Advice to Government on the consumer and competition issues relating to liberalisation of 900MHz and 1800MHz spectrum for UMTS

Advice to the Secretary of State for Business, Innovation and Skills

Ofcom advice to Government

Submission date: 25 October 2010

Contents

Section 1

Executive summary

1.1 This paper is a summary of Ofcom's analysis of the consumer and competition issues that might arise from liberalisation of 900MHz and 1800MHz spectrum for 3G mobile services (UMTS), and the actions that might be taken to address any material distortions of competition arising. This builds upon our February 2009 consultation[1], including responses thereto, and developments since then.

1.2 This advice was prepared in response to a request by the Secretary of State for Ofcom's analysis of the impacts on consumers and competition of liberalising the 900MHz and 1800MHz spectrum for UMTS use.

1.3 In summary, Ofcom considers that liberalising 900MHz and 1800MHz spectrum in the hands of the existing licensees is likely to benefit consumers and is unlikely to result in a material distortion of competition that requires further action to be taken.

2G liberalisation

1.4 The 900MHz and 1800MHz spectrum is currently licensed for use in the UK for the provision of GSM services only. This advice considers the likely effects of varying the current restrictions on the use of that spectrum, to allow UMTS services in addition to GSM services.

1.5 In considering this question, in light of our principal duties under the Communications Act 2003 we have looked at both the likely effects on consumers and on competition of liberalisation of these spectrum bands.

Consumer benefits of liberalisation

1.6 Allowing 900MHz and 1800MHz spectrum to be used to deliver 3G (UMTS) mobile services is likely to bring significant benefits to consumers in some or all of the following ways:

- Greater network capacity allowing more customers to be served and to enjoy higher mobile broadband speeds (both 900MHz and 1800MHz spectrum);
- Improved quality of coverage allowing customers to use mobile broadband in more locations with greater consistency (900MHz spectrum);
- Improved in-building coverage (900MHz spectrum);
- Wider coverage of rural areas (900MHz spectrum).

1.7 UMTS networks using 900MHz spectrum are already deployed and in operation in a number of European markets. An increasing number of handsets and other user devices being sold in the UK today are UMTS900-ready. The only thing that is now stopping consumers with such devices from enjoying the benefits of UMTS900 in the

[1] Application of spectrum liberalisation and trading to the mobile sector – A further consultation, 13 February 2009 http://stakeholders.ofcom.org.uk/consultations/spectrumlib/

UK is the regulatory restriction that limits the technology that can be deployed in the 900MHz band to GSM.

1.8 The situation as regards use of 1800MHz spectrum for UMTS is less well developed in terms of both likely speed of availability of equipment and services, and hence the likely effect on consumers, but equally in our opinion the risks to competition of liberalisation of this spectrum for UMTS are, as we set out below, also considerably less than for 900 MHz spectrum.

1.9 In both cases we therefore consider that from a consumer benefit perspective, it is imperative that decisions are taken quickly allowing this spectrum to be liberalised for UMTS use. The UK is of course also required to liberalise this spectrum for UMTS use by two pieces of European legislation – the amended GSM Directive[2] and the associated Radio Spectrum Decision[3].

900 MHz liberalisation

1.10 In our February 2009 consultation we recognised the likely benefits of 900 MHz spectrum in providing higher quality mobile broadband services compared to the 2100 MHz spectrum currently used. However, we were concerned that, as a result, liberalising 900 MHz spectrum in the hands of the incumbent holders, without constraint, could lead to competitive distortion and/or inefficiencies for around 2-4 years, until services using 800 MHz spectrum could offer a competitive constraint. This could result in consumers facing higher prices and/or lower quality mobile broadband services than they might if the benefits of 900MHz spectrum were available more widely (but the services should still be better and potentially cheaper than those they would receive if 900MHz spectrum were not liberalised at all). Whilst noting that the evidence in favour of any one policy option was not overwhelming, our judgement at that time was that requiring the 900 MHz incumbents to release one block of spectrum between them (2x2.5 MHz each) appeared to be the best option overall to address our competition concerns.

1.11 Since our consultation, demand for mobile broadband services in general, and for use of the 900MHz band to deliver 3G services more specifically, has become clearer. However, our view of the likelihood and size of a competitive distortion arising has, significantly, reduced. This is largely because of the merger between Orange and T-Mobile creating Everything Everywhere (EE). Of the operators today, EE, and to a lesser extent H3G through its network sharing arrangement with EE, are in the strongest position in terms of network capability for providing UMTS services. They have the largest amount of 2100 MHz spectrum and access to the largest number of base station sites. Accordingly, we believe these operators would be able to improve their coverage (if required) and consequently reduce any competitive advantage that O2 or Vodafone might realise from using 900MHz spectrum for the provision of 3G services, albeit at potentially greater cost.

1.12 Updated technical analysis taking account of the availability of these extra sites, and also including refinements made following stakeholder feedback in response to our February 2009 consultation, suggests that a UMTS 900MHz network deployed by O2 or Vodafone could still provide improved quality of coverage to some indoor locations when compared to what Everything Everywhere or H3G could provide with

[2] Directive 2009/114/EC of 16 September 2009 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:274:0025:0027:EN:PDF)
[3] Commission Decision 2009/766/EC of 16 October 2009 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:274:0032:0035:EN:PDF

2100MHz. However, the extent of the improved quality of coverage is relatively small. The extent of this advantage will be dependent on the construction of buildings and the location of the user within the building. Little or no advantage would exist in many easier to serve indoor locations. In addition, other ways of dealing with poor indoor coverage, such as in-building repeaters and femtocells have become a more plausible strategy for EE/H3G to address residual areas of coverage disadvantage since our February 2009 consultation.

1.13 Overall **we now consider the risk and extent of any competitive advantage for O2 or Vodafone arising from liberalisation of the 900MHz spectrum for UMTS to be low and significantly less than our analysis suggested in February 2009.**

1.14 In light of this change in our view of the risk and likely magnitude of any competitive distortion, we have re-assessed what measures, if any, it might be appropriate to take to address any residual competition concerns. Firstly, as a result of the lower risk and likely reduced magnitude of any competitive distortion, we now consider that an option of requiring release of one block of spectrum, with costs of around £60m-£210m (revised slightly upwards from our previous estimates) is likely to be disproportionate – the benefits are unlikely to outweigh the costs. In addition, following further technical research, we continue to believe that there are considerable implementation challenges that would need to be resolved to ensure that regulated access was effective and did not have negative unintended consequences. Consequently, we are not certain that regulated access would be a timely, effective and proportionate option. Therefore, given our judgement that there is a reduced risk of a material competitive distortion and concerns over the leading alternative options, **we consider that liberalising 900 MHz spectrum for UMTS in the hands of the current licensees, without imposing conditions (beyond essential technical requirements), is now likely to be the best option.**

1.15 As regards any concern that the likely lower costs of providing 3G UMTS services using 900MHz spectrum, as compared with higher frequencies, might indirectly give rise to a competitive distortion (for example by virtue of a windfall gain to those operators with 900MHz licences), we firstly note that charging annual licence fees for 900MHz spectrum that reflect the full market value of that spectrum ought to mitigate if not entirely eliminate any such distortion. Furthermore, even if annual licence fees were not accurately to reflect full market value (and in particular the differential in value between 900MHz and higher frequency spectrum) we consider the impact on consumers to likely be limited. This is because we consider it unlikely that any difference in cost would have a material effect on competition, for the reasons set out in our February 2009 Consultation, and almost certainly would not lead to any existing player having to exit the market before alternative spectrum becomes available.

1800 MHz liberalisation

1.16 Our analysis in February 2009 showed that use of liberalised 1800MHz spectrum for 3G provided no material advantage relative to 2100MHz spectrum for providing improved mobile broadband services, in terms of speed or coverage. Although liberalising the 1800MHz band for 3G could in principle offer significant extra capacity to T-Mobile and Orange (as they were then), in practice there was a lack of momentum in relation to compatible equipment, and operators had other options for increasing capacity such as acquiring the right to use additional spectrum in other bands and deploying more base stations.

1.17 Our views on these issues have not materially changed. In addition, as a result of the merger review process T-Mobile and Orange have agreed to divest 2x15 MHz of Everything Everywhere's 1800MHz spectrum (to address European Commission concerns in relation to the provision of LTE services using 1800MHz spectrum in future, rather than UMTS services today) which will therefore be available to another operator in the future. **Our view therefore remains that there is little risk of a material competitive distortion arising as a result of liberalising the 1800MHz spectrum for UMTS in the hands of the current holders, without additional conditions (beyond essential technical requirements), and this is still likely to be the most appropriate option.**

Section 2

Introduction

2.1 This paper considers the consumer and competition issues that might arise from liberalisation of 900MHz and 1800MHz spectrum[4] for 3G mobile services (also referred to as UMTS), and the potential actions that might be taken to address any competition distortion. It does not consider the liberalisation of the spectrum for other technologies as the Government is only currently proposing to liberalise the spectrum for UMTS.

2.2 This paper and its annexes are a summary of Ofcom's analysis as at October 2010. They take into account the main developments since our February 2009 consultation and the most substantive points raised by stakeholders in their responses to that consultation.

2.3 The rest of the paper is organised as follows:

- section 3 provides a summary of the findings of Ofcom's February 2009 consultation;
- section 4 describes the key developments since February 2009 consultation;
- section 5 considers the risk of the liberalisation of 900 MHz spectrum for UMTS resulting in a distortion to competition and its potential magnitude;
- section 6 considers potential remedies to any distortion of competition;
- section 7 considers the liberalisation of 1800 MHz spectrum for UMTS;
- section 8 provides a summary of each of the annexes which contain supporting information.

2.4 The annexes are organised as follows:

- Annex 1. Overview and results of technical analysis
- Annex 2. Benefits of timely liberalisation
- Annex 3. Updated analysis on the costs of release
- Annex 4. Overview of technical challenges in implementing regulated roaming
- Annex 5. Description of technical modelling approach and responses to technical analysis contained in February 2009 consultation
- Annex 6. Technical analysis using non-homogeneous network deployment in a sample area

[4] 900 MHz spectrum refers to spectrum at 880.1-914.9 MHz paired with 925.1-959.9 MHz and the 1800 MHz spectrum refers to spectrum at 1710.1-1781.7 MHz paired with 1805.1 -1876.7 MHz.

