholesale access so that the wholesaler at least earns revenues from providing wholesale access. The greater the number of wholesalers the greater the opportunity for the sub national RAN operator to negotiate wholesale access.
- 7.32 Our view is that with at least four national wholesalers, there is likely to be sufficient competition to ensure sub national RAN operators can achieve access.
- 7.33 Some sub-national RAN competitors, such as Cable and Wireless and BT, have managed to obtain national access to existing 3G networks and there does not seem to have been any systematic refusal to provide commercial access to firms who could potentially have a competitive impact on the market.
- 7.34 It is also relevant that new entrants holding spectrum, e.g. new 3G competitors, have also generally been able to get national roaming services in many countries, sometimes through regulation. However, commercial access has sometimes developed, even after regulation imposing access has expired. For example, in the

¹¹⁷ http://stakeholders.ofcom.org.uk/binaries/consultations/msa/statement/MSA_statement.pdf

¹¹⁸ Mobile Sector Assessment: “Mostly Mobile” (July 2009)

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

¹¹⁹ http://stakeholders.ofcom.org.uk/binaries/consultations/msa/responses/Cable_Wireless.pdf

¹²⁰ <http://stakeholders.ofcom.org.uk/binaries/consultations/msa/responses/BT.pdf>

¹²¹ <http://www.analysismason.com/About-Us/News/Newsletter/Let-me-be-your-host-proactive-mobile-wholesale-competition/>

UK H3G held a competitive tender for national roaming following its initial contract with O2. New national wholesalers are likely to pose an even greater commercial threat than sub national RAN operators.

Costs of regulated access arising from the risk of regulatory failure

7.35 The costs of regulated access due to the risk of regulatory failure are potentially material and can be characterised follows:

- There is a risk that we do not set the terms and conditions of access correctly. If we set terms of access that were too generous to access seekers, there may be a chilling effect on investment. This could happen if incentives to rollout new networks become blunted because access could increase competition with wholesale providers' own retail operations, hence lowering their profits and the potential return on rolling out new network. Network deployment may be slower or less extensive than it would have otherwise been, potentially causing considerable loss of benefit to consumers.
- Alternatively, if the terms were set too harshly for access seekers, regulated access may be ineffective as access seekers may not be prepared to purchase wholesale services. In this case, there may be little to no benefit from regulated access. Whilst the costs may also be low, there could still be a chilling effect on investment. National wholesalers may still face uncertainty surrounding the amount of access that is sought, reducing the incentives to roll out.
- Effectiveness may also be blunted by the likelihood that in practice regulated access is less flexible than commercial access, e.g. more limitations on the regulated wholesaler to vary terms and conditions between access seekers. This may be one reason why some access seekers prefer unregulated to regulated access (given a reasonable degree of competition between national wholesalers).

Costs of implementation and/or opportunity costs of regulated access

7.36 The direct costs of regulated access arise from two sources:

- The initial fixed costs of the additional equipment which access providers and access seekers need to deploy in order for the access service to operate. Some of these investments may have already been made in respect of commercial access agreements and these should not be attributed to regulated access.
- The net running costs of providing access services. This is principally the cost of transporting wholesale access traffic *net of* the costs which would have been incurred by access seekers to transport traffic if wholesale access were not available.

7.37 It is difficult to estimate the initial fixed costs in much detail because they depend on the detailed specification of the access service, however we have looked at the components of the initial fixed costs, which are listed below, and from their nature we consider that they are likely to be relatively low.

- Network optimisation for the wholesale competitor to manage the handling of access traffic on its network

- Links between the wholesale competitor's and the access seeker's networks (the capacity of the links will depend on the amount of access traffic)
- Software upgrades to the wholesale competitor's core network and RNCs, and the access seeker's core network
- Software upgrades to user handsets.

7.38 It is also difficult to estimate the net running costs of regulated access. It depends on whether the downstream competitors would generate the same amount of traffic if wholesale access were not available.

Additional costs and benefits of a dormant regulated access condition

7.39 We consider that the risk and magnitude of a problem in national wholesale access is similar for a dormant access condition and a live access condition. In other words, we consider that regarding sub national RAN operators, there is a moderate risk that the problem is small and a small risk that the problem is material, whilst the risk of a problem is likely to be low in respect to other retailers. However live and dormant access conditions differ in their potential costs (both due to regulatory failure and the costs of implementing and operating access services).

