Application of spectrum liberalisation and trading to the mobile sector

A further consultation

Consultation

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Contents

Section 1

Executive Summary

1.1 This consultation is about the future of the spectrum currently used to provide 2G and 3G mobile services in the UK – the 900 MHz, 1800 MHz and 2.1GHz spectrum bands. In particular we are consulting on how we should implement a proposed European Directive[1] and a draft Radio Spectrum Decision[2] that would require the 900 MHz and 1800 MHz bands to be made available for UMTS (3G) as well as GSM (2G) technologies.

1.2 UK consumers and citizens already enjoy enormous benefits from the services provided using spectrum in these bands. Our goal is to ensure that UK consumers and citizens continue to enjoy the greatest possible benefit from the use of these and other frequency bands, as demand, technology and the services offered, continue to develop and evolve.

1.3 We can already foresee, for example, potentially significant consumer and citizen benefits arising from the deployment of 3G technology in the spectrum bands currently used to provide 2G services – the 900 MHz and 1800 MHz bands. The deployment of 3G technology in the 900 MHz band in particular could bring significant benefits to consumers and citizens in the form of deeper and wider availability of mobile broadband services – access to these services at good data rates, available deeper in buildings and in more rural areas than would otherwise be the case.

1.4 Our policy is, in general, not to direct such changes however; rather it is to ensure that there are no regulatory barriers that could hinder such beneficial developments. At the same time our role is not entirely passive either – where we foresee a risk that the market will fail to deliver the full benefits of spectrum use to UK consumers and citizens, for example because spectrum is concentrated in the hands of fewer operators than it might otherwise be, we may take steps to reduce or eliminate that risk (provided that such steps are justified and proportionate).

1.5 On 29 January 2009 the Government published its Digital Britain Interim Report. In that report the Government specified a Wireless Radio Spectrum Modernisation Programme, which highlighted the importance of resolving quickly the future of the 2G spectrum, to allow re-use of the spectrum whilst maintaining a competitive market. The Government went on to explain that it believed that an industry-agreed set of spectrum trades could represent a better and quicker solution than one imposed through regulation. It gave the industry until the end of April 2009 to agree a way forward, or the Government will support an imposed solution.

1.6 Ofcom too would welcome a proposal from the industry for a set of spectrum trades that would address potential distortions of competition arising from liberalisation of the 2G spectrum, and promote efficient use of this spectrum, for the benefit of consumers. This consultation document is intended to provide greater clarity as to Ofcom's concerns in these regards, and hence what we will be looking for a voluntary

[1] See Annex 17 and http://ec.europa.eu/information_society/policy/radio_spectrum/ref_documents/index_en.htm#gsm

[2] See Annex 12, Application of spectrum liberalisation and trading to the mobile sector, 20 September 2007 http://www.ofcom.org.uk/consult/condocs/liberalisation/

solution to achieve. It also sets out Ofcom's proposals as to what an imposed regulatory solution would look like, were the industry to fail to agree an acceptable way forward by the end of April 2009. As such we hope that it will provide a helpful context for discussions within the industry.

1.7 What follows therefore sets out Ofcom's proposals in the event that there is not an acceptable agreed industry solution by the end of April, under the Government's Wireless Radio Spectrum Modernisation Programme.

1.8 In the case of the 900 MHz, 1800 MHz, and 2.1GHz spectrum bands, we propose that a regulatory solution would comprise the following key steps to address potential distortions of competition and facilitate the efficient use of these spectrum bands for the provision of mobile services, for the benefit of UK consumers:

a) To remove the technology restrictions that currently apply to these bands: in the first instance to allow 3G (UMTS) technology to be used in the 900 MHz and 1800 MHz bands; in the longer term to allow any technology that will not cause harmful interference to neighbouring users to be deployed in both these bands and the 2.1GHz band.

b) To allow spectrum in these bands to be traded, so that those who can make best use of this spectrum have the opportunity to gain access to it through commercial negotiation, rather than regulatory intervention. We none the less propose monitoring transfers of spectrum in the 900 MHz band to ensure that there is no adverse effect on competition arising from any trading of this spectrum.

c) To require the current holders of the 900 MHz spectrum (Vodafone and O2) each to give up a proportion of the 900 MHz spectrum they currently hold (2 x 2.5MHz each, out of a current total of 2 x 17.4MHz each) to allow a third operator to have access to this particularly important spectrum. We propose giving Vodafone and O2 two years in which to clear and release this spectrum – a period that we judge long enough for them to be able to clear this spectrum without causing significant disruption to existing customers. We propose holding an auction for the released spectrum (to be awarded as a single lot of 2 x 5MHz) as soon as practicable – likely to be about a year in advance of the spectrum becoming available – with Vodafone and O2 prohibited from acquiring the released spectrum through this auction.

d) To review the level of Administered Incentive Pricing (AIP) applying to the 900 MHz and 1800 MHz spectrum so that in future it reflects the full economic value of this spectrum post liberalisation, so as to encourage its efficient use.

1.9 We previously consulted on these matters in September 2007[3], and on the basis of responses to that consultation, and subsequent analysis set out in this document, we are currently minded to make the following decisions:

- To reject the option of requiring the existing licensees to give up all of the 900 MHz and 1800 MHz spectrum for re-award by Ofcom.

- To liberalise spectrum in the 2.1GHz band – removing the current restriction to UMTS technology.

[3] Application of spectrum liberalisation and trading to the mobile sector, 20 September 2007 please see http://www.ofcom.org.uk/consult/condocs/liberalisation/

- To make spectrum in the 2.1GHz band tradable.

1.10 Anyone with an interest in these matters is invited to comment on our proposals, conclusions and supporting analysis. We would also welcome any evidence that interested parties are able to provide in support of their comments. Comments and supporting evidence should be submitted to us by no later than Friday 1 May 2009.

Section 2

Introduction

2.1 This consultation is about the future of the spectrum currently used to provide 2G and 3G mobile services in the UK – the 900 MHz, 1800 MHz and 2.1GHz spectrum bands. In particular we are consulting on how we should implement a proposed European Directive[4] and a draft Radio Spectrum Decision[5] that would require the 900 MHz and 1800 MHz bands to be made available for UMTS (3G) as well as GSM (2G) technologies.

2.2 We believe that liberalisation of the conditions of use for this spectrum has the potential to bring significant benefits to consumers, for example in the form of deeper and wider availability of mobile broadband services across the UK – access to mobile broadband services at good data rates deeper in buildings and in more rural areas than would otherwise be the case. At the same time we are concerned that some approaches to liberalisation might have the potential to distort competition and result in these benefits not being fully realised. We are therefore consulting on the approach to be taken to liberalisation of these bands in order to ensure that the approach we ultimately adopt delivers the best possible outcome for consumers, in line with our statutory duties.

2.3 This consultation follows an earlier consultation on these issues in September 2007. That document consulted on how a then draft decision of the European Commission's Radio Spectrum Committee on the harmonisation of the 900 MHz and 1800 MHz bands (the "draft RSC Decision") should be implemented in the UK. The consultation outlined four options for liberalising the 900 MHz and 1800 MHz spectrum:

- Option A – Liberalisation in the hands of the incumbents.
- Option B – Regulated access.
- Option C – Partial spectrum release.
- Option D – Full spectrum release .

2.4 Regarding the 900 MHz spectrum, Ofcom expressed a preference for requiring the release of three blocks of 2 x 5 MHz of the 900 MHz spectrum in total from O2 and Vodafone, to be auctioned to secure wider access to the 900 MHz band.

2.5 Regarding the 1800 MHz spectrum, Ofcom expressed a preference for liberalisation in the hands of the incumbent licensees.

2.6 Ofcom received a number of significant and divergent responses to that consultation, and a number of these suggested that Ofcom needed to refine and enhance its analysis. Ofcom has spent some time doing this and is now in a position to consult further.

[4] See Annex 17 and http://ec.europa.eu/information_society/policy/radio_spectrum/ref_documents/index_en.htm#gsm.
[5] See Annex 12, Application of spectrum liberalisation and trading to the mobile sector, 20 September 2007 http://www.ofcom.org.uk/consult/condocs/liberalisation/.

2.7 At the same time, adoption of the draft RSC Decision by the European Commission stalled as a result of disagreement between the Commission and the European Parliament over abrogation of the GSM Directive. That process is now moving forward again, following a proposal by the Commission for a new Directive amending the GSM Directive, put forward in November 2008.

2.8 More recently, on 29 January 2009, Her Majesty's Government published its Digital Britain Interim Report. In that report the Government specified a Wireless Radio Spectrum Modernisation Programme, which highlighted the importance of resolving quickly the future of the 2G spectrum, to allow re-use of the spectrum whilst maintaining a competitive market. The Government went on to explain that it believed that an industry-agreed set of spectrum trades could represent a better and quicker solution than one imposed through regulation. It gave the industry until the end of April 2009 to agree a way forward, or the Government will support an imposed solution.

2.9 Ofcom too would welcome a proposal from the industry for a set of spectrum trades that would address competition concerns arising from liberalisation of the 2G spectrum and promote efficient use of this spectrum for the benefit of consumers. This consultation document is intended to provide greater clarity as to Ofcom's concerns in these regards, and hence what we will be looking for a voluntary solution to achieve. It also sets out Ofcom's proposals as to what an imposed regulatory solution would look like, were the industry to fail to agree an acceptable way forward by the end of April 2009. As such we hope that it will provide a helpful context for discussions within the industry.

2.10 What follows therefore sets out Ofcom's proposals in the event that there is not an acceptable agreed industry solution by the end of April, under the Government's Wireless Radio Spectrum Modernisation Programme.

2.11 The rest of this introduction:

- Explains why liberalisation of this spectrum is an important issue for UK citizens and consumers
- Explains proposed changes in Community legislation and the need for further consultation on liberalisation of this spectrum
- Provides an overview of the rest of the document
- Sets out key terminology used throughout the document

Mobile communications and the importance of liberalising 900 MHz and 1800 MHz spectrum for UK citizens and consumers

2.12 Mobile communications play an important role in any modern society and economy. In the UK, the mobile sector is now larger by revenue than the fixed voice and fixed broadband sectors combined, with total retail revenues of £15.1bn in 2007, with mobile services available to, and used by, almost the entire population. We estimate that in 2007 84 per cent of people aged 8 or over used, or had access to, mobile services, and that mobile accounted for 51 per cent of UK household spend on telecoms. Mobile services are also a critical input for business, with mobile communications now a vital element in an increasingly services-based economy.

2.13 Ofcom's principal duty is to further the interests of UK citizens and consumers in relation to communications services, with mobile communications being a key focus. In addition to this overall duty to UK consumers and citizens, we also have specific duties to ensure optimal use of the radio spectrum and to promote competition. These are particularly important in the context of the mobile sector because availability, and efficient use of, spectrum, and competition between providers, are pre-requisites for realising the full benefits of mobile communications.

2.14 Over the last year, mobile broadband has emerged as an important new development in mobile communications. Mobile broadband services allow consumers to access the internet from mobile handsets, laptops and other mobile devices, at speeds approaching those that could previously only be provided via a fixed broadband connection. Although early in its development, the promise of mobile broadband is hard to ignore – promising the freedom and ease of use of the public internet with the ubiquity, portability and popularity of mobile devices. It also carries the prospect of increasing the scope for competition between mobile and fixed broadband providers, thereby benefiting consumers[6].

2.15 Evidence about the rapid take-up of mobile broadband services is striking. For example, by July 2008, nearly one quarter (23 per cent) of people who access the internet away from home or work said that they did so using a USB dongle or datacard – almost as many as did so using their mobile phone (31 per cent)[7]. If these patterns of take-up become widely established, mobile broadband services could well become a significant influence in the wider picture of the UK broadband market, and potentially act as a similar catalyst for innovation and market development. However, currently there remains considerable uncertainty about the role mobile broadband will play and to what extent it will fulfil its potential.

2.16 Nonetheless, given the potential importance of mobile broadband for the mobile sector and for UK consumers and citizens, it seems particularly important to encourage the efficient use of spectrum for mobile broadband services and their competitive provision. Ofcom is working on a number of projects with this in mind. This includes undertaking a broad review of the mobile sector[8] and working to release large amounts of additional spectrum (for example at 2.6GHz and the 'digital dividend' released from digital switchover) that can be used, amongst other things, for mobile broadband services.

2.17 This particular document considers how to implement liberalisation of the 900 MHz and 1800 MHz spectrum bands. This spectrum is currently used for, and restricted to use for, 2G mobile services (GSM) – that is the provision of voice, text and lower speed data services. Liberalisation would allow it to be used for other services, including mobile broadband using 3G (in particular UMTS) and other technologies. The spectrum is currently licensed to O2, Vodafone, Orange and T-Mobile and used for their 2G mobile services.

2.18 As discussed below future developments in European regulation are expected to require these changes.

[6] Ofcom's most recent review of regulation applying to wholesale broadband access markets can be found at www.ofcom.org.uk/consult/condocs/wbamr07/statement/statement.pdf.
[7] Communications Market Report 2008, Figure 2.8, see http://www.ofcom.org.uk/research/cm/cmr08/.
[8] Mobile citizens, mobile consumers: Adapting regulation for a mobile, wireless world, see http://www.ofcom.org.uk/consult/condocs/msa08/.

2.19 Liberalising 900 MHz spectrum is particularly important to UK consumers and citizens because it could allow operators to offer faster and more reliable mobile broadband services. Both bands, 900 MHz and 1800 MHz, could provide additional capacity for mobile broadband, helping operators to offer more megabytes per month to more consumers. Such changes could bring considerable benefits to consumers of communications services, by significantly improving mobile broadband services without requiring many more mobile phone masts.

2.20 However, the spectrum is unevenly held at present – all the 900 MHz spectrum is held by O2 and Vodafone, and most of the 1800 MHz spectrum is held by T-Mobile and Orange. In contrast, the spectrum currently used for 3G services, in the 2100 MHz band, is relatively evenly held amongst five operators – the four 2G operators plus Hutchison 3G (H3G).

2.21 Therefore we have carefully considered how to go about liberalising this spectrum with the aim of ensuring that its potential benefits to consumers are fully realised. In particular, we have considered whether simply liberalising the spectrum in the hands of the existing holders would secure efficient use of this spectrum and promote competition between providers, or whether it might be appropriate to take another approach to ensure the benefits to consumers are fully realised.

Changes to proposed Community legislation and the need for further consultation

2.22 The respondents to the 2007 consultation expressed strong and divergent views about the appropriate method of liberalisation. A number of stakeholders also provided detailed comments and supporting analysis to support their views.

2.23 We have considered those responses very carefully, and have carried out significant further work and analysis, detailed in this rest of this document, to refine our views.

2.24 We have also had regard to significant external developments in the market and other spectrum policy developments which may be relevant to a decision on this issue.

2.25 In the light of our further work and analysis, and market developments, we have modified our preferred options, and our current views are set out in this document. Given the wide variety of stakeholder views and the importance of this issue for citizens and consumers in the UK, we consider that further consultation is appropriate and necessary.

2.26 We are however currently minded, subject to any new evidence or arguments that we receive in response to this consultation, to reject the option of full release for both the 900 MHz and the 1800 MHz spectrum (Option D in the 2007 consultation). Our reasons for this are explained in Sections 5, 6 and 7.

2.27 At the time of the 2007 consultation, it was anticipated that the draft RSC Decision would come into force imminently, subject only to repeal of the GSM Directive. That RSC Decision was to replace the GSM Directive as the piece of European legislation which governed the 2G spectrum. The RSC decision would have mandated liberalisation by Member States.

2.28 On 19 November 2008, the European Commission published a proposal to amend the GSM Directive[9], rather than to repeal it. The amendments would be achieved by a new Directive which amends the GSM Directive (and the RSC decision would not replace the GSM Directive). The proposals would require Member States to permit use of the 900 MHz band for certain services other than GSM services, provided that such services are capable of co-existing with existing GSM services.

2.29 The current draft from the European Commission is produced at Annex 17.

2.30 In addition to requiring liberalisation, the draft also requires Member States, when implementing the Directive, to examine whether the existing assignment of the 900 MHz band to the competing mobile operators in their territory is likely to distort competition in the mobile markets concerned and, where justified and proportionate, Member States must address such distortions in accordance with Article 14 of Directive 2002/20/EC. Article 14 concerns amendments of rights of use of radio frequencies (amendments of licences in the UK context).

2.31 In other words, the draft would require Member States to look at existing spectrum holdings in the 900 MHz band and to address distortions of competition by amending existing spectrum holdings.

2.32 This requirement is in accordance with Ofcom's approach in the 2007 consultation which considered amendments to existing spectrum holdings.

2.33 In that document Ofcom sought to identify which of various available options would implement the draft RSC decision in a timely way, and

- promote competition; and
- secure the optimal use of the spectrum.

2.34 These criteria reflected Ofcom's principal duties in the Communications Act 2003 to further the interests of consumers, where appropriate, by promoting competition and to secure the optimal use of the spectrum.

2.35 Ofcom considered that the option which best met these objectives would also meet its overarching duty to further the interests of consumers and citizens in these circumstances. In addition, Ofcom had to ensure that the option identified is non-discriminatory, proportionate and transparent. Ofcom had accordingly carried out a cost/benefit analysis of each of the options.

2.36 We must now have regard to the current backdrop of the new draft European legislation. In that regard, we note that previously in the 2007 document Ofcom was seeking, in the light of its statutory duties and the draft RSC decision, to promote competition. That test has been altered slightly by the new requirement and wording in the draft Directive which says that Member States shall address distortions of competition where justified and proportionate.

2.37 We do not consider that this leads to any difference to the substance of Ofcom's considerations. This is because the 2007 consultation aimed at addressing distortions of competition arising from existing spectrum holdings as part of Ofcom's wider statutory duty to promote competition. Indeed the draft Directive takes the

[9] http://ec.europa.eu/information_society/policy/radio_spectrum/docs/in_transit/gsm/gsm_proposal_en.pdf.

same approach to dealing with existing spectrum holdings as that of the 2007 consultation.

2.38 The draft Directive is not yet settled or agreed under the EU legislative process. When it has been agreed it is likely that the UK will make a Statutory Instrument under the European Communities Act 1972 in order to transpose the EU obligations into domestic law. That Statutory Instrument may well oblige Ofcom to carry out its functions under the Wireless Telegraphy Act 2006 so as to give effect to the obligations in the draft Directive. This has been done previously in relation to EU legislation[10].

2.39 Ofcom considers it likely that the amending Directive will be agreed at European level substantially on the current terms. Ofcom identifies in this document which of the various available options would:

- implement the liberalisation requirement in Article 1(1) the draft Directive in a timely way; and
- when doing so, meet the second requirement of the draft Directive in Article 1(1), namely: where justified and proportionate, address any distortions of competition which are otherwise likely to be caused by the existing assignment of the 900 MHz band.

2.40 When identifying which, among several options which would meet the Directive requirements, is the best option for the UK, Ofcom will also have particular regard to its duties to secure the optimal use of the electromagnetic spectrum when carrying out its functions and to promote competition.

2.41 Ofcom considers that the option which best meets these objectives will also meet its overarching duty to further the interests of consumers and citizens in these circumstances. In addition Ofcom has to ensure that the option identified is non-discriminatory, proportionate and transparent.

2.42 As mentioned in the 2007 consultation document, Ofcom has taken into account the history of licensing of spectrum which can be used to offer mobile services in the UK which has resulted in significant differences between the existing five Mobile Network Operators ("MNOs") in terms of their spectrum holdings. In short, Ofcom is not "starting with a blank page". It follows from this that any particular approach to implementing the amended draft Directive is likely to have different commercial impacts on individual licensees.

2.43 It is our understanding that the European Commission and European Parliament hope to agree the amendment of the GSM Directive before the summer of this year. It is as yet unclear whether the draft RSC Decision will be adopted in amended form.

Overview of this document

2.44 We have received a very large amount of feedback from companies interested in this matter. We have also done extensive further work and analysis since the consultation in 2007. We have therefore chosen to present the conclusions and to summarise the

[10] For example, The 3400-3800 MHz Frequency Band (Management) Regulations 2008 (S.I. 2008/2794) transposed into UK law Commission Decision 2008/411/EC of 21st May 2008 on the harmonisation of the 3400–3800 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community.

analysis in the main body of this document at Sections 4 to 8. The detailed evidence and analysis is presented and discussed in full in Annexes 6 to 18. The Annexes therefore form an essential part of this document and the reasoning for our conclusions.

2.45 **Sections 3 and 4** provide important **background information** and **supporting analysis** for the assessment of policy options in **Sections 5 and 6**.

2.46 Details on the current spectrum holdings of the mobile operators are provided in **Section 3**, highlighting the **uneven holding of 900 MHz and 1800 MHz spectrum** amongst the five mobile operators.

2.47 In our September 2007 consultation we considered four options for liberalising 900 MHz and 1800 MHz taking into account issues arising from these uneven holdings. **Section 3** provides a **summary of our initial views** on those options and of **stakeholders' responses** to the proposals we put forward.

2.48 In developing our revised proposals for this consultation we have carefully considered stakeholders' responses as well taking into account important external developments since our last consultation, both developments in the mobile market and in spectrum policy. **Section 3** sets out a summary of the most important **market and spectrum policy developments** relevant to the issues being considered, including the growth of mobile broadband and developments affecting the future availability of 800 MHz spectrum for mobile services.

2.49 Our assessment of the options for liberalising 900 MHz and 1800 MHz spectrum in our previous consultation was supported by several pieces of important, and in some cases quite complex analysis. We received significant comments on this analysis from stakeholders in response and have undertaken considerable additional work to update and refine that analysis. **Section 4** sets out a summary of our findings from that refined analysis, including summarising the work we have done to respond to stakeholder comments on our original analysis. It covers:

- The **availability of 800 MHz spectrum** as an alternative to 900 MHz spectrum (drawing on the developments noted in Section 3).
- The **differences in costs in deploying 3G networks** using different frequencies (with the detailed analysis set out in Annexes 10-15).
- The **impact of changes in competitive intensity** in the provision of mobile services (with the detailed analysis set out in Annex 9).
- The **costs of clearing and releasing 900 MHz spectrum** (with the detailed analysis set out in Annex 16).

2.50 As identified above, much more detail on this analysis is set out in the annexes to this consultation. The annexes are to be read in conjunction with the main body of this consultation document. Cross-referencing to the annexes is given throughout the main document. In addition, the supporting technical and economic models are available from Ofcom's website.

2.51 The information and analysis presented in Sections 3 and 4 then informs our assessment of options in Sections 5 and 6.

2.52 **Section 5** sets out the options assessment we have undertaken in order to identify how best to liberalise **the 900 MHz spectrum**. It highlights relevant findings from the previous sections (and appropriate annexes) and introduces **three key scenarios** for the future significance of low frequency spectrum which we use to assess the impact of different policy options. For each of the three significance scenarios we consider the likely outcomes of each of the different policy options. This analysis pulls together both **qualitative** and **quantitative** evidence (supported by a detailed cost benefit analysis in Annex 7) to identify the best options for liberalising the 900 MHz band under each significance scenario. To identify the best overall policy option we bring together the analysis from each of the significance scenarios in order to identify the best overall policy option in light of our duties and objectives, taking account of the relative likelihood of the different significance scenarios.

2.53 **Section 6** sets out the options assessment we have undertaken in order to identify how best to liberalise the **1800 MHz spectrum**. At a high level this takes a similar approach as Section 6, though significantly simplified, and focuses on a **qualitative** rather than quantitative analysis.

2.54 Our further analysis of **full spectrum release** is set out in **Section 7.** This draws on the findings of Sections 5 and 6.

2.55 If our preferred options for liberalising 900 MHz and 1800 MHz spectrum (as identified in Sections 5 and 6) were adopted following consultation then there are a number of aspects of their **implementation** to be considered which are set out in **Section 8**. These include, for example, the terms of the liberalised licences and the nature of the award for any released spectrum. A number of the implementation issues discussed in this section (for example auction design) will be the subject of more detailed further consultation once we have decided upon an overall approach to liberalisation.

2.56 In addition, to liberalisation of 900 MHz and 1800 MHz spectrum, our previous consultation also considered **liberalisation and the introduction of trading for the 2100 MHz spectrum**. Following consideration of responses to that consultation, we are currently minded to liberalise and make tradable the 2.1 GHz licences. Our reasoning is set out in **Section 9**.

2.57 A summary of our proposals at this stage and the next steps in the process are set out in **Section 10.**

Opportunity to comment

2.58 Anyone with an interest in these matters is invited to comment on any aspect of our proposals, conclusions and supporting analysis. We would also welcome any evidence that interested parties are able to provide in support of their comments. Comments and supporting evidence should be submitted to us by no later than Friday 1 May 2009.

Terminology

2.59 Throughout this document the following terms are used:

- **Mobile broadband** refers to mobile data services which can only be provided, or are best provided, using 3G technologies and beyond.

- **Quality,** of mobile broadband services, means how good the coverage is and how fast the service is, in terms of the data rates consumers actually experience (considering only the speed of the mobile network itself, rather than any limitations of websites and the wider internet etc). Annex 6 considers these aspects of mobile broadband services in more detail.

- **800 MHz** spectrum means the spectrum in the upper sub-band to be released as part of the digital dividend, which Ofcom has proposed in its recent consultation on clearing the 800 MHz band should consist of 790-862 MHz.

- **900 MHz** spectrum means 880.1 MHz – 914.9 MHz paired with 925.1 MHz – 959.9 MHz.

- **900 MHz incumbent operators** refer to O2 and Vodafone.

- **1800 MHz spectrum** means 1710. MHz – 1781.7 MHz paired with 1805.1 MHz – 1876.6 MHz.

- **1800 MHz incumbent operators** refer to Orange, O2, T- Mobile and Vodafone.

- **2100 MHz or 2.1 GHz** spectrum means 1920 – 1980 MHz paired with 2110 – 2170 MHz for frequency division duplex ("FDD") and 1900 – 1920 MHz for time division duplex ("TDD").

- **2100 MHz operators refer to** H3G, Orange, O2, T- Mobile and Vodafone.

- **2600 MHz or 2.6 GHz** spectrum means 2500 – 2690 MHz.

- **2G spectrum** means 900 MHz and 1800 MHz spectrum.

- **3G** refers to UMTS technologies comprising the W-CDMA radio network technologies standardised by 3GPP.

- **W-CDMA** means Wideband-CDMA, the modulation and multiple-access scheme used by 3G UMTS technology.

2.60 The glossary provides a comprehensive list of terms used in this document.

Section 3

Background

Introduction

3.1 The purpose of this section is to provide a background to the rest of this document, by providing:

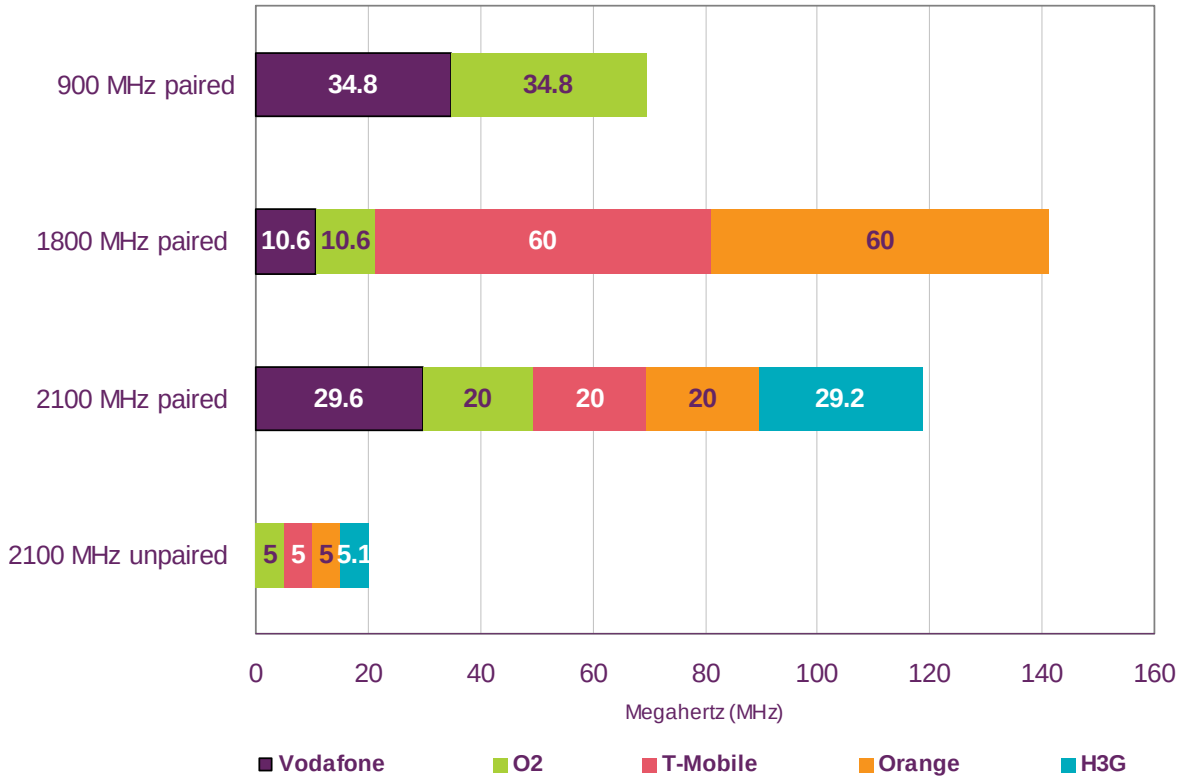
- information on the current distribution of 900 MHz and 1800 MHz spectrum;
- an overview of the September 2007 consultation;
- a summary of stakeholder responses to the 2007 consultation; and
- a description of the main market developments and spectrum policy developments since the 2007 consultation that are relevant to the issues considered in this document.

Current distribution of 900 MHz and 1800 MHz spectrum

3.2 The 900 MHz and 1800 MHz spectrum is currently used for the provision of 2G mobile services, but as Figure 1 below shows, it is unevenly distributed among the five mobile network operators. The entirety of the 900 MHz spectrum is held by Vodafone and O2 only. Orange and T-Mobile hold over 80% of the 1800 MHz spectrum, with the rest split between Vodafone and O2. H3G does not hold any 900 MHz or 1800 MHz spectrum. All five operators hold 2100 MHz spectrum, which is currently used for the provision of 3G mobile services using UMTS technology.

3.3 The 900 MHz and 1800 MHz licences were awarded by the government by a process known as comparative selection. This took place in 1985 and 1991. The 2100 MHz licences were awarded by an auction in 2000.

Figure 1: Current mobile operator spectrum allocations for paired and unpaired spectrum



The 2007 consultation

3.4 Ofcom's September 2007 consultation outlined our proposals to implement the Radio Spectrum Committee's decision ("draft RSC decision") relating to the 900 MHz and 1800 MHz bands. Implementing the decision would effectively liberalise i.e. allow the use of this spectrum for 3G, and potentially other technologies. The consultation recognised that the way in which the draft RSC decision is implemented could have major consequences for UK citizens and consumers, as it could affect the extent of competition in the mobile market, and the degree to which mobile broadband services are deployed in the UK. We recognised that mobile data is likely to be important to consumers in the UK, although demand for mobile broadband services was relatively low at that time.

3.5 Ofcom consulted on four options for implementing the draft RSC decision:

- Option A - liberalisation of spectrum in the hands of the incumbent licensees.
- Option B - liberalisation of the spectrum in the hands of the incumbent licensees, subject to a regulatory obligation to offer roaming to third parties.
- Option C - partial mandatory spectrum release (revocation of part of the spectrum usage rights held by existing licensees and re-award by Ofcom) and liberalisation of the remainder of the spectrum in the hands of the incumbent licensees.
- Option D – full mandatory spectrum release (revocation of all of the spectrum usage rights held by existing licensees for this spectrum and re-award by Ofcom).

3.6 After analysing each of the options for 900 MHz and 1800 MHz spectrum, Ofcom proposed that:

- for 900 MHz spectrum – Option C, partial spectrum release, was the most appropriate option, with a preference for three blocks in total to be released; and
- for 1800 MHz spectrum – Option A, liberalisation in the hands of the incumbent licensees, was the most appropriate option.

A summary of our views with respect to each of the options in the September 2007 consultation is set out below.

Table 1: Summary of our views in the September 2007 consultation on the options for liberalising 900 MHz spectrum

	Initial view in the September 2007 consultation
Option A Liberalisation in the hands of the incumbents	Although liberalising 900 MHz spectrum in the hands of the incumbents would implement the draft RSC Decision, there was a clear risk that the benefits of this option in relation to other options could be substantially limited because of the potential failure of the market to deliver wider access to this spectrum. Quality was likely to be important for mobile broadband users and there was a significant risk of a substantial cost difference between 900 MHz spectrum and other relevant bands. Given this risk, we considered that it was plausible that the 900 MHz incumbents would not provide wider access to 900 MHz spectrum. This was because the value to them of using the spectrum (which they would lose by selling it), together with the impact of wider competition on their profits, might exceed what a 2100 MHz MNO would pay for access.
Option B Regulated roaming	Roaming was unlikely to be the most appropriate way to implement the draft RSC decision. Regulated roaming could benefit consumers through enabling the 2100 MHz operators to offer higher quality services and/or provide higher quality at lower cost than by using 2100 MHz. However, we could not be certain that the full benefits would be achieved. Roaming could, for example, act as a disincentive for 900 MHz operators to deploy UMTS 900 MHz networks. We also identified a risk of regulatory failure if we had to step in to set the charges and conditions for roaming, and that this option could involve a significant and costly ongoing administrative burden.
Option C Mandatory partial spectrum release	This was our preferred option for liberalising 900 MHz spectrum, with a preference for three-block release in order to safeguard competition in the mobile market. We also considered that the incumbents would need to be excluded from the award of the released spectrum in order for partial release to achieve its objective of promoting competition / efficiency through wider access to 900 MHz. Our assessment was based on the initial view that there was a clear

	risk of an adverse effect on competition and efficiency from liberalising 900 MHz in the hands of the incumbents. Given this, we considered that partial mandatory spectrum release was likely to best address these concerns because it addressed the heart of the issue: the concentration of the 900 MHz spectrum in the hands of just two MNOs.
Option D Mandatory full spectrum release	Although full release could bring about significant competition and efficiency benefits, it was likely to be disproportionate and/or cause considerable delay to the realisation of the benefits of liberalisation. We considered whether phasing the full release of spectrum would alleviate its disadvantages, but our analysis showed that, even if phased, full release was unlikely to be proportionate in that less interventionist and costly options were available which adequately addressed the competition and efficiency concerns which we had identified.