- Annex 7. Assumptions in relation to network deployment site numbers
- Annex 8. The timing and duration of any competitive distortion

Section 3

Summary of the findings of the February 2009 consultation

3.1 In our February 2009 consultation[5] we said that we believed that liberalisation of the 900MHz and 1800MHz spectrum had the potential to bring significant benefits to consumers but we were also concerned that liberalisation of the 900MHz spectrum in the hands of the incumbent holders, and its unfettered use, could lead to competition and efficiency problems, at least for an 'interim period' of 2-4 years. The reasoning we used to support this can be summarised as follows:

a) We thought that incumbents would be likely to use 900MHz to rollout out 3G services in the near future. This was because of evidence of continued and growing consumer demand for mobile broadband, the potential cost advantages of lower frequency spectrum, the potential quality advantages of lower frequency spectrum, plus our estimates showed that the cost of clearing the spectrum for their own use (£30-60m) was low compared to the potential additional revenues and/or cost savings it could generate.

b) Our analysis showed that there was a considerable technical advantage from using lower-frequency spectrum at 900MHz over 2100MHz, the higher frequency band at which current 3G (UMTS) networks are deployed. A network at 900MHz would need fewer than 50% of the sites required at 2100MHz to provide an equivalent mobile broadband service in most scenarios. Of particular importance was our analysis that 900MHz spectrum offered significant advantages in providing in-building coverage for mobile broadband (since usage patterns suggest that mobile broadband is most commonly used indoors). In addition, the lower-frequency spectrum also offers a cost advantage when used to provide outdoor coverage in more rural areas. Therefore a UMTS network at 900MHz could provide higher quality mobile broadband services, including the extent and quality of coverage (such as the speed of data services offered in locations that are hard to reach, e.g. deep within buildings), than one at 2100MHz.

c) Assuming that demand for mobile broadband is high, our analysis was that there would either be a concern about competition or about productive efficiency:

- **Competition concern**: If consumers were sensitive to differences in mobile broadband quality, and 900MHz networks were deployed using a large number of sites, the number of sites needed at 2100MHz to replicate the quality of a 900MHz network would be too high to match viably – i.e. the 900 MHz operators would have an unmatchable advantage.

- Hence, the 900MHz operators would gain a competitive advantage over other operators from providing better quality mobile broadband services. We thought it was likely that the market would fail to address this problem by facilitating wider access to 900MHz (e.g. through spectrum trading or commercially

[5] Application of spectrum liberalisation and trading to the mobile sector - A further consultation, 13 February 2009 http://stakeholders.ofcom.org.uk/consultations/spectrumlib/

offered access) because it would probably be against the strategic interests of the holders of 900MHz to bring this about.

and/or;

- **Productive efficiency concern**: If consumers were less sensitive to differences in mobile broadband quality, a 2100MHz operator might be able to replicate sufficiently the quality of a 900MHz operator to avoid a competitive disadvantage, but at significantly higher cost.

- We thought it was plausible, but by no means certain that it would be in the commercial interest of the 900MHz operators to negotiate wider access to 900MHz in this scenario. If commercial access did not arise, there could be a significant impact on efficiency because 2100MHz operators would not be able to achieve the cost savings from lower frequency spectrum, so their networks would be significantly more expensive to build (than if they had access to 900MHz).

d) Use of the 800MHz band, specifically for LTE800, could be expected to resolve the potential competition concern, but it would not become a competitive constraint on mobile broadband provided using UMTS900 for an 'interim' period of 2-4 years ie not just until 800MHz LTE networks were deployed but also a significant number of consumers had LTE800 capable handsets.

3.2 To address this risk we proposed that O2 and Vodafone release 1 block (2x5 MHz) of 900MHz spectrum in total (i.e. 2x2.5 MHz each) and that this spectrum be awarded to a third party.

3.3 To inform the choice of the appropriate option for liberalisation the consultation included a detailed impact assessment with our judgement informed by a quantified cost-benefit analysis of the options for 900MHz liberalisation. However, significant uncertainties over numerous aspects meant that the quantified analysis was not definitive and we recognised that the evidence in favour of any one policy option (e.g. liberalisation in the hands of the incumbents, spectrum release or regulated access) was not overwhelming. We recommended a release of one block of 900MHz spectrum taking into account qualitative judgements, in particular we considered that one block release was likely to be more effective in promoting competition than regulated access and that the higher costs of two block release (compared to one block) were unlikely to be proportionate given the uncertainty around the additional benefits.

3.4 In response to that consultation we received 11 responses, with very detailed responses from each of the five existing MNOs. We have reviewed these responses and the key developments since the consultation and taken them into account in preparing this advice.

Section 4

Key developments since the February 2009 consultation

4.1 We have considered the most significant issues raised in responses to our February 2009 consultation and have taken account of developments over the last year or so, including growth of the mobile broadband market, progress in the development of LTE and greater certainty over availability of the 800MHz band, all of which have important implications and benefits for consumers. Perhaps most significantly, we have also considered the impact of the recent T-Mobile / Orange merger.

Greater certainty over the importance and benefits for consumers of mobile broadband, UMTS900 deployment and 800MHz availability

4.2 Whilst our February 2009 consultation foresaw the likely growing importance of mobile broadband and future UMTS900 deployment, developments since then have generally increased the level of certainty in relation to these factors. In particular:

- Use of mobile broadband services (for example measured by data volumes) and the take up of 'dongles' and smartphones (such as the iPhone) which rely heavily on mobile broadband connectivity for much of their functionality continues to grow.

- There is growing evidence of the importance of mobile broadband network quality from the marketing strategies of mobile operators (for example Orange's campaign on their 3G coverage) and from consumer research. For example, research[6] notes that customers' perceptions of relatively poor network performance can be a driver for a lack of likelihood to renew a contract.

- Both O2 and Vodafone, who currently hold 900MHz licences, have applied to Ofcom requesting variation of their 900MHz and 1800MHz licences to allow them to deploy UMTS technology in that spectrum in the UK.

- There is now a wide range of UMTS900 compatible handsets available in the market so consumers can quickly benefit from any UMTS900 network deployed. For example, recently launched popular smart phones such as the Palm Pre, Google Nexus One, and iPhone4 support UMTS900, and we believe around 40% of devices in O2 / Vodafone catalogues (as at April 2010) support UMTS900.

4.3 Taken together, the above factors suggest to us that there are likely to be significant consumer benefits to be gained in the near future from liberalisation of the 900MHz bands for UMTS use (Annex 2 provides further details).

4.4 In addition, the future availability of the 800MHz band for mobile broadband, and the timing of this availability, is more certain than it was at the time of the February 2009

[6] YouGov DongleTrack Wave 8 April 2010 (slide 29)

consultation. For example, it was decided in June 2009 to clear the 800MHz band – 790-862 MHz, channels 61 to 69 in UHF Bands IV and V – of existing and previously planned users and align the upper band of the UK's digital dividend with the spectrum being identified for release by an increasing number of other European countries. This, together with emerging EU plans to harmonise technical parameters across the EU concerning deployment of mobile services in this spectrum, means that it is now very likely that mobile broadband will be deployed in the 800MHz band in the near future. Licences have even been issued for such use in Germany following an auction earlier this year.

4.5 All the developments above are consistent with the scenarios on which we placed most weight in February 2009. However, they do reduce the uncertainty associated with some of the assumptions – the importance of high quality mobile broadband, the deployment of UMTS900, and the future availability of 800MHz spectrum for mobile broadband - underpinning that analysis.

Timing: LTE800 and the duration of any competitive distortion

4.6 Deployment of LTE in the 800MHz band is expected ultimately to provide the opportunity for a complete competitive constraint on UMTS services in the 900MHz band. This is because we expect that LTE800 networks will in time be able to (at least) match the mobile broadband quality and/or cost savings of UMTS900 networks. A key consideration is therefore how long this will take.

4.7 It is now more than a year since our previous assessment, and there have been a number of positive developments on LTE. However, we believe the period over which any competitive distortion could arise is still broadly unchanged at around 2-4 years (though this period will now start somewhat later than we previously envisaged). Our updated reasoning on timing, taking account of developments since February 2009 is summarised in Annex 8.

T-Mobile/Orange merger

4.8 The merger of T-Mobile and Orange's UK businesses to create Everything Everwhere provides them with a significantly larger total number of sites on which they can deploy 3G than either of the two operators were likely to have been able to do individually. This is the most significant development since our previous consultation because it potentially materially reduces the competitive advantage that O2 or Vodafone could realise from deployment of a UMTS900 network. In simple terms, the extra sites could off-set to some extent the lack of 900MHz spectrum. In particular, Everything Everywhere recently announced that it intends to create a consolidated national network of around 18,000 sites, delivering both 2G and 3G services, providing 99.6% population coverage.[7] See Annex 7 for further discussion of site number assumptions in light of the merger.

4.9 [Paragraph removed as it contained confidential information]

[7] http://everythingeverywhere.com/2010/09/28/everything-everywhere-unveils-plans-for-growth-through-network-leadership-2/

Femtocell and other in-building solution developments

4.10 Other ways of dealing with poor indoor coverage seem increasingly plausible. Such technologies include femtocells, WiFi and in-building repeaters. A femtocell is a miniature, low cost and low power 2G/3G mobile base station for indoor residential and enterprise use. Femtocells can offer consumers better indoor mobile reception and capacity in their own home and offices. Our February 2009 consultation considered the potential role of femtocells (and other in-building systems) in mitigating any differences in indoor coverage quality and capacity between networks. However, we did not place great weight on femtocells as at that time it was uncertain to what extent there would be widespread commercial deployments.

4.11 The commercial launch of femtocells and other in-building solutions by Vodafone in the UK and other operators internationally over the last year has increased the plausibility of their extensive deployment. However, we still consider it doubtful whether femtocells or other in-building solutions could be used to eliminate any widespread systematic differences in quality between 900MHz and 2100MHz macro networks. This is because this would likely require installation of 'open access'[8] femtocells or similar systems in a significant proportion of indoor locations. We also note that 900MHz operators are equally able to deploy femtocells and other in-building solutions, and potentially could as a result enjoy the benefits of holding lower frequency spectrum at higher volumes of demand, by off-loading traffic onto such systems as demand grows.