7.40 With a dormant access condition, direct costs are only incurred if the condition is triggered and the requirement to provide access is imposed. Hence, if satisfactory commercial wholesale access services are provided (or are not requested) and the condition is not triggered, this option would avoid incurring any extra costs that would arise from imposing regulated access as opposed to commercial access (e.g. management costs in dealing with the regulatory process).

7.41 However, a dormant access condition introduces a new risk of regulatory failure. As discussed below, there is an important trade-off in setting the criteria for triggering the dormant access condition between the objective for the trigger to be easily measurable and provide certainty on the one hand and the objective to promote competition on the other.

- If we were to opt for a trigger that fully captured our objectives to promote competition, such as a review at fixed future dates of competition in national wholesale access, it would not be simple for the licensee to measure whether the criteria had been or would be likely to be met as the trigger would depend on a further detailed review by Ofcom.
 - As a result we would introduce uncertainty into the combined award process, complicating the process of valuing the relevant spectrum. The uncertain regulatory environment may also reduce ongoing incentives for network deployment for some time after the combined award.
 - In mitigation of this, if commercial access was provided anyway, the threat and uncertainty of regulatory intervention would recede, although the licensee may remain uncertain as to whether the access it decided to provide commercially was sufficient to remove the need to trigger the dormant obligation.
- If we were to opt for a trigger that could be measured definitively, such as the number or proportion of access requests granted in a pre-specified period the effectiveness of the condition would depend on whether or not we had

reasonably correctly set the levels of these triggers. As a result there is a material risk that either:

- The condition might not be triggered when it should have been, such that consumers might suffer because competition will be less intense than it could have been; or
- The condition is triggered and regulated access imposed when it was not in fact necessary. This might deter investment and consumers might again lose out.

7.42 Our initial view, therefore, is that the evidence in favour of introducing a dormant access condition is not compelling. Moreover, we have other competition powers, including powers under the Competition Act 1998 and Enterprise Act 2002 (see further at section 9 of this Annex) which we could consider exercising in the future as appropriate to address concerns which might arise.

Provisional conclusions

7.43 We consider that, if there are at least four competitors capable of being credible national wholesalers, commercial access is likely to be provided without regulatory intervention. Hence, we consider that if we put in place measures to ensure at least four credible national wholesale competitors after the combined award, it is unlikely to be appropriate or proportionate additionally to put in place a live regulated access condition, given the low risk of a potential competition problem and the risk that costs are incurred, such as deterring the national wholesalers from deploying new infrastructure.

7.44 However, we accept there may be some residual risk that effective commercial access services do not develop for new LTE networks, particularly for sub national RAN operators. Our initial view is that the evidence for whether a dormant access condition would be an appropriate and proportionate safeguard against this risk is not compelling given the risks set out above.

Section 8

Potential measures to promote retail competition

Introduction and summary

- 8.1 This section considers whether we should take any measures to promote competition in retail markets, given the measures we propose to take to promote competition in wholesale markets. As set out in section 5, we consider that provided retailers are able to obtain national wholesale access on reasonable terms, 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. As set out in section 7, we consider that access is likely to be provided commercially given our proposals to ensure that at least four competitors are capable of being credible national wholesale competitors. Retailers such as existing MVNOs and potential MVNO entrants should therefore be able to compete in retail markets.
- 8.2 However, we consider that there may be a risk that, if we took no measures to promote competition, entry by sub-national RAN operators¹²² may not occur, even if it were of benefit to consumers. This is because sub-national RAN operators are likely to use shared spectrum for low powered cells that cover small areas, which may give rise to coordination problems when bidding for shared spectrum. Furthermore, the aggregate value of spectrum to potential low powered users may not reflect the full social value their collective use could generate, for example in terms of dynamic competition benefits. There is also a risk that national wholesale operators, anticipating the future competition impacts from entry by shared low powered users, may increase their valuation of spectrum in outcomes in which such a competitive threat does not exist.
- 8.3 We consider that sub-national RAN operators may be particularly important because they offer greater scope for innovation and could potentially have a greater impact on increasing competition in retail markets compared to other retailers. We therefore focus on whether it is appropriate and proportionate to promote entry for sub-national RAN operators. We consider two possible approaches to assisting entry by sub national RAN operators:
- Introducing a mechanism in the auction to aggregate bids from concurrent low powered users and allowing these to compete with bids for individual high power use.
 - Reserving some 2.6GHz paired spectrum to be used on a low powered shared use basis.
- 8.4 We consider that there is a strong case for aggregating bids amongst low powered users and allowing competition between low and high powered users over a fixed amount of spectrum. There may also be a case for going further and reserving some 2.6 GHz spectrum for low powered use. But, given the uncertainty of any benefits