Table 2: Summary of our views in the September 2007 consultation on the options for liberalising 1800 MHz spectrum

	Initial view in the September 2007 consultation
Option A Liberalisation in the hands of the incumbents	Liberalising 1800 MHz spectrum in the hands of the incumbents could be both pro-competitive and efficient. The risk of significant competition and efficiency issues arising from the current distribution of 1800 MHz spectrum was low because: • It seemed unlikely that 1800 MHz spectrum would, in practice, offer a cost advantage compared to 2100 MHz spectrum. • Given that four operators already hold 1800 MHz spectrum, we considered that, if a redistribution of spectrum could improve competition and efficiency, the market was likely to achieve this without regulatory intervention. • Any benefits of wider access to 1800 MHz spectrum were unlikely to be large, in the light of the proposed redistribution of 900 MHz spectrum, which would offer much greater advantages than 1800 MHz spectrum, compared to 2100 MHz spectrum.
Option B Regulated roaming	Roaming was unlikely to be a more proportionate way than Option A to implement the draft RSC Decisions, because although either could lead to an efficient pro-competitive outcome, regulated roaming carries a much greater regulatory risk. We also noted that there are significant regulatory difficulties in implementing regulated roaming and that it imposes an administrative burden both on Ofcom and on the operators.
Options C and D Mandatory full and partial	We provisionally concluded that regulatory intervention to ensure wider access to 1800 MHz spectrum was unlikely to bring significant additional competition and efficiency benefits, compared to Option A. It would, however, be likely to impose costs on the incumbent holders of 1800 MHz, whereas Option A would not impose any significant additional costs. Mandatory release of 1800 MHz spectrum is unlikely

spectrum release	to be a proportionate option for liberalising the 1800 MHz spectrum as there is a less costly option (Option A) that appears to fulfil Ofcom's duties and objectives.

3.7 We also proposed that the 2.1 GHz licences should be liberalised so that their technology restrictions (currently licensed for 3G use only) are removed and that they are made tradable.

Responses to consultation

3.8 Ofcom received 15 responses (13 published on the Ofcom website and two confidential responses) to the September 2007 consultation from a range of stakeholders. The responses expressed a wide variety of views on this matter.

3.9 We have carefully reviewed these responses and our detailed analysis of them is set out in Sections 4-9 of this document and in the accompanying annexes. In general terms:

- T-Mobile and Orange were supportive of Ofcom's preference of Option C for 900 MHz spectrum and Option A for 1800 MHz spectrum.
- O2 and Vodafone disagreed with Ofcom's approach to 900 MHz spectrum. Both operators asserted that the benefits of 900 MHz spectrum were significantly overestimated and the costs associated with releasing 900 MHz spectrum were significantly underestimated by Ofcom. Both operators outlined other approaches to liberalisation, which rely on the market in the first instance to achieve wider distribution of 900 MHz spectrum.
- Vodafone thought that liberalisation should be postponed until 2012, although the licences should be made tradable to give the market a chance to achieve wider distribution of 900 MHz if necessary. O2 proposed a similar option, but suggested that 900 MHz should be liberalised and made tradable now, and that any further intervention should be deferred to a future date. They argued that the threat of future intervention would act as an incentive for the incumbents to trade spectrum if it was efficient to do so.
- In regard to 1800 MHz spectrum, O2, Vodafone and H3G all raised the potential capacity advantage that T-Mobile and Orange may have over other operators in the future, due to the large blocks of contiguous spectrum which they hold in the 1800 MHz band.
- H3G did not support the approach proposed for liberalisation; it advocated a wider redistribution of 900 MHz and 1800 MHz spectrum, either by auction or administrative re-allocation.
- Tesco Mobile saw that liberalisation could affect its current MVNO arrangements with O2, because O2 would potentially have less capacity on its network after giving up some of its 900 MHz spectrum.
- The Council of National Parks and the Scottish Parliament welcomed 2G liberalisation in principle because of the potential for liberalisation, leading to fewer masts and the possibility of improving rural coverage.

- Two respondents raised the issue of new equipment required for consumers to access 3G technologies at 900 MHz and the potential for disruption to current 2G services, if Vodafone and O2 had to hand back 900 MHz spectrum.

- Network Rail raised the issue of GSM-R technologies operating in the spectrum band adjacent to the 900 MHz spectrum, and the impact liberalisation could have on its emergency equipment.

- Qualcomm supported liberalisation - as soon as possible - and outlined the advantages of UMTS 900.

- Vectone Mobile was not in complete agreement with our proposals but agreed that they were proportionate.

3.10 A brief summary of the most significant points expressed by stakeholders in relation to each of the options in the September 2007 consultation is set out below Stakeholder comments are further discussed in the rest of the document.

Table 3: Summary of responses on options for liberalisation of 900 MHz spectrum

	Responses
Option A Liberalisation in the hands of the incumbents	Orange and T-Mobile agreed with our analysis. Vodafone and O2 disagreed with the analysis and sought to show that that there was not a significant risk of such a market failure occurring.
Option B Regulated roaming	Several respondents felt that the risks associated with regulated roaming were much lower than we had suggested. In contrast, T-Mobile and H3G considered that regulated roaming was a poor substitute for direct access to spectrum.
Option C Mandatory partial spectrum release	Vodafone and O2 said that we had overestimated the benefits of spectrum release. Orange and T-Mobile generally agreed with our analysis but thought that we had underestimated the benefits of release.
Option D Mandatory full spectrum release	There was a divergence of views among respondents. H3G believed that we should implement full release, and either administratively allocate, or auction, the 900 MHz band. One confidential response argued that we had overestimated the costs of full release. Other respondents, including O2 and T-Mobile, agreed that full spectrum release was unlikely to be proportionate because of its potential costs and disruption to consumers.

Table 4: Summary of responses on options for liberalisation of 1800 MHz spectrum

	Responses
Option A Liberalisation in the hands of the Incumbents	Vodafone, T-Mobile, O2 and Orange, supported Option A. H3G disagreed with our analysis. H3G argued that Option A would be discriminatory, disproportionate and would distort competition. In particular, trading would not occur in 1800 MHz band.
Option B Regulated roaming	All five MNOs opposed regulated roaming for 1800 MHz spectrum.
Option C and D Mandatory partial and full release	Vodafone, O2, Orange and T-Mobile agreed that release of 1800 MHz spectrum is not required. H3G supported full release of 1800 MHz spectrum. H3G considered it imperative that all five existing MNOs be given an equal opportunity to gain access to 1800 MHz spectrum.

Market developments since the last consultation

3.11 At the time of the last consultation, we considered it relatively likely that mobile broadband services would become an important part of the mobile market, and the benefits of liberalisation would be significant. However, it was not clear how important mobile broadband services would become. Liberalised spectrum and supporting technologies, such as UMTS 900, seemed likely to play an important part to support high speed, high quality mobile broadband, but at the time no operator anywhere in the world had rolled out a UMTS 900 network.

3.12 Over a year later, the demand for mobile broadband and attention from operators, market analysts and consumers has increased significantly. A number of factors seem important, including:

- the increased take-up of mobile broadband 'dongles';
- handset developments that make internet access easier;
- data tariffs, particularly for dongles, becoming cheaper and clearer;
- mobile network operators upgrading their networks to deliver faster and more reliable mobile broadband; and
- the UMTS 900 roll-outs outside the UK since the last consultation.

3.13 As discussed in more detail in our recent consultation on the mobile sector *Mobile Citizens, Mobile Consumers,* we believe that the growth of mobile broadband has the potential, in time, to bring considerable benefits to UK citizens and consumers.

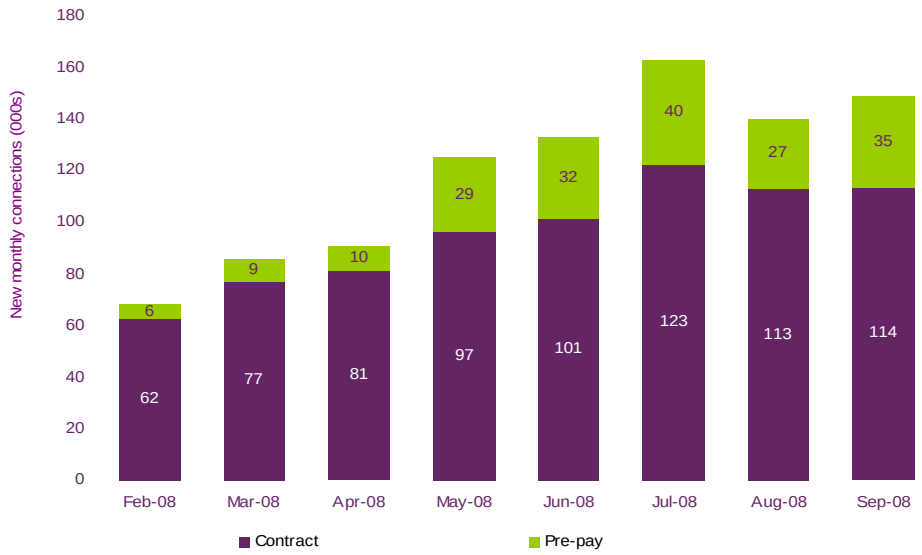
Take-up of mobile broadband dongles has increased rapidly

3.14 The increased take-up of mobile broadband 'dongles' has been one of the significant developments since the last consultation. In this context 'dongle' usually refers to a wireless modem that plugs into a computer's USB port. Dongles allow consumers to access mobile broadband services from a laptop in any area with mobile broadband coverage. They were launched in September 2007 and have since been heavily

promoted by operators.[11] All MNOs have now launched dongles and associated mobile broadband tariffs.

3.15 The take-up of dongles has been reported in a number of recent Ofcom reports. Both the *Communications Market Report 2008* and *Mobile Citizens, Mobile Consumers* describe the increase in demand for mobile data, through the take-up of dongles[12]. Figure 2 below illustrates this trend.

Figure 2: New consumer mobile broadband connections



Source: GfK retail data

3.16 Increase in the take up of dongles may be due to aggressive marketing by operators, wider HSDPA coverage, and faster data rates or cheap, easy to understand pricing structures. In addition, operators have started to bundle laptops and netbooks with their mobile broadband subscriptions, so removing the need for consumers to have purchased a laptop already.

Handsets and other devices

3.17 Although dongles seem to be driving the increase in demand for mobile broadband, 3G and HSDPA handsets, and other smartphones, are also increasing in range and usability. The user experience of browsing the internet from a mobile device has improved dramatically in the last few years. Several components of mobile handsets have improved by a very large margin, and simultaneously: screens, batteries, memory, user interfaces and processing power.

3.18 The most powerful handsets, providing the best mobile broadband user experience, are still relatively expensive and limited to a small proportion of mobile subscribers. However, past experience suggests that the performance of today's high-end devices will become the norm within a few years. In addition, software developers are

[11] For example, H3G launched its USB modem on 4 September 2007, see http://www.three.co.uk/news/h3gnews/searchresultsnewsview.omp?cid=1187800250280.
[12] Also see Communications Market Report 2008, section 5.1.5.

beginning to invest significantly in applications for mobile phones which may support improved usability of mobile internet for consumers.

Network upgrades

3.19 MNOs in the UK have upgraded their networks for faster HSDPA over the last year, resulting in headline download speeds increasing from around 1 Mbps to 7.2 Mbps. HSUPA networks are now being rolled out nation-wide, which will increase headline upload speeds from 384 kbps to around 2 Mbps. There are however, a number of factors, including the quality of coverage, which mean that consumers are unlikely to receive speeds that consistently approach the headline rates.

UMTS 900 networks and handsets are now a reality

3.20 Since the last consultation a limited number of UMTS 900 networks have been deployed. Elisa launched the world's first commercial UMTS 900 network in two cities in Finland in November 2007. Since then, coverage has been extended to several other towns in Finland. Elisa has also launched a test network, available for use by consumers in Järvamaa County in Estonia. AIS in Thailand has also launched a limited UMTS 900 network in Chiang Mai and Bangkok. Siminn in Iceland has formed a partnership with Ericsson to expand its rural coverage using UMTS 900. In Australia, Optus has begun rolling out and upgrading existing sites for UMTS 900 to expand 3G coverage. In both Australia and New Zealand, Vodafone has announced its intention to roll out UMTS 900 networks.

3.21 An important factor in the development of UMTS 900 networks is the availability of compatible handsets for consumers. Increasing numbers of UMTS 900 devices are now available and there is increasing evidence that device manufacturers expect there to be a significant market for UMTS 900 devices. A number of UMTS 900 handsets are set for imminent release or have already been released in the UK. UMTS 900 dongles are now also available.

UMTS 1800 continues to lack momentum

3.22 There continues to be a lack of momentum, both with UMTS 1800 networks and UMTS 1800 handsets. We understand that vendors can produce UMTS 1800 equipment if necessary, but that to date, demand from operators has been almost non-existent.

3.23 One stakeholder response to the September 2007 consultation pointed to a UMTS 1800 roll-out in Japan by E-mobile. The frequency band in Japan is categorised as Band IX (1749.9 -1784.9 MHz paired with 1844.9 -1874.9 MHz). This band is distinct from the GSM band used in the UK and elsewhere in Europe. From a standards perspective, equipment manufactured for the Japanese standard cannot be used in the UK, and vice versa. For this reason we do not believe the developments in Japan will add momentum to UMTS 1800 manufacture or roll-out in the UK.

Next generation technologies continue to develop

3.24 Next generation wireless technologies, including Long Term Evolution (LTE) and WiMAX have continued to develop since our previous consultation.

LTE

3.25 LTE is designed to deliver existing mobile broadband services with increased quality, speed and capacity at a lower cost to operators. LTE is said to be more spectrally efficient than current technologies, so operators benefit from reduced cost per bit. Unlike existing 3G/HSPA, which requires 5 MHz bandwidth, LTE can be deployed in bandwidths ranging from 1.4 MHz to 20 MHz (i.e. channel for paired use of 2 x 1.4 MHz to 2x20MHz) and also in unpaired spectrum. The widest LTE channel, based on a bandwidth of 20 MHz, will support the highest speeds. Theoretical peak speeds are 100 Mbps for download and 50 Mbps for upload[13], although users are unlikely to receive speeds as high as this in practice.

3.26 In the past twelve months, standardisation work for LTE under 3GPP release 8 has identified all current GSM and UMTS bands as potential LTE bands. This includes the 900 MHz and 1800 MHz bands under consideration in this document, as well as the 2.1 GHz and 2.6 GHz bands, but not the 800 MHz band (also see below). These first standards for LTE were functionally frozen in December 2008.

3.27 In addition, the last twelve months has seen a number of operators (including NTT DoCoMo, Verizon, AT&T and TeliaSonera) announce plans to deploy LTE in the future. Despite developments regarding LTE in the past year, based on current information, there is reason to believe that LTE will have relatively little impact on the mobile market in the UK in the short to medium term. There are expected to be initial deployments around 2010, particularly in Japan and US. In Europe the timing of commercial deployments in Europe is uncertain, though active steps have been taken towards deployment in Norway and Sweden using the 2.6GHz band which has been awarded in those countries. In Annex 12 we outline a range of possible timescales for LTE use in the 800 MHz band in the UK.

Mobile WiMAX

3.28 WiMAX, developed with a strong input from the internet and IT sectors, is optimised for data services (with voice over IP being one of the potential data applications) and equipment is ready and available now for operation in unpaired (TDD) mode. WiMAX developments over the past 12 months include its first products being WiMAX Forum Certified[14] and initial deployments in the US (SprintNextel) and in South Korea (using WiBro, the South Korean WiMAX equivalent). In principle WiMAX can operate in any frequency band, but there is no current WiMAX profile defined for the 900 MHz, 1800 MHz or 2.1 GHz bands. However, the 2.6 GHz is a defined band for WiMAX operation.

Network sharing

3.29 Network sharing between the mobile operators in the UK has grown in importance since the last consultation. Two pairs of operators have announced their intention to share some elements of their access networks:

- on 18 December 2007, H3G and T-Mobile announced their intention to share their radio access networks; and

[13] Ericsson, Long Term Evolution : An introduction October 2007 White Paper.
[14] Certified means that the equipment conforms to the IEEE 802.16e standard for Mobile WiMAX.

- on 19 February 2008, Vodafone and Orange announced their intention to engage in access network sharing, involving passive network elements in the first phase of deployment.

Spectrum policy developments since the last consultation

3.30 A number of spectrum policy developments that have relevance to 2G liberalisation have occurred since the last consultation.

Draft RSC Decision and GSM Directive

3.31 As we set out in the September 2007 consultation, the liberalisation of the 900 MHz spectrum is currently prohibited by the GSM Directive[15]. At the time of the September 2007 consultation, it was anticipated that the draft RSC Decision would come into force imminently, subject only to repeal of the GSM Directive. Since then, as described in Section 2, the GSM Directive has not in fact yet been repealed and so the draft RSC Decision remains in draft and is not in force.

3.32 On 19 November 2008, the European Commission published a proposal to amend the GSM Directive[16], rather than to repeal it. The proposal would require Member States to permit use of the 900 MHz band "*for GSM systems and for UMTS systems as well as for other terrestrial systems capable of providing electronic communications services that can co-exist with GSM systems*". It is our understanding that the European Commission and European Parliament hope to agree the amendment of the GSM Directive before the summer of this year. It is as yet unclear whether the draft RSC Decision will be adopted in amended form.

2G liberalisation by other countries

3.33 At the time of the previous consultation no other countries had yet made a decision to allow the liberalised use of 2G spectrum. Now a number of countries both within Europe and outside Europe have allowed the use of 2G spectrum for technologies other than 2G.

- Within Europe, we understand that France, Belgium, Finland and Estonia have allowed technologies other than GSM to be used at 900 MHz.

- A number of other European countries, including Switzerland, have initially consulted on this issue as part of national frequency plans or the 2G licence renewal process. Italy continues to work on the issue. Greece, Ireland and Spain have recently held consultations on the issue.

- Other countries outside the EU, including Indonesia, New Zealand and Australia, have made 900 MHz spectrum available for technologies other than GSM.

800 MHz (UHF upper sub-band)

3.34 At the time of our previous consultation our view was that spectrum covered by the Digital Dividend Review was unlikely to be a substitute for 900 MHz in the short to medium term. We noted that although international negotiations had identified 798-862 MHz as potentially suitable for mobile, and that in pure propagation terms the

[15] Council Directive 87/372/EEC of 25 June 1987, OJ L 196, 17.7.1987, p.85.
[16] http://ec.europa.eu/information_society/policy/radio_spectrum/docs/in_transit/gsm/gsm_proposal_en.pdf.

respective frequencies are similar, there were uncertainties over many aspects of its potential future use for mobile services. Since that consultation, there have been a number of major developments in relation to the UHF upper sub-band (now often referred to as the 800 MHz band).

3.35 Relevant developments since the consultation include:

- The World Radio Conference 2007 (WRC-07) was held in Geneva in October – November 2007. One relevant development from WRC-07 was that the regulatory status of the 790–862 MHz band, currently used for analogue television, was changed, facilitating future use for mobile applications.

- Ofcom issued a statement on its approach to awarding the UK's digital dividend in December 2007 and has since issued three further consultation documents setting out its proposals for the detailed design of the digital dividend awards. The consultation on the cleared award set out proposals for packaging and an auction design that would facilitate the widest possible range of uses, including potential mobile broadband use of the upper sub-band (806–854 MHz) of the cleared spectrum, as well as a proposal to include the interleaved spectrum between 790-806 MHz. The consultation raised the question of whether some form of intervention may be required to promote competition in future mobile broadband markets. A "soft" spectrum cap on holdings of spectrum below 1 GHz was suggested as an appropriate intervention if action were to be required. The consultation ended on 15 August 2008.

- It is increasingly likely that other European countries will make the whole upper sub-band (790- 862 MHz) available to allow its use for new mobile services in the medium term. Decisions have been announced in France, Finland, Sweden and Switzerland. Norway has also set out a clear proposal to this end, and both Germany and Ireland are known to be examining the options available to them. Other countries are likely to follow suit. It is clear now that the focus for these countries will be on creating an 800 MHz band (790 – 862 MHz).

- The European Commission has suggested some form of harmonised approach across Europe to make the upper sub-band available for wireless services. In November 2007 the European Commission published a Communication[17] to the European Parliament. This recommended identifying common bands that can be optimised by enabling 'clusters' of services using a similar type of communications network: broadcasting, mobile multimedia and mobile broadband.

- The European Conference of Postal and Telecommunications Administrations (CEPT), in its response to a subsequent Commission mandate on this issue, concluded that the preferred sub-band for the harmonised mobile broadband cluster proposed by the Commission is the upper part of UHF, and that this should include 790-862 MHz, as this offers the best possibility for Europe-wide non-mandatory, non-exclusive harmonisation. Following a further Commission mandate, work continues within CEPT on the identification of common technical conditions and channelling arrangements.

3.36 In the light of recent European developments, Ofcom has proposed to re-organise the frequencies covered by its digital dividend so that it would clear the whole of 790

[17](COM/2007/0700) *Reaping the full benefits of the digital dividend in Europe: A common approach to the use of the spectrum released by the digital switchover.*

– 862 MHz. It set out its rationale for this proposal and how it could be implemented in a recent consultation, Digital Dividend: clearing the 800 MHz band[18].

Conclusion

3.37 This section has outlined a number of important changes that have occurred since the time of our previous consultation in September 2007. As well as providing context for the analysis set out in the rest of the document, they feed into this analysis in a number of ways, including:

- Stakeholders' responses to the previous consultation, outlined above, are expanded upon, and the relevant responses are discussed, throughout Sections 4–9 and in the accompanying annexes.

- Market developments such as the significant growth in take up of mobile broadband services and network sharing arrangements, feed into our assessment of cost differences, summarised in Section 4, and our assessment of policy options in Sections 5 and 6.

- Technology developments, including LTE and WiMAX developments, feed into our assessment of policy options outlined in both Sections 5 and Section 6.

- Developments in spectrum availability, in particular the spectrum made available through digital switchover (800 MHz spectrum) and the spectrum coming to market through the 2.6 GHz award are relevant to our discussion of potential alternatives to both 900 MHz and 1800 MHz spectrum in Sections 5 and 6.

[18] See Digital Dividend: clearing the 800 MHz band at http://www.ofcom.org.uk/consult/condocs/800mhz.

Section 4

Findings of our supporting analysis

Introduction

4.1 Our September 2007 consultation on the options for liberalising 900 MHz and 1800 MHz spectrum was supported by several pieces of important analysis. This section summarises the findings from our updated analysis, including summarising the work we have done to respond to stakeholder comments on our original analysis. It covers:

- The availability of 800 MHz spectrum as an alternative to 900 MHz spectrum.
- Our refined analysis of the impact of using different frequency bands on the deployment of 3G networks and services.
- Our refined analysis of the benefits of competition in the provision of mobile broadband services.
- Our refined analysis of the costs of clearing and releasing 900 MHz spectrum.

4.2 We have refined our analysis in light of comments on our initial consultation and external developments since that consultation, including the market and spectrum policy developments outlined in Section 3. Much more detail on our analysis is set out in the annexes to this consultation. In addition, the supporting technical and economic models are available from Ofcom's website.

The availability of 800 MHz spectrum

4.3 When considering the implications of liberalisation an important consideration is the extent to which there are other bands available which would offer similar benefits. At the time of our previous consultation our view was that spectrum covered by the Digital Dividend Review was unlikely to be an effective substitute for 900 MHz spectrum in the short to medium term. We noted that although international negotiations had identified 798-862 MHz as potentially suitable for mobile, and that in pure propagation terms the respective frequencies are similar, there were uncertainties over many aspects of its potential future use for mobile services.

4.4 However, since that consultation there have been a number of developments (see Section 3) in relation to this spectrum, which have reduced, although not completely eliminated, several of these uncertainties. As a result, the upper sub-band of cleared digital dividend spectrum, around 800 MHz, now appears likely to be an alternative for competing effectively with networks deployed using 900 MHz spectrum. This is because 800 MHz, being near in frequency to 900 MHz, has similar physical characteristics. The practical barriers to use of 800 MHz, such as equipment availability, are now being addressed by the harmonisation efforts mentioned in Section 3.

4.5 However, the availability and potential use of 800 MHz spectrum for mobile broadband are more uncertain than for 900 MHz spectrum. 900 MHz spectrum is expected to be widely available for UMTS shortly, with UMTS900 networks and handsets already in use in some countries. In contrast a number of uncertainties remain for 800 MHz spectrum, for example, the nature and extent of European

harmonisation of this spectrum, the number of member states that make available spectrum at the 800 MHz band (i.e. 790-862 MHz) so it can be used for mobile services, and when suitable equipment will become available. In the UK Ofcom has recently set out its proposals for clearing the 800 MHz band (see Digital Dividend: clearing the 800 MHz band) to allow it to align its digital dividend for the 800 MHz band with the emerging consensus in Europe.

4.6 There is also likely to be a material gap, of at least two to four years, between when consumers could start to benefit from high quality mobile broadband services using 900 MHz spectrum (around 2011 to 2012) and when the use and quality of services using 800 MHz spectrum, if deployed, could catch-up with 900 MHz services (around 2014-2015). This is one of the main conclusions of the timing analysis set out in Annex 12[19]. This is because 900 MHz user equipment and spectrum are likely to be available significantly earlier than 800 MHz equipment and spectrum. Annex 12 sets out our analysis of the potential timing of use of 800 MHz and 900 MHz spectrum in more detail.

Differences between bands for deploying 3G services

4.7 In our 2007 consultation we sought to quantify the impact of the use of different frequency bands on the provision of high quality mobile broadband services. We did so because the impact (if any) of the uneven distribution of the 900 MHz and 1800 MHz spectrum between MNOs depends (amongst other things) on the extent of these differences. We estimated that by using 900 MHz spectrum as opposed to 2.1 GHz spectrum to provide a high quality mobile broadband service, an operator could save around £1bn in deploying a network in more densely populated areas (covering 80% of the population) and £250m in less densely populated areas (covering the remaining 19% of the population). Our analysis indicated that having access to 1800 MHz spectrum as opposed to 2.1 GHz spectrum would not in practice make a significant difference to the cost of network deployment.

4.8 The advantages associated with use of 900 MHz spectrum stem from the physical characteristics of the frequencies. Lower frequency signals, such as those at 900 MHz, can travel further and pass through walls more easily than higher frequency signals, all other things being equal. For operators, this may translate into fewer masts, as each mast can cover a bigger area, saving costs. For consumers, this may translate into better services, especially indoors, because signals using those frequencies travel better through walls (Annex 6 provides further background on the advantages of lower frequencies in general for proving mobile broadband services).

Feedback on our previous analysis

4.9 The responses to our consultation expressed a wide range of views about the differences between bands and whether this would give operators holding 900 MHz spectrum a significant advantage. Broadly O2 and Vodafone considered that we had significantly overstated the benefits, whilst the other MNOs thought that they were understated. O2 and Vodafone in particular provided detailed comments on our technical and cost analysis.

4.10 Some MNOs also provided site number estimates which appeared to differ materially from our estimates. Stakeholders raised a number of issues about the extent to which differences in sites numbers required at different frequencies would in practice result in cost differences between operators.

[19] See in particular paragraphs A12.45-A12.49.

4.11 There were a range of views expressed in response to our initial consultation as to the future level of market demand for mobile broadband services and the appropriate level of service to assume when assessing differences between bands. In addition, as discussed in the next section, there have also been significant developments in the mobile broadband market since our last consultation.

4.12 We followed up on this feedback by seeking further technical input from MNOs during the process of refining our analysis.

4.13 A more comprehensive description of the feedback received, and how we took account of it can be found in Annexes 13 to 15[20].

Changes in the available evidence

4.14 The mobile broadband market has changed very quickly since the time of the last consultation. In nine months between that time and summer 2008, total data traffic carried by mobile networks increased more than seven fold[21]. Some of the reasons behind this growth includes the market success of USB dongles (wireless modems for computers) and high-end phones such as the iPhone[22]. As a result of these developments, high future demand for mobile broadband services seems more likely than at the time of our original consultation.

4.15 We also now believe that operators without 900 MHz spectrum may be able to acquire and use 800 MHz spectrum and that this spectrum may in time be able to offer comparable services at comparable costs as 900 MHz spectrum, as explained earlier.

4.16 Network sharing between the mobile operators in the UK has also grown in importance since the last consultation. Two pairs of operators have announced their intention to share some elements of their access networks, as mentioned in Section 3.

How we refined our analysis

4.17 Given the detailed and technical nature of this analysis, the significant and wide ranging comments received, and the importance for our analysis of policy options, we have undertaken considerable additional work to refine our analysis. We have also updated our analysis, where appropriate, to take into account changes in the available evidence since our previous consultation.

4.18 Our further work includes market analysis, technical analysis, analysis of network rollout and cost modelling.

Market analysis.

4.19 To inform our analysis in this consultation, we have reviewed mobile broadband developments and market expectations about how it is likely to develop in the future,

[20] See in particular: Annex 13, paragraphs A13.105-A13.370; Annex 14, paragraphs A14.21-A14.49; Annex 15, paragraphs A15.30-A15.56.
[21] See Annex 11, in particular paragraph A11.16, and Figure 1.
[22] See Annex 11, in particular paragraph A11.17.

as well as commissioning focus group research[23]. Annex 11 on market scenarios provides a summary of our findings from this review[24].

Technical analysis

4.20 We have undertaken a significant amount of additional technical work and refined our methodology for calculating the site differences between frequency bands from the previous consultation. The new methodology is more flexible allowing us to explore quickly a wider range of different deployment scenarios and also gives a better view of site numbers across the UK.

4.21 The new methodology, for analysis of more densely populated areas, is explained in Annex 13 in detail. The changes are technical in nature and can be better understood as part of a detailed explanation of the methodology, which is provided in Annex 13[25].

4.22 We have also refined our technical analysis of differences in less densely populated areas, taking account of stakeholder comments (although these comments were less extensive than for our analysis in more densely populated areas). Annex 14 provides details of these refinements[26].

Analysis of network rollout and costs

4.23 The most substantive change to this analysis is to take account of the fact that operators without 900 MHz spectrum may be able to acquire and use 800 MHz spectrum to offer comparable services at comparable costs as 900 MHz spectrum, as mentioned earlier.

4.24 We have refined our methodology to take into account the fact that some operators may have access to, and use, multiple bands for providing mobile broadband services, that these bands may be usable at different times and that there are likely to be practical limits over how quickly networks can be deployed. Annex 12 sets out our analysis of the timing of rollout and consumer use of networks at different frequencies.

4.25 Our cost analysis set out in Annex 15 estimates the costs of network build, upgrade, operation and decommissioning of different network roll-out profiles. The analysis has been enhanced to reflect investments operators may make in multiple bands, e.g. 2100 MHz, 900 MHz and 800 MHz, and to consider the different costs faced by network sharing operators.

Changes in input parameters

4.26 Our analysis uses a very large number of input parameters, and many of them have changed as part of the analysis refinement process. The main changes are[27]:

[23] The full research report commissioned for this consultation can be found at http://www.ofcom.org.uk/consult/condocs/spectrumlib/mobilebb.pdf.
[24] See Annex 11, in particular paragraphs A11.7 to A11.9, and A11.15 to A11.23.
[25] In particular see A13.12 – A13.19.
[26] In particular see A14.15-A14.18; A14.50 – A14.61.
[27] For a full list see: Annex 12, Tables 1-11; Annex 13, Tables 13-23; Annex 14, Tables 1-7, 10, and 14-22; Annex 15, Tables 1-9, 11, 20-22.

- We examine a wider and higher range of mobile broadband data usage which reflects the rapid growth experienced since the last consultation and how this might continue in the future[28].

- We explicitly consider the use of higher speed HSDPA services (offering up to 10Mbit/s), whereas our last consultation only considered use of 144kbit/s and 384kbit/s services[29].

- We also consider the possibility that operators may offer a shallower depth of indoor coverage than we considered last time, taking account of comments from operators on this point[30].

- We have revised the technical parameter sets used following a thorough review of the parameters used in the model taking input from the consultation response, from discussions with key stakeholders and through a rigorous analysis of industrial and academic research and the parameters set in the 3GPP standards body[31].

- We have revised our estimates of the time at which UMTS 900 is likely to be in use, if deployed, as well as using additional inputs about the time of use of 800 MHz[32].

- We have revised the inputs of unit site costs to account for network sharing agreements, and to allow a wider set of sensitivities in this variable[33].

How analysis and results are organised

4.27 We have organised our refined analysis around three main questions:

- If we liberalise 900 MHz and 1800 MHz spectrum and there is no change in the current distribution of that spectrum, what speed and coverage differences could arise between mobile broadband services as a result of operators having different spectrum holdings?

- If we liberalise 900 MHz and 1800 MHz spectrum and there is no change in the current distribution of that spectrum, what would be the differences in costs for operators to provide the same mobile broadband services using different spectrum?

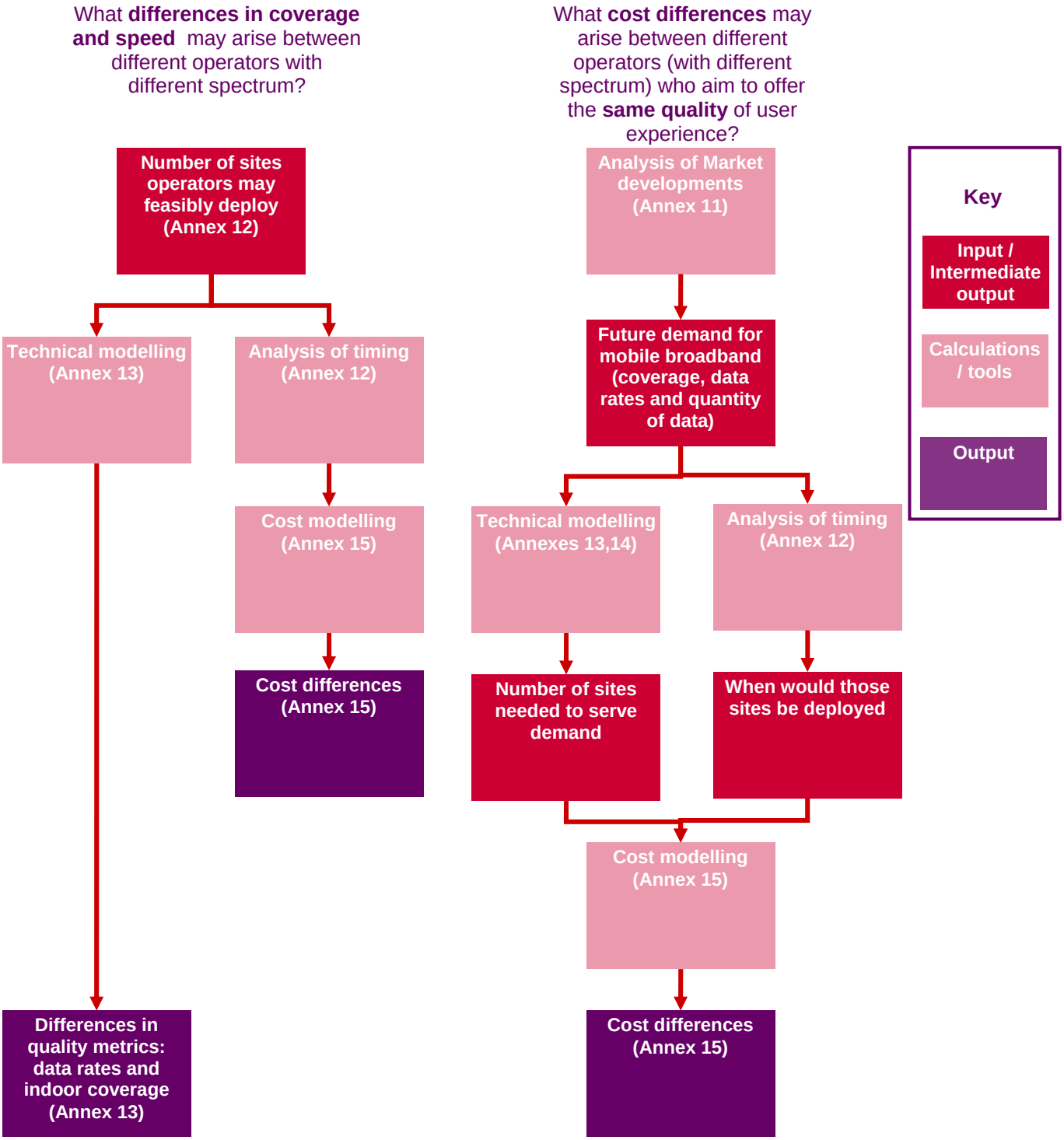
- What savings would be achieved for an operator initially without 900 MHz spectrum who acquires one block (2x5MHz) of this spectrum?