Refinements to our technical analysis

4.12 The most significant issue with our technical analysis raised by stakeholders in response to our February 2009 consultation was the treatment of interference in the model used to analyse the differences in quality that could arise between networks. In particular, some respondents argued that the variation of signal quality across the cell area needed to be analysed in a more explicit fashion. Following investigation of this issue we undertook some more sophisticated analysis, the result of which is to reduce our estimates of the advantages of deploying UMTS900 compared to UMTS2100 in some situations, particularly when considering 'partial matching' situations in which we analyse the likely differences in quality between networks using different frequencies and different numbers of sites. We have also undertaken some non- uniform analysis which we believe confirms that our uniform analysis provides a reasonable estimate of network performance. (see section 5 and Annexes 1, 5 and 6).

[8] Initial deployments of femtocells usually restrict usage to a whitelist, eg 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.

Section 5

Assessment of potential for liberalisation of 900 MHz spectrum to distort competition

5.1 In this section we set out our assessment of whether liberalisation of the spectrum in the 900 MHz band for UMTS is likely to distort competition in mobile markets. Our conclusion now is that liberalisation of 900 MHz for UMTS is unlikely to distort competition. We recognise however that there are a number of inherent uncertainties involved in the assessment. Given the degree of uncertainty, we cannot completely rule out a distortion of competition arising.

5.2 We also consider potential productive efficiency implications. We note that liberalisation can only improve productive efficiency overall and conclude that there are not strong reasons for being concerned about liberalisation of 900 MHz for UMTS from a productive efficiency perspective.

Competition in mobile markets currently

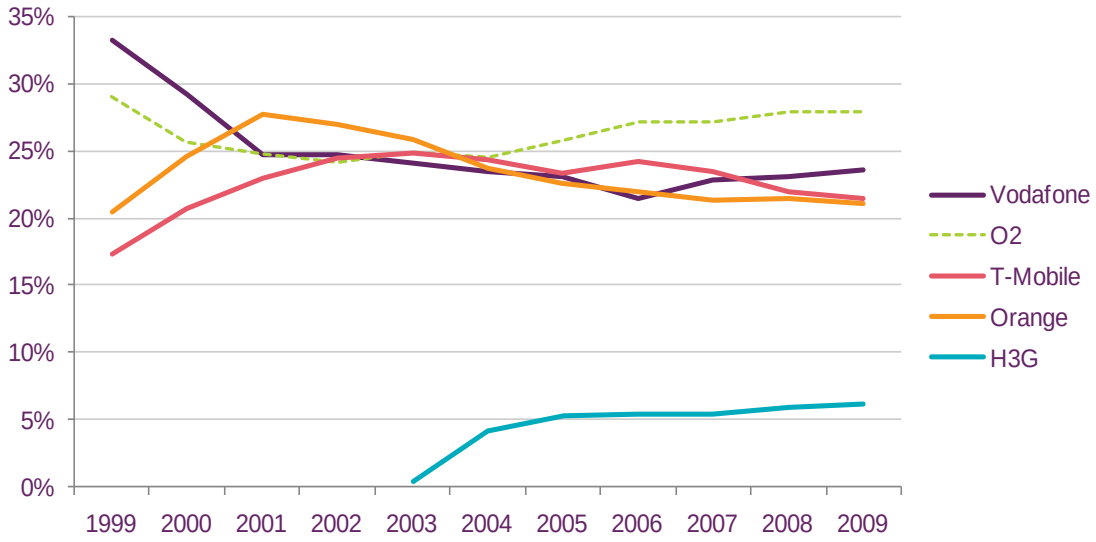
5.3 Before considering the impact of liberalising 900 MHz spectrum for UMTS, we first consider the current position in mobile markets.

5.4 Our December 2009 assessment of the mobile sector concluded that effective competition was occurring within the mobile sector at that time.[9] There was evidence of shifts in retail and wholesale market shares between existing players, robust switching levels, new suppliers (such as MVNOs) have entered the market, and service providers are innovating with new product and price options.

5.5 Figure 5.1 below shows the market shares for total connections to the five MNOs networks. These figures include MVNOs and resellers that use the networks.

[9] See paragraph 3.36 in http://stakeholders.ofcom.org.uk/binaries/consultations/msa/statement/MSA_statement.pdf

Figure 5.1: Market shares for wholesale mobile connections



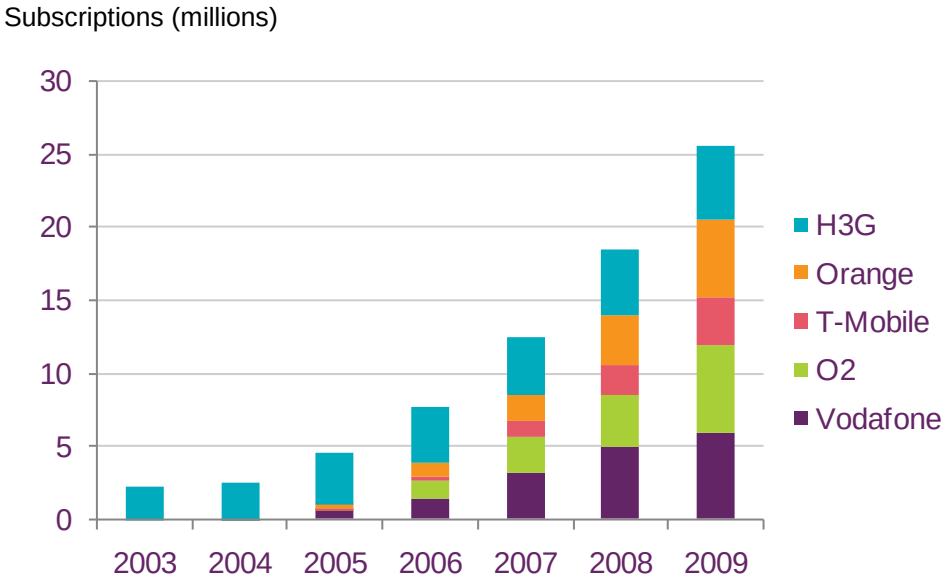
Source: Ofcom/operators
Note: includes estimates where Ofcom does not receive data from operators

5.6 In our mobile sector assessment, we showed how the real cost of a basket of mobile services had fallen over time and this trend has continued.[10] We also presented evidence showing that the UK mobile sector exhibited lower profitability than elsewhere in the EU and evidence that retail pricing was lower. We considered that this provided indirect evidence that the market was working in consumers' interests.[11]

5.7 When assessing the impacts of liberalisation of 900 MHz spectrum for UMTS, we are particularly interested in mobile broadband. Figure 5.2 shows just 3G subscriptions and how these have grown over time and how the relative position of the different operators has changed. These market shares are for all 3G subscriptions, including both datacards/dongles and handsets.

[10] See Figure 5.75 in http://stakeholders.ofcom.org.uk/binaries/research/cmr/753567/UK-telecoms.pdf
[11] See page 19 of our December 2009 mobile sector assessment: http://stakeholders.ofcom.org.uk/binaries/consultations/msa/statement/MSA_statement.pdf

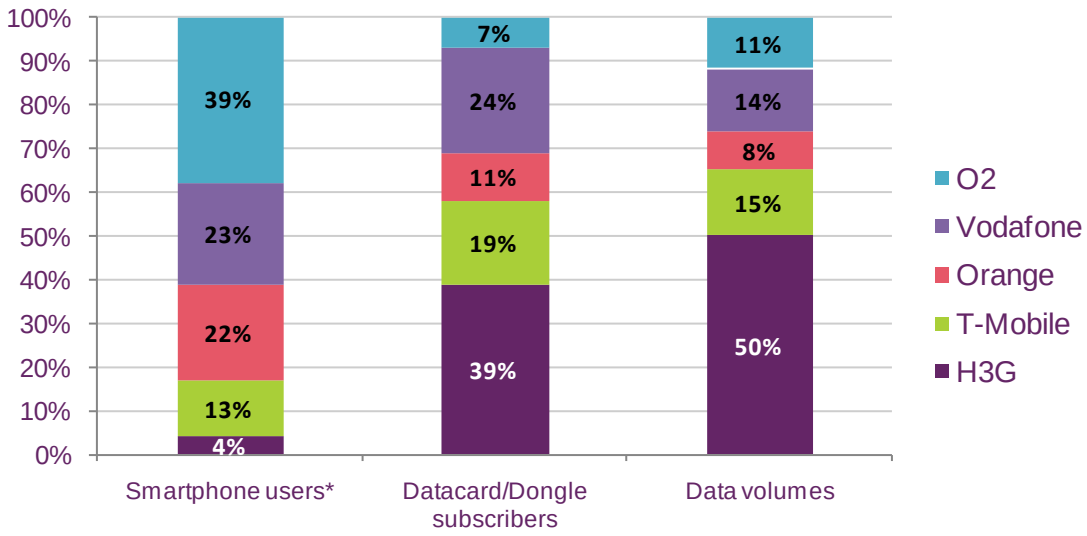
Figure 5.2: 3G subscriptions



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

5.8 Figure 5.3 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 operators varies considerably between the smartphone and datacard/dongle market segments. They also show that H3G has a very high share of data volumes, driven by datacard/dongle use.

Figure 5.3: 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

5.9 Since we completed our mobile sector assessment, T-Mobile and Orange have merged and are now together called Everything Everywhere. 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 subscriptions. This is illustrated in the table below.