¹²² By sub national RAN operator we mean a company that provides mobile services partly using its own RAN in particular localities. It is likely to provide retail services including outside the localities covered by its RAN through purchasing national wholesale access from a national wholesaler.

associated with entry by low powered users and the risks to efficiency, it is unclear whether it is an appropriate and proportionate measure to promote competition. We welcome stakeholders' views and relevant information on the potential costs and benefits of the measures considered in this section.

Shared use of low powered spectrum as a route to entry by sub-national RAN operators

- 8.5 Sub-national RAN operators are likely to use low powered cells that cover small areas, such as an individual home or the floor of an office building. It is likely to be effective and efficient for these operators to share use of low powered spectrum. Existing national wholesalers might also consider using a low power in-building coverage approach, either in non-shared spectrum or in shared spectrum, as a complement to a more traditional macro-network.
- 8.6 We believe that as many as 10 concurrent users could share mobile spectrum and still be in a position to achieve effective technical coordination for the purpose of managing interference, as explained in the technical analysis undertaken by Real Wireless Ltd.¹²³ This would therefore provide an opportunity for four national wholesalers to have access to shared spectrum and still allow six new entrants to use the shared spectrum as well.
- 8.7 In confidential discussions with us, some stakeholders who do not currently operate as national wholesalers have expressed a strong interest in providing high-speed mobile services using this in-building small cell approach with shared low power spectrum. Existing offerings support the idea that such networks may offer opportunities for new entry (see paragraph 4.10).
- 8.8 The following sections consider whether there is a risk that valuable entry by sub national RAN operators would not occur absent any measures to promote entry. In particular, we consider:
- the extent to which sub national RAN operators need access to licensed spectrum in order to compete effectively;
 - the nature and extent of any market failures which would prevent sub national RAN operators from acquiring licensed spectrum efficiently;
 - the likely magnitude of any benefits for consumers and citizens associated with sub national RAN entry; and
 - the options available for addressing any market failures.

Risk and magnitude of the problem regarding entry of sub national RAN operators

Potential for sub-national RAN entrants to use unlicensed spectrum

- 8.9 It may be possible for sub national RAN operators to operate with unlicensed spectrum using Wi-Fi rather than using licensed spectrum. There is growing use of

¹²³ <http://stakeholders.ofcom.org.uk/binaries/consultations/combined-award/annexes/real-wireless-report.pdf>

Wi-Fi to offload mobile data traffic – that is, using Wi-Fi hotspots to provide capacity relief for smartphones and dongle use. Examples of sub-national networks that use unlicensed Wi-Fi spectrum include the services that CableVision provides in three US states and the services that BT Fon and the Cloud currently provide in the UK.

- 8.10 However, it may be that Wi-Fi does not offer sufficient control and assurance on quality of service that would be possible with LTE using licensed spectrum. There may also be concerns about the range of user devices if only Wi-Fi is used.
- 8.11 In confidential discussions with us, those stakeholders that expressed an interest in providing high-speed mobile services using in-building small cell approach did not consider that they would be able to offer as attractive retail products by using Wi-Fi with unlicensed spectrum.