4.28 The first question is about differences in quality of user experience. It reflects the idea that operators with access to liberalised spectrum may be able to offer improved mobile broadband services. The second and third questions are about cost differences. They explore the possibility that operators without access to liberalised spectrum may have to spend more in order to offer the same mobile broadband service.

[28] See Annex 11, in particular Table 2.
[29] See Annex 13, in particular A13.332 – A13.344.
[30] See Annex 13, in particular A13.31, and Tables 13 and 14.
[31] See Annex 13, in particular Tables 19-23.
[32] See Annex 12, in particular A12.84 and following charts.
[33] See Annex 15, in particular Tables 1-4, and Table 11.

4.29 Figure 3 shows a high level view of the analysis we have undertaken to answer these different questions and the corresponding annexes which contain the detail of our analysis. The overall structure of our refined analysis is explained further in Annex 10[34].

Figure 3 – How different questions are answered



[34] See, in particular, A10.9-A10.14.

4.30 The following two sub-sections summarise the results from our analysis (represented in Figure 3 by the output boxes at the bottom).

Summary of results: differences in data rates and indoor coverage

4.31 We have estimated the differences in data rates and indoor coverage provided by networks operating at different frequencies that could arise following liberalisation. We have focused on indoor coverage because provision of indoor coverage is widely acknowledged to be technically challenging and because much of the current use of mobiles occurs indoors. For example, research for the Communications Market Report 2008 found that 70% of people with a mobile and a fixed-line phone say they use their mobile to make some calls when they are in the home[35].

4.32 Figure 4 sets out our estimates of the differences arising from the use of 900 MHz spectrum versus 2100 MHz spectrum for the provision of mobile broadband services using UMTS technology (i.e. the differences between a UMTS 900 and UMTS 2100 network). It considers the service provided to an area covering 80% of the population with an equal numbers of base station sites (9,000 sites for each network). The service that would be provided by a UMTS 1800 network using 1800 MHz spectrum is not shown but our technical analysis[36] indicates that this would be very similar to that provided by a UMTS 2100 network.

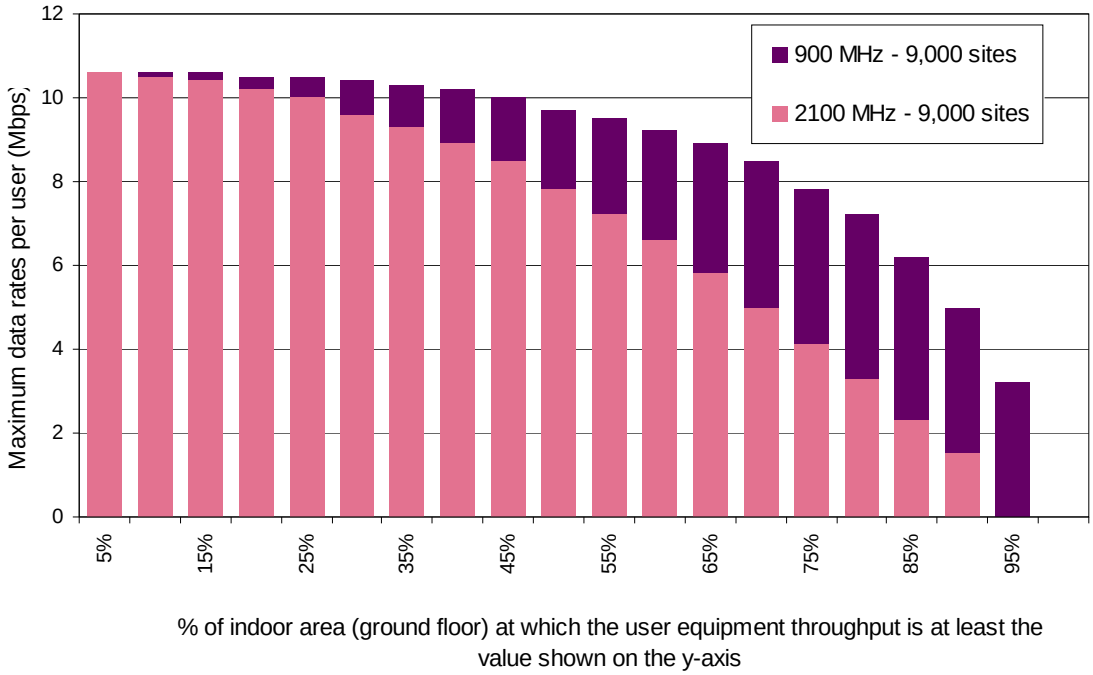
4.33 The comparison shows the data rates (throughput) that users may experience across a range of indoor locations. The horizontal axis shows indoor locations on the ground floor of a typical building. Starting from the left hand side, the chart shows first the data rates achieved in the best 5% of locations (those with the best mobile reception). The chart shows the gradual degradation in speeds as a user moves from the best locations to the worst locations within the typical building. Note that not all buildings will receive the same quality of coverage; some will see better performance than this, but others worse.

4.34 Moving along the horizontal axis from left to right, the advantage of 900 MHz spectrum is reflected in the ability to deliver a given data rate to a larger proportion of indoor locations. For instance, one can follow the grid line next to the 8 Mbps label, horizontally. This shows that the 900 MHz network delivers a minimum of 8 Mbps to 70% of locations; the 2100 MHz delivers the same data rate to only 45% of locations.

4.35 Moving along the vertical axis shows the advantage of 900 MHz spectrum expressed as greater data rates, for a given level of certainty. For instance, the vertical bar marked 85% suggests we should be 85% confident that the modelled 900 MHz network can provide 6 Mbps in a randomly picked ground floor indoor location. The same bar suggests we should be 85% confident that the modelled 2100 MHz network can provide 2 Mbps in a similarly random location.

[35] The Communications Market 2008, pg 294. Also see Annex 11 for further discussion on indoor coverage.
[36] See Annex 13, in particular A13.38 and Table 4.

Figure 4 - Data rates achieved by networks with the same number of sites and different spectrum bands, as seen from a range of indoor locations



4.36 This comparison shows that a UMTS 900 network provides higher data rates than a UMTS 2100 network in most indoor locations.

- For users in the best 50% of locations (for example, perhaps near a window) who get the fastest speeds (8-10 Mbps with UMTS 2100), the differences are relatively small - speeds on the UMTS 2100 network are less than 20% slower.
- However, the differences between the networks is higher in other, more difficult to serve locations. For the next 25% of locations UMTS 2100 speeds are 25-50% slower than UMTS 900. For example a user of the UMTS 2100 network might get around 6 Mbps compared to 9 Mbps in the UMTS 900 network.
- Finally, for the last 20% of locations at which either network provides service, the UMTS 2100 customers get less than half the speed available for UTMS 900 customers, or practically no service at all (below 0.1 Mbps), while UMTS 900 customers still get good data rates (3 to 7 Mbps).

4.37 We have also considered comparisons between UMTS 900 networks and UMTS 2100 networks where the UMTS 2100 network has more sites than the UMTS 900 network. This reflects the fact that UMTS2100 networks are already deployed and that operators without 900 MHz spectrum might invest in additional UMTS 2100 sites. We have focused on differences that might plausibly arise in the period up to around 2015 because after this time consumers may be benefiting from services provided using 800 MHz spectrum.

4.38 Figure 5 sets out a comparison of the mobile broadband service provided by:

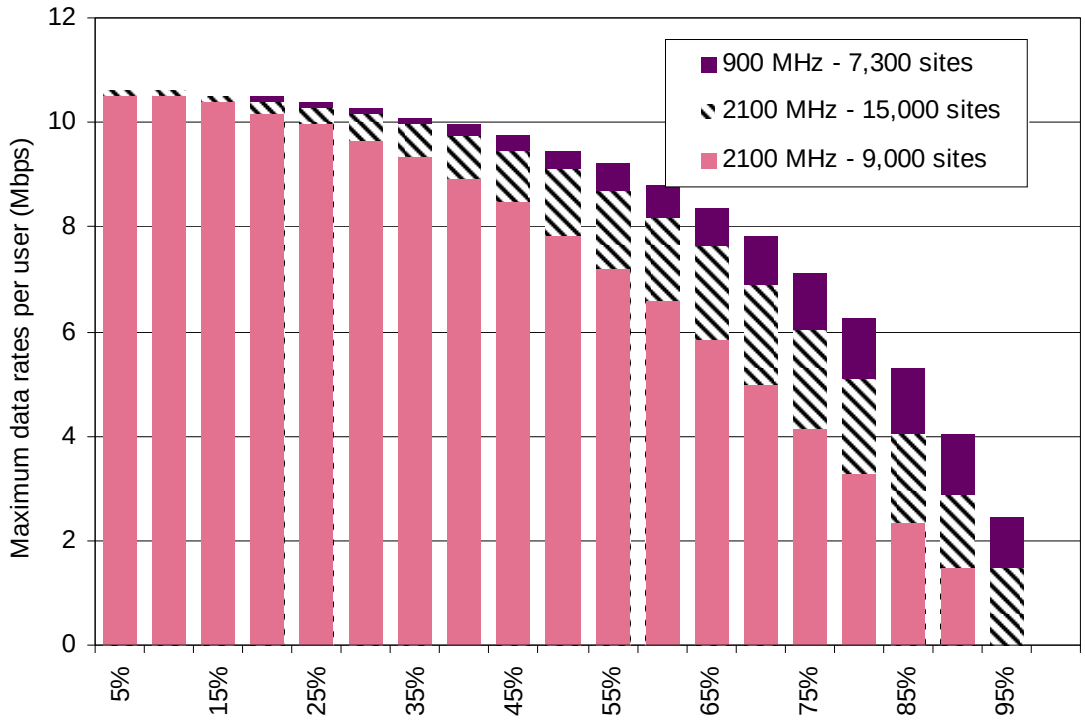
- An operator with 900 MHz spectrum deploying a UMTS 900 network with 7,300 sites. This is a sufficient number of sites to provide a level of service consistent with a “higher demand” scenario (see the next subsection) for mobile broadband

and we believe that this number of sites can feasibly deployed by 2015 (see Annex 12[37]).

- An operator without 900 MHz spectrum who deploys a UMTS 2100 network with 9,000 sites between now and 2015.

- An operator without 900 MHz spectrum who deploys a UMTS 2100 network with 15,000 sites between now and 2015. We believe that this is close to the maximum that is feasible to achieve within this timeline[38].This outcome could arise if operators without 900 MHz spectrum try to minimise the differences between their service and the service provided by operators with 900 MHz spectrum.

Figure 5 - Data rates achieved by different networks, as seen from a range of indoor locations



4.39 When an operator without 900 MHz spectrum does not try to fully match the service provided by the UMTS 900 operator, while still building a larger network (9,000 UMTS 2100 sites versus 7,300 UMTS 900 sites), again a significant difference in data rates emerge, as shown in Figure 5. The structure of Figure 5 is similar to that in Figure 4, so we do not repeat a detailed description here.

4.40 If the operator without 900 MHz does try to match the service of the UMTS 900 operator, by deploying 15,000 sites, the differences in data rates are much smaller than the previous cases, and always below 30%. But they would also incur

[37] See Annex 12, in particular, A12.75 and "pair 6" under *List of illustrative roll out profiles.*
[38] See Annex 12, in particular, A12.75 and "pair 30" under *List of illustrative roll out profiles.*

significantly higher costs, £700m in this scenario due to the higher number of sites they would have deployed. In addition, the UMTS 900 operator would be able to reach the required number of sites more quickly, as the network roll out required is smaller.

Summary of results: cost differences

4.41 The second and third questions we set out above are related to cost differences between bands. They present scenarios where operators without liberalised 900 MHz spectrum would match the quality of user experience provided by a UMTS 900 operator, on a year by year basis, but at higher cost.

4.42 Our main findings are that an operator with 900 MHz spectrum is likely to be able to serve future demand in areas where 80% of the population live by using between 2,900 and 7,300 sites, depending on the level of demand (see Table 5). An operator without 900 MHz spectrum, using UMTS 2100, is likely to need over twice as many sites, between 8,600 and 21,100 sites, to provide the same service. Later on, after 800 MHz spectrum and equipment becomes available, they may be able to reduce this number of sites and still meet the same demand using this lower frequency spectrum, but only after a number of years.

4.43 Although differences in the number of sites necessary to meet demand at different frequencies may eventually narrow as operators add more sites to increase capacity, we estimate that a material advantage is likely to persist even if the average use of mobile broadband is the equivalent of 30 megabytes per user per day (averaged across all users). This volume would correspond to approximately 80 times the average usage in mid 2008.

Table 5: Difference in site numbers required between UMTS 900 and UMTS 2100 networks covering 80% of the population

Scenario	**Lower demand** 384 kbit/s min / shallower indoor coverage 1 MB / subscriber / day	**Higher demand** 2.4 Mbit/s min / deeper indoor coverage 30 MB / subscriber / day
Number of UMTS900 macrocell base stations	2,900 sites	7,300 sites
Number of UMTS2100 macrocell base stations	8,600 sites	21,100 sites

4.44 As a result of these site differences, if UMTS 2100 operators are to provide the same quality (speeds and coverage) as UMTS 900 operators they are estimated to incur additional costs between £50m and £1.6bn (in the case when they eventually acquire 800 MHz spectrum). For operators with a network sharing agreement the additional costs per operator are likely to be lower, but may still be up to £1.0bn. These values are summarised below in Table 6. If operators without 900 MHz spectrum do not acquire and use 800 MHz spectrum for mobile broadband, and continue to use UMTS 2100, then the costs differences would be higher: £250m - £2.2bn for a single operator network.

Table 6 – Additional costs for a UMTS 2100 operator to match the quality of a UMTS 900 deployment – 20 year NPV at 3.5%

Scenario	**Lower demand** 384 kbit/s min / shallower indoor coverage 1 MB / subscriber / day	**Higher demand** 2.4 Mbit/s min / deeper indoor coverage 30 MB / subscriber / day
Single UMTS2100 operator	£50m	£1.6 bn
Network sharing UMTS2100 operator	No cost difference resulting from liberalisation	£1.0bn

4.45 The results above are for the case where UMTS 900 is deployed by an existing holder of 900 MHz spectrum. If a UMTS 2100 operator currently without 900 MHz spectrum is able to acquire one block of 900 MHz spectrum, the cost difference would reduce by 90% or more, to no more than £150m, in the higher demand case. The reason why cost differences may not disappear entirely is that 900 MHz incumbents may be able to extract some savings from re-using existing 900 MHz-specific equipment (antennas in particular). These savings would not be available to an acquirer of 900 MHz spectrum.

4.46 We have analysed separately the cost differences likely to arise in extending a basic level of 3G coverage from an area covering 80% of the population to less densely populated areas so as to replicate current 2G coverage. We estimate the cost differences between UMTS 2100 and UMTS 900 networks in doing this would range between £20m and £60m per operator (NPV over 20 years at 3.5%, for a single operator).

4.47 Our analysis also indicates that, within our plausible range of demand scenarios, an operator with 1800 MHz spectrum is not likely to gain any material cost saving from deploying UMTS 1800 rather than UMTS 2100. Outside our main range of demand scenarios, 1800 MHz could be used to increase network capacity, but there are alternative ways of achieving this goal (as discussed in Section 6).

The benefits of competition in the provision of mobile broadband services

4.48 In order to assess the policy options for liberalisation of the 900 MHz spectrum bands it is important to understand the potential impact of these on the prospects for competition in the provision of mobile broadband services. Competition effects may arise where the quality of mobile broadband services is sufficiently important and cost differences between different spectrum bands prevent operators without low frequency spectrum from matching quality, with the implication that fewer players can afford to compete in the provision of high quality mobile broadband services.

4.49 We looked at the competition benefits of liberalisation in the September 2007 consultation, and quantified these in terms of the impact on economic welfare from increased competition, using a Cournot model.

4.50 Following comments received and other developments, we have updated our modelling. The following paragraphs summarise our revised approach in the light of comments and relevant developments. Full details are given in Annex 9.

Competition benefits

4.51 Some respondents commented on our modelling and use of a Cournot model in our September 2007 consultation. Vodafone in particular commented that it was inappropriate for a number of reasons to use a Cournot model to model competition in the mobile market. These reasons included the view that we had chosen a model that axiomatically assumed that entry would increase competition in mobile markets without providing evidence to support that view.

4.52 Since September 2007 we have refined our analysis in the light both of comments and more recent evidence and data available. We note three major changes for the competition modelling:

- The possibility of greater availability of low frequency spectrum in the longer term (via the potential availability of 800 MHz spectrum) means that the time period and consequently the scale of the potential benefits of intervention may have changed;

- We are using different market demand scenarios to assess cost differences between operators with access to different frequencies. We also need to consider how our assessment of the costs and benefits of different methods of liberalisation is affected by these market demand scenarios, including any impacts on competition; and

- There are now more projections, though they are still few, for mobile data revenues. Hence our present analysis of the potential benefits of liberalisation is better able to evaluate the impact on mobile broadband subscribers.

4.53 We have therefore revised our modelling of the implications of different numbers of players being able to compete in the provision of high quality mobile broadband services. This modelling reflects different assumptions about the extent to which holding 900 MHz spectrum may effectively enable a player to compete in the provision of high quality mobile broadband services. Where such holdings are important, competitive intensity will, all other things being equal, substantially depend on the number of players with access to 900 MHz spectrum. The number of players with access to 900 MHz will in turn depend on policy options adopted, and so our estimates of welfare changes resulting from different competitive conditions enter our appraisal of policy options.

4.54 We have employed a revised version of the Cournot model[39] to estimate welfare effects from changes in the number of players[40]. We have considered the concerns raised by Vodafone but, for a number of reasons, we believe that it is reasonable to use this model[41]. Overall, we believe that it is reasonable to consider that a reduction in the level of competition in the provision of mobile broadband would have a negative impact on the services that consumers receive. Use of a Cournot model enables these kind of effects to be illustrated through the impact of changes in the number of players on the prices consumers pay. We nevertheless note that such

[39] See Annex 9, in particular A9.26 to A9.36.
[40] See Annex 9 paragraphs A9.37 to A9.60 for modelling results.
[41] See Annex 9, in particular A9.13-A9.16.

modelling is a simplification and that resulting estimates need careful interpretation. Our full response to Vodafone's concerns is set out in more detail in Annex 9[42].

4.55 Our base case assumes that the revenues sensitive to changes in quality – and so forming the size of the affected market segment – represent around 25% of the overall UK mobile market. In this base case, our competition welfare result is that increases in the number of players in high quality mobile broadband during the interim period can significantly increase estimated economic welfare, as measured over a 20 year horizon. An increase in the number of players from 2 to 3 for example might in the base case increase economic welfare by around £425 million (£250 million to £600 million in the low and high cases respectively). An increase from 2 to 5 increases welfare by around £750 million in the base case (£450 million to £1bn in the low and high cases respectively). Our low and high cases, where the assumed relevant revenue is around 15% and 35% of UK mobile market respectively.

4.56 Our option appraisal therefore takes account of these effects in the scenarios in which policy interventions have the potential to affect the number of players providing high quality mobile broadband services.

Welfare impacts of delay to liberalisation

4.57 We have also assessed the effect on welfare of delays to the launch of higher quality mobile broadband services. This is because it is possible in some situations that our policy options could introduce a delay to the liberalisation of the spectrum.

4.58 Our model[43] of the effects of foregone benefits where liberalisation is delayed is driven by a modelled delay in consumers migrating to higher quality mobile broadband services.

4.59 Delays in liberalisation of 3 months and associated delays in the uptake of higher quality broadband services can reduce welfare by an estimated £45 million[44].

4.60 In our September 2007 consultation we also included an estimate of the welfare effect of greater competition leading to greater innovation, and hence the earlier launch of new services. For the reasons set out in Annex 9 we do not believe these longer term effects are relevant to the options assessment we complete in this document.

Costs of clearing and releasing spectrum

4.61 In order to assess the policy options for liberalisation of the 900 MHz and 1800 MHz bands it is important to understand the costs associated with clearing and releasing different quantities of this spectrum[45].

Feedback on previous analysis and our refined approach

4.62 We looked at these costs in the September 2007 consultation. We received a varied number of comments on our previous cost of release analysis – most notably from the MNOs. Both Vodafone and O2 provided a significant amount of detail in their comments that overall suggested that we had under-estimated the cost of release. T-

[42] See in particular paragraphs A9.13 to A9.16.
[43] See Annex 9, in particular paragraphs A9.69 to A9.80.
[44] See Annex 9, in particular paragraphs A9.81 to A9.87 for a description of modelling results.
[45] See Annex 16 for full details of our analysis.

Mobile and Orange, on the other hand, provided comments to the effect that we had under-estimated the costs involved[46]. Since the September 2007 consultation we have undertaken a significant amount of additional technical research and refined our analysis considerably. We have investigated three different approaches to dealing with displaced traffic rather than just one. We have had discussions with a number of equipment vendors and operators outside the UK and we have had an extensive dialogue with all the UK operators[47].

4.63 There are two distinct cases when considering clearing and releasing spectrum. The first is a partial clearance and release where only a portion of the spectrum is cleared and released whilst the rest continues to be used for the delivery of 2G services using GSM technology. The second is where the entire 2G spectrum is cleared as might be the case for a full release. The majority of this sub-section deals with the case of a partial clearance and release, however we have also estimated the cost of a full release.

4.64 A consequence of a partial clearance of spectrum currently used to provide 2G services using GSM technology in either the 900 MHz or the 1800 MHz bands will be that the traffic carrying capacity of the GSM networks will be reduced. This reduction in capacity will be most severe in the busiest areas of the networks and will be greater for larger clearances. To be able to continue to carry the same volume of traffic at similar quality operators can do at least two things:

- they can deploy a technical solution that will enable them to use their remaining GSM spectrum more efficiently (i.e. carry more traffic in a given quantity of spectrum); or

- they can transfer a proportion of their traffic to an alternative frequency band (perhaps using a different technology).

4.65 In practice they are likely to adopt a combination of these solutions.

4.66 For our refined analysis for this consultation, outlined in Annex 16, we have considered three approaches to dealing with traffic displaced as a consequence of a partial clearance and release of spectrum in the 900 MHz band and hence to estimating the associated costs. We have also used the first two of these approaches to estimate the cost of a partial clearance of 1800 MHz spectrum (the third is not relevant to 1800 MHz). The three approaches considered are as follows:

- **SFH upgrades plus UMTS2100 widening** (approach 1): we estimate the cost of upgrading the GSM networks to implement synthesised frequency hopping (SFH) to improve their spectral efficiency and then estimate the cost of carrying any remaining 2G traffic displaced as a consequence of clearing GSM spectrum on the operators' UMTS2100 networks, building out additional UMTS2100 infrastructure to absorb this traffic as necessary.

- **SFH upgrades plus GSM cell splitting** (approach 2): again we estimate the cost of upgrading the GSM networks to implement SFH, however any remaining traffic displaced as a consequence of clearing GSM spectrum is handled by cell splitting in the GSM networks.

[46] See Annex 16, in particular A16.39 - A16.79.
[47] See Annex 16, in particular A16.84 - A16.91.

- **GSM1800 upgrades plus cell splitting** (approach 3): this only applies to clearance and release of the 900 MHz spectrum held by O2 and Vodafone. We estimate the cost of expanding the use of GSM1800 on existing GSM sites with any remaining traffic displaced as a consequence of clearing GSM spectrum being handled by cell splitting.

4.67 For the case of a full release of 900 MHz and 1800 MHz the only viable option for dealing with displaced 2G traffic would be **UMTS2100 widening** (i.e. building out additional UMTS2100 infrastructure to carry this traffic as necessary).

4.68 The estimates below are for a spectrum release date of 2011 with clearance work taking place in the two years leading up to this. The estimates are based on a 20 year NPV using a social discount rate of 3.5%. The estimates quoted are the combined costs of the relevant operators as are the spectrum clearance and release quantities (e.g. a 1 block release of 900 MHz spectrum would mean half a block release by each of Vodafone and O2, each block is 2 x 5 MHz of spectrum).

Summary of results: cost of partial clearance and release of 900 MHz spectrum[48]

4.69 The cost of clearing GSM900 spectrum is estimated in Table 7 as follows.

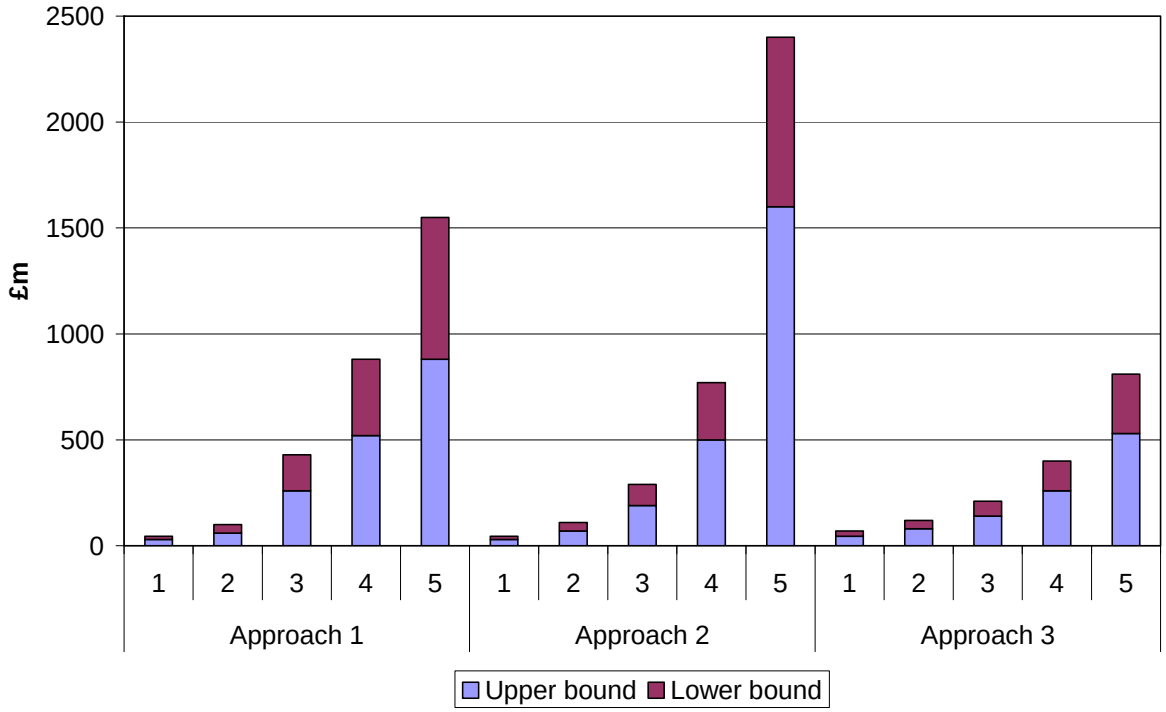
Table 7: 900 MHz – Overall cost of clearance

Blocks cleared	Approach 1		Approach 2		Approach 3	
	Lower	Upper	Lower	Upper	Lower	Upper
1 Block	£30m	£45m	£30m	£45m	£45m	£70m
2 Blocks	£60m	£100m	£70m	£110m	£80m	£120m
3 Blocks	£260m	£430m	£190m	£290m	£140m	£210m
4 Blocks	£520m	£880m	£500m	£770m	£260m	£400m
5 Blocks	£880m	£1,550m	£1,600m	£2,400m	£530m	£810m

4.70 These results are illustrated graphically in Figure 6 below.

[48] See Annex 16, in particular A16.8 - A16.13, and A16.276 - A16.286 and Tables 1 - 3, and Tables 61- 63.

Figure 6: 900 MHz – Overall cost of clearance



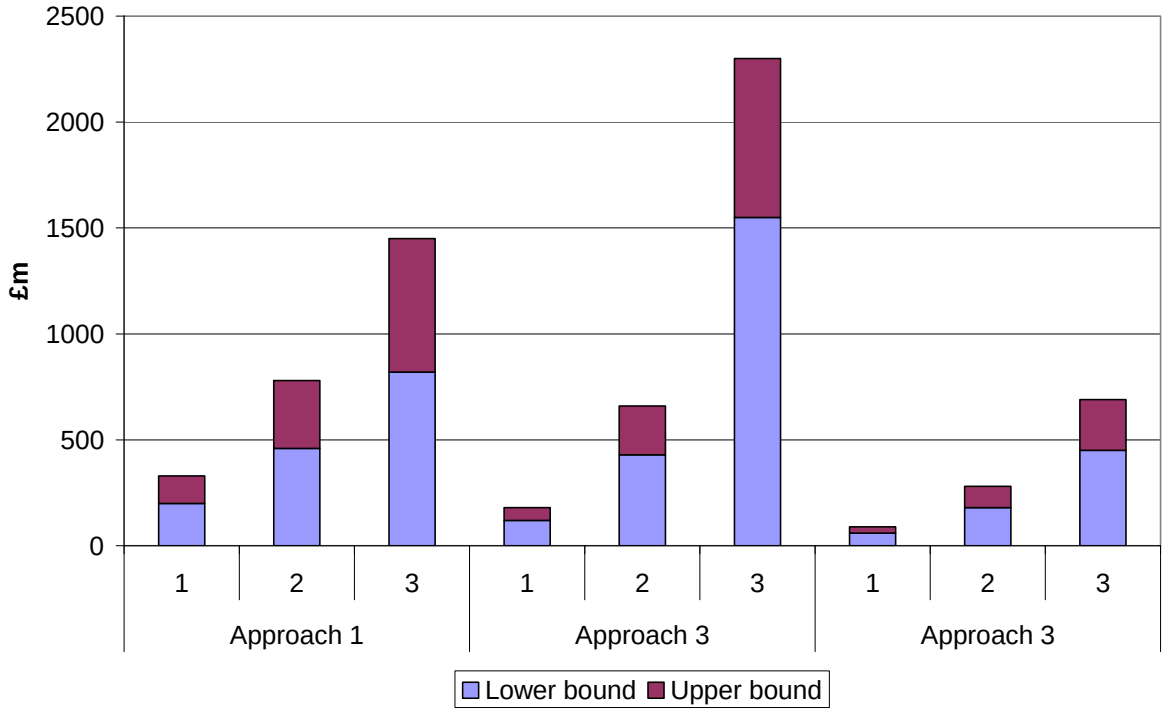
4.71 The cost of releasing GSM900 spectrum is estimated in Table 8 below. This estimate assumes that O2 and Vodafone clear one block (i.e. 2 x 5 MHz) of spectrum each for their own use, the cost of release is therefore the difference between clearing two blocks and clearing subsequent blocks (i.e. the cost of releasing one block is calculated from the difference between clearing 2 blocks and clearing 3).

Table 8: 900 MHz – Overall cost of release

Blocks released	Approach 1		Approach 2		Approach 3	
	Lower	Upper	Lower	Upper	Lower	Upper
1 Block	£200m	£330m	£120m	£180m	£60m	£90m
2 Blocks	£460m	£780m	£430m	£660m	£180m	£280m
3 Blocks	£820m	£1,450m	£1,550m	£2,300m	£450m	£690m

4.72 The overall cost of release is illustrated graphically in Figure 7 below.

Figure 7: 900 MHz – Overall cost of release



4.73 As can be seen, approach 3 appears to be the most cost effective approach regardless of the size of release.

4.74 We do not believe that for partial clearance and release of spectrum it is actually necessary to remove the interleaving of GSM900 spectrum holdings. However, operators may choose to undertake such work at the same time as clearing spectrum. Table 9 below illustrates the cost of clearing GSM900 spectrum including the removal of interleaving.

Table 9: 900 MHz – Overall cost of clearance (including removal of interleaving)

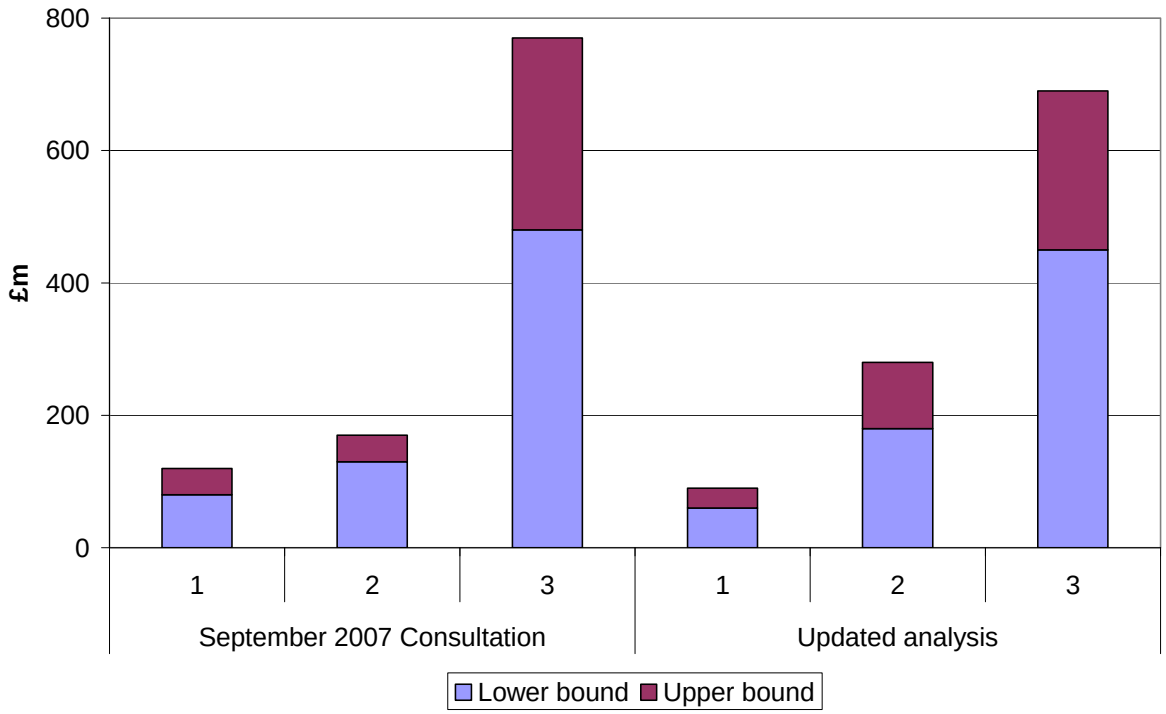
Blocks cleared	Approach 1		Approach 2		Approach 3	
	Lower	Upper	Lower	Upper	Lower	Upper
1 Block	£70m	£110m	£70m	£110m	£90m	£130m
2 Blocks	£100m	£150m	£100m	£160m	£120m	£180m
3 Blocks	£280m	£470m	£220m	£330m	£180m	£270m
4 Blocks	£530m	£900m	£520m	£790m	£300m	£470m
5 Blocks	£880m	£1,550m	£1,600m	£2,400m	£570m	£880m

Comparison with September 2007 consultation[49]

4.75 Figure 8 below compares the cost of release using approach 3 with the equivalent cost of release estimated from the September 2007 consultation.