Based on 2009 subscriber numbers

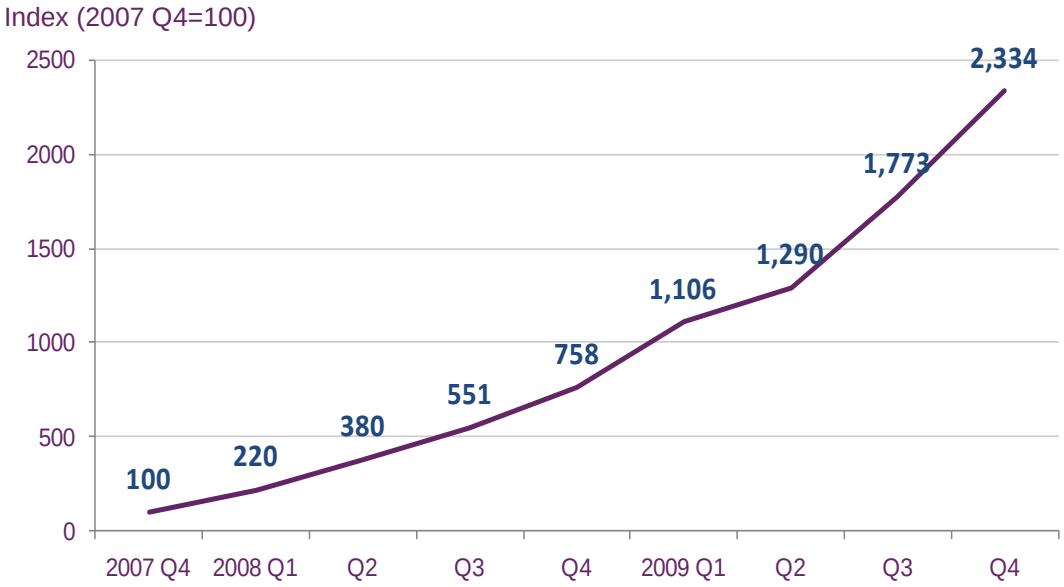
	2G & 3G	3G only
T-Mobile and Orange	42%	33%
O2	28%	24%
Vodafone	23%	23%
H3G	6%	19%

5.10 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.[12]

5.11 We consider that rapid data growth is an important trend that could affect the future competitiveness of mobile markets. Figure 5.4 uses Q4 2007 as a baseline to depict the growth in mobile data volumes, and shows how rapid the growth has been, and continues to be.

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

Figure 5.4: Mobile data use



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.

5.12 In the absence of UMTS900, operators' ability to continue to serve the growing demand depends on UMTS2100 in the short term.[13] In particular, it depends on the amount of 2100 MHz spectrum they hold and their base of sites. Everything Everywhere has the most 2100 MHz spectrum with 2x20 MHz. Vodafone and H3G each have 2x15 MHz and O2 has 2x10 MHz. As well as having the largest 2100 MHz spectrum holding, Everything Everywhere also has access to the greatest pool of sites through the radio access network sharing agreement between the former T-Mobile and H3G, and the integration of Orange's sites.[14]

5.13 We are therefore not starting from a position where the two holders of 900 MHz, Vodafone and O2, have stronger network capability than their rivals. On the contrary, Everything Everywhere, and to a lesser extent H3G, are currently in a stronger position in terms of network capability for providing UMTS services.

Approach to assessment

5.14 Our assessment of the impact on mobile markets of liberalisation of 900 MHz spectrum for UMTS depends on three key factors:

- Whether there is sufficient demand for mobile broadband and whether quality is important enough to consumers for it to be likely that material quality differences could impact on competition;

- The likelihood that UMTS900 provides the holders of 900 MHz spectrum with an unmatchable quality advantage compared to those relying solely on UMTS2100, and the potential significance of any such advantage for competition; and

[13] In theory, UMTS could also be deployed at 1800 MHz. However, we consider that UMTS1800 is unlikely to be deployed, given there is currently a lack of user equipment for it.
[14] Confidential information has been removed from this paragraph.

- The duration of the period over which the holders of 900MHz might enjoy an advantage over the holders of 2100MHz.

5.15 Our view on the first of these factors is that demand for mobile broadband services is significant and growing in importance, and that quality is important to consumers. Hence we consider that it is possible that a quality advantage could lead to a distortion of competition if it were material enough. The evidence for the importance of mobile broadband services and on the importance of network quality, and how this has changed since our February 2009 consultation, is set out in section 4 above.

5.16 Our view on the last factor, the duration of any advantage, is that if the 900MHz operators were to enjoy an unmatchable quality advantage, it would be likely to last for around two to four years. This is broadly the same duration as in our February 2009 consultation. See **Annex 8** for details of this assessment.

5.17 In the next sections, we consider the second factor, that is, whether UMTS900 would give Vodafone and O2 a quality advantage and the potential significance of any such advantage for competition. We are particularly concerned about any quality advantage that O2 and Vodafone's competitors might be unable to match.

5.18 Below, we first summarise our technical analysis for a macro cell network that shows the differences in quality of service that might arise from differences in spectrum holdings. This does not take into account possible responses to any quality advantage through the use of femtocells or other in-building solutions which as discussed in section 4 may offer an effective way to deal with poor inbuilding coverage in some circumstances. We then consider the circumstances in which technical quality differences might convert into a competitive advantage.

Key results from technical analysis for a macro cell network

5.19 Our technical analysis compares the quality of mobile broadband services that could be provided by Vodafone and O2 using UMTS900 with what Everything Everywhere and H3G could provide using UMTS2100. Our analysis has been updated to take account of the T-Mobile/Orange merger and the greater site numbers available to the merged entity as a result, as well as comments received on our February 2009 technical analysis. [15]

5.20 Our modelling makes simplifying assumptions about the distribution of base stations and the 'clutter' (buildings, trees, etc) that surrounds them. In response to comments on our February 2009 analysis, we have examined whether a more sophisticated analysis of these issues would make a material difference to the conclusions of the analysis. That examination indicates that our 'uniform' modelling approach is reasonable for the estimation of quality differences; more specifically, it is unlikely to underestimate the benefits of lower frequencies. This examination is described in **Annex 6**.

5.21 However there remain inherent uncertainties in undertaking a theoretical and forward looking comparison of network performance. Two of the most important uncertainties are:

- Future network deployment by operators, including the rate at which they can acquire new sites, is uncertain. We have considered a number of scenarios for

[15] Confidential information has been removed from this paragraph.

site numbers. The site numbers we have used are based on our judgement of what is likely to be possible.

- The advantage of lower frequencies over higher frequencies in penetrating walls and windows, and hence in providing good quality indoor coverage, varies enormously between different building constructions. This makes it very difficult to accurately determine an average effect and we therefore examine a range of scenarios for how well signals at different frequencies penetrate into buildings ('building penetration loss' or BPL).

5.22 We consider the comparison of a UMTS900 network with 7,000 sites serving the 80% population area, as against a UMTS2100 network with 13,000 sites serving the same area, to be particularly important. This represents what we regard as a credible scenario, where Vodafone and O2 deploy UMTS900 using their existing site bases and Everything Everywhere and H3G complete the H3G/T-Mobile network integration with the inclusion of a number of Orange sites into a larger shared UMTS2100 network. The results we show below are all for this network comparison, and all relate to the 80% population area. We focus on this comparison because we regard it as one of the more likely outcomes and because the results for this comparison give a good illustration of some of the other results. More details on our modelling approach and the results for other site number comparisons are summarised in Annexes 1 and 5.

5.23 There are several aspects to the quality of mobile broadband services that are likely to be important to consumers, including speed of data transfer, consistency of coverage (particularly within buildings), and the capacity of the network to carry traffic. We have considered measures of technical network performance to model this and have chosen three measures which we believe most closely relate to the consumer experience, namely single user throughput, pilot channel quality and data capacity.

5.24 As set out in Annex 1, for pilot channel quality, we do not consider that a 13,000 site UMTS2100 network would be at a material disadvantage when compared to a 7,000 site UMTS900 network. This is because, even though the pilot channel quality is in general better for a 7,000 site UMTS900 network than a 13,000 site UMTS2100 network, the performance of the UMTS2100 network remains above the level likely to be necessary to maintain good service for the majority of locations – only falling below this for approximately the last 5% of locations under the most challenging signal conditions modelled. Given that mobile networks are typically only designed to provide coverage for something like 95% of locations, the pilot channel performance of a 13,000 site UMTS2100 network is therefore not likely to put it at a material disadvantage when compared to a 7,000 site UMTS900 network.

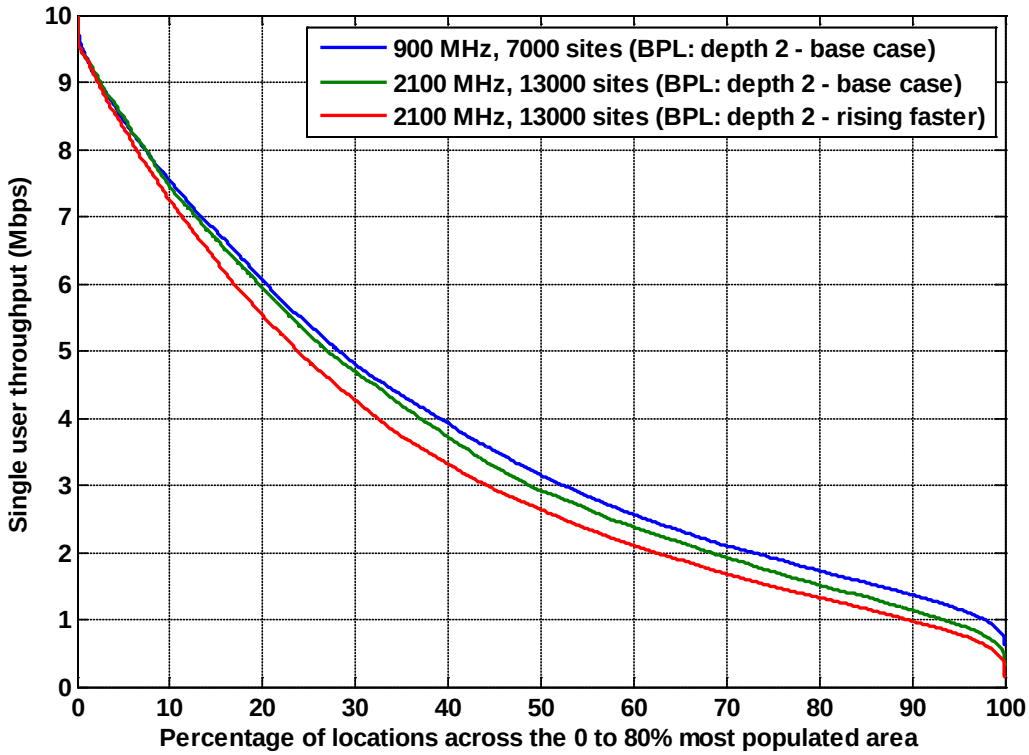
5.25 Similarly, our assessment of capacity to support mobile broadband services (e.g. the number of subscribers that operators can reliably support) indicates that liberalisation would not result in O2 or Vodafone gaining a significant advantage over other operators with respect to capacity. This is because the analysis suggests that the main factors in determining the capacity of a network to serve users at a given data throughput are the number of sites and the quantity of spectrum available, with the specific spectrum bands being used playing a smaller role.