Potential for entrants to acquire licensed spectrum without assistance

- 8.12 Parties interested in acquiring rights to use licensed spectrum for low power shared use may be able to win them without regulatory assistance by bidding for 800MHz and 2.6GHz spectrum in the auction.
- 8.13 We understand that low power shared users are likely to seek access to paired spectrum at 2.6GHz. This is because there may be greater choice, earlier timescales for equipment availability, more innovation and lower costs for LTE equipment using paired compared to unpaired spectrum.¹²⁴ In the case of low power use, this applies equally to the small cell equipment and user equipment.
- 8.14 There is arguably a large supply of 2.6GHz paired spectrum, with 2x70MHz available in total, (the supply of 800MHz spectrum – 2x30MHz – is more limited) and potential low power shared operators may be able to compete effectively in an award process without any measures to promote competition. However, there is a risk that an auction without any measures to promote competition may not deliver maximum benefits for consumers if valuable entry by low-powered users is deterred.
- 8.15 In Section 5, we identify the following possible sources of market failure:
- First, there is a risk that low powered users may not be able to acquire spectrum efficiently through a competitive award if they cannot coordinate effectively in an auction. In particular, it may be difficult to negotiate a joint bid between a number of sharers, and these difficulties are likely to increase the more sharers there are. Also, even where individual bidders are able to coordinate and put forward an aggregate bid, there is a risk that the bid does not fully reflect the aggregate value of the shared use.
 - Second, even if the coordination failure were addressed, the outcome of the auction may not be optimal for consumers if national wholesalers have strategic incentives to secure more spectrum than would otherwise be profitable, in order to deter potential entry by low powered users that are expected to provide a competitive threat in the future.
 - Finally, even absent any coordination failure or strategic incentives, the outcome of an unconstrained auction may not deliver maximum benefits for consumers if

¹²⁴ Recently, TD-LTE the version of LTE for unpaired spectrum, has been gathering momentum, particularly in China, but its prospects are still much more uncertain than LTE for paired spectrum.

the private valuations for spectrum by sub-national operators do not reflect the wider dynamic benefits to consumers that their entry might generate, through increased competition and innovation.

- 8.16 It is difficult to assess the extent to which these market failures could lead to material losses for consumers. It will depend on whether any coordination failure and wider competition benefits are significant enough to deter efficient entry by low powered users and the extent to which such entry would generate consumer benefits over and above those we would expect other competitors to deliver.

The scope for consumer benefits associated with shared use of low power spectrum

- 8.17 Entry by sub-national RAN operators may allow competition over more of the value chain compared to MVNOs, and may facilitate different types of business model and innovation in terms of retail offers. It could therefore be an important source of increased innovation and competitive pressure in the retail market, although the nature and scale of the benefits is uncertain.
- 8.18 For example, sub-national RAN operators might have the potential to deliver benefits to consumers through the provision of improved indoor coverage. A large proportion of mobile use takes place indoors: two thirds of time spent accessing the internet with mobile services takes place at the home or in the workplace (see section 4). Sub national RAN operators could develop their own networks inside buildings, deploying small base stations (e.g. femto-cells) and then rely on buying access from national wholesalers in order to be able to offer a retail product with national coverage.
- 8.19 We consider that sub national entry has the potential to bring about greater competition, choice and innovation for consumers, although the nature and scale of the benefits is uncertain. We consider there is a relatively high likelihood of sub-national RAN operators having a positive impact in terms of increasing competitive pressures in the retail market for specific or niche customer groups. Sub-national RAN operators may be able to offer a wider range of services using their own networks than are offered by sub national RAN operators currently. For example, they could offer LTE over their RAN networks as well as 2G services.
- 8.20 We consider there is a smaller chance of a more radical effect on competition and consumers from entry by sub-national RAN operators with more unpredictable or paradigm-shifting commercial models. This is because sub-national RAN operators compete over more of the value chain and could potentially adopt quite different business models to national wholesale operators. For example, it is possible that the traditional approach to developing mobile networks, which involves first building a macro-network, may change and move towards strategies which place greater emphasis on developing networks inside buildings. However, the nature of any radical effects on competition associated with entry by sub national RAN operators is inherently difficult to predict.
- 8.21 As we identified above, the presence of market failures could deter entry by sub national RAN operators if they cannot acquire spectrum for low powered use efficiently through a competitive award. Given this, and stakeholder interest in this approach, we consider below possible measures for assisting entry for sub-national RAN operators in the auction.

Potential measures to promote entry by sub national RAN operators

8.22 In this section we describe the measures we could take in the auction to assist entry for sub-national RAN operators using low-power shared use of the spectrum in the auction. The two approaches we consider are:

- Introducing a mechanism in the auction to aggregate bids from concurrent low powered users and allowing these to compete with bids for individual high power use.
- Reserving some 2.6GHz paired spectrum to be used on a low powered shared use basis.

8.23 We have focussed on measures that involve aggregating bids from potential low power shares and reserving spectrum, rather than considering bidder credits (i.e. increasing bids for low power shared use by a fixed sum or percentage). We do not consider it would be appropriate and proportionate to use bidder credits, partly because of the difficulty of identifying suitable values for bidder credits and the added auction complexity.¹²⁵

We consider it highly unlikely that it would be appropriate and proportionate to take measures to promote shared low power use with 800MHz spectrum. This is because this spectrum is relatively scarce and is particularly well suited to high power macro cell deployment because of its technical characteristics (as set out in section 5). The opportunity cost of using this spectrum for low power use would therefore be very high.