[49] See Annex 16, in particular A16.14 - A16.15 and Figure 3.

Figure 8: 900 MHz – Cost of release comparison with September 2007 consultation



4.76 As can be seen, the estimated cost of releasing 1 block of spectrum (based on approach 3) has fallen, the estimated cost of releasing 2 blocks has risen significantly and the estimated cost of releasing 3 blocks has fallen from the September 2007 equivalent. Overall, however, the costs appear to be of a broadly similar magnitude.

Summary of results: cost of partial clearance of 1800 MHz spectrum[50]

4.77 The cost of clearing the GSM1800 spectrum held by Orange and T-Mobile is estimated in Table 10 as follows[51]:

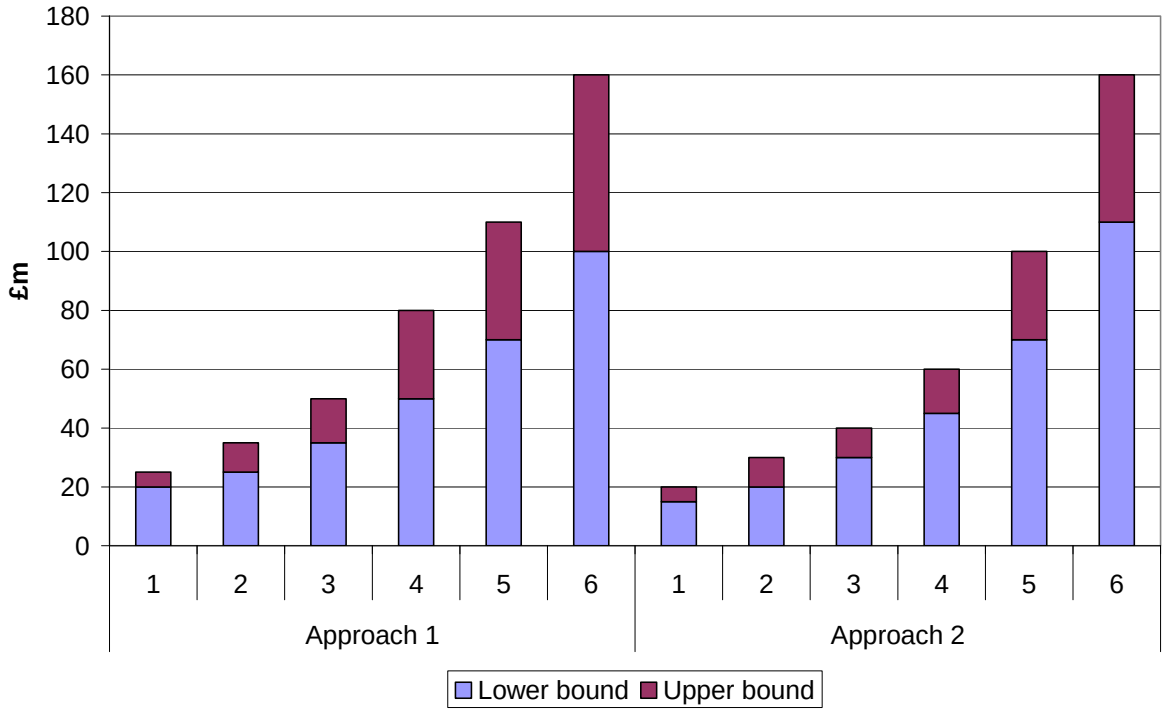
Table 10 : 1800 MHz – Overall cost of clearance

Blocks cleared	Approach 1		Approach 2	
	Lower	Upper	Lower	Upper
1 Block	£20m	£25m	£15m	£20m
2 Blocks	£25m	£35m	£20m	£30m
3 Blocks	£35m	£50m	£30m	£40m
4 Blocks	£45m	£70m	£45m	£60m
5 Blocks	£70m	£100m	£70m	£100m
6 Blocks	£100m	£150m	£110m	£160m

4.78 These results are illustrated graphically in Figure 9 below.

[50] See Annex 16, in particular A16.16 - A16.17, and A16.287- A16.295, and Tables 4, 64 and 65.
[51] Not applicable to O2 and Vodafone 1800 MHz spectrum holdings.

Figure 9 : 1800 MHz – Overall cost of clearance



4.79 Unlike 900 MHz, spectrum holdings at 1800 MHz are not interleaved and therefore there is no equivalent case for the removal of interleaving.

Summary of findings: timing and the risk of transitional network disruption[52]

4.80 We believe that, for a spectrum release of 1 block of 900 MHz spectrum, the work necessary to upgrade the networks to enable this could be reasonably achieved within 2 years.

4.81 In considering the process and timing for releasing spectrum we have considered the fact that operators may also be deploying UMTS900 at the same time. We do not believe this would have a material impact on operators' ability to release or the timing of release because much of the physical upgrade work necessary to release spectrum could be planned and implemented alongside the work necessary to deploy UMTS900 - for instance site visits could be combined where appropriate.

4.82 We acknowledge that there may be a period of network disruption during the upgrade. However, impacts can be minimised if the proposed upgrades are planned well in advance and major changes/upgrades are brought on-line at times when the networks are naturally quiet (e.g. at night). Further, all the operators in the UK have experience in making major changes/upgrades to their networks. Although there are challenges when upgrade activities are carried out on a large scale, they are not completely new concepts. In addition, all the operators carry out numerous smaller scale network upgrades and frequency planning modifications as a part of their business as usual activities. We believe that the operators are experienced enough to carry out the types of upgrade we propose without adversely affecting their market

[52] Please see Annex 16, in particular A16.18 – A16.22, and A16.307- A16.344, Figure 41,and Tables 5 and 69 - 75

position and they can make use of their past experience in order to minimise any network disruption.

4.83 It is unclear that there would be any material impact in terms of costs as a consequence of network disruption. If there are costs, we believe that they are likely to be relatively small. We have estimated that, as a worst case, such costs are likely to be no more than those in the following table:

Table 11: Network disruption cost ranges

Blocks released	Lower	Upper
1 Block	£2.3m	£20.8m
2 Blocks	£2.7m	£24.2m
3 Blocks	£3.2m	£28.8m

4.84 Our costing of the three approaches to the partial clearance and release of spectrum is based on maintaining the long term quality of existing services provided to consumers. As such we consider the risk of a long term impact on quality to be extremely low.

Summary of results: cost of full clearance and release[53]

4.85 We have estimated the cost of full clearance and release of all 900 MHz and 1800 MHz spectrum currently used to provide 2G services by assuming that all traffic is migrated to the operators' UMTS2100 network. The cost, made up of expanding the UMTS2100 networks to cope and accelerating the migration of 3G handsets, is estimated in Table 12 as follows.

Table 12: Overall cost of full clearance and release

Spectrum band	Full clearance and release	
	Lower	Upper
900 MHz	£1,900m	£3,100m
1800 MHz	£2,200m	£3,550m

Summary of key findings for 900 MHz spectrum release[54]

4.86 For the purposes of the policy analysis in this consultation, we consider a reasonable rage for the estimated cost of releasing 900 MHz spectrum is:

- **£60m** to **£90m** for 1 block release
- **£180m** to **£280m** for 2 blocks
- **£450m** to **£690m** for 3 blocks

4.87 These costs are based on approach 3 using a social discount rate of 3.5%. We also believe that the work necessary to clear spectrum for a 1 block release could be achieved in 2 years.

[53] See Annex 16, in particular A16.23, and A16.296 – A301, and Tables 6, 66 and 67.
[54] See Annex 16, in particular A16.276 – A16.279, and Tables 2 and 62.

Summary

4.88 This section has provided an overview of key pieces of analysis supporting our assessment of options for liberalisation of 900 MHz and 1800 MHz spectrum.

- **800 MHz spectrum.** As a result of developments over the last year, 800 MHz spectrum now appears a potential alternative for competing effectively with networks deployed using 900 MHz spectrum. However, the availability and use of this spectrum for mobile broadband is still more uncertain than for 900 MHz spectrum and consumers are likely to benefit from its use around two to four years later.

- **Differences between bands.** Networks using 900 MHz spectrum can provide higher speeds for indoor coverage than those using 2100 MHz spectrum. Networks using 900 MHz spectrum also need less than half the number of base station sites compared to those using only 2100 MHz spectrum in order to provide an equivalent service. Depending on the level of demand for mobile broadband services this would correspond to cost differences between operators of up to £1.6bn.

- **Benefits of competition in mobile services.** Changes in the degree of competition in mobile services, including mobile broadband, can have significant impact on the welfare of consumers.

- **Costs of clearing and releasing spectrum.** We have considered a range of approaches for clearing 900 MHz spectrum. We consider a reasonable rage for the estimated cost of releasing 900 MHz spectrum is £60m to £90m for 1 block release; £180m to £280m for 2 blocks; and £450m to £690m for 3 blocks.

4.89 Subsequent sections use the above analysis, and more detailed analysis set out in the annexes to this consultation, in order to inform our assessment of options.

Section 5

Assessment of options for liberalising 900 MHz spectrum

Introduction

5.1 In this section we set out the options assessment we have completed in order to identify how best to liberalise the 900 MHz spectrum. Given the proposed changes[55] to European legislation in relation to the 900 MHz band the decision we need to make is how to liberalise rather than whether to liberalise.

5.2 The structure of this section is as follows:

- The **approach to the assessment** section sets out the approach we have used for the options assessment. In this section we explain how evidence from elsewhere in this document has informed our approach, discuss some of the limitations of the analysis, and set out the three key scenarios which form the basis of our approach to assessing the impacts of the different policy options. These three scenarios span different levels of significance of lower frequency spectrum: from high significance where lower frequency spectrum is essential for the rollout of higher quality mobile broadband services through to low significance, where higher and lower frequency spectrum have similar benefits.

- As our options assessment draws upon evidence and analysis which is set out elsewhere in this document, in the discussion of **background and links to other section** we summarise the key pieces of evidence and analysis which we draw upon and provide cross references to the relevant sections and annexes where this information is discussed in greater detail.

- In the **identification of options** section we describe each of the policy options we have considered and highlight some of their key costs and benefits. These options range in the degree of intervention involved from liberalisation in the hands of the incumbents through to the release of significant amounts of spectrum for re-award.

- Before assessing the policy options we discuss the **availability of 800 MHz spectrum and the timeframe of the options assessment**. In this section we explain the approach we have used to incorporate the potential for 800 MHz spectrum to provide wider access to lower frequency spectrum in our assessment. This section includes a discussion of whether we should consider delaying our decision on how to liberalise the 900 MHz spectrum until after further uncertainties, such as around the timing of the availability of 800 MHz spectrum, have been resolved. (We note that the draft Directive might preclude delay.)

- We then discuss in the **assessment of options for each significance scenario** (the significance scenarios are set out in detail below) the likely outcomes of each of the different policy options under each of the significance scenarios. In this discussion, for each significance scenario, we start by setting out the outcome

[55] See Section 2, in particular 2.22-2.43.

under liberalisation in the hands of the incumbents and then compare the outcomes of the other policy options relative to this benchmark. In this section we pull together both quantitative and qualitative evidence to identify the best option for liberalising the 900 MHz band under each significance scenario.

- The section then concludes with the **interpretation of results across scenarios**. This brings together the analysis from each of the significance scenarios in order to identify the best overall policy option. In reaching this conclusion we take into account the relative likelihood of the different significance scenarios and we pay particular attention to how the outcomes under the different policy options compare to the legal test set out below.

5.3 We received a number of comments in response to our assessment of the options for liberalising the 900 MHz spectrum in our 2007 consultation document. These have been factored into our revised options assessment. Where responses are not explicitly reflected in the assessment in this section we include an explanation for this in Annex 7, in particular A7.396 onwards.

5.4 In reaching conclusions on the best policy option for the liberalisation of the 900 MHz spectrum we have based our assessment on the appropriate legal test as set out in Section 2 (paragraphs 2.39 to 2.41).

5.5 This is applied in this section as follows. As there is uncertainty over the future use of the 900 MHz spectrum and hence the outcome of liberalisation we have developed three significance scenarios which span the range of this uncertainty. In each of these significance scenarios, if there is a risk of a distortion of competition, we assess whether there are options which would be a proportionate response to this. Where there are multiple options which could constitute a proportionate response, or where there is not a risk of a distortion to competition, we apply our duties to secure the optimal use of spectrum and to promote competition in order to identify the best option.

Approach to the assessment

5.6 This section sets out the approach we have developed for the options assessment. The approach has been developed to allow us to reach an informed view on the likely outcome of the different policy options. Given the nature of the policy decision the approach needs to:

- Reflect the inherent uncertainty over the outcome of the different policy options.
- Reflect the importance of the policy decision both for the realisation of citizen and consumer benefits (including the need to avoid distortions to competition) but also for the costs which stakeholders would incur as a result of the policy.
- Bring together in a consistent fashion different evidence, based on different pieces of underlying analysis, and in which we have differing levels of confidence.

5.7 Applying this framework has resulted in a complex cost benefit analysis, the results of which are summarised in this section. The full extent of the analysis which underlies these results is set out in Annex 7.

5.8 Unless otherwise stated the costs and benefit numbers presented in this section are 20 year net present values using a social discount rate of 3.5%. This is the appropriate measure for assessing the impact of different policy options on society

(this is the approach set out in the H M Treasury Green Book for assessing the costs and benefits of policy options[56]).

Significance scenarios

5.9 At the heart of the framework set out above are three different significance scenarios which we have developed to span the uncertainty over the different outcomes which may arise. These significance scenarios are consistent with and have been informed by the market scenarios discussed in Annex 11.

5.10 We have used a scenario based approach to the analysis as the risk of a distortion to competition, and the impact of our policy, is dependent on uncertain outcomes which relate to the future use of the 900 MHz spectrum. By using a scenario based approach, which reflects this uncertainty, we are able to reach an informed view on the potential size of any distortion to competition, and on the impact of our policy proposals to address this in the different potential outcomes.

5.11 The three scenarios used are as follows:

- **High significance** – in this scenario the demand for mobile broadband services is high, and subscribers value high levels of quality and are sensitive to quality differences. Given this, the benefits from liberalisation are very high, and in particular are significantly in excess of the cost of clearing and re-using spectrum. In addition, given the levels of network deployment that are needed to meet demand for such high quality services, it is not possible to replicate the services which can be provided using liberalised 900 MHz spectrum using higher frequency spectrum. In this case, wider access to 900 MHz spectrum helps to promote competition. This significance scenario has been informed by our high demand market scenario.

- **Medium significance** – in this scenario the demand for mobile broadband services is also high, but subscribers are less interested in high levels of quality (in terms of for example the degree of in building coverage or data speed) and/or are less sensitive to quality differences. The level of network deployment required to meet this demand is consequently lower than in the high significance scenario. In this scenario, the benefits from liberalisation are reasonably high, and are higher than the costs of clearing and re-using spectrum in the short to medium term. However, the services which can be provided using liberalised 900 MHz spectrum can plausibly be "matched" using other higher frequency spectrum. By "matched", we mean that operators without lower frequency spectrum are still able to develop their networks to offer services sufficiently similar to operators with lower frequency spectrum to avoid a material competitive disadvantage. In this case, wider access to 900 MHz spectrum reduces the cost of deploying networks (and hence brings productive efficiency benefits). This significance scenario sits between our low and high demand market scenarios.

- **Low significance** – in this scenario demand for mobile broadband services is lower, such that the network deployment required to meet the demand at the requisite quality level, is not significantly greater than the level of deployment currently planned for UMTS2100 networks. Hence, the benefits which are available from liberalisation in the short to medium term are low relative to the costs of clearing and releasing spectrum from its existing uses. As a result,

[56] See, for example, chapter 5 of The Green Book (available at: http://www.hm-treasury.gov.uk/d/green_book_complete.pdf).

during this time period it is likely to be optimal for the 900 MHz spectrum to remain in its existing use, and for any new networks and services to be deployed using other (higher) frequency spectrum. This significance scenario has been informed by our low demand market scenario.

5.12 Based on the current evidence of growing demand for mobile broadband services[57], together with our analysis of the cost advantages of lower frequency spectrum[58], and of the costs of clearing 900 MHz spectrum[59] of its existing use, we think that it is more likely that we are in either the medium or high significance scenario, rather than the low significance scenario. This is explored further in paragraph 5.126.

Interpretation of the results

5.13 In this section we set out factors which are important to keep in mind when interpreting the results of the options assessment. Some readers may find it easier to read the options assessment set out later in this section first, and to then refer back to the information in this section when reading the interpretation of results under each significance scenario.

5.14 The three scenarios set out above help us to ensure that our analysis spans the range of uncertainty over the outcomes which might arise, but uncertainties and unknowns remain over the precise outcomes which could emerge under each of the scenarios. These have influenced our approach to the options assessment in a number of ways which need to be taken into account when interpreting the results. In particular two important effects which are discussed further below are that:

- The quantitative assessment only provides part of the story, it is necessary to include qualitative factors and interpret the results carefully in order to reach a conclusion.

- There are multiple quantitative results which need to be considered in parallel in order to reach a conclusion. The quantification assesses the net benefits in more than one plausible outcome, but only one of these outcomes can arise (they are mutually exclusive). Hence to reach a conclusion, the results across the different outcomes need to be interpreted together, taking into account the relative likelihood of outcomes.

Quantitative assessment is only part of the story

5.15 We have sought to quantify as many of the impacts as we can, but it has not always been possible to quantify effects, and the degree of confidence in the quantitative results differs across the impacts which have been assessed. This means that the net benefit results in the cost benefit analysis do not tell the full story. They need to be combined with a qualitative assessment and interpreted carefully in order to reach a policy conclusion.

5.16 The approach we have used to decide when to include quantitative analysis or rely on a qualitative assessment is based on the following principles:

- Where an impact involves direct costs on a stakeholder we have attempted to quantify these impacts with as high a degree of robustness as can reasonably be

[57] See Annex 11, in particular Figure 1 and paragraphs A11.15 to A11.18.
[58] See Annex 10 for the summary of this analysis.
[59] See Annex 16 for this analysis.

achieved. This holds for our work on the cost difference between different frequencies and the cost of release.

- Given the uncertainty over the assumptions underlying some of the quantifications, we have produced high and low ranges alongside our base case results. The purpose of the high and low ranges is to capture, as far as possible, the plausible range of uncertainty over key input assumptions. Therefore, when looking at the results it is important to consider the high and low ranges as well as the base case results. All of these outcomes are plausible, and it is not necessarily the case that the base case results are any more or less likely than any other point in the range.

- Where there is considerable uncertainty over the impacts, and the quantification will rely on a large number of assumptions on which it is difficult to obtain reliable evidence, we have in some cases provided an illustrative quantification for inclusion in the cost benefit analysis, but in other cases have relied on a more qualitative assessment. The factors which inform the choice between these two approaches are:

    - The extent to which the cost or benefit can be reasonably reflected on a qualitative basis. Where qualitative assessment is adequate we have sometimes opted to include the effect qualitatively (or using limited quantification which is not suitable for inclusion in our core net benefits analysis), as long as the third factor below does not hold. An example of an impact which falls into this category is the potential longer term impacts of options on spectrum efficiency and competition[60].

    - The number and nature of the assumptions which would need to be made to arrive at an illustrative quantification. When these are such that the results would be complex to interpret and include in the cost benefit analysis, we have generally attempted to include the effect qualitatively. An example of an impact which falls into this category is the effect of partial matching[61].

    - The impact that the exclusion of any quantification of an impact would have on the net benefit results, and hence on the value of the cost benefit analysis. When this is significant we have included an illustrative quantification in the cost benefit analysis even when this relies on a large number of assumptions. An example of an impact we have quantified because of this reason is the competition impact which may occur in our high significance scenario. When taking this approach, in order to aid interpretation of the results, we have set out the reasoning for the assumptions used in the illustrative quantification in this section or in the relevant annexes, and have made efforts to ensure consistency of assumptions across scenarios and options.

[60] See paragraph 5.86.

[61] An explanation of why we have not included a quantitative assessment of the impact of partial matching is available in Annex 8, in particular A8.77-A8.82. In these paragraphs we also explain qualitatively why we do not have evidence to believe that this would unreasonably bias the results of the analysis.

Multiple potential outcomes need to be considered in parallel

5.17 The level of uncertainty and unknowns has also influenced our selection of outcomes to assess under each policy option. For example, we reflect uncertainty over whether the market can achieve wider access when it would be efficient to do so, by assessing the impact of our policy option under both the case where the market is successful and when it is not.[62]

5.18 This approach means that careful interpretation is required when assessing the relative net benefit of the different policy options. In order to reach a conclusion it is necessary to consider each of the potential outcomes across each of the different significance scenarios for each of the policy options. This is because all of the scenarios and outcomes are plausible, but only one of these could ever arise. Therefore, it is not possible to simply add the costs and benefits of different outcomes together to reach an overall expected net benefit result. In order to reach a conclusion it is necessary to take into account the net benefit under each of the outcomes and scenarios and the relative likelihood of these different events.

5.19 As the consideration of multiple potential outcomes makes the options assessment more complex we have had to limit the number of options considered. There are many other option variants we could have considered which have not been included because the additional complexity that this would involve was not warranted, given the additional information the further option variants would provide.[63]

Background and links with other sections

5.20 The assessment of options draws upon evidence and analysis which is set out in other sections of, and annexes to, this document. Important examples of these are summarised below and the link with the options assessment is highlighted.

5.21 **The current distribution of 900 MHz spectrum** – the current distribution of 900 MHz spectrum is heavily concentrated, with all the spectrum held by only two of the five operators. The distribution of 900 MHz spectrum is discussed in Section 3[64]. This is an important piece of evidence for our options assessment as it helps to inform our assessment of the impact of different policy options, as only those operators with access to liberalised 900 MHz spectrum will benefit from our policy unless wider access is achieved via other means.

5.22 **Mobile market developments** – in Section 3[65] we discussed the increasing evidence of consumer interest in mobile broadband services since our last consultation and the impact this has upon our assessment of the future demand for these services. This evidence is reflected in our options assessment as it informs our assessment of the likelihood of the different significance scenarios and the magnitude of the impacts of our policy on both the operators and consumers.

[62] Please see Annex 7, in particular A7.22 to A7.30.
[63] For example, when considering the impact of options in outcomes where the market would have arrived at a commercial trading solution, we have assumed that the number of spectrum blocks available via commercial trading mirrors those which are available under the policy option (i.e. 2 block release assumes the commercial solution that would have been arrived at would be 2 block trade). We could have considered other outcome variants when the number of blocks traded varied for each policy option. However, this would have increased the number of outcomes to be considered under each policy option in each scenario, which would have made the results significantly more difficult to interpret.
[64] See Section 3, in particular 3.2-3.3 and Figure 1.
[65] See Section 3, in particular 3.11-3.28, and Annex 11.

5.23 **Cost differences** – our further work on the advantages of lower frequency spectrum has confirmed that there are likely to be significant advantages from deploying future mobile networks using lower frequencies. This work, which is summarised in Section 4[66] shows that these advantages could result in cost differences of up to £1.6bn, even if full service provision using lower frequency spectrum is only unavailable for the period 2011 to 2015. The size of the cost difference is an important factor in our options assessment as this is one of the key differences between the three significance scenarios considered.

5.24 **Cost of releasing and clearing spectrum** – the costs of clearing and releasing spectrum are an important consideration and our further work on this has allowed us to estimate these costs with a greater degree of confidence. This work is summarised in Section 4[67]. This analysis is particularly important in informing our assessment of the costs of some of the policy options.

5.25 **Availability of substitutes** – technological and European developments (which are set out in Section 3[68]) have increased the likelihood that deployments of LTE (or potentially other technologies such as WiMAX) at 800 MHz could allow operators who acquire this spectrum to replicate services which are provided using 900 MHz spectrum, at least in the longer term. However, this is not certain and the spectrum is unlikely to be available and in commercial use before around 2015. This leaves a two to four year period during which 900 MHz spectrum could be exploited by those that hold it without other operators being able to respond, and this period coincides with the time in which take-up of mobile broadband is likely to be increasing rapidly. Given this, for reasons discussed in more detail in paragraphs 5.37-5.42 below, our options assessment focuses on the cost and benefits of the policy options during the period before 800 MHz might be available and could be used to support comparable services.

5.26 **Benefits of wider access to spectrum** – as explained in our 2007 consultation[69] we believe that wider access to liberalised spectrum might be important to achieve the best outcome from the liberalisation of the 900 MHz spectrum. We still believe that this is the case, and that there are plausible reasons why the market may not be able to bring this about when it is efficient for it to do so, although we do not rule out the possibility that the market will do so. Our assessment of why this is the case and our response to the comments we received on this issue are discussed in detail in Annex 8. However, we recognise that while it is plausible that a market may not bring about efficient outcomes, this is not certain. We have factored this uncertainty into our options assessment by assessing the costs and benefits of the policy options in the case where the market is able to bring about wider access as well as in the case where it is not.

Identification of options

5.27 The policy options considered in the options assessment include the options which were included in our earlier consultation and a further option raised in consultation responses (Option E).

- Liberalisation in the hands of the 900 MHz incumbents (Option A)

[66] See Section 4, in particular 4.41-4.47 and Table 6 and also Annex 10.
[67] See Section 4, in particular 4.61-4.87 and also Annex 16.
[68] See paragraphs 3.34-3.36.
[69] See Section 6 of the 2007 Consultation, in particular paragraphs 6.23 and 6.41.

- Regulated access (Option B)
- Partial spectrum release (1, 2 or 3 blocks) (Option C)
- Full spectrum release (Option D)
- Wait and see (Option E)

5.28 We describe these options and the reasons for considering them below. In this discussion we also highlight some of the relative costs and benefits of the different options

5.29 **Liberalisation in the hands of the 900 MHz incumbents (Option A)** – this would involve liberalising the 900 MHz without making any other amendments to the current licences. This would leave Vodafone and O2 holding all the liberalised 900 MHz spectrum. This is the least intrusive option and is similar to the approach we have adopted when liberalising other licences. However, as discussed in our previous consultation[70], and in Annex 8[71], we believe that there are risks that this option may not fully realise the benefits of liberalising to UK consumers and citizens owing to a plausible risk that the market is unable to bring about wider access to this spectrum, and the benefits that would come from such wider access.

5.30 **Regulated access (Option B)** – this would involve us mandating that when the 900 MHz spectrum is liberalised, if it is used to deploy new networks supporting improved mobile broadband services, the licence holder has to provide wholesale roaming or some other form of access to other mobile operators on this network. This approach to the liberalisation of the 900 MHz spectrum is more intrusive than liberalisation in the hands of the incumbents but is less intrusive than some of the other options considered below. The costs of this option are likely to be relatively low[72], but for reasons discussed below[73], we believe that there are likely to be limits to how effective this option would be in addressing the potential distortion of competition and securing the full benefits of liberalisation of the 900 MHz spectrum.

5.31 **Partial spectrum release (Option C)** – this would involve requiring some spectrum to be released alongside liberalisation of the remainder of the 900 MHz spectrum. Any spectrum which is released would be liberalised and re-awarded, and the existing holders of 900 MHz spectrum would not be permitted to re-acquire this spectrum[74]. We have considered three different levels of partial spectrum release:

- 1 block – this would involve one 2 x 5MHz block of spectrum being released (2 x 2.5MHz of spectrum from each of Vodafone and O2).

[70] See Section 8 of the 2007 Consultation, in particular paragraphs 8.4 to 8.31.
[71] See, in particular, paragraphs A8.83 to A8.106.
[72] The costs involved in setting up a regulated access agreement are set out in Annex 7, see in particular, paragraphs A7.159 to A7.168, including Tables 19 and 20.
[73] For example, see discussion in Table 13 in this section.
[74] We do not consider the option of allowing the incumbent 900 MHz operators to re-acquire any of the released spectrum in this case, since were they to do so, we would lose the competition and efficiency benefits that would arise from wider access to 900 MHz spectrum. Whilst we acknowledge if requiring the release of 900 MHz spectrum is not efficient, it would be efficient for the 900 MHz operators to re-acquire it, there are other situations when it would not be. In particular, where the incumbent 900 MHz operators would enjoy a competitive advantage as a result of holding all of the 900 MHz spectrum, they may be in a strong position to re-acquire the released spectrum even though it would not be in the interests of competition and consumers for them to do so.

- 2 blocks – this would involve two 2 x 5MHz blocks of spectrum being released (2 x 5MHz of spectrum from each of Vodafone and O2).

- 3 blocks – this would involve three 2 x 5MHz blocks of spectrum being released (2 x 7.5MHz of spectrum from each of Vodafone and O2).

5.32 The more spectrum that is released the more intrusive is the option, and the higher the costs of release. However, partial spectrum release is likely to be an effective option to guarantee the benefits of wider access to 900 MHz spectrum before 800 MHz spectrum is available, and may also have longer term benefits. Whether it is a proportionate option will depend upon the balance of these costs and benefits.

5.33 In principle, more complex versions of partial release options may be possible. For example, it may be possible to have a partial release option in which a maximum number of blocks to be released is specified, but the award process determines whether it would be efficient for fewer blocks to be released. We have not considered these here as this would make the analysis more complex and we do not believe it would significantly alter our choice between the policy options.

5.34 **Full spectrum release (Option D)** – this would involve giving notice to Vodafone and O2 that their current licences for the use of the 900 MHz spectrum would terminate at some specified future date, before holding an auction or other award process to determine the future holders of the 900 MHz spectrum[75]. Depending upon the outcome of the award process, Vodafone and O2 would have to clear and release any spectrum which they did not re-acquire. This is the most intrusive option for the liberalisation of the 900 MHz spectrum.

5.35 **Wait and see (Option E)** – we are also considering here a further option which was proposed in the comments received in response to our September 2007 consultation. This is the option of delaying a decision on liberalisation until after the uncertainties around how this spectrum might be used and the availability of 800 MHz is resolved. Relative to some of the other options this option is not very intrusive but it involves denying UK consumers and citizens access to the benefits of liberalised spectrum (which are recognised by the draft Directive) for some period of time.

5.36 We assess the wait and see option qualitatively in the following section as this option is linked to the question of the timeframe of our options assessment, and the decision of whether to delay liberalisation until the availability and use of 800 MHz spectrum is clearer.

Availability of 800 MHz spectrum and the timeframe of the options assessment

5.37 In assessing the impact of the various options for how we might liberalise the 900 MHz spectrum we have taken account of the likely availability of 800 MHz spectrum. When we consulted on these issues in September 2007 there was considerable uncertainty about the likely availability and utility of 800 MHz spectrum as an alternative to 900 MHz spectrum for the provision of high quality mobile broadband services. Since then a number of developments, as outlined in Section 3[76], have increased the likelihood that both 800 MHz spectrum, and the technology necessary

[75] Vodafone and O2 would have to be allowed to re-acquire at least some of the 900 MHz spectrum in this case, but in order to ensure that the benefits of wider access to 900 MHz spectrum are realised, a limit may have to be placed on the maximum amount of 900 MHz spectrum that they, and others, can (re-)acquire in the award.

[76] See Section 3, in particular 3.34-3.36.

to use it to provide high quality mobile broadband services, will be available and cost effective within a few years, although this is still by no means certain.

5.38 If 800 MHz spectrum, and the technology necessary to exploit it, does become available within a few years, this could provide another source of lower frequency spectrum suitable for the provision of high quality mobile broadband services, that could compete with such services provided using 900 MHz spectrum, at comparable cost. Were such spectrum and technology to become available, it could allow the benefits of wider access to lower frequency spectrum to be even more fully realised, and for the longer-term benefits to be less dependent upon the way in which the 900 MHz spectrum alone is distributed and used. Nevertheless, access to, and full use of, this spectrum will not be possible for a number of years, and so we need to consider the impacts that different options for liberalisation of the 900 MHz spectrum would have in the interim.

5.39 Given the significant likelihood now that 800 MHz spectrum, and the technology necessary to exploit it, will be available only a few years after the time when it is likely to be possible, in practice, to deploy new networks in the 900 MHz band, we have taken a conservative approach to the quantification of the benefits which would arise from wider access to 900 MHz spectrum, considering only those benefits that might accrue between the time when new networks could be deployed in the 900 MHz band (which we consider likely to be from 2011) and when operators using 800 MHz spectrum could provide a comparable service (likely to be around 2015). Thus in our quantitative analysis of the benefits of different options for liberalisation of the 900 MHz spectrum we generally consider only those benefits that would accrue in the relatively short period of time, in the region of 2 to 4 years, from around 2011 to around 2015[77]. Even though this is a relatively short period of time, it may none the less be a critical period for the take-up of mobile broadband services, and as such the benefits from wider access to lower frequency spectrum, even in this interim period, may still be significant.

5.40 Whilst our quantitative analysis is largely based on scenarios in which 800 MHz spectrum, and the technology necessary to use it to deliver high quality mobile broadband services does become available, and is used to compete with high quality mobile broadband services provided using 900 MHz spectrum, we have also undertaken a more qualitative assessment of the benefits of different options for the liberalisation of the 900 MHz spectrum if this were not to come to pass.

5.41 We also recognise that there are scenarios in which the longer-term distribution of 800 MHz and 900 MHz spectrum among operators may be such that there is a risk that the benefits from lower frequency spectrum, for both consumers and producers, may still not be fully realised, even after 800 MHz spectrum becomes available. This could arise, for example, if all of the 800 MHz and 900 MHz spectrum were held by a limited number of operators, and they did not provide access to their competitors. However, whilst we can foresee now the potential for such problems to arise, we are not now able to predict with sufficient degree of certainty that such problems will arise, what the consequences of them might be, or what the costs of addressing them might be, not least because, the detail of and timetable for any future use of the 800 MHz band is subject to further European policy and technical discussions, international negotiations and the putting in place of suitable arrangements to clear the 800 MHz band. These issues are discussed in our consultation on clearing the

[77] Our quantitative analysis considers a range of plausible dates for both the deployment of new networks in 900 MHz spectrum and the date when operators using 800 MHz spectrum are able to offer a comparable service. Please see Annex 7, in particular A7.9 to A7.10.