5.26 This leaves single user throughput as the one quality measure where there may potentially be material advantages from the use of UMTS900. Single user throughput is the downlink bit rate which can be successfully delivered to a single active user per cell at a particular depth and consistency of indoor coverage. This is the downlink bit

rate or download speed which a user could experience *when not contending with other users for service in that cell*, so that the cell delivers the maximum possible data rate to a single user consistent with the signal quality experienced by that user. If more than one user was active at any one time in the cell, e.g. if the network was more heavily loaded, each user would receive a share of the maximum throughput.

5.27 Figure 5.5 below illustrates the results for single user throughput. It is for users who are, on average, relatively deep inside buildings and/or for buildings which have, on average, relatively high building penetration losses i.e. circumstances where the differences between frequencies are more likely to be pronounced. We refer to this as 'BPL depth 2'. See Annex 5 for more on BPL and the definition of the different depths. Figure 5.5 shows results for two different assumptions about BPL at depth 2 for the 2100 MHz network (shown as 'BPL: depth 2 - base case' and 'BPL: depth 2 - rising faster' in the results). We believe the true answer, in terms of aggregate effect will lie somewhere within this range, but we cannot say exactly where. (Only three lines are shown in Figure 5.5 because for 900 MHz there is no difference between BPL: depth 2 – 'base case' and 'rising faster' cases.)

Figure 5.5: Throughput for a UMTS900 network with 7,000 sites distributed over the 80% population area compared with a 13,000 site UMTS2100 network over the same area. BPL: depth 2, base case and rising faster with frequency

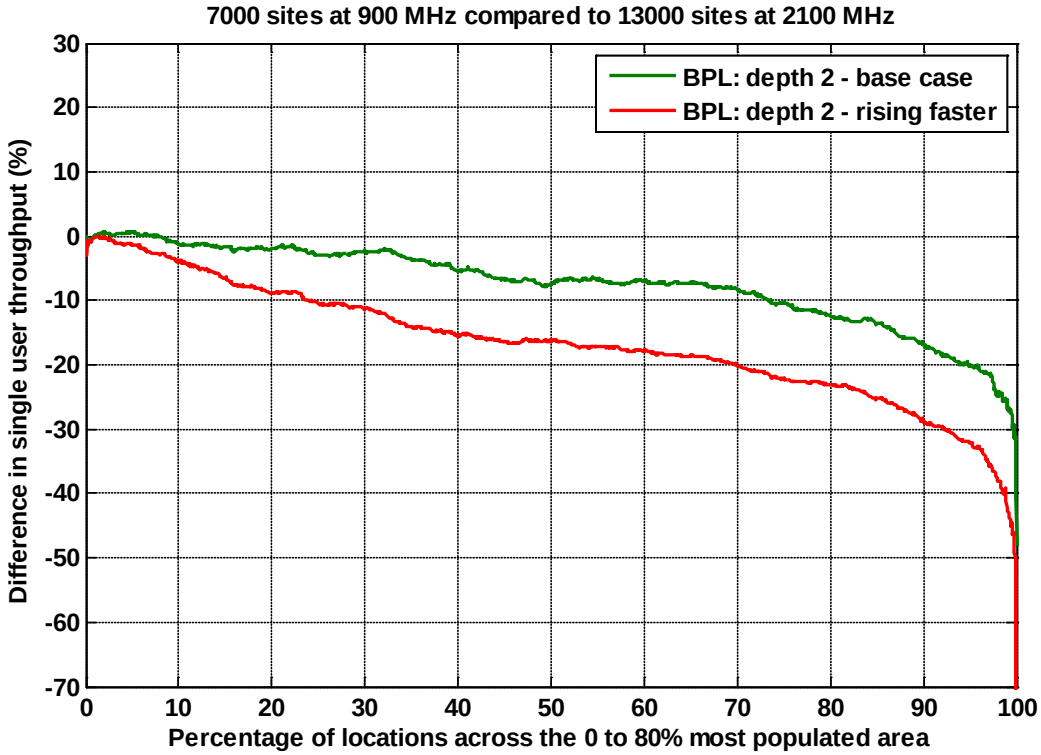


5.28 Figure 5.5 should be interpreted as follows: the x-axis indicates the percentage of locations at 'depth 2' across the whole coverage area ordered such that those having the best signal conditions are to the left, and those with the worst to the right. So "20%" in Figure 5.5 represents the 20% of locations with the best signal conditions and hence highest throughput for each of the 900 MHz and 2100 MHz networks (these are not necessarily the same 20% of locations). The y-axis shows the throughput attained or exceeded at all of these locations when a single user consumes the full capacity of the serving cell (e.g. in a single sector of one base

station site). Thus we see that both the 900 MHz network and the 2100 MHz network with base case BPL achieve a single-user downlink speed of at least 6 Mbps to the first 20% of depth 2 locations. By contrast the 2100 MHz network with 'rising faster' BPL can deliver 6 Mbps to only the first 17% of locations, but can still deliver at least 5.5 Mbps to the first 20% of locations.

5.29 An alternative view of the same comparison is given in Figure 5.6. In this figure the y-axis shows the percentage difference in the single user throughput for the 2100 MHz network compared to the 900 MHz network. So for example, the minimum throughput offered to the 80% of locations that are easiest to serve is somewhere between approximately 12% and 22% lower for the 2100 MHz network when compared to the 900 MHz network. As noted above, we believe the true answer in terms of aggregate effect will lie somewhere in this range, between the red and green lines on this graph, but we cannot say exactly where.

Figure 5.6: Percentage difference in throughput for a UMTS900 network with 7,000 sites distributed over the 80% population area compared with 13,000 sites at UMTS2100 over the same area. BPL: depth 2, base case and rising faster with frequency

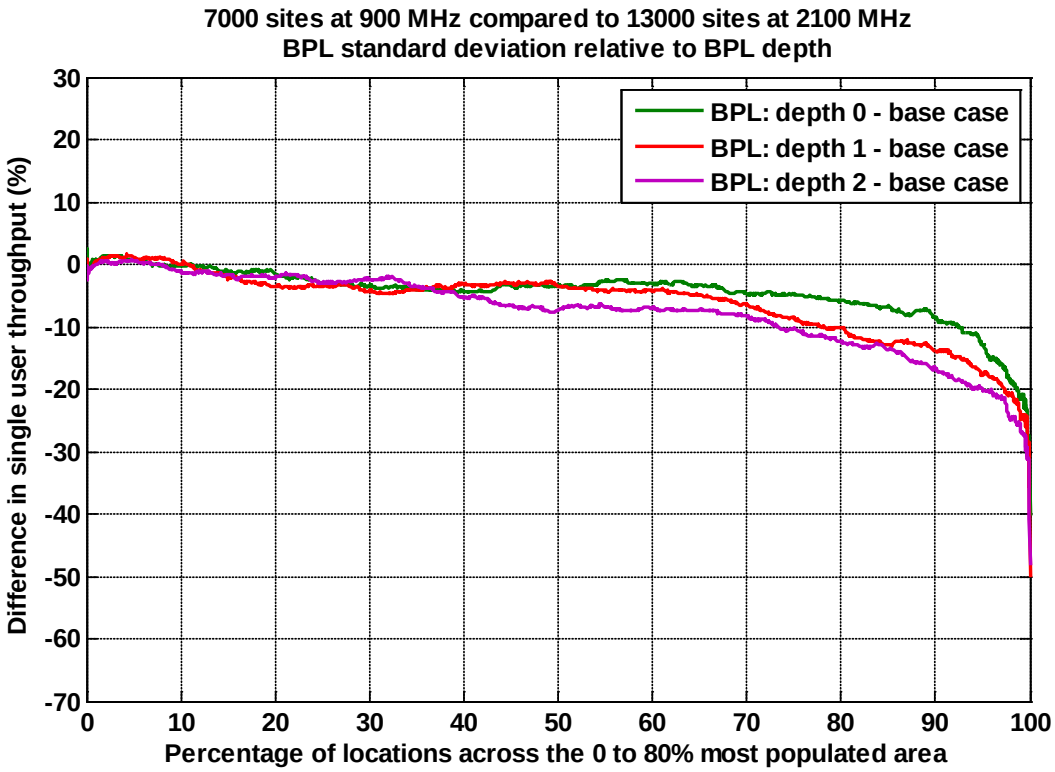


5.30 Thus our analysis indicates that a UMTS900 network, even with considerably fewer sites than a UMTS2100 network, can deliver a small throughput advantage in many locations and a larger advantage in those locations which have the most challenging signal conditions and hence the lowest data throughputs.

5.31 However, the importance of this advantage depends strongly on the location of users and construction of buildings, with relatively little or no advantage experienced for buildings of relatively light attenuation or where users are not particularly deep within the building (e.g. when they are close to windows). Under such circumstances the throughput performance at both frequencies is relatively similar and little advantage may be experienced for users on the 900 MHz network. This is illustrated in Figure

5.7 which compares the percentage difference in single user throughput for building penetration loss at depth 0, depth 1 and depth 2 using base case BPL assumptions (see Annex 5 for the definition of the different building penetration loss depth measures).

Figure 5.7: Percentage difference in throughput for UMTS900 network with 7,000 sites distributed over the 80% population area compared UMTS2100 with 13,000 sites over the same area. BPL depths 0, 1 and 2 - base case and BPL standard deviation relative to BPL depth



5.32 From these results we can see that at depth 0, under these assumptions, a 13,000 site 2100 MHz network can come close to matching the single user throughput performance of a 7,000 site 900 MHz network for the majority of locations (it only dips below 10% less throughput for the last 8% of locations or so – i.e. beyond 92% of locations on the graph).

5.33 We consider that our technical analysis provides a good indication of the potential magnitude of any advantage for the scenarios considered. We have modelled a number of scenarios that we believe encompass a reasonable range of situations likely to be encountered by a real network (e.g. different building types, locations, traffic loadings, etc). However, the results of this modelling show that the magnitude of the advantage varies significantly between these scenarios. Therefore, based on the technical modelling we have carried out and noting the uncertainties above, we think that, whilst useful, it is unlikely that technical modelling will provide conclusive evidence to demonstrate whether an unmatchable technical advantage exists or not.