Cost of aggregating bids (with no reservation) – potential regulatory failure and/or opportunity costs

8.24 It is possible to introduce a mechanism in the auction that aggregates the amounts of individual bids for low power shared users and allows parallel bidding between them and high power users for a given amount of 2.6GHz spectrum. If there were more than 10 bidders – the maximum number of concurrent users we would propose to allow – those with the lowest bids would be disregarded.

8.25 In theory, such an aggregating mechanism could apply over fixed or variable blocks of spectrum or it could be combined with other options (such as those discussed below). However, the costs associated with facilitating competition between low power use and other users in terms of additional complexity in the auction increases significantly if the mechanism is applied over variable amounts of spectrum. This, in turn, could make it more difficult for bidders to understand and verify outcomes, including prices which, ultimately, might create efficiency risks. Therefore we

¹²⁵ We consider that the costs of using bidder credits may be significant. First, it will add to auction complexity. Second, given the range of uncertainties involved in predicting the scale of the free-riding incentive in bids or additional social value associated with low power shared use, we consider that it is likely to be difficult to identify suitable values for bidder credits. Hence it might require a disproportionate amount of resources and the risk of regulatory failure could be large. Third, bidder credits may also be inefficient and distort choices between spectrum and other inputs (spectrum or otherwise) which do not receive an equivalent credit low power shared use. We reached similar conclusions in the Digital Dividend Review:

<http://stakeholders.ofcom.org.uk/consultations/ddr/statement/>

consider it necessary to limit any aggregation mechanism to a fixed block of spectrum in order to avoid significantly complicating the auction process.

- 8.26 The two options for how much spectrum such a mechanism should apply to are likely to be either a 2x20MHz or 2x10MHz block of 2.6GHz spectrum. We invite stakeholders to come forward with suggestions on the amount of spectrum required for low power use to inform our approach to aggregating bids. However, we recognise that views on the required amount of spectrum may vary across stakeholders. There is therefore a risk of regulatory failure associated with identifying the appropriate amount of spectrum over which aggregated bidding should apply. For example:
- If 2x20MHz of spectrum is required to allow sub national RAN operators to compete effectively, applying the mechanism for aggregation to just 2x10MHz could mean valuable new entry is deterred.
 - Conversely, if 2x20MHz is more than what is required to allow sub national RAN operators to compete effectively, applying the mechanism to 2x20MHz could reduce the chances of sub-national RAN operators obtaining any spectrum, potentially preventing valuable entry from occurring on 2x10MHz.
- 8.27 Overall, we consider that there is a sound case for aggregating bids and allowing parallel bidding. By avoiding the need for users to negotiate a joint bid, it will go some way to dealing with any coordination failure. Providing the mechanism applies to a fixed amount of spectrum, the costs in terms of auction complexity are low.
- 8.28 However, absent any further measures to reserve spectrum for shared low power use, there is no guarantee that low powered users would be able to secure any licensed spectrum even if it was efficient. Depending on the nature and extent of any market failures, this could lead to material losses for consumers.

Cost of reserving 2.6GHz paired spectrum - potential regulatory failure and/or opportunity costs

- 8.29 In order to secure entry by low powered users, it may be necessary to reserve 2.6GHz paired spectrum exclusively for low powered users. However, there are a number of potential sources of inefficiency associated with reserving spectrum for low powered use.
- 8.30 Regulatory failure could arise if other bands were the focus for the production of equipment relevant to low power use, such as femtocells, and so equipment for the 2.6GHz band was costly or difficult to obtain as a result. However, stakeholder views (potential users and manufacturers) on this issue lead us to believe that this is unlikely.
- 8.31 Reserving 2.6GHz spectrum would reduce the amount of spectrum available for high powered users, which could potentially create significant opportunity costs. In particular, this might be the case where high powered users are willing to pay more for the reserved spectrum than low powered users and, critically, where this higher valuation reflects the fact that there are greater consumer benefits associated with high powered use, then there may be large opportunity costs associated with reservation that displaces high powered users. At the same time, if low powered users have the potential to generate more benefits for consumers than high powered users but, due to the market failures cited above, are not able to acquire sufficient

spectrum in an unconstrained auction, then there may be costs to consumers if no spectrum is reserved.