800 MHz band[78] We do not therefore think that it is credible for us to seek to address such issues now, in concert with our choice of the method of liberalisation for the 900 MHz spectrum.

5.42 As discussed in paragraphs 5.43-5.48 below, we furthermore do not consider it appropriate to postpone our decision on the method of liberalisation of the 900 MHz spectrum until such time as we may be able to address these issues together, given the significant delay that this would cause to liberalisation of the 900 MHz spectrum.

Delaying liberalisation decisions – assessment of "wait and see" option

5.43 It was put to us by some respondents to our September 2007 consultation that we did not need to make a decision on liberalisation of the 900 MHz spectrum until some of the uncertainties affecting that decision were resolved, or at least until the likelihood of certain outcomes was clearer.

5.44 We do not believe that such a "wait and see" approach is likely to be appropriate for two reasons:

- Firstly, because such an approach would preclude the realisation of the potential benefits, for both consumers and producers, of the liberalisation of the 900 MHz spectrum, for some considerable time.

- Secondly, because we expect to be required by European legislation to "make available" the 900 MHz band for UMTS as well as GSM use within 6 months of that legislation coming into force, which could well be in the summer of this year.

5.45 We think that the net benefits of liberalisation of the 900 MHz spectrum could be very significant. Postponing our decision on the liberalisation of the 900 MHz spectrum would preclude the realisation of these benefits for some considerable time, since both existing and potential new holders of 900 MHz spectrum would be unable to deploy new networks in the 900 MHz band, to the detriment of both consumers – who would not enjoy the benefits of the enhanced services that could have been delivered – and producers – who would not enjoy the cost savings that could have been made through use of this lower frequency spectrum. Our analysis of the cost of delay to liberalisation, if this results in a delay to the launch of new mobile broadband services, suggests that even a 3 month delay could reduce total welfare (consumer and producer value) by in the region of £45m or more.[79]

5.46 The delay would necessarily need to be for a significant period of time if it were to be of any material benefit in helping us to assess the significance of lower frequency spectrum and the likelihood of the market achieving an efficient outcome in the real world, since many of the uncertainties affecting our decision will not be resolved for some considerable time – for example exactly when user equipment will be available for the 800 MHz band, and how quickly it will be adopted by consumers, is unlikely to be clear much before 2013.

5.47 At the same time, the draft European Directive that is expected to amend the GSM Directive, requiring Member States to "make available" the 900 MHz bands for UMTS as well as GSM use, is expected to come into force in the summer of this year, and in its current form would require Member States to make the changes necessary to implement the Directive within 6 months. We could therefore be required to "make

[78] Available at: http://www.ofcom.org.uk/consult/condocs/800mhz/800mhz.pdf.
[79] Please see Annex 7, in particular A7.135 to A7.139.

available" the 900 MHz band for UMTS as well as GSM use as early as the end of this calendar year, although the first quarter of 2010 is perhaps more likely.

5.48 For both of these reasons we therefore do not consider it likely that a "wait and see" approach to liberalisation of the 900 MHz spectrum will be feasible or proportionate. Hence, this has not been included as an option in our assessment of the options by significance scenario.

Assessment of options for liberalisation in each significance scenario

5.49 In the following sections we summarise our assessment of options A to D (as set out above) for liberalisation of the 900 MHz spectrum in each significance scenario. Starting with the high significance scenario, we describe in more detail the outcomes which may arise in that scenario under our benchmark policy option of liberalisation in the hands of the incumbents (Option A). We then go on to consider the relative cost and benefits of the other policy options compared to this benchmark.

High significance scenario

5.50 As set out in paragraph 5.11 above, in the high significance scenario demand for mobile broadband services is high and subscribers demand high levels of quality and are sensitive to quality differences. The benefits from liberalisation are very high in this scenario, and are significantly in excess of the cost of clearing and releasing spectrum. In addition, the services which can be provided with access to liberalised spectrum are such that it is not possible to replicate these using higher frequency spectrum. In this case, wider access to 900 MHz spectrum helps to promote competition.

5.51 Our assessment of the key elements of this scenario and its potential outcome under the option of liberalisation in the hands of the incumbents option are as follows.

- The **cost difference** which would arise in this scenario, if operators were to rollout services at 2100 MHz which fully match the services provided at 900 MHz, is in excess of £1bn and could possibly be as high as around £1.6bn[80]. This is consistent with an outcome in which consumers place a high value on high quality mobile broadband services.

- The lower bound on this cost difference range has been informed by an assessment of the practical limit on the number of sites 2100 MHz operators can feasibly rollout over a three year period[81]. When the cost difference is in excess of this, it is increasingly unlikely that operators without lower frequency spectrum will be able to completely match the service provided using 900 MHz spectrum and hence provide services which can compete fully. Therefore, in assessing the impact of this scenario, if operators do not have access to 900 MHz spectrum, we need to consider the impact on total welfare (consumer and producer value) if some operators are unable to compete fully in the provision of higher quality mobile broadband services. Our approach to assessing this impact is set out in detail in Annex 9 and is summarised in Section 4[82]. This work suggests that the

[80] This is the cost difference for a single operator. See Annex 7, in particular paragraphs A7.57 and Figure 3.
[81] Three years is the base case assumption in our cost benefit analysis for the time gap between the full availability of 900 MHz spectrum and when an operator using 800 MHz spectrum would be able to offer a comparable service.
[82] See Section 4, in particular 4.51-4.56.

impact on competition in the provision of mobile broadband services could result in a total welfare loss of in the region of £250m to £1bn concerning the period from 2011 to 2015. This range is consistent with a significant reduction in competitive intensity from current levels. The bottom end of this range is informed by a situation in which the number of players providing high quality mobile broadband is limited to 2 rather than 3. The top end of the range occurs in a high demand environment where the number of players is limited to 2 rather than 5.[83]

- The **cost of clearing 900 MHz spectrum** in this scenario are relatively minor relative to the benefits – of the order of £30-60m[84] per 900 MHz operator for the first block each to be cleared. The benefits of clearing spectrum (either from the lower costs of deployment or from an operator avoiding an impact on its ability to compete fully) are significantly in excess of this. Hence, in this scenario it is very likely that operators will use liberalised spectrum for new uses over the period 2011 to 2015.

- In this scenario we think that, while it is possible that a market could achieve wider access to liberalised spectrum if we were to liberalise the spectrum in the hands of the incumbents, it is unlikely that it will. The reasoning for this is set out in detail in Annex 8[85]. In summary, when access to spectrum can impact upon the ability of operators to compete fully, a decision over whether or not to trade (or otherwise provide access to lower frequency spectrum) will be influenced by the strategic impact of this on an operator's business. When this type of strategic impact - maintaining a competitive advantage - is included in the decision making process, it is **possible for a market to fail to result in wider access**, even though this would be the best overall outcome for UK citizens and consumers.

5.52 As the impact of the other policy options (relative to liberalisation in the hands of the incumbents) depends upon whether or not the market would have achieved wider access, we start by assessing the relative impact of the policy options in the case where wider access is not achieved, and then consider the case where it is.

Table 13: Impact of policy options under high significance scenario

Liberalisation option	Impact relative to the option of liberalisation in the hands of the incumbents, if the market would not have achieved wider access
Regulated access (Option B)	As the 900 MHz operators are assumed to rollout in this scenario the access obligation would be triggered. The 900 MHz operators would incur the costs of putting in place the access agreement. However, these costs would be offset by the benefits of the option, as when the market would not otherwise have delivered wider access to 900 MHz spectrum, regulated access will promote competition (through addressing likely distortions) during the period until an operator using 800 MHz spectrum can effectively compete. The degree to which an access agreement promotes competition will depend upon how successful the agreement is. Where access works it can be a low cost means of promoting competition, which is an important consideration given that

[83] See Section 4, in particular paragraph 4.55 and Annex 7, Table 2.
[84] See Section 4, Table 7. Total costs to clear 2 blocks for both operators is estimated between £60-120m (depending on the approach to clearance taken). The costs of clearing one block for each operator is estimated at half this. See Annex 16, in particular Table 61.
[85] See Annex 8, in particular A8.85-A8.96.

Liberalisation option	Impact relative to the option of liberalisation in the hands of the incumbents, if the market would not have achieved wider access
	wider access to lower frequency spectrum may be achieved within a few years via the availability of 800 MHz. However, there are significant risks that regulated access does not fully realise these benefits. This is largely because of the asymmetries of information between the regulator and the parties, and the complexity of the regulatory intervention needed when the incentives of the parties to reach an agreement are not well aligned. This represents an important difference between access mandated by regulation and an access agreement that is achieved through commercial negotiation.
Partial spectrum release (Option C)	Under this option the 900 MHz operators would incur the costs of release. These costs increase with the number of blocks which are released. The benefits of this option are that it will promote competition (through addressing likely distortions) – the degree to which competition is promoted will depend upon the number of spectrum blocks released and whether commercial access to the released blocks is agreed. We think some form of spectrum release is more likely to realise competition benefits then regulated access, as release allows direct access to the spectrum which is the underlying source of the competition benefits. As with access, spectrum release is subject to risks of regulatory failure, such as a failure to identify the efficient number of blocks to be released or to specify the optimal release timetable, but these are of a different nature to the failures of regulated access (where the failures relate to whether the competition benefits are realised at all).
Full spectrum release (Option D)	The sources of the relative costs and benefits of this option are similar to those of partial spectrum release. However, whilst the benefits are unlikely to be higher, the costs are at best the same, but could be higher. This is because full spectrum release involves risks such as the risk that a more complex award delays release, and the greater regulatory uncertainty created by giving notice to Vodafone and O2 of the termination of their rights to use all of the 900 MHz spectrum. Whether the benefits of full release are higher than those of partial release depends upon whether the full release option results in more blocks being acquired by other operators than under partial release. For a start we think it unlikely that full release would result in more than 3 blocks being acquired by other operators, because of the constraints this level of release would impose upon the ability of Vodafone and O2 to sustain their existing networks and services, and because the benefits of additional release declines rapidly as more blocks are released[86]. Hence the benefits of full spectrum release are unlikely to be higher than those of 3 block release. Furthermore, if there is a competitive advantage to be had by the incumbent 900

[86] The results in Annex 7 show that the competition benefits of the first released block ranges from £375m to £875m (see Table 54 in Annex 7), but the incremental benefits of the second block are only £75m to £125m (the competition benefits in Annex 7 Table 78 minus the 1 block release benefits), and its possible that the third block has no incremental competition benefits if one of the first two blocks is shared between more than one operator (in Annex 7 the competition benefits in Table 97 are the same as those in Table 78). These particular results depend upon the assumptions made about whether released blocks are shared between operators. However, irrespective of these assumptions, it is generally true that as the number of players with access to low frequency spectrum increases, the incremental benefit per additional player decreases.

Liberalisation option	Impact relative to the option of liberalisation in the hands of the incumbents, if the market would not have achieved wider access
	MHz operators from the re-acquisition of 900 MHz spectrum, we consider it unlikely that they would not re-acquire as much of the 900 MHz spectrum as they were allowed to in the auction (even to the extent of re-acquiring all of the 900 MHz spectrum if that were permitted), for the same reasons as they are unlikely to voluntarily trade 900 MHz spectrum to potential competitors. Hence the competition benefits of full spectrum release are unlikely to be greater than those of whichever partial spectrum release option corresponds to the amount of spectrum the 900 MHz incumbent operators would be prohibited from re-acquiring in the full release auction.

5.53 If the market would have achieved wider access then the relative impact of the different policy options depends upon whether or not the outcome achieved via the market is the same (or similar) to the outcome achieved by the policy.

5.54 If the outcome achieved via the market is the same as the outcome of our policy, then there may be some (relatively limited) incremental costs but no incremental benefits:

- Where the market would have achieved commercial access and we impose regulated access – there may some relatively limited incremental costs for no incremental benefit[87].

- When the market would have arrived at spectrum release, through a spectrum trade, and we impose a comparable level of spectrum release – there are likely to be some incremental costs, but once again these may be relatively limited, and once again these are incurred without any incremental benefit[88].

5.55 If the outcome achieved via the market differs from the outcome of our policy then there may be some (possibly significant) incremental costs but in some cases there will also be some incremental benefits.

- Where the market would have achieved a spectrum trade and our policy imposes regulated access – the costs of access will be incurred but there will be some incremental benefits if this allows more operators to benefit from access to lower frequency spectrum than would have been the case under the commercial trade[89].

- Where the market would have achieved commercial access and we impose spectrum release – the costs of release will be incurred but the incremental benefits of the policy may be relatively limited if commercial access allowed at

[87] Explanation of the net benefit of regulated access when the market would have achieved commercial access is available in Annex 7, in particular see Table 28, the columns MS/A in Table 30, and paragraphs A7.207-A7.212.
[88] Explanation of the net benefit of spectrum release policy options when the market would have achieved a commercial trade is available in Annex 7, in particular see Table 51 the columns MS/T in Tables 54, and paragraphs A7.249-A7.255.
[89] See for example, the net benefit of regulated access in the columns MS/T in Table 30 of Annex 7.

least as many operators to benefit from access to lower frequency spectrum as is achieved via our policy[90].

5.56 When quantifying the net benefits in these outcomes we have assumed that, when the market would have achieved wider access, our intervention does not disrupt this market outcome. For example, if the policy option we impose is 1 block release and the market would have reached a commercial access agreement, we assume this commercial agreement still occurs even after our policy intervention. In Annex 7 we also provide results showing the net benefit when our policy does disrupt the market outcome[91]. However, we think it is more appropriate to assume that the market outcomes are not disrupted. If the operators have incentives to arrive at a commercial agreement before our intervention, these incentives will still be present afterwards. Further to this, if it became clear that our intervention was preventing more beneficial commercial agreements being reached, we would review the implementation of our policy in this light.

5.57 The diagram below shows the quantified part of our assessment of net benefits for liberalisation options B and C (regulated access and partial release)[92], relative to liberalisation in the hands of the incumbents. We have not shown the net benefits of full release as, for the reasons set out above, we think that at best these are similar to the net benefits of partial release. The reasons why the net benefit of this option may be lower than partial release are discussed qualitatively below.

5.58 The diagram shows the range of net benefits for the different policy options both in the case where the market would not have achieved wider access (highlighted by a red solid box), and where the market would have achieved wider access (highlighted by a blue dashed box). The results where the market would have achieved wider access are the average net benefits across the two outcomes mentioned above, namely the outcome where the policy achieves the same result as the market and that where the market outcome differs to the policy (e.g. the market would have achieved a commercial trade but our policy results in regulated access).[93]

5.59 When reading the diagram it is important to recognise that the outcomes highlighted by blue and red boxes represent alternative outcomes which may arise as the result of our policy. Both of these net benefit results need to be taken into consideration when reaching a conclusion as these two results cannot be simply added together to get an overall result, as the overall net benefit will depend upon the relative likelihood of the different outcomes.

5.60 In the diagram, we show our base case and high and low net benefit assessments. In order to draw any conclusions from the net benefit results it is important to take into account the high and low range of the net benefits as well as the base case results. As discussed earlier, we generate high and low ranges as these help us to reflect:

- the significant uncertainty over the outcomes which may arise, and
- the illustrative nature of the quantification of some impacts which rest on uncertain assumptions.

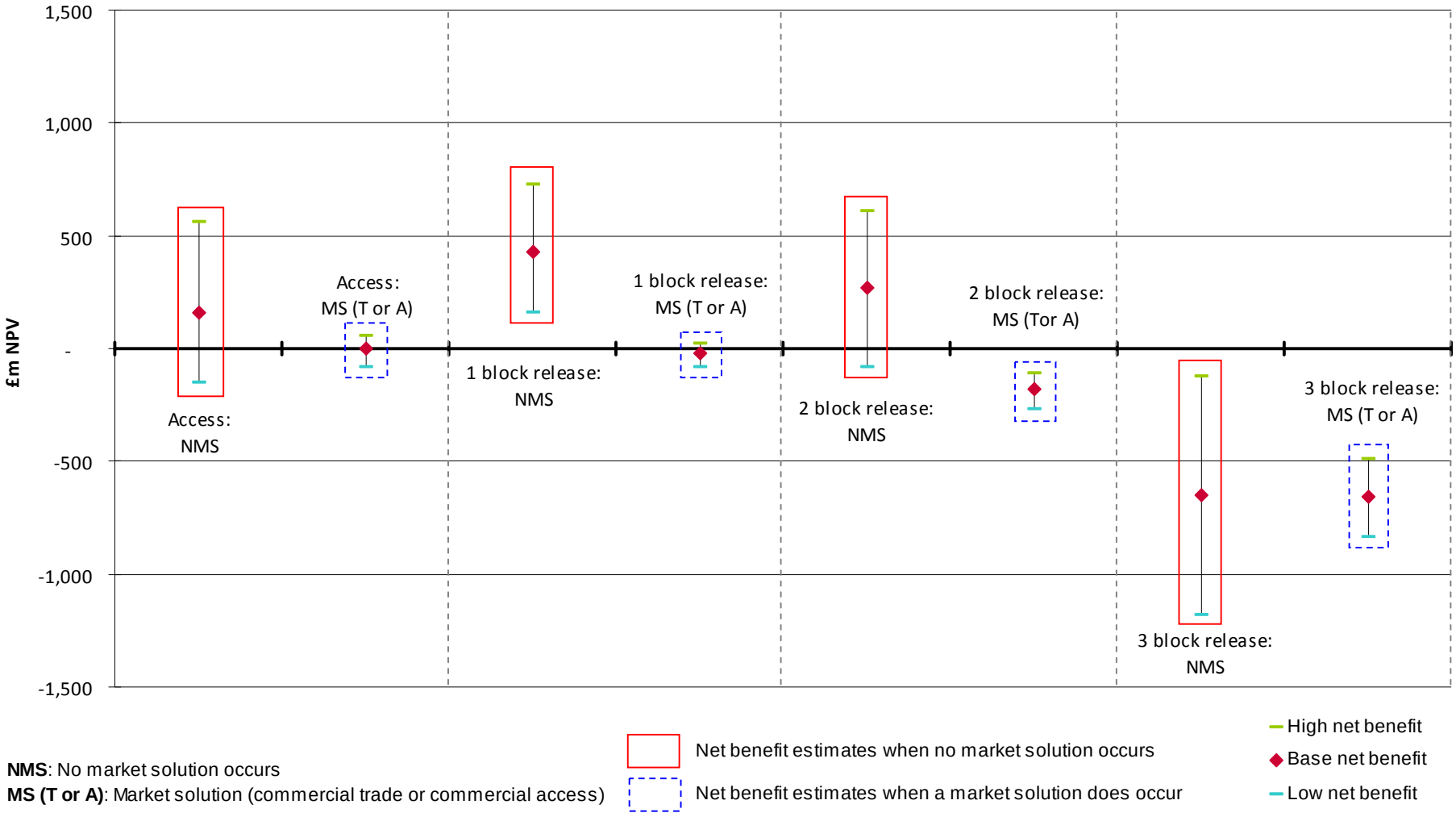
[90] See for example, the net benefit of 1block release in the columns MS/A in Table 54 of Annex 7.
[91] See Annex 7, in particular paragraphs A7.237-A7.242 and A7.285-A7.290.
[92] This diagrams are from Figure 21 in Annex 7, and show they summarised results from our quantitative net benefit analysis which is available in Table 112 in Annex 7.
[93] In the absence of evidence to suggest that either of these outcomes is more likely than the other we are assuming (by taking that simple average of these two) that they are equally as likely. Please see Annex 7, in particular A7.193.

5.61 Therefore, the base case results should not be interpreted to mean our assessment of the most likely net benefit result. The high, base and low results are all plausible outcomes.

5.62 The full detail of the analysis which underlies this assessment is set out in Annex 7.

5.63 After the table we explain the key drivers of the net benefits of each of the liberalisation options. We then go on to discuss the interpretation of the results, including drawing out some of the qualitative factors which need to be incorporated into our analysis. As discussed earlier, the quantification of the net benefits is only one piece of the evidence required to reach a conclusion, and even this evidence requires careful interpretation given the nature of the quantitative assessment.

Figure 10 : High significance scenario net benefit results



Net benefits quantified based on a 3 year period without access to low frequency spectrum, expressed as a 20 year net present value results using a social discount rate of 3.5%

Drivers of the net benefits in the high significance scenario

5.64 We set out below the key drivers of the net benefits for each of the policy options in this high significance scenario.

5.65 In the **regulated access** option the key benefits of this policy are the competition benefits which are realised (through addressing likely distortions to competition) in the case where the market would not have achieved wider access. The results capture a high level of competition benefit – they are based on an illustration of the potential impact of access allowing 5 players to fully compete in the provision of high quality mobile broadband services, compared to potentially only 2 fully effective competitors without access. However, the scale of these benefits is adjusted to reflect the risk mentioned above, that access imposed through regulation will not fully realise the desired benefits (see table 13). The adjustment ranges from a 30% to 70% reduction across the low to high range of net benefits[94].

5.66 The key costs which are included in the net benefits results include:

- if access results in the operators having to increase the capacity of their networks, we include an illustration of the impact this has on the costs of the networks the 900 MHz operators rollout;
- if our policy delays the time at which the 900 MHz operators can use their 900 MHz spectrum for new networks, we include the costs of delaying the benefits of liberalisation[95], and
- the administrative, legal and regulatory costs involved in putting in place a regulated access agreement.

5.67 The **partial spectrum release** options differ in relation to the assumed size of the competition benefits they achieve (and hence the extent to which they remove distortions to competition). It is necessary to make assumptions in order to assess the relative impact of the different options, and these assumptions are consistent with the models which underlie the analysis. However, it is important to keep these assumptions in mind when interpreting the results.

- 1 block release is assumed to increase the number of players who can fully compete in the provision of high quality mobile broadband services from 2 to 4 during the relevant time period. This is in part because we think it is plausible that the first released block might be shared between two parties as a result of commercial agreement[96]. However, this assumption is also to ensure that the net benefits analysis is consistent with our quantitative modelling[97]. There are other impacts which our modelling work does not include, such as the impact of partial matching. Moreover, sharing outcomes could under some circumstances have drawbacks which make their use less likely or desirable. These factors might

[94] See Annex 7, in particular A7.118 to A7.121 and Table 10.
[95] The Directive may preclude delay to liberalisation, hence it may be conservative to include these costs. If this is the case our assessment of the policy options relative to liberalisation in the hands of the incumbents may understate the net benefits.
[96] For the purposes of the cost benefit analysis we assume that the nature of sharing agreed commercially is RAN sharing.
[97] The modelling work completed suggests that commercially agreed sharing (i.e. two RAN sharing operators) is a likely outcome as the benefits to sharing operators in our modelling work, and hence the willingness to pay for the released spectrum, is greater than the benefits to a single operator. See for example, the results in Annex 7 Table 7.

suggest that alternative (non-sharing) outcomes could arise and may be preferable in some circumstances. Hence, the use of a sharing assumption does not imply that we think sharing is most likely, or most beneficial, merely that this is the appropriate assumption to use in our quantitative net benefits analysis.

- 2 block release assumes an increase in the number of players from 2 to 5, as does 3 block release. This is because we assume that in the 2 block option, one block is shared, as with 1 block release, and the other block is obtained by a single operator. Whereas in 3 block release we assume that 2 blocks are held by parties who are sharing and 1 block is held by a single operator.

- The high to low range of the competition benefits (i.e. the impact of addressing likely distortions to competition) reflect assumptions about the extent of the competition impact, in terms of the proportion of mobile services revenues and subscribers affected. The assumptions range from 15% to 35% of total UK mobile revenues. These assumptions are explained in Section 4 and Annex 9[98].

- The key costs which are reflected in the net benefits results are the costs of spectrum release and as with access, any costs which result if our policy delays access to liberalised spectrum.

Interpretation of the high significance scenario results

Liberalisation in the hands of the 900 MHz incumbents

5.68 Relative to liberalisation in the hands of the incumbents the quantitative analysis suggests that, when the market would not have brought about wider access (i.e. the red boxes in Figure 10), the majority of other policy options are more likely than not to have net benefits. And in some cases, most notably for access and 1 and 2 block release, the net benefits are potentially very significant (as is reflected by the proportion of the net benefit range which is above zero for these options).[99]

5.69 This result is even clearer when the benefits to consumers are considered, as the consumer surplus benefits when the market would not have achieved wider access are materially greater than the total welfare results suggest. The total welfare results include a significant reduction in producer surplus as a result of the promotion of competition.[100]

5.70 When the market would have arrived at wider access in any event (i.e. the blue boxes in Figure 10), the more intrusive policy options are all likely to have net costs relative to liberalisation in the hands of the incumbents. However, in the case of the lower cost options, such as access or 1 block release, these net costs (in the blue boxes) may not be significant in comparison to the net benefits when the market would not have achieved wider access (in the red boxes). The overall judgment depends upon the relative likelihood of the two market outcomes, and as discussed earlier, under the high scenario we believe that there is a greater likelihood of the market failing to achieve wider access than under other scenarios.

5.71 Based on these results we believe that one of the policy options other than liberalisation in the hands of the incumbents is likely to be better. However, this result

[98] See Annex 9, in particular A1.21-A1.24.
[99] See Annex 7, in particular Table 112.
[100] The benefits to consumers are set out in greater detail in Annex 7, in particular Table 113.

holds more strongly for the lower cost options, such as regulated access and 1 block release, than it does for more intrusive and hence, more costly, options.

5.72 However, it is important to recognise that the competition benefits which are captured in the assessment of the other policy options are only illustrative, as there is considerable uncertainty over the size of any impact.[101] We have sought to reflect this uncertainty in the large low to high range around the competition benefits. Despite the illustrative nature of the quantification, we still think that the overall picture found in the results is a plausible one.

- We think the magnitude of the competition benefits (and hence the impact of addressing any distortion of competition) is consistent with the specification of the high scenario – this is a scenario in which 900 MHz operators have found it profitable to rollout a high level of coverage at 900 MHz, to improve the quality of the mobile broadband services they could offer relative to those they are able to provide through more limited investment in their 2100 MHz networks. This is consistent with on outcome in which there is a high consumer value for higher quality mobile broadband services, and hence a material effect on competition if only a sub-set of the operators can provide this quality.

- The overall picture created by the illustrative calculations is consistent with our qualitative expectations of the impact of competition. Because of the very large subscriber base, relatively small changes in prices of mobile communications services can have very significant impacts on the aggregate value of these services to consumers. Hence, we believe it is reasonable to assume that in the case where liberalisation in the hands of the incumbents fails to promote competition, and consumers value highly the quality of their mobile broadband service, other policy options which promote competition would be expected to have potentially very significant consumer benefits.

5.73 Even after taking in account the limitations in the accuracy of the quantification of the competition benefits, we still believe that, in this scenario, one of the policy options other than liberalisation in the hands of the incumbents is likely to be better. This conclusion reflects our objectives to secure the best outcome for UK consumers and citizens and to promote competition. There are likely to be very significant benefits for consumers in the case where our policy option increases the ability of operators to compete fully in the provision of mobile broadband services and the market would not otherwise have achieved wider access.

5.74 Furthermore, while we acknowledge that it might, in principle, be possible for us to take regulatory action to address any distortion of competition arising from liberalisation of the 900 MHz spectrum in the hands of the incumbents at a later date, for example after it has become clear that such a distortion has arisen, we think it unlikely that we would be able to take effective action sufficiently quickly to prevent harm to both competition and consumers in such circumstances. The option of delaying action until after a distortion has occurred was suggested by O2 in its response to our 2007 consultation. We also note that the draft of the proposed Directive to amend the GSM Directive would, if enacted, requires us to address any potential distortion of competition arising from the liberalisation of the 900 MHz

[101] This is a particular issue for the assessment of liberalisation in the hands of the incumbents relative to the other policy options under our high significance scenario. It is less important for the comparison between the other policy options as these all include competition benefits calculated on a comparable basis. It is also not a significant issue for the medium and low scenarios, as the key source of benefits in these cases are the productive efficiency savings from wider access.

spectrum at the same time as we implemented the other requirements of the Directive (i.e. liberalised the 900 MHz spectrum). We do not believe that it would therefore be sufficient for us to rely on taking action at a later date alone to address any potential distortion of competition arising from the liberalisation of the 900 MHz spectrum, if there are other proportionate actions that we can take now to reduce or mitigate the risks to competition and consumers.

3 block release

5.75 We believe that the net benefit results also suggest that 3 block release is unlikely to be the best option. In reaching this conclusion we have taken into account:

- The points made above which suggest that this option may not be better than liberalisation in the hands of the incumbents.

- The absolute level of costs imposed upon stakeholders under this option. These are materially higher under 3 block release for limited additional benefits. As the cost of release in this option is in excess of £225m per operator (£450 million in total), this compares to a cost of release in the 1 block release option of less than £45m per operator[102]. We note that the potential consumer surplus benefits under this option are particularly significant. However, when reaching a conclusion we think it is important to consider the size of the consumer benefits if the market would not have achieved wider access alongside the size of the real costs which the option would impose on producers. This is in part because the costs are certain to be incurred but the benefits are only realised if the market would not have achieved wider access. But also because it is important for us to make sure that any costs imposed on stakeholder are proportionate. This issue is particularly important given the current economic climate. Overall, we think that the balance between potential consumer benefits and the real costs on producers is more proportionate under some of the other options than under 3 block release.

Full release

5.76 As explained earlier in Table 13, we think that the net benefits of full release are very unlikely to be greater than those of partial release, and while the benefits of these two options could be comparable, there is a risk that the net benefits of full release are materially lower.

5.77 Our assessment of full release is set out in more detail in Section 7.

5.78 We do not believe it is likely that full release would result in more than three blocks being released. Hence, full release would not be expected to result in higher benefits than could be achieved under one of our partial release options. This is because:

- The costs imposed on Vodafone and O2 of higher levels of release are likely to be disproportionate to the benefits of higher levels of release. As explained earlier (see footnote 86) the competition benefits of release declines rapidly with the number of blocks released (the benefit of the first block ranges from £375 to £875, while the incremental benefits of the second block is only £75m to £125m,

[102] See Section 4 and Annex 16, in particular A16.280. Total costs of release for both operators is estimated at £450-690m (3 block release) and £60-90m (1 block release). The costs of release included in our quantitative assessment are also show in Annex 7, see in particular, paragraphs A7.141 to A7.1.44 and Table 13.

and the incremental benefits of the third block are likely to be significantly lower again). While the costs of release increase significantly with the number of blocks released. The cost of the first block is between £60m and £90m, but the incremental costs of the second and third blocks are £120m to £190m and £270m to £410m respectively.[103]

- Also, in the high scenario, the amount of spectrum which full release achieves is likely to be influenced by the strategic benefit to Vodafone and O2 of holding 900 MHz spectrum. As a result we would expect to need to limit the amount of spectrum Vodafone and O2 could re-acquire in the award process. However, we are unlikely to set this limit at a level which would guarantee greater than 3 block release, and given the costs of release involved, we may need to set the limit at a lower level. Hence, given that it is likely that the result of the process would be that the amount of spectrum released is determined by the limit we impose on Vodafone and O2 to re-acquire spectrum, its plausible that the benefits of full release could be capped by those of either 1 or 2 block release.

- In addition, as discussed in Section 7, we think it is unlikely that an auction would be able to efficiently determine whether 1, 2, or 3 blocks should be released in the high significance scenario, owing to the strategic benefits mentioned above. Hence, full release would not be expected to have additional benefits over partial release in this regard.

5.79 In addition, the costs of full release are at best the same as those of partial release, but are plausibly greater than these. This is because there are risks involved with full release which are not present under partial release.

- One risk is that there is a delay to release. This could arise because additional time is required for release in order to prevent inefficient release costs being incurred prior to the award[104] or because the more complex award process that would be required results in a delay. As explained in Section 7, a one year delay to release could result in roughly one third of the of benefits being lost.

- Other risks include the impact of the greater regulatory uncertainty involved in full release (when compared to for example 1 or 2 block release) on investment decisions.

5.80 Hence, we believe that full release is an inferior option to partial release in the high significance scenario.

Regulated access, 1 and 2 block release

5.81 This leaves us with a choice between three options: regulated access, and 1 and 2 block release. The choice between these options is not clear cut based on the quantitative analysis alone. There is some evidence that 1 block release may be the best outcome. This is because 1 block release is the most likely option to deliver a positive net benefit, for any one view concerning the relative likelihood of a market versus non market solution[105]. We acknowledge that this is not a particularly

[103] These numbers can be derived from the cost of release results for approach 3 in Section 4, see Table 8.
[104] Under full release the number of blocks to be released is determined by the award. Hence, if the operators were to prepare for spectrum release prior to the award they may incur release costs which are not ultimately required once the outcome of the award is known.
[105] See Annex 7, in particular Table 112 and Figure 10 in this section.

compelling result given the level of uncertainty in our quantitative assessment. But there are other qualitative factors which we think reinforce this conclusion.

5.82 First of all, when we consider the relative merits of 1 and 2 block release, there are a number of qualitative factors which we think suggest that 1 block release should be preferred.

- The real costs that 2 block release imposes on producers are materially greater than those of 1 block release (a minimum of £180m compared to £60m)[106]. However, the incremental benefits for consumers of moving from 1 to 2 block release may not be as material[107] (while the absolute size of the consumer surplus increase is far greater than the costs, this reflects approximately a 30% increase in consumer value for approximately an 190% increase in the costs imposed on stakeholders).

- As discussed above, the regulatory failure risks involved in release suggest that lower levels of release may be preferable. A regulatory failure risk which we think is important for the choice between 1 and 2 block release is the risk that this results in inefficient fragmentation of the 900 MHz spectrum in the future. This is because higher levels of release impose more significant constraints on the use of the remaining 900 MHz spectrum, given the likely ongoing need for Vodafone and O2 to maintain some level of GSM network on their 900 MHz spectrum. We have tried to capture this in our quantitative analysis but the quantification of this effect is only illustrative and may understate the impact.[108]

5.83 Therefore, on balance, we think that 1 block release is likely to be a more proportionate policy option than 2 block release.

5.84 If we then consider the choice between 1 block release and regulated access. There are, we believe, strong qualitative arguments which suggest that the net benefits of 1 block release are likely to be understated relative to those of access.

5.85 As explained earlier in table 13, we believe that while commercial access might have significant benefits in some situations (particularly when implemented on a temporary basis which reduces its impact on dynamic efficiency), regulated access is unlikely to achieve the same result. We sought to capture this effect by discounting the benefits of regulated access in our net benefit analysis,[109] but we do not believe that this has fully captured the impact as it fails to reflect the following:

- Regulated access could have a negative impact on incentives to invest. This is an effect which is unlikely to occur under commercial access. When access is imposed by regulation the incentives of the operators involved are unlikely to be aligned, in which case the requirement to provide access if you roll out is likely to be considered as a cost of rolling out. However, when commercial access is provided, it is much more likely that the interests of the parties are aligned, as it is unlikely that the agreement would have been agreed unless both parties wished to roll out services.