Likelihood of competitive distortion arising from liberalisation of 900 MHz for UMTS

5.34 When considering the potential for competitive distortion to arise from liberalisation of the 900MHz spectrum for UMTS it is important to note that we are not starting from a position where the two holders of 900 MHz, Vodafone and O2, have stronger network capability than their rivals. On the contrary, Everything Everywhere, and to a lesser extent H3G, are currently in a stronger position in terms of network capability for providing UMTS services.

5.35 However, our technical analysis of macro cell networks suggests that an advantage may pass to O2 or Vodafone if they deploy UMTS900 widely across their existing networks. Based on the results summarised above, and in other scenarios considered in Annex 1, Vodafone and O2 may have a small speed advantage in more challenging conditions – relatively deep inside buildings further from the base station – with a larger advantage in the very hardest-to-serve places. However, in many easier to serve indoor locations liberalisation of 900 MHz for UMTS would result in little or no advantage to O2 or Vodafone.

5.36 A key uncertainty is how prevalent hard-to-serve indoor locations will be in practice and hence how difficult it might be to remedy the problem using other solutions. If these conditions are not very widespread then deployment of femtocells or other in-building solutions may be an effective way for operators without 900MHz spectrum to mitigate this disadvantage. Our technical analysis, and hence the graphs above, do not take account of femtocells or other in-building solutions.

5.37 We next need to consider whether potentially having a throughput advantage in some locations would convert into a competitive advantage. This depends on various factors. These include how prevalent the locations are where there is an advantage, whether consumers would have sufficient information about the performance of different networks to make decisions on that basis and the value consumers placed on better coverage in the hardest-to-serve places relative to other aspects of service. While there is evidence suggesting that network coverage matters to consumers (see, for example, paragraph 4.2 above), it is not clear how much difference having better coverage in just the hardest-to-serve locations would make.

5.38 Even if Vodafone and O2 were likely to enjoy some improvement in their competitive position as a result of the liberalisation of the 900 MHz for UMTS, we do not consider that this necessarily implies that competition is distorted. Even if there were an unmatchable competitive advantage, this may not necessarily be material enough to distort competition. In competitive markets, it is not unusual for some operators to have temporary advantages over others at particular points in time. For example, Everything Everywhere and H3G currently have access to a more extensive UMTS2100 network than Vodafone and O2. Small differences in some aspects of quality are common in competitive markets, and do not necessarily imply any distortion of competition. Furthermore, if Vodafone and O2 were to enjoy some competitive advantage from the liberalisation of 900 MHz for UMTS, it would likely only be temporary. We believe it would last for around 2 to 4 years.

5.39 On balance, our view is that the liberalisation of 900 MHz for UMTS is unlikely to result in such a material unmatchable advantage for Vodafone and O2 that it could be regarded as distorting competition. This is because any throughput advantage is likely be modest in most locations. Only in the very hardest-to-serve locations is there likely to be a material technical advantage for Vodafone and O2. It may also be

possible for Everything Everywhere and H3G to respond to this, at least in part, with the deployment of femtocells or other in-building solutions.

5.40 While there remain some uncertainties, the direction of change compared to our February 2009 analysis is that both the likelihood of a significant quality advantage and its likely magnitude are reduced by the increased site numbers available to Everything Everywhere (as a result of the merger), refinements to our technical analysis and the potential for commercial use of femtocells and other in-building solutions. [16]

5.41 We therefore consider that the liberalisation of 900 MHz for UMTS is unlikely to distort competition, but we cannot completely rule it out. This is because of the many inherent uncertainties in the analysis. We have therefore gone on to consider whether any remedies would be justified and proportionate in light of this potential, albeit in our view low, risk – see section 6 below.

Risk of competitive distortion arising from lower costs of using UMTS900

5.42 We have also considered the argument that the likely lower costs of providing mobile broadband services using 900MHz spectrum, as compared with higher frequencies, might indirectly give rise to a competitive distortion as a result of an asymmetric profit shock, for example, a windfall gain to those operators with 900MHz licences. It would be possible for large asymmetric profit shocks to have an impact on competition if they were to lead to a firm exiting the market, but we consider this to be unlikely in this case. This is because there are large sunk costs in the radio access network and we do not consider that any profit shocks arising from liberalisation of 900MHz for UMTS would likely be sufficiently large to force firms to exit the market. Given we think market exit is unlikely, we continue to consider it unlikely that asymmetric profit shocks would have a material effect on competition, for the reasons set out in our February 2009 consultation.[17] We also note that if annual licence fees for the 900MHz spectrum were to be revised to reflect the full market value of the spectrum, then this may reduce any such windfall gain and hence any risk of competitive distortion arising as a result.

Productive efficiency considerations

5.43 In addition to considering whether liberalising the 900 MHz band for UMTS would be likely to distort competition, we have in light of our statutory duties (including in particular our duty to have regard to the desirability of promoting the efficient use of the spectrum and the economic benefits that may arise from the use of wireless telegraphy), considered the likely relative productive efficiency of using the various different bands for UMTS use in order to determine whether these considerations might separately warrant any intervention.

5.44 The main productive efficiency[18] consideration is that the 2100 MHz operators might be able to save network costs by having fewer sites if they had access to 900 MHz spectrum for UMTS use, which might imply more efficient use of the spectrum. In our February 2009 analysis we considered that the productive efficiency benefits of wider access to 900 MHz could be considerable. We considered that if the 2100 MHz

[16] Confidential information has been removed from this paragraph.
[17] See paragraphs 5.102 and A8.107 to A8.114 of http://stakeholders.ofcom.org.uk/binaries/consultations/spectrumlib/annexes/annex8.pdf
[18] i.e. producing a certain level of output with the minimum resources, or at minimum cost to society.

operators tried to match the services offered by the 900 MHz operators they would have to build a large number of new sites. We assumed that these sites would only be used for a short period and would start to be decommissioned when 800 MHz was available. In some scenarios we estimated that the productive efficiency savings was £750 to £850 million, though responses challenged some of the assumptions underlying this. The main driver in these productive efficiency savings was from existing 2100 MHz operators avoiding the cost of building a large number of new sites. The cost of building a new site is considerably more expensive than the cost of upgrading an existing site.

5.45 We now consider that any productive efficiency benefits of wider access to UMTS900 would be much smaller. The merger of T-Mobile and Orange means that Everything Everywhere will be reducing the number of 2100 MHz sites it has, as it integrates Orange's network. If the availability of 900 MHz would mean that more sites would be decommissioned, then we consider that this would be likely to happen anyway if Everything Everywhere acquire the right to use 800 MHz at a later date. The productive efficiency benefits of any remedies would therefore most likely consist only of operating costs for sites for a short period[19], as they would be decommissioned slightly earlier than they otherwise would have been. The costs of operating sites for two or three years are far lower than the costs of building new sites. By way of illustration, we estimate that the cost of operating 5,000 sites for two years might be of the order of £10 to 30 million. However, we do not necessarily consider that the most likely scenario is that 5,000 extra sites would be decommissioned sooner if 900 MHz were available. The 2100 MHz operators may wish to retain an extensive UMTS2100 layer for capacity even if they have access to 900 MHz. Any productive efficiency benefits would therefore likely be much smaller.[20]

[19] The period of any benefit would be shorter than the period of around two to four years that we consider would be the likely duration of any competitive advantage for Vodafone and O2 from UMTS900 if we were to liberalise in the hands of incumbents. This is because any remedy is likely to lead to access to UMTS900 for one of the 2100 MHz operators somewhat later than when Vodafone or O2 could launch UMTS900 if no remedies were imposed.
[20] Confidential information has been removed from this paragraph.

Section 6

Are any potential remedies justified and proportionate?

6.1 In the previous section we set out why we consider the risk and magnitude of a distortion of competition is likely to be low. However, we also said that because of the inherent uncertainties, we could not completely rule out the risk of a distortion of competition. In this section, we therefore consider whether any potential remedies are likely to be justified and proportionate.

6.2 Our conclusion is that the potential remedies are not justified and proportionate.

Assessment of options for liberalisation in February 2009

6.3 In our previous assessment in February 2009, our view at the time was that the relative merits of the principal options for liberalisation – liberalisation in the hands of the incumbents, mandatory wholesale access, one block release and two block release – were finely balanced. However, for the reasons summarised in section 3 above, we considered that one block release was likely to be the best option. Also, as set out in section 4 above, we consider that there have been very significant changes in circumstances since February 2009.

6.4 Our previous assessment included a detailed quantitative analysis of the costs and benefits of the options. However, we also relied on a wider qualitative assessment because the significant and multiple uncertainties affecting the quantitative analysis meant that it did not yield definitive results. Similarly, given that we still believe that there are inherent and material uncertainties that we cannot qualify, we consider that further quantitative assessment would add no substantive insight to the decision that needs to be made now. Quantitative assessment would not help resolve the key uncertainties nor provide a more definitive assessment of the options. Hence we have not repeated the type of quantitative analysis we undertook in the February 2009 consultation.

Framework for assessing options

6.5 The underlying framework for our assessment is as follows. This framework was also implicit in our February 2009 assessment. For ease of explanation, we take the option of liberalisation in the hands of the incumbents and compare the other options to it. In particular we assess:

- The **maximum potential benefit** of intervention relative to liberalisation in the hands of the incumbents, which is largely determined by the risk and magnitude of a material distortion of competition, and is the same for all options.

- Since there are differences in how the options work, we consider their likely **effectiveness**, i.e. the extent to which each could achieve the maximum potential benefit in principle and the risk that the option fails to achieve its objectives (which is a type of regulatory failure).

6.6 We then consider the potential costs of the options relative to liberalisation in the hands of the incumbents. This determines whether each option is proportionate given

the potential benefits and the effectiveness of the option. The costs fall into two categories:

- The **direct costs** of implementing the option
- **Indirect costs** and **risk of unintended consequences**[21] (which is another type of regulatory failure) including any costs which might arise in the longer term.

6.7 We now look at each option in turn.

One and two block release

6.8 We now consider that the risk and magnitude of a distortion of competition is likely to be low (and in particular lower than we thought in February 2009). Hence the maximum potential benefit compared to liberalisation in the hands of the incumbents is likely to be low.