- 8.32 In practice, it is likely to be difficult to identify the extent to which the bids made in the auction reflect the true value that different users will generate for consumers. There is therefore a risk of regulatory failure in terms of the decision of whether to reserve spectrum for low powered use. In addition, where spectrum is reserved, there are further regulatory risks associated with identifying how much should be reserved. On the one hand there is a risk that low power users will not have access to sufficient spectrum to be sustainable and effective competitors. On the other hand, if the amount reserved were more than necessary there would be significant opportunity costs of denying spectrum to high power users.
- 8.33 Stakeholders have put to us different views on the amount of spectrum required for low powered use, with some stakeholders saying 2x10MHz of 2.6GHz spectrum would be sufficient and others arguing that 2x20MHz would be necessary. This suggests that the risk that we reserve too little spectrum is likely to be low where effectively 2x20MHz is guaranteed to be available for low power use. However, it is unclear whether it would be enough for low power users to be sustainable and effective competitors if only 2x10MHz is guaranteed for low power use does not seem significantly higher.
- 8.34 There is a further risk of inefficiency from reserving spectrum for low powered use where there are benefits of holding large contiguous channels of spectrum for high powered use. The opportunity costs would be greatest from reserving 2x20MHz of 2.6GHz, which is likely to reduce the total number of 2x20MHz channels to four (two at 1800MHz and two at 2.6GHz).¹²⁶ Whereas a reservation of 2x10MHz would not reduce the total number of 2x20MHz channels (there would be five 2x20MHz channels, as with no reservation).
- 8.35 Our technical work suggests that it may be possible for high power and lower power users to share 2x10MHz block if the low power users already had access to another 2x10MHz block. This option would effectively make 2x20MHz available for low power use, allowing the maximum potential benefits in terms of service quality without the opportunity costs associated with reserving 2x20MHz solely for low power use. But we recognise that there are still some open issues that we would need to consider further if we were to proceed with such an option (see chapter 4 of the main consultation).
- 8.36 We consider that the opportunity costs are likely to be significant were we to reserve 2x20MHz exclusively for low powered use and that this is unlikely to be appropriate and proportionate to its intended effect. We consider that there may be a stronger case for reserving only 2x10MHz of 2.6GHz spectrum for low powered use. But, given the uncertainty of any benefits associated with entry by low powered users and the risks to efficiency, it is still unclear whether it is an appropriate and proportionate measure to promote competition.

¹²⁶ In light of the importance of sub-1GHz spectrum to wide area coverage and in-building penetration and the resulting demand for sub 1GHz spectrum, it seems unlikely that one or more operators would be able to acquire a 2x20MHz channel at 800MHz (or 900MHz). The total supply of contiguous channels of 2x20MHz therefore comes from higher frequencies.

8.37 Figure 8.1 below summarises the costs and benefits of the options for promoting entry by low powered users of shared spectrum.

Figure 8.1: Spectrum available for future mobile services using LTE and/or UMTS

	Costs	Benefits
No measures	<p>Risk that potential entrants cannot coordinate and put forward a joint bid.</p> <p>Risk that bids for shared spectrum do not reflect the true value to consumers due to incentives to free ride, strategic bidding and wider competition benefits.</p> <p>If entry by sub national RAN operators is deterred, uncertain but potentially significant consumer benefits are forgone.</p>	<p>Maximises scope for national wholesalers to acquire their desired quantity of spectrum. May therefore increase efficiency and consumer benefit through allowing highest possible service quality.</p>
Mechanisms to aggregate bids only (no reservation)	<p>Risk that bids for shared spectrum do not reflect the true value to consumers due to incentives to free ride, strategic bidding and wider competition benefits.</p> <p>If entry by sub national RAN operators is deterred, uncertain but potentially significant consumer benefits are forgone.</p> <p>May introduce additional complexity to the auction process.</p>	<p>Provides opportunity for low power users to compete in the auction whilst retaining scope for national wholesalers to acquire their desired quantity of spectrum.</p>
Reservation of 2.6GHz paired spectrum	<p>Risk of inefficiency if low power use is not successful or if too much spectrum is reserved.</p> <p>If 2X10MHz is reserved, quality of service may be lower (relative to 2X20MHz) but likely to allow for sufficiently high quality service.</p> <p>If 2X20MHz is reserved, high opportunity cost of capacity lost to high power users.</p> <p>Potential issue if contiguous 2x20 MHz channels are important for national wholesalers.</p>	<p>Consumer and citizen benefits associated with entry are secured. But the scale of these benefits is uncertain.</p>

Provisional conclusions

8.38 In summary, we consider that there is a risk to competition from sub national RAN operators who would rely on shared access to licensed spectrum, arising from coordination problems in the auction and the risk that any allocation of spectrum

based on private valuations may not deliver maximum competition benefits for consumers.