[106] See Annex 16, in particular A16.280.
[107] See the consumer surplus impact of 2 to 5 players compared to 2 to 4 players in Table 2 of Annex 7.
[108] See Annex 7, in particular A7.155 and Table 17.
[109] See Annex 7, in particular A7.118 to A7.121.

- While access can have significant static efficiency benefits, if it is present over a longer time horizon, it can also have significant negative effects on dynamic efficiency. Regulated access agreements can act as a barrier to innovation, as innovation may require a re-negotiation of the agreement, and at worst, if the network provider wishes to innovate but the access seeker does not or vice versa, then innovation may not be possible. If a regulated access obligation was put in place it might be difficult to remove this obligation in a timely fashion, even if 800 MHz becomes available, if there are operators who are still relying on the access agreement to provide services to their subscribers.

- Finally, regulated access can involve significant on-going regulatory intervention as the access agreement may need to be re-negotiated over time, and may need to be changed in line with changes in the services provided over the network. These on-going regulatory costs are not captured in our quantitative analysis.

5.86 There are also reasons why the net benefits of 1 block release may be understated relative to regulated access. These are primarily because our quantitative assessment fails to capture the role that 1 block release could potentially play in the promotion of competition in the longer term. This impact is unknown at the moment and it is difficult to assess how likely these benefits are. However, if 1 block release were to have longer term benefits in relation to the promotion of competition, these could be material (as the benefits could extend over a significant time period). To illustrate this, the total welfare benefits that would arise if 1 block release played an important role in allowing a sixth operator to enter the mobile broadband market in 2015 could be in the region of £190m (over the period until 2027)[110].

Conclusion

5.87 Therefore, in the high significance scenario, we believe that the best policy option for the liberalisation of the 900 MHz spectrum may be 1 block spectrum release, but that regulated access and 2 block release, whilst inferior, are both credible alternatives, and that all these options are likely to be better than liberalisation in the hands of the incumbents.

Medium significance scenario

5.88 In this section we set out our assessment of the outcome which may arise under the medium significance scenario. This assessment relies in places on points which have already been made in relation to the high significance scenario. Where this is the case we only provide a summary of the point in this section.

5.89 As set out earlier in paragraph 5.11, in this scenario demand for mobile broadband services is high, but subscribers are less interested in high levels of quality (in terms of for example the degree of in building coverage or data speed) and/or are less sensitive to quality differences than there are under the high significance scenario. The benefits from liberalisation in this scenario are reasonably high, and are higher than the costs of clearing and releasing spectrum over the relevant time period (2011 to 2015). However, the services which can be provided with access to liberalised 900 MHz spectrum can plausibly be fully matched using other higher frequency spectrum. In this case, wider access to 900 MHz spectrum reduces the cost of deploying

[110] See Annex 9, in particular A9.44.

networks (and hence brings productive efficiency benefits) but is generally not needed to promote competition[111].

5.90 Our assessment of the key elements of this scenario and its potential outcome under the liberalisation in the hands of the incumbents option is as follows:

- Operators with 900 MHz spectrum are likely to find it **profitable to use this spectrum to deliver higher quality mobile broadband services** because at least some consumers value the higher quality they could provide if they invest in a 900 MHz network rather than in their existing 2100 MHz networks in the interim period. And because the costs of clearing 900 MHz spectrum are less than £100m to each 900 MHz operator for the first block to be cleared[112]. This is significantly less than the cost advantage which results from deploying at 900 MHz rather than 2100 MHz in this scenario (which is up to £1.3bn)[113]. Hence, it is likely that operators will use liberalised spectrum for new uses during the interim period (i.e. 2011 to 2015).

- It is **plausible and profitable for other operators to provide comparable services using higher frequency spectrum**. Therefore, we think it is likely that these operators will rollout networks at 2100 MHz which allow them to compete on a comparable basis with the services provide over the new 900 MHz networks.

- However, these operators will be at a potentially substantial **cost disadvantage**. If they were to deploy a comparable service (i.e. a service which is close enough to be competitive) using 2100 MHz spectrum until 800 MHz spectrum is available, these operators would incur costs which are in the region of £150m to £1.3bn[114] higher than those incurred by the 900 MHz operators. The more extensive the network deployed by the 900 MHz operators, and hence the higher the number of sites they deploy, the greater the cost difference.

- In addition, if the 900 MHz network deployment is at the higher end of this range, and hence the number of additional base stations needed to match is high, it **may only be possible to match if you are RAN sharing operators,** who in aggregate would be willing to invest more in their shared infrastructure in order to be able to provide a comparable service to that provided using 900 MHz.[115]

- Given that it is likely that other operators would be able to provide comparable services, and because the benefits of access to liberalised spectrum are likely to

[111] Where the cost difference is high enough such that only RAN sharing operators can feasibly match, wider access can have competition benefits when there are some operators which are not sharing. However, these benefits only affect a sub-set of the outcomes under the medium scenario and are less significant than the competition benefits under the high significance scenario. See, for example the Annex 7, paragraph A7.216.
[112] See Annex 16, in particular Table 61.
[113] This is the Figure for breakpoint 3, where 2100MHz operators are no longer able to match quality. See Annex 7, in particular A7.41-A7.53.
[114] The lower bound here is break point 1, the upper bound is break point 2. An explanation of breakpoints is given in Annex 7, in particular A7.36-A7.57.
[115] As explained earlier, our options assessment makes assumptions about whether operators are engaged in RAN sharing or are acting as individual operators. In order to produce a quantified net benefit result, assumptions of this nature need to be made. We have made assumptions which are consistent with the results of the underlying quantitative modelling work, but that does not imply that these are the most likely outcomes as out modelling work is necessarily stylised. However, we do think that the sharing assumptions which are made are plausible.

be in excess of the costs of releasing one block of spectrum, we think it is **plausible, but by no means certain, that wider access to the liberalised spectrum may be achieved through the market** under our liberalisation in the hands of the incumbents option. However, wider access is more likely when the cost difference is at the lower end of the range for this significance scenario than at the higher end[116].

5.91 As with the high significance scenario, the impact of the other policy options (relative to liberalisation in the hands of the incumbents) depends upon whether or not the market would have achieved wider access. Hence, we start by assessing the relative impact of the policy options in the case where wider access is not achieved, and then consider the case where it is.

Table 14: Impact of policy options under medium significance scenario

Liberalisation option	Impact relative to the option of liberalisation in the hands of the incumbents, if the market would not have achieved wider access
Regulated access (Option B)	As the 900 MHz operators are assumed to rollout in this scenario the access obligation would be triggered. The costs of this option to the 900 MHz operators include the costs of putting in place the access agreement, but unlike the high significance scenario, the benefits of the option in this case relate to the promotion of efficient spectrum use during the period until 800 MHz spectrum becomes available. As with the high significance scenario above (see table 13), the degree to which an access agreement promotes efficient outcomes will depend upon how successful the agreement is. We think that there are significant risks that regulated access does not fully realise the benefits it might be possible to realise via a commercially negotiated access agreement, where the incentives of the parties to reach an agreement are well aligned.
Partial spectrum release (Option C)	The 900 MHz operators incur the costs of release. These costs increase with the number of blocks which are released. In this scenario, the benefits of this option relate to the securing of efficient spectrum use. The degree to which this is secured will depend upon the number of spectrum blocks released and whether commercial access to the released blocks is also agreed. As with the high significance scenario, we think release is more likely to realise these benefits then regulated access, as it allows direct access to the spectrum which is the underlying source of the benefits. As discussed in relation to the high significance scenario, spectrum release is subject to regulatory failures, such as a failure to identify the efficient number of blocks to be released or to specify the optimal timetable for release, but these are of a different nature to the failures of regulated access (where the failures relate to whether the efficiency benefits are realised at all).
Full spectrum release (Option	As with the high significance scenario (see table 13), the sources

[116] See Annex 8, in particular A8.102-A8.106.

D)	of the relative costs and benefits of this option are similar to those of partial spectrum release. However, the benefits are unlikely to be higher while the costs are at best the same and could be greater.

5.92 The diagram below shows the quantified part of our assessment of net benefits for liberalisation options B and C (regulated access and partial release), relative to liberalisation in the hands of the incumbents. We have not shown the net benefits of full release as, for the reasons set out above, we think that at best these are similar to the net benefits of partial release. The reasons why the net benefit of this option may be lower than partial release are discussed qualitatively below.

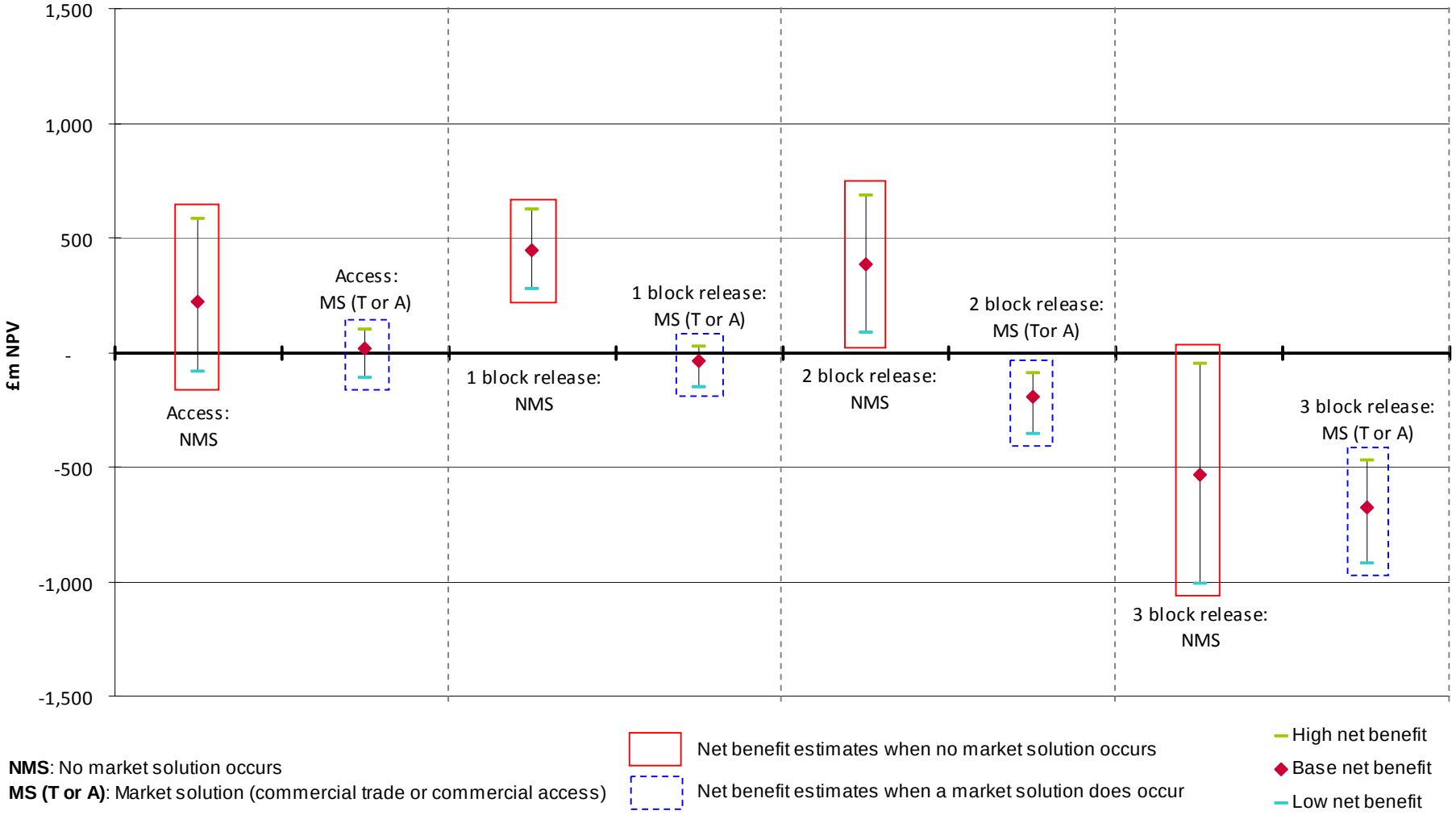
5.93 These results need to be combined with a more qualitative assessment of the impacts before drawing conclusions.

5.94 An explanation of how to read the diagram below has been provided in the discussion of the high significance scenario[117].

5.95 The full detail of the analysis which underlies this assessment is set out in Annex 7.

[117] See in particular 5.57-5.61.

Figure 11 : Medium significance scenario net benefit results



NMS: No market solution occurs
MS (T or A): Market solution (commercial trade or commercial access)

Net benefits quantified based on a 3 year period without access to low frequency spectrum, expressed as a 20 year net present value results using a social discount rate of 3.5%

Drivers of the net benefits in the medium significance scenario

5.96 We set out below the key drivers of the net benefits for each of the policy options.

5.97 The key benefit of **regulated access** is assessed as the productive efficiency benefits which result if 3 operators (1 single operator and 2 RAN sharing operators), who would have rolled out at 2100 MHz, now rely on regulated access. As with the high significance scenario, the benefits are adjusted to reflect the risk mentioned above in table 14, that the regulatory imposed access will not fully realise the desired benefits. The adjustment ranges from a 30% reduction to a 70% reduction across the high to low range of net benefits.[118] The results also reflect the impact regulated access could have on the costs of the networks that the 900 MHz operators rollout (if access results in them having to increase the capacity of their networks), the costs of delay which may arise as a result of our policy, and the administrative and other costs involved in agreeing access.

5.98 The **partial spectrum release** options differ in relation to the efficiency benefits they achieve:

- 1 block release is assumed to increase the number of players who have access to the efficiency benefits from 2 to 4 during the relevant time period. This is because, as explained under the high significance scenario in paragraph 5.67, we think it is plausible that the first released block might be shared between two parties as a result of commercial agreement.

- 2 block release assumes an increase in the number of operators with access to the efficiency benefits from 2 to 5, as does 3 block release. This is because, as with the high significance scenario, we assume that in the 2 block release option one block is shared and the other block is obtained by a single operator. Whereas in the 3 block release option we assume that 2 blocks are held by parties who are sharing and 1 block is held by a single operator.

- The magnitude of the efficiency benefits which are realised reflect the cost difference range which applies to this scenario (£150m to £1.3bn) and take in to account whether the benefits are for a single operator or RAN sharing operators.[119]

- The key costs which are reflected in the net benefits results are the costs of spectrum release and, as with regulated access, any costs which result if our policy delays access to liberalised spectrum.[120]

Interpretation of the medium significance scenario results

Liberalisation in the hands of the incumbents

5.99 The assessment of liberalisation in the hands of the incumbents relative to the other more intrusive options is similar in the medium and high significance scenarios. As with the high significance scenario, in the medium significance scenario:

[118] Please see Annex 7, in particular A7.118 to A7.121.
[119] The detail of this analysis is set out in Annex 7, in particular A7.78 to A7.117.
[120] See Annex 7, in particular paragraphs A7.127 to A7.134 and A7.140 to A7.158.

- Where the market would not have achieved wider access there are likely to be net benefits from the other policy options, and these benefits may be significant in the case of some options (most notably 1 block and 2 block release).

- Where the market would have achieved wider access the other options are likely to have net costs relative to liberalisation in the hands of the incumbents. But these costs are lowest under regulated access and 1 block release.

5.100 However, there are some important differences in the results for the medium significance scenario:

- Unlike in the high significance scenario, for the medium significance scenario the net benefits assessment on a consumer surplus basis would look similar to the assessment on a total welfare basis.[121] This is because the benefits relate to input cost savings (which are likely to be shared between producers and consumers) rather than from addressing distortions of competition (where the total welfare effect includes a positive consumer benefit which is partially offset by a loss in producer value).

- Compared to the high significance scenario, the range of net benefits is significantly tighter for the release options in the outcome where the market would not have achieved wider access. This is particularly so for 1 block release, which in the medium scenario has a significant net benefit even at the low end of our range. The main reason for the tighter net benefit range in the medium significance scenario is that the key benefit in this scenario is the cost savings which operators gain if they have access to 900 MHz spectrum. Within a scenario, there is less uncertainty around the magnitude of the cost differences than there is around the level of any competition benefits which result from addressing distortions to competition, and this is reflected in the tighter high to low range.

- We consider the likelihood of the outcomes in which the market would and would not have achieved wider access to be more evenly balanced under the medium significance scenario than in the high. Towards the lower end of the cost difference range under this scenario, wider access achieved through the market is probably quite likely, but as you move towards the higher end of the range the likelihood of wider access achieved through the market reduces.

5.101 Given the points above, we think the choice between liberalisation in the hands of the incumbents and the other policy options is finely balanced for many of the options. However, on balance, we think that there is sufficiently strong evidence from the quantitative analysis to suggest that 1 block release may be preferred to liberalisation in the hands of the incumbents. Assuming that the likelihood of the market achieving wider access is evenly balanced, liberalisation in the hands of the incumbents is marginally worse than 1 block release if the lowest benefits outcome of 1 block release when then market would not have achieved access is compared to the highest costs (i.e. the lowest net benefits). This comparison results in a £65m net benefit relative to liberalisation in the hands of the incumbents)[122]. For other combinations of benefits across the different outcomes for 1 block release, this policy

[121] Please see Annex 7, in particular Tables 112 and 113.

[122] This number can be generated using Table 112 in Annex 7 by comparing the low net benefit of 1 block release under NMS and MS (T or A) under the medium significance scenario, assuming that these two outcomes are equally likely (i.e. assuming there is a 50% probability of each of these outcomes occurring).

option performs significantly better than liberalisation in the hands of the incumbents (for example using our base case analysis the net benefit is estimated to be in the region of £200m).[123]

5.102 An additional issue which we believe is more relevant under the medium scenario, and which could in principle affect our decision between liberalisation in the hands of the incumbents and the other policy options, is the potential for liberalisation in the hands of the incumbents to result in asymmetric profit shocks. Our assessment of this issue is set out in detail in Annex 8[124]. However, in summary we acknowledge that large asymmetric profit shocks could have an impact on investment incentives in the sector in general. Therefore, some form of intervention may be justified to prevent this. However, we consider that correctly applying administered incentive pricing (AIP) could substantially reduce asymmetric profit shocks (although that would not of itself be our objective in revising AIP). Our proposal to review AIP for the 900 MHz spectrum is discussed further in Section 8 below.

5.103 Given this, we now compare 1 block release to the other policy options under this scenario.

3 block release

5.104 The net benefit results suggest that 3 block release performs significantly worse than 1 block release. Hence this is unlikely to be the preferred policy option. In reaching this conclusion we have also taken into account the points made in our analysis under the high significance scenario which we think are also relevant here. Namely that:

- The absolute level of costs imposed upon stakeholders is materially higher under 3 block release for potentially limited additional benefits.
- The risk of regulatory failure in relation to the release options suggests that smaller release options are likely to be preferred.

Full release

5.105 As under the high significance scenario we think that the benefits of full release are likely to be no greater than those of partial spectrum release, whereas the costs are at best the same but could be higher (see table 14).

5.106 As with the high significance scenario, we think it is unlikely that full release would result in more than three blocks of spectrum being released. As set out in paragraph 5.78 above, the costs of release increase significantly as the number of blocks to be released increases. However, the efficiency benefits of additional spectrum blocks fall materially once all operators have access to low frequency spectrum. If more than three blocks were released we think it is very likely that any additional blocks released (e.g. a 4th or 5th block) would not be the first block of low frequency spectrum for the operators who acquire them. Hence, the efficiency benefits of these blocks (which primarily provide additional capacity rather coverage benefits) will be very substantially lower than for the first three blocks to be released (as lower

[123] This number can be generated using Table 112 in Annex 7 by comparing the base net benefit of 1 block release under NMS and MS (T or A) under the medium significance scenario, assuming that these two outcomes are equally likely.
[124] See Annex 8, in particular A8.107-A8.114.

frequency spectrum does not have the same advantages over higher frequency spectrum for providing capacity as it does for providing coverage).

5.107 The only key difference between the assessment of full release under the medium and high scenarios is that under the medium scenario there may be less incentive for strategic behaviour in the award process. Hence, the ability of full release to determine the efficient number of blocks to be released is greater. However, as set out more fully in Section 7, we do not think that these benefits suggest that full release should be preferred to partial release. This is because:

- Partial release can also be designed to allow the auction to determine the efficient number of blocks to be released (if there were significant benefits from allowing this)[125]. The only difference between full and partial release in this case would be that partial release would set a cap on the number of blocks to be released. However, for the reasons set out above, we do not believe that full release is likely to result in more than three blocks being released. Hence, the benefits of full release are still expected to be no greater than those of partial release in the medium significance scenario.

- There are some additional risks with full release, such as the risk of delays to release and the greater level of regulatory uncertainty, which could result in higher costs under this option than under a partial release option.

5.108 Therefore, we believe that full release is an inferior option to partial release.

5.109 Our assessment of full release is set out in more detail in Section 7.

1 and 2 block release and regulated access

5.110 Comparing 1 block release and regulated access, the quantitative net benefit analysis suggests that 1 block release is likely to be the preferred outcome. While the net costs of regulated access are slightly lower than those of 1 block release, the likely net benefit is significantly lower. The lower end of the net benefit range for regulated access is negative, while the low end of the benefit range for 1 block release is significantly positive.

5.111 In addition, the qualitative arguments, which in our analysis of the high significance scenario suggested that 1 block release should be preferred[126], also hold here. Namely that:

- The benefits of regulated access may have been overstated as the quantitative analysis does not capture the impacts this could have on incentives to rollout or the potential dynamic efficiency effects if the policy did not adapt to changed circumstances in a timely fashion.

- The benefits of 1 block release may have been understated relative to access, as these do not include the potential for release to have longer term benefits.

5.112 Finally, comparing 1 and 2 block release, the choice between these two options is less clear cut based on the quantified part of the net benefit analysis alone. The base case benefits of the two options are similar in the case where the market would not

[125] Allowing a partial release auction to determine the efficient number of blocks to be released is explained in more detail in Section 7, in particular paragraph 7.46.
[126] See in particular paragraph 5.84-5.86.

have achieved wider access, but while the high end of the benefits range of 2 block release is higher, the low end is lower than that for 1 block release. Also the net costs of 2 block release when the market would have achieved access are always greater than the comparable point in the net cost range of 1 block release.

5.113 However, we think that the qualitative reasons for preferring 1 block release to 2 block release under the high significance scenario also hold here. Namely that:

- The risk of regulatory failure in relation to the release options suggests that smaller release options are likely to be preferred.
- There is a materially greater cost imposed upon stakeholders under 2 block release.

Conclusion

5.114 Therefore, in the medium significance scenario, while the evidence is not clear cut, we believe that the best policy option for the liberalisation of the 900 MHz spectrum may be 1 block spectrum release, but that liberalisation in the hands of the incumbents and 2 block release are both credible alternatives.

Low significance scenario

5.115 In this section we set out our assessment of the outcomes which may arise under the low significance scenario. Where this assessment relies on points which have already been made earlier in relation to other scenarios we only provide a summary of the point here.

5.116 The low significance scenario is a scenario in which demand for mobile broadband is low, and consequently only limited additional network deployment at 2100 MHz is required, when compared to the operators' current deployment plans. The benefits that are available from liberalisation over the relevant period (2011 to 2015) therefore turn out to be low relative to the costs of clearing and releasing spectrum from its existing uses. As a result, during this time period it is likely to be optimal for the 900 MHz spectrum to remain in its existing use and for new networks to be deployed using other (higher) frequency spectrum (if at all).

5.117 Our assessment of the key elements of this scenario and its potential outcome under the liberalisation in the hands of the incumbents option is as follows:

- The cost difference which arises in this scenario is relatively low[127] (less than £150m). This might be because demand for high quality mobile broadband services is low.
- The costs to the existing 900 MHz operators of each clearing a block for re-use range from £60m to £120m in total (£30m to £60m per operator)[128]. Hence, they are plausibly of a similar order of magnitude to the benefits of clearing spectrum.
- The cost to the existing 900 MHz operators of clearing an additional block for release to a different operator could plausibly be up to £90m[129].

[127] See Annex 7, in particular A7.37-A7.40.
[128] See the cost of clearing two blocks in Annex 16, in particular Table 61.
[129] See Annex 16, in particular A16.280.

- Hence, under this outcome we expect that the operators are very unlikely to use liberalised spectrum for new services in the short to medium term.

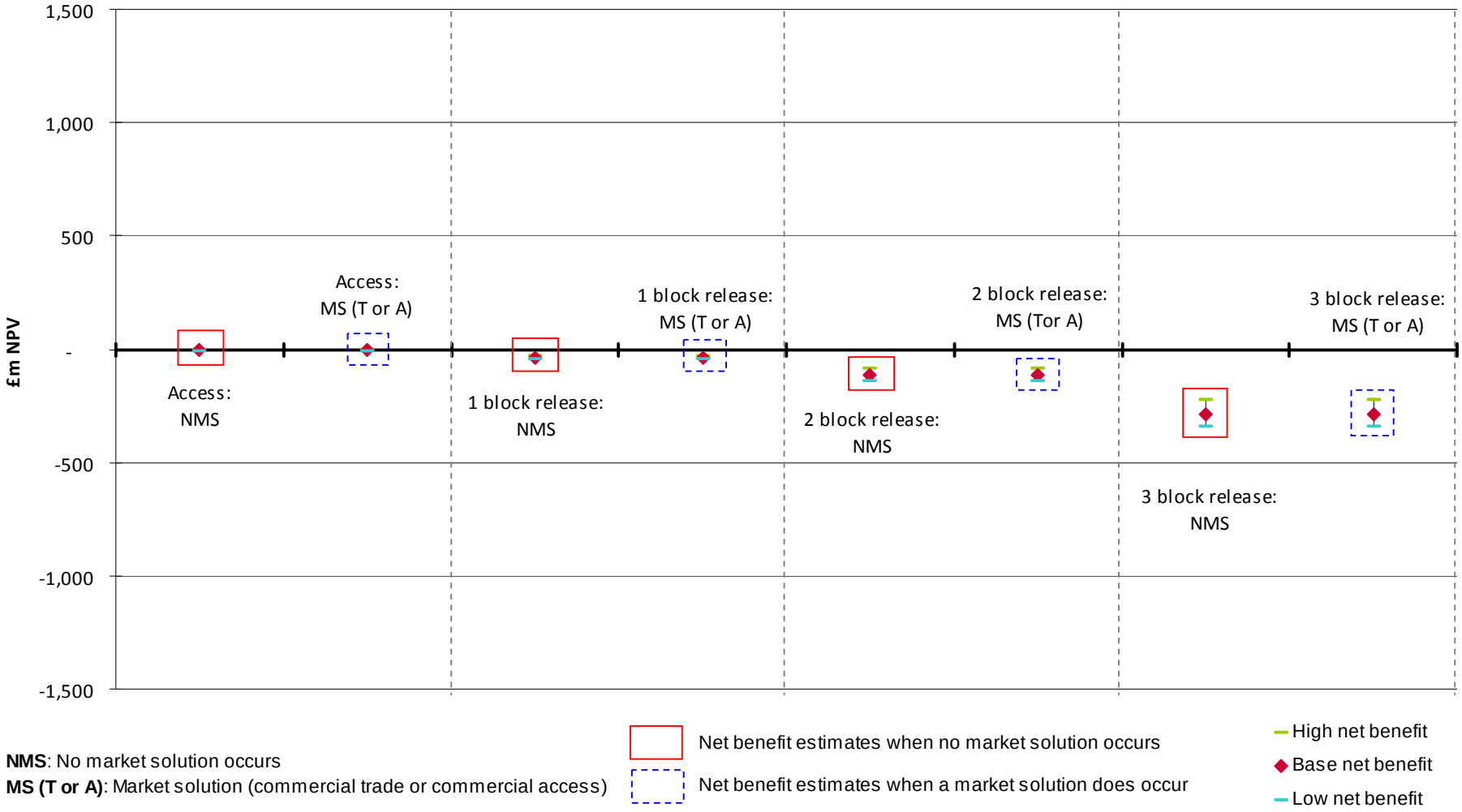
5.118 The diagram below shows the quantified part of our assessment of net benefits for liberalisation options B and C (regulated access and partial release), relative to liberalisation in the hands of the incumbents. We have not shown the net benefits of full release as we think that at best these are similar to the net benefits of partial release.

5.119 These results need to be combined with the other, more qualitative parts of the assessment before drawing conclusions.

5.120 An explanation of how to read the diagram below has been provided in the discussion of the high significance scenario in paragraphs 5.57-5.61.

5.121 The full detail of the analysis which underlies this assessment is set out in Annex 7.

Figure 12 : Low significance scenario net benefit results



Net benefits quantified based on a 3 year period without access to low frequency spectrum, expressed as a 20 year net present value results using a social discount rate of 3.5%

Drivers of the net benefits in the low significance scenario

5.122 In the low significance scenario it is likely to be efficient to maintain 900 MHz in its existing use and so wider access does not yield benefits but still incurs costs. So, relative to liberalisation in the hands of the incumbents, any more intrusive options would only result in a net cost under the low significance scenario. This is demonstrated in the quantitative part of the net benefit results shown above.

5.123 The assumptions underlying this analysis are set out in Annex 7.

Interpretation of the low scenario results

5.124 In the low significance scenario we think that liberalisation in the hands of the incumbents would be the best option. However, as mentioned earlier in paragraph 5.12, we think that the low significance scenario is less likely than the high and medium significance scenarios in aggregate.

Interpretation of results across scenarios

5.125 The analysis set out above reached the following conclusions:

- In the high significance scenario, 1 block release may be the best option, but 2 block release and regulated access are credible alternatives.
- In the medium significance scenario, 1 block release may be the best option, but liberalisation in the hands of the incumbents and 2 block release are credible alternatives. The quantitative analysis suggests that regulated access is inferior to the 1 and 2 block release options in the medium scenario.
- In the low significance scenario, liberalisation in the hands of the incumbents is the best option.
- In none of the scenarios does the option of 3 block release appear to be best, although in both the high and medium significance scenarios it might still yield a positive net benefit in some circumstances.
- In none of the scenarios does the option of full release appear to be best. Full release is likely to be inferior to the partial release options as its benefits are no greater while its costs are at best the same but are plausibly greater.

5.126 It is difficult to know which of the different scenarios is most likely, but on balance we think that the low scenario is almost certainly less likely than the other two taken together. The low significance scenario is consistent with our low market demand scenario, which is characterised by a rapid slowing in the growth in mobile broadband demand. In Annex 11 we explain that this market scenario would be consistent with pessimistic outcomes for mobile broadband, perhaps where mobile broadband perhaps turns out to a niche service[130]. Hence, we believe that the current evidence of increasing consumer demand for mobile broadband services suggests[131] that we are more likely to be in either the medium or high significance scenarios.

[130] See Annex 11, in particular paragraph A11.19.
[131] See Section 3, in particular 3.11-3.18 and Figure 2 and Annex 11, in particular A11.13-A11.18 and Figure 1.

5.127 It is difficult to know which of the medium or high significance scenarios is more likely. However, as 1 block release may perform best in both of these scenarios, this might suggest that this should be our preferred option.

5.128 The evidence in favour of any one policy option is not overwhelming. However, at its most basic, the question we need to ask ourselves is what certain costs do we think it is proportionate to impose on stakeholders in order to reduce the risk of uncertain, but potentially very significant lost benefits in the case where the market would fail to achieve wider access.

- For the choice between liberalisation in the hands of the incumbents and 1 block release this comes down to a judgment as to whether the risk of the market failing to achieve wider access is sufficient to warrant imposing costs of up to £90m[132] in total on Vodafone and O2. Given our statutory duties to promote the interests of citizens and consumers, and secure efficient use of spectrum, we think that this is a proportionate action given the magnitude of the potential benefits (which if they arise could amount to hundreds of millions of pounds[133]).

- For the choice between 1 block release and regulated access this comes down to an assessment of the effectiveness of these options given their costs. Regulated access appears to be a low cost solution, but as discussed above (such as in paragraph 5.85) we have significant concerns over its likely effectiveness. Hence, even though 1 block release is more costly, we think its likely greater effectiveness justifies this greater cost.

- For the choice between 1 block release and larger release options (such as 2 block, 3 block and full release) this comes down to whether the greater costs involved in greater levels of release are proportionate. Given that the additional benefits of these options are even more uncertain than the benefits of 1 block release, we believe that 1 block release is the most proportionate option.

5.129 On the basis of this analysis we therefore now consider 1 block release to be the best option for liberalisation of the 900 MHz spectrum and therefore, subject to the outcome of this consultation, propose to implement this option.

[132] See Annex 16, in particular A16.280.
[133] See the net benefits of 1 block release under the NMS outcomes in Table 112 in Annex 7 and in Figures 10 and 11 above.

Section 6

Assessment of options for liberalising 1800 MHz spectrum

Introduction

6.1 This section sets out the option assessment we have undertaken to identify how best to liberalise the 1800 MHz spectrum.

2007 consultation

6.2 Our proposal in our 2007 consultation was to liberalise this spectrum in the hands of the incumbent holders. In developing our updated assessment we carefully considered the comments raised by stakeholders in response to that consultation.

6.3 The four 2G operators that currently hold 1800 MHz spectrum agreed with our original proposals. H3G disagreed and argued that all 1800 MHz spectrum should be released. H3G, and on some points O2, highlighted the large disparity in the current distribution of 1800 MHz spectrum, and argued that liberalisation would give an advantage to Orange and T-Mobile in terms of capacity and the ability to provide high data rate services. H3G believed that secondary trading of 1800 MHz spectrum would not occur.

6.4 We have considered the issues in relation to capacity and the provision of high data rate services using next generation technologies in detail below. Other specific stakeholder comments are considered at the end of this section.

Structure

6.5 The structure of the rest of this section is as follows:

- Background information and analysis on 1800 MHz spectrum
- Identification of options and approach to the assessment
- Assessment of options
    - Liberalisation in the hands of the incumbents
    - Mandatory regulated access
    - Mandatory partial spectrum release
    - Mandatory full spectrum release
- Other stakeholder comments
- Conclusions

6.6 In reaching conclusions on the best policy option for the liberalisation of the 1800 MHz spectrum we have based our conclusions on the appropriate legal test as set

out in Section 2[134]. This is applied in this section as follows. We consider the uncertainty over the future use of the 1800 MHz spectrum and hence over the outcome of liberalisation in order to identify if there is a risk of a distortion of competition.

Background

6.7 The assessment of options for 1800 MHz spectrum draws upon evidence and analysis which is set out in other sections of, and annexes to, this document. The most important of these are:

6.8 **The current distribution of 1800 MHz spectrum.** 1800 MHz spectrum is currently held by the four 2G operators and used for 2G services. It is however unevenly distributed amongst them, with Orange and T-Mobile holding approximately 80% of the spectrum between them, having 2x30 MHz each[135].

6.9 **Development of next generation mobile technologies.** In Section 3[136] (and Annex 11) we discussed the increasing evidence of consumer interest in mobile broadband services since our last consultation and the development of next generation mobile technologies, LTE and WiMAX. These can offer higher data rates using wider contiguous bandwidths, e.g. 2x10 MHz and 2x20MHz.