6.9 But if there were a distortion of competition, our view on the ultimate effectiveness of one block release is unchanged. Namely, to the extent 900MHz gives an unmatchable advantage, one block release would be likely to be reasonably effective. It would allow at least one operator to match the quality of the 900MHz incumbents, and it is possible, but not certain, that the market would offer commercial access to any other operator without 900MHz spectrum, given there would then be three holders of 900MHz spectrum.

6.10 However, it would take some time for another operator to be able to use UMTS900 with released spectrum. The existing 900MHz operators would need to be given sufficient time to clear a sufficient amount of 900MHz to both release spectrum for others and to launch their own UMTS900 service. We would also need to hold an auction for the right to use the released 900MHz and the acquirer would probably want to have the certainty of the completion of the auction before starting substantial work on deploying UMTS900. This delay reduces the benefits of one block release.

6.11 Release could have a benefit in terms of improved productive efficiency. However, for the reasons set out in paragraph 5.45 above, we consider that any such benefit is likely to be small.

6.12 In terms of the direct costs of release, our revised estimate of the costs of one block release, taking into account responses to the Consultation, is, at £60m to £210m, somewhat higher than our previous estimate of £60m to £90m. (see **Annex 3**).

6.13 There would also be indirect costs from release and potential unintended consequences. Firstly, we believe that forced release could delay the benefits of UMTS900 for consumers since it could disrupt the plans of the existing holders to deploy UMTS900 relatively quickly.

6.14 Secondly, forced release could even lead to the 3G market being less competitive for a while, as compared with the situation if we were to liberalise in the hands of the incumbents. Some of the existing 3G operators have less spectrum, and fewer sites than others, in particular than Everything Everywhere. Some of these operators are, we understand, starting to experience real difficulties in meeting the rapidly growing demand for mobile broadband from consumers. As discussed elsewhere, liberalised 900MHz spectrum might be used to address this capacity problem, and this could

[21] Unintended consequences can also be positive, though we consider this less likely in these cases.

potentially be done quite quickly. If the current holders of 900MHz spectrum are forced to release part of their existing holding there is a very real risk that they will not be able quickly to use 900MHz for capacity expansion and consequently be unable to quickly expand the capacity of their own 3G network to be able to cope with growing demand. In these circumstances it is entirely possible that they would have to throttle back their efforts to attract new mobile broadband customers. Until UMTS900 is deployed, the existing 900MHz operators will continue to rely on UMTS2100 to provide mobile broadband. Different operators have different holdings of 2100MHz spectrum and site portfolios. If the existing 900 MHz operators delay the launch of UMTS900, this is likely to strengthen the relative competitive position of the operators with the most 2100MHz spectrum and sites, in particular Everything Everywhere. Thus competition in the market for mobile broadband customers could be less intense for a while than it would be if we were to liberalise the 900MHz spectrum in the hands of the incumbents.

6.15 We also note that one block release could now have another undesirable unintended consequence. If Everything Everywhere won the released block, there is a risk that they might obtain an unmatchable advantage over the other operators, given the larger pool of sites to which it now has access as a result of the merger.

6.16 Another potential unintended consequence would be if requiring release of some 900 MHz spectrum were to have some detrimental effect on future investment in the use of spectrum more generally. This could be the case if requiring release were to lead to a perception that Ofcom may revoke other spectrum licences. However, we believe that this would be a low risk, because there are very particular circumstances relating to the 900 MHz spectrum in this case, and because we have consulted extensively on this issue.

6.17 For the reasons set out above, we now consider that release is unlikely to be justified and proportionate. Compared to our February 2009 consultation, when we considered the options finely balanced, the maximum potential benefits are now likely to be lower, the direct costs of one block release are if anything likely to be somewhat greater than we previously estimated, and there are indirect costs and potentially adverse unintended consequences that we believe are also somewhat greater than we previously thought.

6.18 The direct and indirect costs of two block release remain materially higher compared to one block release, and, as in our previous assessment, the additional benefits of two block release are uncertain, hence we consider that two block release is even more unlikely to be justified and proportionate.

Regulated access

6.19 If the terms for regulated access were set appropriately, regulated access could be an effective and low cost way of remedying any distortion to competition resulting from uneven holdings of 900 MHz spectrum. Like release, regulated access could also have a benefit in terms of improved productive efficiency, though we consider any such benefit is likely to be small for the reasons set out in paragraph 5.43 – 5.45 above. The direct costs of implementing a regulated access solution are, we believe, still likely to be relatively low (compared to spectrum release).[22]

[22] If Vodafone and O2 are required to build a larger UMTS900 network than they otherwise would, then they should be remunerated for this through access charges. Provided it is cheaper to provide

6.20 In order to set up access it will be necessary for the terms of this access to be agreed between the different parties who are seeking and providing access – or if agreement cannot be reached, be determined by us, the regulator. The success or otherwise of access as a remedy will depend upon the nature of this agreement. It can be particularly difficult to agree terms when setting up regulated access as the incentives of the different parties involved are not well aligned. This can also impact upon the time it takes to reach agreement. Hence, when assessing the benefits of regulated access we think it is important to take these factors into account.

6.21 There are two opposing ways in which the access terms eventually put in place might not be effective, or have unintended consequences.

- Firstly, the terms could be too generous to access seekers. This could be very detrimental for consumers. Vodafone and O2 may be disincentivised from rolling out UMTS900, or at least may roll out less widely or more slowly than they otherwise would. This would reduce the benefits of UMTS900 for consumers. Moreover, the 3G market may become less competitive for a while, as compared with the situation if we were to liberalise in the hands of the incumbents, for the reasons set out in paragraph 6.14 above.

- Alternatively, the terms could be too harsh for access seekers. In this case regulated access may be ineffective, as access seekers may not be prepared to use UMTS900. In this situation, there may be no benefits from imposing regulated access, although the costs of the remedy might also be small. However, even if the terms eventually imposed were too harsh to access seekers, before the terms were finalised there could be more serious unintended consequences. In particular, Vodafone or O2 may be more cautious than they otherwise would be about rolling out UMTS900 in case the terms were too generous to access seekers. This could reduce the benefits of UMTS900 for consumers.

6.22 Reaching an agreement on appropriate terms in a timely manner is key to realising the benefits of regulated access. We therefore need to consider whether it is likely that the regulated terms of access could be set in an appropriate way and regulated access made effective. Regulated access is very different to commercial access. The commercial interests of the parties are unlikely to be aligned. The access providers may not want to give access on acceptable terms. Regulated access is also different from commercial access in that the access provider does not have the option of walking away from the negotiations, so access seekers may have an incentive to push for generous terms.

6.23 In addition, even after an access agreement is in place, the access provider(s) may have an incentive to try to frustrate access through the way the agreement is implemented at an operational level. The situation may be different from a normal commercial relationship where to some extent parties may be prepared to work together to make access arrangements work successfully. This tends to mean that regulated access agreements have to be sufficiently detailed and well specified to ensure that in practice the access providers are unable to frustrate access.

6.24 In order to inform our view on how easy it would be to put in place effective access terms, we have carried out further research on the technical challenges to implementing regulated access (see Annex 4). This research shows that there are

---

the additional capacity with 900 MHz rather than 2100 MHz, then there would be no costs to society from any additional network deployment.

specific technical challenges to the implementation of access solutions to address coverage differences arising from the deployment of UMTS900 – challenges that would require specific consideration compared to typical roaming agreements. In typical roaming agreements, access is provided over pre-identified, relatively large contiguous areas (e.g. a whole country or part of a country, such as rural areas). However, in the case of UMTS900, access would be needed in a large number of small geographic areas (e.g. areas within buildings which are hard to cover) and across the whole of the access provider's network. The operators involved would need to find ways of dealing with the multiplicity and potential variability of areas where access is required, forecasts for how many users are likely to be moving on and off the access provider's network and corresponding user numbers and load at any one time across their respective networks. This would also be likely to present some commercial challenges for both sides, to balance investment in their networks and quality of service for their customers. Resolving these challenges in the context of regulated access might raise particular difficulties. This research also shows that there can be distortions and problems created by inappropriate access terms, which can potentially degrade performance for all customers (both home and roaming).

6.25 Hence, overall, we consider there to be a material risk that it would not be possible to achieve agreement on appropriate terms to a regulated access agreement in a timely manner, and/or to police its implementation in a way which ensured that the intended benefits of such an intervention were realised.

6.26 In conclusion, we consider that it would be difficult to put in place an effective access regime in a timely manner and there would be a material risk of putting in place a regime that had some detrimental effects. Hence, given that we consider the risk and magnitude of a distortion of competition to be low, and that regulated access may not necessarily be effective and involves potential risks of unintended consequences, we do not consider that regulated access would be a justified and proportionate option.

Delaying liberalisation

6.27 Subject to the UK's obligations under the amended GSM Directive and associated RSC Decision, another option might in theory be to delay liberalisation until either: (a) an assessment of the prospects for competition in the longer-term has been completed, and any measures intended to promote competition in the longer term, e.g. through the award of the 800MHz and 2.6GHz spectrum, have been at least decided upon if not implemented; or (b) some or all of the 800MHz spectrum is actually available for competing mobile broadband use.

6.28 The first of these options might be appropriate if the impact on consumers of delaying liberalisation by around 9 to 12 months (the time likely to be necessary to undertake a long-term competition assessment, consult on it and make decisions) was not material, and the result of considering both short-term and longer-term competition issues together was likely to give a better outcome for consumers than considering them separately and sequentially. However, we consider the impact on consumers of delaying liberalisation any further to be materially detrimental for the reasons set out in section 1 and in Annex 2. Moreover, we consider that a sequential analysis of the competition issues arising from liberalisation of the existing 2G spectrum for UMTS, and the opportunities to promote competition through the award of the 800MHz and 2.6GHz spectrum and liberalisation of existing 2G and 3G spectrum for other technologies is unlikely to lead to a materially sub-optimal outcome for consumers. This is because we are confident that it will be possible to design the auction and/or take other steps so as to effectively promote competition through the award of the 800 MHz spectrum.