- 8.39 We consider that there is a strong case for aggregating bids amongst low powered users and allowing parallel bidding between low and high powered users for a fixed amount of 2.6GHz spectrum. However, this approach may not be enough to secure new entry. Therefore, we consider that there may be a case for going further and reserving spectrum for low powered use.
- 8.40 Based on the evidence currently available, we consider that the costs are likely to be significant were we to reserve 2x20MHz exclusively for low powered use and that this is unlikely to be appropriate and proportionate to its intended effect. We consider that there may be a stronger case for allowing high power and low power users to share a 2x10 MHz block if the low power users already had access to another 2x10 MHz block - however this is subject to further technical work. Alternatively, there might be a case for reserving only 2x10MHz of 2.6GHz spectrum for low powered use. However, given the uncertainty of any benefits associated with entry by low powered users and the risks to efficiency, it is still unclear whether this would be an appropriate and proportionate measure to promote competition.

Section 9

Other powers to promote competition

9.1 This section describes other powers Ofcom has to promote competition.

Powers under the Competition Act 1998 and the Treaty on the Functioning of the European Union (EU Treaty)

9.2 Ofcom has powers to apply and enforce competition law in relation to the prohibitions under the Competition Act 1998 (“CA98”) and Articles 101 and 102 of the EU Treaty.

9.3 Given the measures we propose to take in the combined award to ensure that four companies are capable of being credible national wholesale operators, we currently consider it unlikely that we would need to intervene due to single or joint dominance. However, this could change if the market developed in a way we do not anticipate.

9.4 It is likely that any future network or spectrum sharing agreements would be subject to competition law. As for network sharing deals in the past, an essential part of the analysis would be to assess the impact of sharing at the network level on competition at different levels of the vertical industry structure. As described in more detail in section 55, the responsibility to act in accordance with competition law rests with the parties to any such agreement.

Power under the Enterprise Act 2002

9.5 We also have the powers under the Enterprise Act 2002 to make a reference to the Competition Commission in relation to communications matters if we have reasonable grounds for suspecting that any feature, or combination of features, of a market in the United Kingdom for goods or services prevents, restricts or distorts competition in connection with the supply or acquisition of goods or services in the UK or any part thereof.

Competition check on spectrum trades

9.6 We have recently consulted on a notice to make the 900, 1800, and 2100 MHz licences tradable.¹²⁷ In that notice we also set out how our proposals would affect the 800MHz and 2.6GHz bands. We propose to include an ex ante competition check in respect of a spectrum trade. This would allow Ofcom to take into account whether competition is likely to be distorted in determining whether or not to consent to a trade, or to consent to a trade subject to certain conditions.

End-to-end connectivity obligations

9.7 End-to-end (e2e) connectivity describes the process of enabling retail customers to make calls to other customers or services on the same network or other providers’ networks. This is important for both competition generally and end-users individually. Competing communications providers need to be able to interconnect with other networks in order to provide a full service to their customers. Customers expect to be

¹²⁷ <http://stakeholders.ofcom.org.uk/consultations/trading-900-1800-2100/>

able to call every other retail customer irrespective of the network to which the called party is connected.

- 9.8 Ofcom's policy is for all public networks to connect to all other public networks.¹²⁸ Ofcom has a power to impose an e2e obligation on certain persons. To date, we have only imposed a regulatory e2e obligation on BT. This is on the basis that other networks would generally have the incentive to connect to other networks and that to impose an e2e obligation on all networks would be disproportionate. If we found that our policy was being frustrated and that other networks were not providing e2e connectivity, we could consider imposing an e2e obligation on other operators. However, we do not currently see the need for further action.

¹²⁸ See End-to-end connectivity Statement, September 2006, http://www.ofcom.org.uk/consult/condocs/end_to_end/statement/statement.pdf