6.10 **Cost differences.** Our further work on the differences between bands has confirmed that there is likely to be no material differences between 1800 MHz and 2100 MHz spectrum in terms of the number of sites required to provide mobile broadband coverage (also see Section 4, Annexes 10 and 15).

6.11 **Cost of releasing and clearing spectrum.** We have estimated the costs of clearing and releasing 1800 MHz spectrum and these are set out in Section 4 and Annex 16[137]. This analysis is relevant in assessing the options of mandatory release of 1800 MHz spectrum.

6.12 **The availability of other spectrum.** Annex 6 provides information on other spectrum that may be available for the provision of mobile broadband services. This includes spectrum in the 800 MHz, 900 MHz, 2.1 GHz and 2.6 GHz bands[138].

Identification of options and approach to the assessment

6.13 The options we have considered for liberalising the 1800 MHz spectrum are those included in our 2007 consultation:

- **Liberalisation in the hands of the 1800 MHz incumbents (Option A).** This is the least intrusive option and is similar to the approach we have adopted when liberalising other licences.

- **Regulated access (Option B).** This would involve us mandating that when the 1800 MHz spectrum is liberalised, if it is used to deploy new networks supporting improved mobile broadband services, the licence holder has to provide wholesale roaming or other access services to other mobile operators on this network. This

[134] See paragraphs 2.39-2.41 in particular.
[135] See Section 3, in particular Figure 1.
[136] See paragraphs 3.11-3.23 in particular.
[137] See paragraphs A16.16-A16.23 in particular.
[138] See Annex 6, for example Figure 4.

approach to the liberalisation of the 1800 MHz spectrum is more intrusive than liberalisation in the hands of the incumbents but is less intrusive than some of the other options considered below.

- **Partial spectrum release (Option C).** This would involve requiring some spectrum to be released alongside liberalisation of the remainder of the 1800 MHz spectrum. Any spectrum which is released would be liberalised and re-awarded.

- **Full spectrum release (Option D)**. This would involve re-awarding all 1800 MHz spectrum, and depending upon the outcome of the award process, the incumbent holders would have to clear and release any spectrum which they did not re-acquire. This is the most intrusive option for the liberalisation of the 1800 MHz spectrum. This option is also considered in Section 7 below.

6.14 We do not consider the option of 'wait and see' in detail. This is the option of delaying a decision on liberalisation of 1800 MHz spectrum until after the uncertainties around how this spectrum might be used, and the implications of this, have been significantly reduced. A short term delay in liberalising 1800 MHz spectrum is unlikely to bring any significant additional clarity and a longer delay could significantly reduce the consumer benefits from liberalised spectrum as well as being incompatible with forthcoming European legislation.

6.15 Our approach in assessing the options is first to consider the range of possible outcomes in the case of liberalisation in the hands of the incumbents (Option A) and whether any of these are likely to result in the benefits of liberalisation not being fully realised (including assessing whether there is a risk of a distortion of competition). Similar to our assessment of options for the liberalisation of the 900 MHz spectrum, we then go on to compare the costs and benefits of other, more intrusive options, against the outcome of this option, and consider whether on balance, these options would be likely to lead to a better outcome, taking into account the legal test we are applying (as set out in paragraph 6.6 above).

6.16 The analysis we have used to assess the options for liberalising 1800 MHz spectrum is significantly simpler than that for 900 MHz spectrum, although it follows a similar framework. In particular, it has not been necessary or appropriate to undertake a detailed quantitative assessment of all the options. This is because we consider that the qualitative analysis set out in this section is sufficient to allow the best option for liberalisation to be identified.

Liberalisation in hands of the incumbents (Option A)

6.17 To assess the option of liberalisation in the hands of the incumbents we have considered a number of different outcomes based on how the incumbent holders of 1800 MHz spectrum would use the spectrum following liberalisation. The uses we consider are:

- Continued use of all of the spectrum to provide 2G mobile services (no substantive change to current use).

- Clear some of the spectrum of 2G traffic and deploy UMTS carriers in order to increase mobile broadband capacity.

- Clear some of the spectrum of 2G traffic and deploy next generation mobile technologies (e.g. LTE or WiMAX), probably using 2x10 MHz or 2x20 MHz of spectrum.

6.18 We do not consider the case where operators use the spectrum solely to improve their mobile broadband coverage because, as discussed above, UMTS1800 does not appear to offer any coverage advantages over existing UMTS2100 networks.

Continue providing 2G mobile services

6.19 If the most efficient future use of all 1800 MHz spectrum is simply the continued provision of 2G mobile services then liberalisation would not bring any material benefits, at least not in the short term. At the same time the absence of significant benefits in this situation means that there is almost certainly no competitive distortion arising out of the liberalisation of this spectrum. It might also be that wider or more equal access to 1800 MHz spectrum would be efficient, even if only for the provision of 2G mobile services, but that too would not be as a result of liberalisation.

Deploy extra UMTS carriers to increase capacity

6.20 The existing holders of 1800 MHz spectrum could in principle clear some of this spectrum of 2G traffic and use it to provide additional UMTS capacity through the deployment of one (or more for Orange and T-Mobile) UMTS1800 carriers in addition to their existing UMTS 2100 carriers[139]. This may bring benefits for consumers in terms of increasing the capacity available for mobile broadband services, assuming there was consumer demand for this additional capacity. The realisation of these benefits would be dependent on UMTS1800 equipment being available and user equipment (phones, dongles etc.) being in the hands of consumers in scale. In Section 3[140] we noted the current lack of momentum in relation to the provision of UMTS1800 equipment although it is possible that this might change in future.

6.21 However, other operators could also increase their mobile broadband capacity through a number of alternative means including: acquiring additional spectrum or changing the use of existing spectrum bands, or deploying additional base station sites.

6.22 Options for acquiring or re-using existing spectrum include:

- Acquiring 2.6 GHz spectrum as a result of Ofcom's planned auction of this band. This spectrum is already cleared and will be available for use immediately after the auction[141]. This is likely to be earlier than 1800 MHz spectrum could be cleared of 2G traffic for use.

- Operators with liberalised 900 MHz spectrum could re-use some of that spectrum by clearing some 2G traffic and deploying UMTS 900 in that band. This would give them additional capacity as well as improving coverage (as discussed in Section 4[142]).

[139] Each UMTS carrier requires one block, that is 2x5 MHz, of spectrum.
[140] In particular, see paragraphs 3.22-3.23.
[141] The award was due to take place in summer 2008. However, the award has been delayed as a result of a legal challenge brought by two mobile operators.
[142] See paragraphs 4.18-4.26 in particular.

- Operators may be able to acquire additional spectrum at 800 MHz for providing mobile broadband services, although operators may not get the full benefits from that spectrum until 2015 (assuming deployment of LTE).

6.23 Increased capacity can also be achieved through deploying additional base stations sites. Operators have a number of technology options for deploying additional sites to increase their capacity, including macro-, micro-, pico- and femto-cells. Table 9 in Annex 13 provides further details on the different technologies available and their potential use.

6.24 We therefore consider it very unlikely that operators with 1800 MHz spectrum could realise a significant competitive advantage (i.e. provide services which could not be matched at other frequencies[143]) through use of that spectrum to increase their mobile broadband capacity. Other operators would be able to replicate any such capacity increases, and so it is very unlikely that this outcome would weaken competition between operators.

6.25 Furthermore, if that were the case, there is less reason for a holder of this spectrum to refuse to trade it to a competitor. We therefore think that it is plausible, although not certain, that wider or more equal access to liberalised 1800 MHz spectrum could be achieved through the market, if that would facilitate efficient use of spectrum. Therefore, we do not think that there is likely to be a distortion of competition as a result of the current spectrum holdings.

Deploy next generation mobile technologies

6.26 T-Mobile and Orange have 2x30 MHz of contiguous 1800 MHz spectrum and therefore in time may seek to clear 2G traffic from 2x10 MHz or even 2x20 MHz of contiguous 1800 MHz spectrum in order to deploy Next Generation Mobile technologies. This option would not be available to Vodafone and O2 (individually) as they only hold 2x5 MHz of 1800 MHz spectrum each, or to H3G which does not hold any 1800 MHz spectrum.

6.27 We specifically consider deployment of LTE below, although deployment of other technologies such as WiMAX is also relevant. LTE networks deployed in 2x10 MHz of contiguous spectrum are expected to be able to offer maximum data rates roughly twice as fast as LTE in 2x5 MHz. Similarly LTE using 2x20 MHz is expected to be able to offer maximum data rates roughly twice as fast as LTE using 2x10 MHz (all other things being equal). Use of liberalised 1800 MHz spectrum in this way may therefore bring benefits to consumers, in terms of faster, as well as higher capacity, mobile broadband services. The implications of this are, however, a good deal more distant and uncertain than for current generation mobile broadband services (e.g. UMTS).

Implications of 2x10 MHz deployment

6.28 Other operators could realise similar benefits as LTE deployed in 2x10 MHz at 1800 MHz by deploying services in 2 x10 MHz of contiguous spectrum at another frequency. The options here include:

- Use of the 2.6 GHz band. This band offers 190 MHz in total and therefore provides significant potential for a number of other operators to acquire and use

[143] This is the approach used in our assessment of the options for liberalising the 900 MHz spectrum to distinguish between our high and medium significance scenarios.

2x10 MHz of spectrum. In addition, this spectrum is likely to be usable earlier (as discussed above[144]) than 1800 MHz spectrum and LTE equipment is currently expected to be available for the 2.6 GHz band before the 1800 MHz band. The 2.6GHz band is a vacant band, which is already available in some major global markets, and should be available shortly throughout the entire EU. It is therefore well-suited to the deployment of new technology layers requiring wide bandwidths.

- Deployment of LTE using 2x10 MHz is also likely to be possible in the 800 MHz band.

- Other operators also have existing spectrum at 900 MHz and 2100 MHz which they could in time re-use for LTE, although this would be subject to clearing existing traffic. Clearance of 2x10 MHz in these bands might however be more costly than clearing 2x10 MHz at 1800 MHz because individual operator holdings in these bands are smaller than Orange and T-Mobile holdings in the 1800 MHz band. For example, operators with 2x10 MHz of 2100 MHz spectrum may need to clear all of their existing 3G traffic.

6.29 Note that if 1800 MHz spectrum provides coverage advantages over 2.6 GHz spectrum and these turn out to be important then we would expect other operators to seek to use 800 MHz or possibly 900 MHz spectrum for LTE, which are likely to provide even greater coverage advantages.

6.30 Due to the availability of these options it seems very unlikely that operators with 1800 MHz spectrum could realise an significant competitive advantage over other operators through use of that spectrum to deploy LTE technologies in 2x10 MHz. Therefore we consider it very unlikely that competition between operators would be weakened in this outcome.

6.31 Furthermore, if that were the case, there is less reason for a holder of this spectrum to refuse to trade it to a competitor. We therefore think that it is plausible, although not certain, that wider or more equal access to liberalised 1800 MHz spectrum could be achieved through the market, if that would facilitate efficient use of spectrum. Therefore, we do not think that there is likely to be a distortion of competition as a result of the current spectrum holdings.

Implications of 2x20 MHz deployment

6.32 There are a number of reasons why it currently seems unlikely that a deployment of LTE using 2x20 MHz of 1800 MHz spectrum would lead some operators to have an significant competitive advantage in the near future:

- Other operators may be able to acquire 2x20MHz of contiguous spectrum in the 2.6GHz band and thereby replicate the data rates that operators with 1800 MHz spectrum might provide. Moreover, as discussed above, 2.6 GHz spectrum is likely to be usable earlier than 1800 MHz spectrum for next generation mobile technologies, and so the use of 1800 MHz rather than 2.6 GHz spectrum is unlikely to give 1800 MHz operators an advantage in this respect (particularly as deployment of 2x20 MHz mobile broadband in the 1800 MHz band may be dependent on 2G traffic volumes falling significantly). Although 1800 MHz spectrum is likely to provide better coverage than 2.6GHz spectrum, it is not yet clear whether operators would seek to deploy the highest data rates possible with

[144] Also see Annex 6 paragraphs A6.29-A6.44

2x20 MHz with extensive wide area coverage or, for example, limit this to 'hot spot' coverage. However, if coverage were important then it is also uncertain whether or not operators with 2.6GHz spectrum would be able to match the coverage of 1800 MHz operators by deploying more sites.

- Technology developments may mean that the rates achievable with contiguous spectrum could be replicated using non-contiguous spectrum, for example using LTE-Advanced. In this case, the data rates provided using 2x20 MHz at 1800 MHz might be replicated (or closely approximated) by operators with a combination of spectrum at other frequencies.

- It also remains uncertain whether consumers would value significantly more the higher maximum speeds that could be provided using 2x20 MHz rather than 2x10 MHz for mobile broadband. For example, using LTE, this might allow a maximum data rate of 90MBit/s rather than 45 MBit/s, which is an order of magnitude faster than the speeds provided by current generation broadband. The market demand for next generation mobile services with data rates up to 90 Mbit/s is inherently more uncertain than the demand for current generation mobile broadband using HSDPA.

6.33 Therefore, a competitive problem in the near future resulting from deployment of LTE using 2x20 MHz of 1800 MHz spectrum currently seems unlikely.

6.34 And once again, if this is the case, there is less reason for a holder of this spectrum to refuse to trade it to a competitor. We therefore think that it is plausible, although not certain, that wider or more equal access to liberalised 1800 MHz spectrum could be achieved through the market, if that would facilitate efficient use of spectrum.

6.35 Nonetheless, if, in the future, market developments suggested that the risks of a problem had significantly increased, it might be appropriate for Ofcom to re-visit this issue. For example, we could review whether those market developments were likely to impact negatively on competition and hence consumer benefits from mobile broadband, and where necessary we could take action at the time to promote competition and efficient use of spectrum.

6.36 One method to facilitate addressing this issue in future would be to put part of the spectrum holdings at 1800 MHz on an explicitly shorter notice term, of say one or two years, to enable us to take back spectrum more quickly if we had evidence that a competition problem was likely, or had developed. However this would also create additional regulatory uncertainty for holders of the spectrum and therefore could negatively impact incentives to use the spectrum efficiently. On balance, our current view is that such a shorter notice period would not be justified.

Summary

6.37 In summary, there is little evidence at present to suggest that liberalising 1800 MHz spectrum in the hands of the incumbent holders would risk a distortion of competition, nor that it would result in the full benefits of liberalisation being fully realised, at least in the short term. Although holdings of the spectrum are relatively concentrated, other operators can realise similar benefits to those that are likely to be possible in the next few years using other means. It therefore seems unlikely that the current holders of 1800 MHz spectrum would be able to enjoy an significant competitive advantage in the near future as a result of the liberalisation of 1800 MHz spectrum. In these circumstances there is less reason for a holder of this spectrum to refuse to trade it to a competitor (or agree to provide network access). It therefore seems plausible,

although not certain, that wider or more equal access to liberalised 1800 MHz spectrum could be achieved through the market, if that would facilitate efficient use of spectrum.

Other options

6.38 All of the other options that we have identified involve intervention in the market to a greater or lesser extent, to promote wider or more equal access to 1800 MHz spectrum, or to networks deployed using 1800 MHz spectrum.

6.39 We have concluded above that the holding of 1800 MHz spectrum is unlikely to bestow an significant competitive advantage on the current holders in the near future (and there is considerable uncertainty about whether it might do so even in the longer term). Such intervention is therefore not necessary to address a potential distortion of competition.

6.40 Wider or more equal access to 1800 MHz spectrum, or networks deployed using 1800 MHz spectrum, might none the less promote efficient use of spectrum.

6.41 The question is then whether regulatory intervention in the market is more or less likely to secure the efficient distribution of spectrum (whether that is the existing distribution or some other distribution), or efficient access to networks, and whether any increase in the likelihood of achieving the efficient outcome outweighs the costs of the intervention.

6.42 We first note that once trading of this spectrum is permitted, there will be no legal barriers to the market agreeing wider or more equal access to 1800 MHz spectrum. Likewise there are no legal barriers to the market agreeing commercial terms of access to networks deployed using 1800 MHz spectrum. The market is therefore able to achieve the same types of outcome as we can.

6.43 Furthermore, it is even open to the market to follow the same type of process as we would to secure a commercial outcome (whether or not this is actually likely). For example a current holder of 1800 MHz spectrum could choose to auction a part of that spectrum to the highest bidder (most likely with a reserve price reflecting their own value for the spectrum).

6.44 All that we would therefore be doing by intervening in the market is forcing our own view on the market as to the appropriate timing, nature and mechanism for a widening or equalisation of access to occur (and possibly bearing some of the costs of the process, although we would also be imposing costs on the market).

6.45 The risks with this approach include the following:

- We risk forcing the market to engage in a process when none is required (wider or more equal access is not efficient) and if we are not careful about the design of that process, we risk imposing unnecessary costs on operators and causing disruption to consumers.

- We risk forcing the market to engage in the process at the wrong time – most likely too early, but also possibly too late, e.g. if an announcement by us of a regulatory process undermines commercial deals in the mean time.

- We risk forcing the market to engage with a particular approach to the widening or equalisation of access, which may not be the efficient approach.

- We risk imposing a less effective solution than the market would agree commercially, and one that could potentially require ongoing regulatory oversight rather than commercial agreement.

6.46 We consider that these risks are not justified as we do not have good reason to (a) believe that wider or more equal access would be necessary and would deliver significant efficiency benefits and (b) that the market would fail to achieve such wider or more equal access, but in the case of the 1800 MHz spectrum (as distinct from the 900 MHz spectrum).

6.47 Below we briefly considering each of the alternative options in turn.

Mandatory regulated access (Option B)

6.48 Under this option, we would liberalise 1800 MHz spectrum in the hands of the incumbent holders and place a requirement on them to provide access to other operators to any new network that they deployed using the spectrum. Access could potentially encompass a range of agreements including roaming and spectrum sharing.

6.49 In summary we do not consider mandatory regulated access to be an appropriate option for liberalisation because:

- We have concluded that liberalisation of the 1800 MHz spectrum in the hands of the incumbents would be unlikely to give rise to a distortion of competition in the near term, and whilst it is possible that the holding of a large amount of 1800 MHz spectrum might yield a competitive advantage in the longer term, there is considerably uncertainty about the chances of such an outcome arising in practice.

- Were it to become apparent that such an outcome was likely, it would be open to Ofcom to take action nearer the time.

- Absent such competition concerns, the only reason for us to intervene in the market to ensure wider or more equal access to networks deployed using 1800 MHz spectrum would be if such wider or more equal access would secure more efficient use of spectrum. It is unclear that it would.

- Such intervention would also have to be more likely to yield an efficient outcome than would commercial negotiation, and the additional costs and risks of intervention would have to be justified by the additional benefits. We do not believe that regulated access to 1800 MHz networks would be more likely to secure an efficient outcome than commercial negotiation, and consequently we do not believe that the benefits of regulated access would outweigh the costs.

Partial mandatory spectrum release (Option C)

6.50 Under this option existing holders of 1800 MHz spectrum would be required to release some of their spectrum and the released spectrum would be re-awarded, most likely by auction. To avoid the risk of imposing costs of spectrum release when the existing distribution of spectrum is efficient, it would almost certainly be necessary for the length of notice given to be sufficient for the existing holders of the 1800 MHz spectrum not to have to take any action as regards the release of spectrum until after the outcome of the auction were known. Similarly, it would almost certainly be necessary to allow the existing holders of the 1800 MHz spectrum to re-

acquire some or even all the spectrum through the auction, in case the existing distribution of spectrum was efficient (which it might be).

6.51 In summary we do not consider partial spectrum release to be an appropriate option for liberalisation for the following reasons:

- We have concluded that liberalisation of the 1800 MHz spectrum in the hands of the incumbents would be unlikely to give rise to a distortion of competition in the near term, and whilst it is possible that the holding of a large amount of 1800 MHz spectrum might yield a competitive advantage in the longer term, there is considerably uncertainty about the chances of such an outcome arising in practice.

- Were it to become apparent that such an outcome was likely, it would be open to Ofcom to take action nearer the time.

- Absent such competition concerns, the only reason for us to intervene in the market to promote wider or more equal access to 1800 MHz spectrum would be if such wider or more equal access would secure more efficient use of spectrum. It is unclear that it would.

  Such intervention would also have to be more likely to yield an efficient outcome than would commercial negotiation, and the additional costs and risks of intervention would have to be justified by the additional benefits. We do not believe that mandatory partial spectrum release would be more likely to secure an efficient outcome than commercial negotiation, and consequently we do not believe that the benefits of this option would outweigh the costs

Full mandatory spectrum release (Option D)

6.52 This option would be similar to Option C, but would involve the existing holders of 1800 MHz spectrum being given notice to quit all the spectrum. Again, to avoid unnecessary costs of release it would be necessary for the period of notice to be sufficiently long to allow the existing holders not to take any action to release spectrum until after the outcome of the auction were known. And to ensure that the outcome of the auction could be efficient, even if that meant that the existing holders simply re-acquired all the spectrum, it would be necessary to allow them to do so.

6.53 In summary we do not consider full spectrum release to be an appropriate option for liberalisation for the reasons set out under our assessment of mandatory partial spectrum release above.

6.54 The option of full release of 1800 MHz is also considered further in Section 7 below.

Other stakeholder comments

6.55 Response to comments made by Stakeholders in response to our proposals in the 2007 consultation which have not already been reflected above are set out below.

- H3G also noted that it could be disadvantaged if particular technologies were developed only for 1800 MHz and it did not have any of this spectrum whereas the other four MNOs did. Our current view is that whilst it is possible that a situation could arise in the future where there are particular new technologies available that are essential to complete and only available in 1800 bands, at

present this is not the case, and it is very uncertain whether or when this would arise.

- H3G disagreed with our view there were no current plans for UMTS1800 equipment. Our updated understanding on UMTS 1800 equipment is set out in Section 3[145].

- H3G also considered that it would be discriminatory not to treat 1800 MHz MNOs the same as 900 MHz MNOs. However, the position of the 900 MHz MNOs and 1800 MHz MNOs are different, in particular due to the different characteristics of 900 MHz and 1800 MHz spectrum[146] and differences in the distribution of 900 MHz and 1800 MHz spectrum[147], with different issues being raised by liberalisation as a result. Given these different circumstances, our view is that it is not discriminatory to treat liberalisation of 900 MHz and 1800 MHz spectrum differently.

- H3G believed we should have considered a variation of full spectrum release where the auction was held around 2-3 years before release such that incumbent operators have sufficient time to clear spectrum. We have considered this in Section 7 below.

- An individual disagreed that maintaining the existing distribution of 1800 MHz spectrum would be likely to promote competition. We have considered the competition implications of liberalisation in our analysis above.

Conclusions

6.56 Our provisional conclusion remains that 1800 MHz spectrum should be liberalised in the hands of the incumbent holders. This is based on our assessment that this option is not likely to result in a distortion or competition, is likely to bring about the full benefits of liberalisation for consumers, and no other option appears to be superior.

6.57 Nonetheless, we retain the option to consider whether intervention would be appropriate in the future, should the market and technology develop in such a way as to raise serious competition or efficiency concerns.[148]

[145] In particular, see paragraphs 3.22-3.23.
[146] Our analysis indicates that 900 MHz spectrum has material advantages in providing 3G coverage compared to 2100 MHz spectrum whereas 1800 MHz spectrum does not. See Section 4, in particular paragraph 4.47, and Annex 13, in particular paragraph 13.38 and Table 4.
[147] See Section 3, in particular paragraphs 3.2-3.3.
[148] This form of "wait and see" approach was rejected under our assessment of options for the liberalisation of the 900 MHz spectrum because with that spectrum band, we can foresee the risk of distortions to competition in the near future.

Section 7

Further consideration of the full release option for both 900 MHz and 1800 MHz spectrum

Introduction

7.1 Following consideration of the responses to our earlier consultation, we are currently minded, subject to any new evidence or arguments that we receive in response to this consultation, to reject the full release option for both 900 MHz and 1800 MHz spectrum.

7.2 Full release would involve giving notice to terminate the current licences to use the 900 MHz and/or 1800 MHz spectrum at some specified future date. We would then re-award all of the 900 MHz and/or the 1800 MHz spectrum. Depending on the outcome of the award process, those operators who currently use the spectrum bands to provide services would have to clear and release any spectrum which they did not re-acquire.

7.3 This is the most intrusive option for liberalising the 900 MHz and the 1800 MHz bands which we have considered.

7.4 We consulted on full release options in our September 2007 consultation as “Option D”. In that consultation, we set out our provisional view that full release of the 900 MHz and 1800 MHz bands was not likely to be appropriate as we had identified alternative options which were less interventionist and which met our statutory duties and objectives.

7.5 In relation to the 900 MHz band, we provisionally considered that some form of partial spectrum release (i.e. release of some but not all the band) was most likely to meet our duties. This was because we considered that partial release was capable of addressing our concerns post liberalisation. Namely, that the existing distribution of 900 MHz spectrum was not likely to be efficient and there was a clear risk of a reduction in efficiency and competition in the mobile market with such a distribution, especially if there was strong growth in the future in the demand for mobile broadband services.

7.6 In relation to the 1800 MHz band, we provisionally considered that, given the characteristics of the spectrum and the wider existing distribution of the band between four operators, changes to the existing distribution were unlikely to be necessary to promote competition or secure efficient use of the spectrum post liberalisation. We considered that it was reasonable to expect the market to determine whether any more efficient distribution of the 1800 MHz spectrum existed, and to achieve this through trading if necessary.

7.7 Therefore, in light of our provisional conclusions, our view was that less interventionist options than the full release option were available, and those less interventionist options were capable of addressing the concerns we had identified in respect of the distribution of the bands. We also noted in our analysis that the costs of more intrusive spectrum release (beyond the levels of release which we proposed

in respect of the 900 MHz band but below full release levels) were likely to be very significant. As result, we were not confident that the benefits associated with full release would exceed the costs of this option, and we were concerned that full release would impose a significant risk of disruption to the existing operators using the band which could in turn lead to a lower quality of service and material detriment to consumers currently using the band. We considered that these costs and risks would be likely to significantly reduce, if not eliminate, most of the benefits associated with liberalisation of the bands.

Responses to our September 2007 consultation in relation to full release

7.8 Only one respondent to our September 2007 consultation commented in detail on the full release option. H3G supported the full release option but proposed a variant of the option set out in that consultation.

7.9 H3G argued that Ofcom should either administratively re-allocate the whole of the 900 MHz and 1800 MHz bands to the five existing mobile network operators or hold a clear auction of both bands. It argued that such an auction should be held in advance of any actual release of the band, so that the operators currently using the bands would not incur the costs of clearing any spectrum which they subsequently retained as a result of the auction.

7.10 H3G maintained that only full release and re-award/re-allocation of all of the 900 MHz and 1800 MHz bands in a manner which gave the five existing mobile operators "*broadly equivalent access to both 900 MHz and 1800 MHz spectrum*" could meet Ofcom's duties of non-discrimination and proportionality. H3G argued that any other outcome would put H3G at a particular disadvantage vis-à-vis the other mobile operators, and would exacerbate existing distortions in the market.

7.11 H3G further maintained that in the Information Memorandum relating to the auction of 3G licences in 2000, the Government gave assurances that in relation to liberalising the 900 MHz and 1800 MHz bands, it would "*take account of potential effects on the viability of existing 2G and 3G operators and of the case for rectifying any distortions in the market caused by historic assignments*".

7.12 H3G argued that it had bid for and won a 3G licence in reliance on this statement and further statements in the same document encouraging new entrants to take part in the 3G auction. As a result, H3G claimed it has a legitimate expectation that such existing competitive distortions will be rectified as part of the process for liberalising the 900 MHz and 1800 MHz bands. H3G further maintained that recital 16 of the draft RSC Decision, which states that "*differences in the national legacy situations could result in competitive distortions. The existing regulatory framework gives Member States the tools to deal with these problems in a proportionate, non-discriminatory and objective manner, subject to Community law including the Authorisation Directive and the Framework Directive*" clearly envisaged that "*measures would need to be taken to level the playing field where legacy 2G operators would acquire a significant advantage in the 3G market as a result of 2G spectrum liberalisation*".

7.13 In the following sections we set out:

- Our assessment of the arguments put forward by H3G on discrimination and legitimate expectations.
- Our assessment of H3G's arguments relating to administrative allocation.

- Our revised assessment of the full release option, including our assessment of the variant of this option proposed by H3G.

- Our intention, subject to this consultation, to reject the full release option for both the 900 MHz and 1800 MHz spectrum.

H3G's arguments on discrimination and legitimate expectations

7.14 As we set out in our September 2007 consultation, we have taken into account the history of licensing of spectrum which can be used to offer mobile services in the UK which has resulted in significant differences between the existing five MNOs in terms of their current spectrum holdings. We are not "starting with a blank page". It follows from this that any particular approach to implementing the European obligation to liberalise the 900 MHz and 1800 MHz spectrum is likely to have different commercial impacts on individual stakeholders.

7.15 As a public authority, we are under a general duty not to discriminate without objective justification. It is settled case law that discrimination may only arise where different treatment is given to persons in similar circumstances, or where the same treatment is given to persons in different circumstances, and there is a lack of objective justification for the treatment given.

7.16 We do not accept H3G's argument that full release is the only option capable of meeting Ofcom's duties in relation to non-discrimination. It is not discriminatory for different operators to have different rights to use spectrum, as is currently the case. Whilst it may be the case that full release is the only liberalisation option which could result in all the current mobile network operators holding rights to use "broadly equivalent" amounts of the 900 MHz and 1800 MHz spectrum, we do not accept that it would be discriminatory if, following liberalisation of the 900 MHz and 1800 MHz bands, operators continue to hold differing rights to use the spectrum.

7.17 At its heart H3G's argument is one about "fairness", namely that the only "fair" outcome would be for each of the existing mobile network operators to come out of the liberalisation process with roughly the same rights to use similar amounts of each type of spectrum.

7.18 We note that we are not however under a duty to equalise the amount and nature of the spectrum which different stakeholders have licences to use in the UK, nor do we accept any suggestion that stakeholders have an expectation in law that we would do so (as to which see further below).

7.19 As we have set out above, we are not starting with a blank page, and we must take into account the effect on all stakeholders, and in particular the effect on consumers, of the liberalisation option which is ultimately adopted. Our analysis set out later in this section has shown that the benefits of the full release option can in practice be equalled or bettered through the use of a partial release option, at the same or lower cost, whilst creating less regulatory uncertainty. Consequently, even if full release were equally capable of meeting our statutory duties (which we do not accept), it would not be a proportionate option to adopt.

7.20 We also do not accept H3G's contention that it has a legitimate expectation in law that we should liberalise the 900 MHz and 1800 MHz bands in a way that results in all existing mobile network operators holding "broadly equivalent" rights to use it.

7.21 As we set out in our September 2007 consultation, we have carefully reviewed statements made in relation to the potential for the 2G licences to be refarmed or liberalised, including those made at the time of the 3G auction in 2000. H3G has not identified any statements of representations capable of creating a legitimate expectation in law in relation to liberalisation of the 2G licences at the time of that auction or at any other time. Further, and in any event, we consider that the events at the time of the 3G auction should as a matter of principle not be determinative if by following this route the benefits that would follow from the liberalisation of 2G licences are less likely to be fully realised. Spectrum licensees are not entitled to expect that spectrum management regulation and policy will remain static, particularly in the light of changes to the background EU legislation.

H3G's arguments relating to administrative allocation

7.22 As set out above, H3G has also argued that we should administratively re-allocate the entirety of the 900 MHz and 1800 MHz spectrum.

7.23 We remain of the view, as set out at paragraph 12.18 of the September 2007 consultation, that administrative allocation[149] would not comply with the requirements of Article 5(2) of the Authorisation Directive to grant rights of use of radio frequencies through open procedures.

7.24 H3G maintained that liberalising the spectrum in the hands of the incumbent licensees would itself constitute administrative allocation because, broadly, Ofcom would be allocating to the incumbent licensees:

- rights to use the spectrum for any technologies rather than just 2G technologies;
- extended rights of use and/or greater certainty, in that Ofcom proposes to change the notice period of the licences from one to five years; and
- rights to trade the spectrum for value which would not otherwise be available to them.

7.25 H3G also argued that the key requirement of Article 5(2) of the Authorisation Directive is the requirement of transparency, and that "open and non-discriminatory" in this context means little more than that Ofcom must act on an objective basis by reference to identified criteria rather than by reference to the identity of the proposed recipients. H3G considered that allocation to all five existing MNOs on this basis would satisfy the requirements of Article 5(2), based on a market intervention to level the playing field between the five 3G MNOs. H3G also considered that any other interested parties could acquire spectrum in a trading environment, or from new awards already proposed, if it were efficient for that to happen.

7.26 We address each of these points below.

7.27 Radio frequencies are a scarce and finite resource. As a result, Article 5(1) of the Authorisation Directive provides that where possible, use of radio frequencies should not be made subject to individual rights of use.

[149] By administrative allocation, we mean a process by which the regulator would require spectrum release and then itself decide to whom it should be awarded, without any applications from licensees, or any comparative or competitive selection process.

7.28 Article 5(2) applies to instances where it is necessary to grant individual rights of use of radio frequencies. It sets out the minimum requirements which Member States must meet in such circumstances. We consider that it is clear from both the text and intention of Article 5(2), when read in the context of the European Communications Directives as a whole, that it is intended to relate to instances in which Member States grant individual rights of use over radio frequencies to entities that did not previously hold rights to use those frequencies. The minimum requirements set out in Article 5(2) are intended to ensure that all potential users of radio frequencies have an opportunity to gain access to use them, and that Member States should not grant individual authorisations without affording all interested parties that opportunity.

7.29 The requirement of Article 5(2) to grant individual rights of use through open *procedures* means that Ofcom is, in our view, required to adopt a procedure which is open to third parties (notwithstanding that the effect of criteria under such a procedure may have the effect of excluding certain undertakings from taking part in a competitive or comparative selection procedure[150]). We do not consider that it simply requires Ofcom to act according to objective selection *criteria*, as H3G suggests, as this is separately specifically required by Article 7(3) of the Authorisation Directive[151].

7.30 In light of the above, we disagree that Article 5(2) applies in every situation in which a Member State varies an existing licence (in other words, where a right to use the frequencies in question has previously already been granted); this would, however, be the logical consequence of H3G's arguments summarised above. Each of H3G's points raised relates to the variation of an existing licence to use specified radio frequencies, and does not alter the scope of the frequencies for which those licences have been granted.

7.31 We disagree with H3G's contention that an allocation of the 2G spectrum to the existing five 3G MNOs would be capable of satisfying the requirements of Article 5(2). Such an allocation, whether of all or part of the 2G spectrum, would (as H3G appears to accept) exclude any other interested parties and as such, would not in our view satisfy the requirement to hold an "open" grant procedure. We do not consider that H3G's suggestion, that any such interested third parties could subsequently acquire spectrum through trading or other spectrum auctions, would be sufficient to justify a failure to hold an open process.