6.29 So far as delaying liberalisation of the 2G spectrum until 800MHz spectrum is available is concerned, this would only be an appropriate option if the risks of competitive distortion arising from 2G liberalisation, and the consequent impacts on consumers, were greater than the significant benefits that we believe consumers will enjoy as a result of 2G liberalisation. Our analysis of the risks of competitive distortion and the benefits of liberalisation leads us strongly to believe that this would not be the case.

6.30 We also note that delaying liberalisation would be likely to have differential impacts amongst the operators given their different holdings of 2100MHz spectrum and site portfolios. Delaying liberalisation would be likely to strengthen the relative competitive position of the operators with the most 2100MHz spectrum and sites, in particular Everything Everywhere. This could lead to the market being less competitive in the interim, which would likely not be in the interests of consumers.

Section 7

Liberalising 1800MHz spectrum for UMTS use

7.1 This section summarises our assessment of the options for liberalising 1800MHz in the February 2009 consultation and sets out our updated thinking.

Analysis in the February 2009 consultation

7.2 Our February 2009 assessment considered the potential impacts of liberalising 1800MHz spectrum for UMTS. Our analysis showed that 1800MHz spectrum had similar properties to 2100MHz spectrum, and worse than 900MHz, for providing higher quality coverage. So, the potential benefits of using 1800MHz compared to other bands for UMTS related only to providing additional capacity.

7.3 Our view was that 1800MHz spectrum was also unlikely to have an unmatchable advantage in providing UMTS capacity because other MNOs appeared able to obtain sufficient capacity to meet likely demand, either by using existing spectrum (900MHz and 2100MHz) or purchasing new spectrum (2.6GHz). Moreover, even if an operator did not have or could not acquire the right to use sufficient spectrum, it had other (though potentially more costly) options for increasing capacity such as:

- Deploying more base stations
- Using other technologies such as femtocells to carry some of its traffic
- Network sharing

7.4 We also noted the lack of industry momentum at the time behind the development of UMTS1800 equipment. Hence we concluded that liberalisation of 1800MHz spectrum for UMTS in the hands of the incumbents was unlikely to lead to competition concerns. We also concluded that, if there were efficiency advantages from a wider distribution of 1800MHz, it was plausible that the market would achieve this (e.g. through spectrum trading) given the absence of competition issues and the fact that four operators already held 1800MHz spectrum.

7.5 The consultation also considered potential issues associated with liberalising 1800 MHz spectrum for other technologies, notably its potential future use for LTE but we do not consider those issues further here as the current proposal by Government is to liberalise for UMTS and not other technologies.

Responses to the Consultation and our updated thinking

7.6 There was a relatively limited response to the consultation on the question of 1800 MHz spectrum liberalisation for UMTS use, and the responses we did receive focused on the longer term issues around the use of 1800MHz spectrum for LTE.

7.7 Since the February 2009 consultation, T-Mobile and Orange have merged in the UK to form Everything Everywhere. In reviewing the merger, the European Commission

considered whether any competition problem might arise out of the holding of the majority of 1800MHz spectrum by the merged entity and considered that there was a potential risk in respect of LTE, but not UMTS. However, T-Mobile/Orange offered to divest 2x15 MHz of their 1800MHz spectrum, which the European Commission considered to be sufficient to mitigate this risk.

7.8 Our view therefore continues to be that the risk is low of the existing holders of 1800MHz spectrum obtaining an unmatchable competitive advantage as a result of liberalisation of that spectrum for UMTS, in particular given the large quantity of additional spectrum that will be becoming available in the future and the requirement on Everything Everywhere to divest 2x15 MHz of 1800MHz spectrum.

Section 8

Summaries of supporting annexes

8.1 This section provides a short summary of each of the supporting annexes to this paper.

Annex 1 Overview and results of our technical analysis of potential quality advantages of 900MHz spectrum for UMTS

8.2 Annex 1 describes results of technical analysis we have conducted on the potential for a quality advantage associated with UMTS networks for holders of 900MHz spectrum compared with those with access only to 2100MHz. The analysis accounts for both the physical characteristics of the spectrum and the difference in the site numbers likely to be accessible to the operators. We have chosen to model three aspects of network performance which we believe are likely to impact user experience to a significant degree: single user throughput, pilot channel quality and data capacity. We have considered network deployments in the most densely populated areas of the country, covering 80% of the population.

8.3 Our analysis indicates that a 900MHz network, even with fewer sites than a 2100 MHz network, can deliver a throughput advantage in those locations which have the most challenging signal conditions and hence the lowest data throughputs. The likelihood of a throughput being too low to sustain a particular application with sufficient quality is reduced. However the magnitude of this advantage depends strongly on the construction of buildings, with relatively little or no advantage experienced for buildings of relatively light attenuation or which are closest to base stations, or when users are outdoors. In many other situations where a 2100MHz network has access to more sites than a 900MHz network, the 900MHz network has no advantage at all and may actually deliver less throughput.

8.4 Pilot channel quality is a key network performance indicator for UMTS networks. The pilot channel (CPICH) aids estimation of channel quality and is important in cell selection and handover. Unless a terminal can ‘see’ the pilot channel with sufficient quality it cannot access the network. As is the case for the throughput analysis above, the significance of any advantage enjoyed by 900MHz networks depends strongly on the construction of buildings, with relatively little advantage experienced within buildings of relatively light attenuation or which are closest to base stations. At such locations little practical advantage will be experienced by a 900MHz network. However at more difficult to serve locations a 900MHz network may be able to provide a more consistent quality of coverage than a 2100MHz network, even with fewer sites.

8.5 Our analysis suggests that the main factors in determining the capacity of networks to serve users at a given data throughput are the number of sites and the quantity of spectrum available, with the frequency of the bands employed playing a relatively minor role. Our analysis shows that EE / H3G are likely to have as much, if not higher capacity, than Vodafone or O2.

Annex 2 Benefits of timely liberalisation for UMTS

8.6 This annex provides information on the benefits to consumers of liberalising 900MHz and 1800MHz spectrum for UMTS and illustrates the impact of a delay to liberalisation on consumers. First we describe the benefits of liberalisation to consumers qualitatively, in terms of better quality of service and cheaper and faster increases in capacity. Then we provide some evidence from our technical analysis to illustrate the improved quality that a UMTS900 network would provide compared to a UMTS2100 network of the same size.

8.7 We illustrate the impact of a delay to liberalisation by estimating how many fewer sites could be deployed in a UMTS900 network by start of 2013 (the earliest that it is likely to be possible to deploy a UK-wide UMTS900 network if liberalisation happened as soon as possible) if liberalisation were delayed by a year. We then compare the difference in quality between this smaller network and the full national network.

Annex 3 Update analysis of costs of release

8.8 This annex provides our revised estimates of the cost of releasing 900MHz spectrum in the light of the responses we received to our February 2009 consultation.

Annex 4 Overview of technical challenges in implementing regulated roaming

8.9 This annex investigates the technical challenges of implementing access to a UMTS900 network as a remedy to any coverage difference between 900MHz and 2100MHz networks. We consider how the roaming arrangements required here differ from more common access arrangements because of the need to provide in-building coverage.

Annex 5 Description of technical modelling approach and response to technical analysis contained February 2009 consultation

8.10 Annex 5 describes the approach we have used for technical modelling of the potential advantages of UMTS operating at 900MHz versus 2100MHz. It underpins the results presented for both the uniform clutter modelling reported in Annex 1 and the investigation of the impact of non-uniform site and clutter distributions reported in Annex 6. The Annex comprises the following sections:

- Modelling Approach, which describes the model we have used for generating the results in the main paper.
- Parameters and Assumptions, which tabulates the parameters used within the model.
- Summary of issues raised in response to February 2009 consultation, which summarises the main issues that were raised in response to the technical modelling work in our February 2009 consultation, and our responses thereto, covering in particular those comments which have led to changes in our modelling approach.

Annex 6 Technical analysis using non-homogeneous network deployment in sample areas

8.11 Annex 6 provides the results of additional modelling carried out to look at the impact of non-uniform site and clutter distributions. This analysis considers a more realistic distribution of sites overlaid on the clutter distribution for a sample area centred on west London. The aim was to establish whether the results obtained from the uniform clutter model for the 80% population area provide a reasonable approximation of network performance in the real world where sites and clutter are non-uniform. The results from this analysis suggest that the 'uniform' modelling approach is more likely to overstate rather than understate the differences in performance between 900MHz and 2100MHz networks, although the differences are not particularly large. Our overall conclusion is therefore that the 'uniform' modelling approach does provide a reasonable approximation of real network performance in this regard.

Annex 7 Assumptions in relation to network deployment site numbers

8.12 This annex summarises our assumptions about how many sites in the 80% population area different operators may be able to use for 3G by the end of 2013. We assess how many sites MBNL (the RAN share agreement between EE and H3G) could deploy at 2100MHz and how many sites either Vodafone or 02 could deploy at 900MHz. We estimate that MBNL could deploy around 13,000 sites without any new site acquisitions, and up to 16,000 sites if it undertook an intensive site acquisition programme. Vodafone or 02 could deploy up to 7,000 sites each without site acquisitions, or up to 10,000 if they either acquired new sites or shared sites between them. We consider our estimates of the size of networks that could be achieved through site upgrades alone to be reasonable central estimates, whilst the rate of site acquisition we assume is plausible, but relatively aggressive. The key uncertainty relating to overall network size relates to how much of Orange's existing site base can be used to enhance the coverage of the MBNL network.

Annex 8 The timing and duration of any competitive distortion

8.13 This annex considers the timing and duration of any period of potentially reduced competitive intensity as a result of the 900MHz operators being able to use UMTS900 before other operators can deploy LTE at 800MHz. It concludes that if there were a period of reduced competitive intensity, it is likely to be of around 2-4 years duration.

Annex 1

Overview and results of technical analysis

See separate document

Annex 2

Benefits of timely liberalisation

See separate document

Annex 3

Updated analysis on the costs of release

See separate document

Annex 4

Overview of technical challenges in implementing regulated roaming

See separate document

Annex 5

Description of technical modelling approach and responses to technical analysis contained February 2009 consultation

See separate document

Annex 6

Technical analysis using non-homogeneous network deployment in a sample area

See separate document

Annex 7

Assumptions in relation to network deployment site numbers

See separate document

Annex 8

The timing and duration of any competitive distortion

See separate document