Our refined analysis of the full release option

7.32 In our September 2007 consultation we considered three different variants of the full release option for 900 MHz: early release, late release and phased release. Based on the analysis set out in that document we reached a provisional conclusion that although full release could bring some benefits, it was likely to be disproportionate or cause unreasonable delay to (and hence reduce) the benefits of liberalisation.

7.33 For 1800 MHz we reached a provisional conclusion in 2007 that any form of spectrum release was unlikely to be a proportionate option as there is a less intrusive option (namely liberalisation in the hands of the incumbents) that appeared to fulfil our duties and objectives.

[150] See Recital 23 of the Authorisation Directive.
[151] For this reason, we disagree with H3G's further contention that a beauty contest applying objective selection criteria, would constitute administrative allocation as defined above.

7.34 In the following we assess whether the provisional conclusions reached are still valid, given our revised analysis of the issues. We also go on to consider a fourth full release variant suggested by H3G in its response to the 2007 consultation.

Refined analysis of full release options for 900 MHz

7.35 The three variants of full release considered for 900 MHz in our 2007 consultation are set out below and the provisional conclusion reached on each of these is provided.

7.36 **Early full release** involved revoking all of the 900 MHz spectrum at the earliest practical date (which was considered to be 2010 for the analysis in the 2007 consultation, but based on our current analysis would probably be 2011). We would then have held an auction to re-award the spectrum. The current licensees would then have released in 2010 any spectrum they did not re-acquire at award.

7.37 In the 2007 consultation we provisionally concluded that the very high costs involved in an early full release option meant that it was likely to be a disproportionate option.

7.38 **Late full release** involved revoking all of the 900 MHz spectrum in 2018. We would then hold an auction to re-award this spectrum two to three years before the revocation date (perhaps in 2015 or 2016). Once again, the current licensees would have only released spectrum they did not re-acquire at award. The spectrum would not have been liberalised until after the date of release.

7.39 In the 2007 consultation we provisionally concluded that late full release would significantly delay the benefits of liberalisation and would appear inconsistent with timely implementation of the draft RSC Decision.

7.40 **Phased full release** involved an initial release of part of the 900 MHz spectrum with the rest of the spectrum being released in one or more later phases. An example of which could have involved 2 blocks of 2x5MHz in 2010, 2 further blocks in 2012 and 3 final blocks in 2014. The auctioning of the released spectrum would be similarly phased. The rationale for phasing release was that early blocks allow early benefits of liberalisation, while delaying the release of additional blocks may reduce the cost of release.

7.41 In the 2007 consultation we provisionally concluded that, while phased full release may have some advantages compared to early or late full release, it was still very unlikely to be proportionate, particularly when compared to phased partial release options. This was because it would create uncertainty for all market participants which could reduce incentives to invest, and because it could incur greater costs for benefits which are uncertain. In addition the later phases of phased release might constitute an unacceptably late implementation of the RSC Decision.

7.42 Therefore, in summary our view at that time of the 2007 consultation, was that:

- full release was not required to address the competition and efficiency concerns identified with liberalisation in the hands of the incumbents for 900 MHz - other less intrusive options appeared to be sufficient to address those concerns;
- the additional benefits of full release were small; and
- the additional costs high.

7.43 Hence, we provisionally concluded that there was not a convincing case for full release of 900 MHz.

7.44 While certain aspects of our analysis of the costs and benefits of spectrum release have been refined since our September 2007 consultation, our provisional conclusions on each of the three variants that we considered in that consultation remain valid.

7.45 In the case of **early full release**, we continue to believe that the additional costs that would be incurred by the existing licensees in advance of the auction, in having to prepare to release an uncertain amount of spectrum shortly after the auction, would be very material (even if they would not be the full costs of releasing all of the spectrum).[152]

7.46 At the same time we consider it highly unlikely that this option would lead to significant additional benefits over and above those that would be realised through a partial release of a suitable amount of spectrum. This is for two reasons:

- Firstly, we consider it unlikely to be efficient for any full release option to result in more than 3 blocks of 900 MHz being released. Our evidence and reasoning is set out in Section 5 (see paragraphs 5.78 and 5.106).

- Secondly, partial release options can achieve any remaining benefits of full release. The key to this is allowing the auction to determine how many blocks are released. For example, we could set up a partial release auction in which the maximum number of blocks to be released was 3, but which allowed the auction to decide if it would be more efficient for only 1 or 2 blocks to be released. This could either be achieved by setting a reserve price for the released blocks that reflects our estimate of the cost of release or by setting a minimum number of blocks which must be released, and allowing the incumbents the opportunity to bid to re-acquire any blocks in excess of this amount. Therefore, full spectrum release is not necessary to allow an auction to determine the efficient number of blocks to be released. Appropriate auction design could allow this to be achieved under partial release options.

7.47 We note that the two points set out above apply to all variants of full release. They are not specific to early full release alone.

7.48 So far as a **late full release** option is concerned, there are three reasons why we still believe this is not a proportionate option. These are set out below.

7.49 Firstly, for the reasons set out above under early full release, we think it is unlikely that this option would lead to significant additional benefits over and above those that would be realised through an appropriate partial release option.

7.50 Secondly, given the delay to release under this option we consider that the net benefits of this option are very likely to be lower than under a comparable partial release option. This is because, while the costs of release fall if release is delayed (our analysis of the impact of delay on the costs of release is set out Annex 18),

[152] Our revised estimate of costs of full release have been set out in Annex 16 (see Table 6). These show the full cost of release for the 900 MHz could amount to £1.9bn to £3.1bn. While the full costs of release would not be incurred under early full release unless the incumbent operators do not re-acquire any of their spectrum, we expect that a significant proportion of these costs would need to be incurred before the auction in order to allow the spectrum to be released by the likely release date (e.g. 2011).

these reductions are more than offset by the significant reductions in the efficiency or competition benefits of release under this policy option. For example, for 1 block release of 900 MHz, a one year delay would be expected to:

- reduce the costs of release by around £20m (see Annex 18, table 5); but
- reduce the benefits of release by hundreds of millions of pounds. If the benefits of 1 block release are efficiency benefits we expect that this would be reduced by at least £225m to £300m (see Annex 18, tables 2 and 3). If the benefits of 1 block release relate to competition benefits these could be reduced by £150m to £350m (if 1 block release allowed a third operator to gain access to low frequency spectrum, if release allowed even more operators to gain access the lost competition benefits would be greater) (see Annex 18, table 4).

7.51 Hence, we consider that late full release is not a proportionate option. It is inferior to other options, such as partial spectrum release, for addressing any concerns we have about the liberalisation of the 900 MHz spectrum.

7.52 In relation to the **phased full release** option proposed in our previous consultation, we continue to believe that the additional uncertainty that would arise under this option could have a significantly adverse impact on the incentives to invest. The uncertainty would arise because information about the ultimate distribution of spectrum would not be known until all phases of the award process were completed (which might not be for a number of years).

7.53 We consider that the uncertainty created under the phased full release option would be particularly great. This is because, relative to partial release, it would leave unresolved the future of all of the 900 MHz spectrum until after the final auction in the sequence of auctions. Hence, uncertainty remains for a significant period under this option. This could be particularly damaging to the incentives to invest in new technology in the 900 MHz band. If the existing users of this spectrum have significant uncertainty over the amount of this spectrum that they will be able to use in future, they are likely to be unwilling to invest in new technology in these bands until that uncertainty is removed. Thus it is possible that phased full release could significantly reduce the benefits of liberalisation arising from new use by existing users. The impact of delaying the benefits of liberalisation have been set out in Section 5. In paragraph 5.45 we explain that a 3 month delay to the benefits of liberalisation could lead to £45m of lost benefits.

7.54 In addition, for the reasons set out in paragraph 7.46 above, we think it is unlikely that this option (or any variants of the full release option) would lead to significant additional benefits over and above those that would be realised through an appropriate partial release option.

7.55 Hence, phased full release could impose additional costs of spectrum release for uncertain and likely limited benefits.

Refined analysis of 1800 MHz

7.56 As set out in Section 6 (see paragraph 6.56) we identified that our revised analysis confirms the view we held at the time of the 2007 consultation. Namely, that the 1800 MHz spectrum should be liberalised in the hands of the incumbent holders. This is because we consider that this option is not likely to result in a distortion to competition, is likely to bring about the full benefits of liberalisation for consumers, and no other option appears to be superior.

7.57 Given our assessment that liberalisation in the hands of the incumbent licence holders would not be expected to result in a competitive distortion, or in a loss of the benefits of liberalisation from 1800 MHz, full release for 1800 MHz would be unlikely to result in material benefits but there are likely to be costs involved.

Analysis of the H3G proposal

7.58 The further variant that H3G proposed is essentially a variant of the release options put forward in our September 2007 consultation. Under H3G's proposal:

- As with our early full release variant, the auction would happen as soon as possible, for example in 2010.
- However, as with our late full release option, we would set a deadline for release which was two or three years after the auction had been held (and hence release would be later than in our early full release variant). For example, assuming the earliest we could hold an auction is in 2010, release would be in 2012 or 2013 (as opposed to 2011 in the case of early full release).
- All of the 900 MHz spectrum would be awarded at the same time (i.e. there would be no phasing of the awards).

7.59 Our analysis below assesses the H3G proposal in relation to 900 MHz. However, the points made here would also apply if this proposal was applied to 1800 MHz.

7.60 We have assessed the H3G variant and consider that it would also not be a proportionate option because other policy options are likely to be superior (i.e. their benefits are expected to be significantly higher for relatively little additional cost). The reasons for this are summarised below, and then each of the points is set out in more detail.

7.61 The benefits of this variant are expected to be significantly lower than other policy options because:

- the delay to release significantly reduces the benefits (relative to options without delay such as early full release or partial spectrum release), and
- any additional benefits of full release under this or any variant (e.g. allowing the market to determine the efficient number of blocks to be released) are either expected to be low or could be realised via other policy options.

7.62 The costs of this variant are not significantly lower than those of other options because:

- delaying release reduces the costs significantly less than it reduces the benefits; and
- full release options involve additional risks (relative to partial release options) which could increase the costs.

Delay significantly reduces the benefits of release

7.63 Our analysis of the impact of a delay to release on the benefits is set out in Annex 18 and paragraph 7.50 above. In summary, taking 1 block release of 900 MHz as an

example, a one year delay would be expected to reduce the benefits of release by hundreds of millions or pounds.

The additional benefits of full release are limited or replicable

7.64 As indicated in paragraph 7.46 above, a potential benefit of full release (over partial release options) under the H3G variant and any other variant is that it would use an auction to determine the number of blocks to be released. This might lead to a more efficient outcome than a process in which we have to determine the number of blocks to be released.

7.65 However, there are reasons why these potential benefits may not be realised in practice or can be achieved via other policy options.

7.66 One reason why these benefits may be limited is because auctions may not be able to reach efficient outcomes when some participants could derive a competitive advantage as a result of the auction. This is a risk with any auction of released 900 MHz spectrum if we allow the current licensees to bid. This is because the existing licensees will have the same incentive to re-acquire spectrum in the auction, in order to maintain their competitive advantage, as they do not to allow wider access in the first place.

7.67 As a result of this potential competitive advantage, we would expect to need to place limits on the ability of the current licensees to bid in any auction for released 900 MHz spectrum. There are potentially two ways in which we could achieve this.

- Firstly, we could exclude the current licensees from bidding. However, for the reasons set out below, this would reduce the ability of the auction to efficiently determine the efficient number of blocks to be released.

- Secondly, we could limit the number of blocks the current licenses could re-acquire. However, as set out below, this does not fully address the strategic issues set out above.

7.68 If we were to exclude the current licensees from bidding at all, then in order to achieve an efficient outcome we would need to set a reserve price which accurately reflects the incremental value of the released spectrum to the current licensees. There is a risk that we are unable to estimate this with sufficient accuracy[153], and as a result the auction would not be efficient at determining the number of blocks to be released.

[153] Our estimate of the incremental value would need to include both the incremental costs the current licensees would save if they were not to release the spectrum and any incremental (efficient) option value they would retain from holding the spectrum. By “efficient” option value we mean, any option value which is not related to the maintenance of a competitive advantage. The reason why an option value would be included in the value of the spectrum to the current licensees is set out in Annex 8, in particular paragraphs A8.18 to A8.20. This option value would be expected to feature equally in the willingness to pay for spectrum of prospective licence holders, and the valuation of retaining the spectrum to the current licensees. This figure does not need to be included in our estimate of the costs of release for our options assessment in Section 5, as in the options where this is lost to the current licensees it would be gained by the new licence holders (i.e. it would net off for the purpose of that analysis). But it may need to be factored into a reserve price, if the auction was to be used to determine the efficient number of blocks to be released.

7.69 An alternative, would be for us to allow the current licensees to bid to re-acquire some but not all of the released spectrum. For example, we could impose a limit that at least one block of spectrum would need to be released (in other words the current licensees could re-acquire all but 1 block of the 900 MHz spectrum). However, this solution does not fully address the underlying strategic issues which are set out above, and if these are significant we would expect the auction to result in only the minimum number of blocks being released irrespective of whether this is the efficient outcome.

7.70 The discussion above has highlighted why it may not be possible for an auction to efficiently determine the number of 900 MHz blocks to be released. However, irrespective of whether an auction was efficiently able to do this, for the reasons set out in paragraph 7.46 above, full release (either via H3G's variant or any other variant) is not necessary to allow an auction to determine the number of blocks to be released. This is because:

- We consider it very unlikely that it would be efficient for more than 3 blocks of 900 MHz to be released (because the costs of releasing more blocks are greater than the benefits). The detail of this analysis is set out in paragraphs 5.78 and 5.106 of Section 5.

- Partial release options can be designed to allow the auction to determine whether it would be efficient for fewer than 3 blocks to be released (albeit subject to the same caveats as discussed above).

The impact of delay on the costs of release is less significant than on the benefits

7.71 Our analysis of the impact of a delay to release on the costs is set out in Annex 18 and paragraph 7.48 above. In summary, taking 1 block release of 900 MHz as an example, a one year delay to the release of this block would be expected to reduce the costs of release by around £20m. However, this is small relative to the loss in benefits from delay (as set out in paragraph 7.63 above), which are likely to be in the hundreds of millions of pounds.

7.72 Hence, the reduction in costs are not sufficient on their own to justify the delay that would arise as a result of adopting H3G's further variant of full spectrum release.

There are additional risks involved in full release

7.73 In addition, there are risks with full release, set out below, which are not present to the same extent with partial release. These mean that partial release potentially involves lower cost (and/or higher benefit).

- The full release option would require a more complex auction design since it would be for all of the 900 MHz spectrum, and not simply for that part of the spectrum being released by the existing holders. The design of this auction is likely to be contentious, since it would determine the entire allocation of 900 MHz spectrum. Given these challenges, there is a risk that the design and implementation of this award will take longer than that for a partial release, with consequent further delay to the release of spectrum. And as noted above, the costs of delay to the release of spectrum, in the form of benefits foregone, can be significant.

- The full release option would also create additional uncertainty, relative to partial release, as it would leave unresolved the future of all of the 900 MHz spectrum

until after the auction. This uncertainty could be damaging to the incentive to invest in new technology in the 900 MHz bands. Thus it is possible that full release could reduce the benefits of liberalisation arising from new use by existing users.

Assessment of H3G's further option

7.74 We therefore consider that H3G's further variant of full release would be unlikely to have advantages over and above those of partial release, and could have higher costs and/or lower benefits - in particular significantly lower benefits as a result of delayed release.

Our conclusions

7.75 We consider that when implementing the proposed amended GSM Directive, it is likely to be necessary to address a possible distortion of competition in respect of the 900 MHz spectrum.

7.76 While full mandatory release would be capable of addressing that issue, for the reasons set out above, our analysis shows that less intrusive options, such as partial release of the 900 MHz band, would be capable of:

- addressing the potential distortion of competition which might arise if the 900 MHz spectrum was liberalised in the hands of the incumbent 900 MHz licensees, and

- achieving the same or greater benefits than full release, at the same or lower cost, and with less risk.

7.77 As a result, we do not consider that full mandatory release of the 900 MHz spectrum would be a proportionate way to address the potential distortion of competition.

7.78 In the case of the 1800 MHz spectrum we have provisionally concluded that liberalising the 1800 MHz spectrum in the hands of the incumbent 1800 MHz licensees is unlikely to distort competition, and consequently that liberalisation in the hands of the incumbents is likely to be the most appropriate liberalisation option. Even if we were ultimately to conclude that liberalisation of the 1800 MHz spectrum in the hands of the incumbents could give rise to a distortion of competition, we do not consider that it could be justified or proportionate to adopt a full release option for the 1800 MHz spectrum. Partial release options could achieve the same or greater benefits, at the same or lower cost, and with less risk.

7.79 In light of our analysis set out above, we are currently minded, subject to any new evidence or arguments that we receive in response to this consultation, to reject the full release option for liberalising both the 900 MHz and 1800 MHz spectrum.

Section 8

Implementation of proposals for 900 MHz and 1800 MHz spectrum

Introduction

8.1 This section considers certain aspects of the implementation of our preferred options for liberalisation of the 900 MHz and 1800 MHz spectrum. For the purposes of seeking stakeholders' comments on the implementation issues arising, this section assumes that our preferred options (as set out in Sections 5 and 6) are adopted. However, this does not mean that Ofcom has closed its mind to other options for liberalisation of the 900 MHz and 1800 MHz spectrum, which are the subject of this consultation. We are raising these implementation issues to ensure that stakeholders have sufficient information to be able to respond fully to our proposals.

8.2 This section is structured as follows:

- Implementation issues common to our proposals for both 900 MHz and 1800 MHz spectrum.
- Implementation issues specific to implementation of mandatory partial spectrum release (Option C) for the 900 MHz spectrum.
- Summary of implementation proposals.

8.3 A number of the implementation issues discussed in this section (for example auction design) will be the subject of more detailed further consultation once we have decided upon an overall approach to liberalisation.

Implementation issues common to both 900 MHz and 1800 MHz licences

8.4 The following implementation issues, common to both the 900 MHz and 1800 MHz spectrum, are considered below:

- Technology neutral licensing.
- Introduction of spectrum trading.
- Terms of licences for spectrum retained by incumbents.
- Review of administered incentive pricing (AIP) for liberalised licences.

Technology neutral licensing

8.5 In our September 2007 consultation we outlined our preference for the liberalised 900 MHz and 1800 MHz licences to be technology-neutral, subject to a restriction that the technologies used by licence holders be FDD and follow the same duplex arrangements as current GSM use. In general, Ofcom believes that technology-neutral licensing is likely to bring greater benefits to consumers and citizens than a technology-specific approach.

8.6 We noted that the draft RSC Decision required that any systems, other than GSM and UMTS, may only be authorised to use the spectrum if they can co-exist with GSM and UMTS systems, both in the UK and in neighbouring EU Member States. We noted that the technical work to consider the feasibility of systems other than GSM and UMTS had not yet been undertaken. However, we understand that the European Commission intends to present a draft mandate at the March 2009 RSC meeting, requesting CEPT to carry out further work on the feasibility of other systems, with the intention of adding these to the decision.

8.7 As set out in Section 2, the current status of the draft RSC Decision is unclear. On 19 November 2008, the European Commission instead published a proposal to amend the GSM Directive. The proposed amendments would (when in force) require Member States to make available the 900 MHz band "*for GSM systems and for UMTS systems as well as for other terrestrial systems capable of providing electronic communications services that can co-exist with GSM systems, in accordance with technical implementing measures adopted pursuant to Decision 676/2002/EC*".

8.8 The draft RSC Decision would be a decision adopted pursuant to Decision 676/2002/EC, and we currently consider it likely that the technical requirements set out in the draft RSC Decision will apply to the 900 MHz band, once the amended GSM Directive comes into force. If they do, it is likely to mean that only other mobile FDD technologies that respect the same uplink/downlink arrangements as current GSM could use the spectrum. This is because if other duplex arrangements were allowed this would be likely to cause interference such that the spectrum could not be effectively used by GSM and or UMTS FDD technologies.

8.9 The CEPT interim report 19[154] on minimal and least restrictive technical conditions for WAPECS provides information on the conditions for co-existence between GSM and UMTS in the 900 MHz and 1800 MHz bands.

8.10 Two approaches for introducing technology neutral licences at 900 MHz and 1800 MHz were also outlined in the previous consultation. These were:

- Approach A: technology neutral licences, including full specification of technical conditions, introduced at the outset;
- Approach B: licence would initially allow only GSM and UMTS, but would allow use of other technologies through licence variation on a case-by-case basis.

8.11 Our initial view was a preference for approach A. Although approach B would be simpler to implement, approach A is likely to give greater regulatory certainty to licence-holders and be less of a disincentive to develop innovative services.

Stakeholder responses

8.12 Consultation responses were mixed in their support for liberalised 900 MHz and 1800 MHz licences to be technology-neutral. Vodafone was supportive of technology-neutral licences. T- Mobile and Orange supported Option B, specifically to protect against any potential interference. Qualcomm supported opening the bands for IMT technologies but cautioned that sharing studies within the CEPT would be required for

[154] Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for frequency bands addressed in the context of WAPECS, date 21st December 2007.

new technologies, to ensure that a pan-European harmonised approach is taken and that interference is minimised.

8.13 A number of other respondents, including those requesting confidentiality, noted potential interference issues with technology-neutral licensing.

8.14 Network Rail raised a specific interference concern. Its response outlined concerns about technology roll-outs, other than GSM, in the 900 MHz band and the impact such roll-outs could have on GSM-R, used for rail emergency systems in the 876-880 MHz and 921-925 MHz bands. T-Mobile also raised this issue and asked Ofcom to clarify whether there would be additional constraints for each frequency band boundary.

Preference for technology neutral licensing

8.15 We note the issues raised by stakeholders. Our preference continues to be for technology neutral licensing for 900 MHz and 1800 MHz spectrum in the medium term. This will allow for the optimal use of spectrum as users will have the flexibility to provide services that consumers and citizens are demanding now and in the future.

8.16 We assure our stakeholders concerned about potential interference issues that we will undertake the sharing and compatibility studies necessary, both to ensure efficient use of spectrum and to accord with the guidance in CEPT report 19[155]. We will also continue to participate actively in sharing and compatibility activities within Europe to ensure a harmonised approach wherever possible.

8.17 In practical terms however, if at the time of liberalisation interference compatibility work for technologies other than GSM and UMTS has not been completed, we could issue licences containing technical conditions suitable for GSM and UMTS. Then, as required by each individual operator's network plans, or more generally, we could proceed to amend these licences with updated technical conditions to allow additional technologies, while also addressing potential interference concerns. We will ensure that there are appropriate technical conditions at the boundaries between these bands and other bands, to protect adjacent users.

Spectrum trading of licences for 900 MHz and 1800 MHz spectrum

8.18 In the September 2007 consultation, we outlined our view that 900 MHz and 1800 MHz spectrum should be made tradable at the time of liberalisation. Our view was that the introduction of trading has the potential to bring benefits to consumers and citizens.

8.19 We also suggested that a competition review would be necessary for any trading of 900 MHz spectrum.

8.20 On the whole, respondents were supportive of making 900 MHz and 1800 MHz licences tradable.

- Vodafone supported making licences tradable in 2008.

[155] Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for frequency bands addressed in the context of WAPECS, page 45.

- O2 supported making 900 MHz and 1800 MHz spectrum tradable as soon as possible as part of its "wait and see" response to 2G liberalisation.

- T-Mobile supported trading and supported the competition review on 900 MHz spectrum trades.

- Orange supported trading, but questioned the use of a specific competition review on trades of 900 MHz spectrum.

- H3G supported trading for these licences, provided access had been achieved on an equitable, fair and non-discriminatory basis.

8.21 Our preferred option remains that we should make the licences tradable at the same time as they are liberalised, which, subject to the outcome of this consultation, would be as soon as practicable. We believe that extending trading to these licences is likely to have few costs (other than the cost of any regulatory activity involved).

8.22 We also remain of the view that any trades of 900 MHz spectrum should be subject to a competition review. We consider that the benefit of a competition review is to support our policy preference for a wider distribution of 900 MHz spectrum. Without a competition review there is a risk that our policy preference would prove ineffectual if the incumbent operators, through trading, were to regain any 900 MHz spectrum they had released.

8.23 We recognise that a having a competition review may have administrative and regulatory costs associated with it, in particular delaying the trading process. However, we believe these costs are likely to be low. The need for a competition review of 900 MHz spectrum trades may lessen, when alternative spectrum, such as 800 MHz digital dividend spectrum, becomes available.

8.24 We will make more detailed proposals on the introduction of spectrum trading for 900 MHz and 1800 MHz licences in due course.

8.25 In light of any industry agreed traded solution for 2G spectrum made in response to the Government's Digital Britain Interim Report, we will make the licences tradable in a timeframe appropriate to facilitate the traded solution.

Proposal to clarify the notice period in 900 MHz and 1800 MHz licences

8.26 In the September 2007 consultation, we set out our provisional view that it would be appropriate to clarify the notice period for licences for the 900 MHz and 1800 MHz spectrum in a similar way as for other licences which have been liberalised and made tradable. This would involve changing the conditions in current 2G licences, which on their face permit variation or revocation of the licences at one year's notice, to make it clear that we will in future give at least five years' notice of revocation for spectrum management reasons.

8.27 Both Vodafone and T-Mobile were supportive of this licence change. Other stakeholders did not respond specifically to this issue.

8.28 We continue to support varying the current 2G licences, to clarify that we will in future give at least five years' notice of revocation on spectrum management grounds. This would provide licensees with greater clarity as to the amount of notice that they can expect to be given in these circumstances, and thereby allow better investment decisions to be made.

Review of AIP for liberalised licences

8.29 While AIP is not integral to how we may liberalise the 900 MHz and 1800 MHz spectrum, we think it helpful to highlight that we intend to review the level of AIP applicable to licences for the 900 MHz and 1800 MHz spectrum.

8.30 The current levels of AIP applicable to licences for the use of spectrum in the 900 MHz and 1800 MHz bands were set in 2004, by reference to estimates of the opportunity costs of this spectrum when used to provide 2G services. As with other spectrum prices, the levels of AIP for 900 MHz and 1800 MHz spectrum were also set conservatively, so as to avoid undermining efficient spectrum use.

8.31 Developments since 2004 mean that the opportunity costs of this spectrum are likely to have changed, and overall seem likely to have risen: demand for mobile services has grown considerably since 2004; technology has developed to the point at which 3G technology is now being deployed in these bands in some markets; and standards are already being developed for a further generation of mobile technology to make use of these bands (e.g. LTE). These bands, along with the 2.1 GHz and 2.6 GHz bands, continue to be at the heart of the provision of mobile services in Europe.

8.32 At the same time, our analysis of the impact of the use of different frequencies on the costs of providing 3G services suggests that we may need to revisit the differential in AIP between spectrum in the 900 MHz and 1800 MHz bands.

8.33 Therefore, while not directly related to our choice of method to liberalise licences for the use of these frequency bands, we believe that it would be appropriate to review the level of AIP payable on these licences, in the light of these developments, at or around the same time as liberalisation.

8.34 When we do so, we will use the best information available to us at the time as to the opportunity cost of the spectrum. We expect this to include the results of economic modelling, analysis of the costs of alternative means of delivering mobile and other services, and the results of spectrum auctions completed up to that time.

8.35 This should include the results of the 2.6 GHz auction that we expect to hold within the next few months, and could also include the results of any auction for released 900 MHz spectrum, and for the cleared digital dividend spectrum, if completed by then. These auctions should provide a good indication of the market value of the spectrum being awarded at that time, but it must be recognised that the spectrum being awarded may have both advantages and disadvantages relative to 900 MHz and 1800 MHz spectrum, and that the specific circumstances of the auctions may mean that auction prices are not a true reflection of long-run opportunity costs. For these reasons we expect to use the results of such auctions as one input to our decisions about the future level of AIP, but not to be entirely determinative.

8.36 It is also important to note that, as discussed in Section 5, we consider that correctly applying AIP could substantially reduce asymmetric profit shocks (although that would not of itself be our objective in revising AIP). The relevance of profit shocks is discussed in Annex 8[156].

8.37 We will publish further details of our intended approach to the review of AIP for these bands in due course.

[156] See in particular paragraphs A8.107 to A8.114.

Implementation of 900 MHz partial spectrum release

8.38 The implementation aspects of partial spectrum release (Option C) for 900 MHz, considered below, are:

- the timing of release;
- the timing of liberalisation;
- the mechanism for award of released 900 MHz spectrum; and
- the terms of released 900 MHz spectrum.

Timing of release

8.39 In the 2007 consultation we set out our preference for spectrum release to occur in 2010, assuming that we would give two years' notice in 2008. In responses to the consultation:

- Vodafone and O2 argued that it would not be possible to clear spectrum in the timescales proposed by Ofcom.
- T-Mobile claimed (based on its own experience) that release could be achieved in one year.
- Orange cast doubt on the practicality of release within two years and used this to support an argument for a geographically phased transition (with rural areas being released first).

8.40 We have reviewed these arguments carefully and we discuss the technical issues related to release in Annex 16. In summary, our view is that the necessary network upgrades for O2 and Vodafone to clear at least three blocks of 900 MHz spectrum in total (i.e. 2 x 7.5 MHz each for O2 and Vodafone) could be reasonably achieved within a two-year period. This would enable them each to re-farm one block (2x5 MHz) for their own use, and to clear one block to be released (with half coming from each).

8.41 A geographically phased release could bring significant extra complications and costs – e.g. buffer zones to avoid interference in boundary areas, and hence our current preference is not to mandate a phased release.

8.42 In conclusion, our proposals are that the incumbent holders of 900 MHz spectrum should be given two years' notice to clear the spectrum; for example, release in 2011 following a decision in 2009.

Timing of liberalisation

8.43 In our earlier consultation we proposed that the 900 MHz spectrum retained by the current licence holders should not be liberalised until any spectrum that they have been required to release is available for use by the acquiring operator(s). This was intended to ensure that the incumbent holders of 900 MHz spectrum did not gain a competitive advantage, relative to the acquirer(s), through being able to deploy new technology in the 900 MHz band earlier.

8.44 We recognise, however, that this proposal could delay by up to six months the availability to consumers of higher-quality mobile broadband services from the incumbent 900 MHz operators, and the consequent benefits of such availability. Such a delay might arise if an incumbent operator cleared the 900 MHz spectrum for its own use within 18 months of our decision to liberalise, while our timetable for release and re-award meant that it would not be available to a new owner until 24 months after the decision (for further details on timing see Annex 12).

8.45 The cost to consumers of such a delay could be significant, particularly given the current rapid growth in demand for mobile broadband services. But if we were to liberalise the 900 MHz spectrum retained by the incumbent licensees as soon as possible, competition might be less intense than would be ideal during any period in which the incumbents were able to exploit the 900 MHz spectrum for new technology before any acquirer were able to do likewise. If the effect on competition of such earlier access were to be enduring, then we might consider the cost of delay, in the form of lost benefits to consumers, to be worthwhile, in order to ensure that the longer-term benefits of competition were maximised. In the current situation, however, we consider it unlikely that a short delay in the availability of the released spectrum, relative to the liberalisation of the retained spectrum, would have a significant and enduring impact on competition; the period of time during which the existing licensees would, in practice, be able to offer enhanced services in advance of any acquirer is, we believe, too short to be significant.

8.46 Furthermore, it now seems likely that we will be required by European law to "make available" the whole of the 900 MHz band for UMTS as well as GSM systems by no later than six months after the coming into force of the amended GSM Directive. It is our current understanding that to meet this requirement, we will have to liberalise all of the existing 900 MHz licences by the deadline, allowing the deployment of UMTS as well as GSM technology, irrespective of the situation at the time, or other steps that we might take in regard to this spectrum, for example to promote competition or to secure efficient use of the spectrum.

8.47 We therefore now think that we will be required to liberalise the 900 MHz spectrum as soon as practicable. Delay to liberalisation is fairly unlikely, notwithstanding that this may allow the incumbent licensees to deploy new technology in the band for a short period in advance of any acquirer.

Mechanism for awarding released spectrum

8.48 Ofcom's initial view in the September 2007 consultation was that an auction was likely to be the best way of awarding the released spectrum in line with our statutory duties, but noted that a "beauty contest" or comparative selection process might also be possible. We also considered that it would be appropriate for the incumbent holders of the spectrum being released to be excluded from the award of released spectrum. This would ensure that the spectrum release was most likely to achieve our objective of securing wider access to the 900 MHz spectrum, which would be frustrated if the incumbents were able simply to re-acquire the released spectrum.

8.49 Stakeholders' responses on this issue were mixed.

- T- Mobile supported an auction or a beauty contest, with a condition that the incumbents, 02 and Vodafone, would not be allowed to acquire the released spectrum.

- Vodafone expressed the view that it would be less efficient if incumbents were excluded from any 900 MHz auction than if they were allowed to bid.

- O2 did not support the exclusion of itself and Vodafone from bidding in the auction. It believes that it is disproportionate and discriminatory to exclude the incumbents from bidding.

- H3G maintained that the 900 MHz and 1800 MHz spectrum should be administratively allocated, or alternatively that an auction should be held for the entirety of the 900 MHz and 1800 MHz bands in which all bidders would have equal bidding rights.

- Orange did not support an open auction process for any released blocks of 900 MHz spectrum. It believed that re-allocation should take place among the five existing mobile operators.

8.50 Having given careful consideration to these responses, we continue to believe that the most appropriate regulatory method for awarding any released 900 MHz spectrum is by means of an auction, open to all except O2 and Vodafone. In particular:

8.50.1 We continue to believe that we would be justified in excluding the holders of the retained 900 MHz spectrum, O2 and Vodafone, from the award of the released spectrum, since otherwise it would be possible for them to re-acquire the released spectrum and thereby frustrate our efforts to promote competition and the efficient use of this spectrum. While we acknowledge that there are circumstances in which the re-acquisition of this spectrum by O2 or Vodafone would be efficient, our analysis of the options for liberalisation has highlighted circumstances in which such re-acquisition would not be in the best interests of consumers, even if O2 or Vodafone had the greatest willingness to pay for the spectrum. We consequently continue to believe that exclusion of these players from the award of any released spectrum would be proportionate, and not discriminatory.

8.50.2 We remain of the view that administrative re-assignment of any released spectrum would not be compatible with the requirements of European law, in particular the Authorisation Directive, which requires us to hold an open and transparent process for the award of new rights of use, such as those for the released spectrum.

8.50.3 Similarly, we do not believe that it would be appropriate, or compatible with the Authorisation Directive, for us to restrict the parties that are able to apply to acquire the released spectrum to just the existing mobile network operators; the Authorisation Directive requires any award of new rights of use to be “open”.

8.50.4 We have also given further thought to the question of whether a process of comparative selection might have advantages over an auction in helping us to achieve our statutory duties, particularly in the context of the release of a single block of 900 MHz spectrum. We have concluded, subject to the outcome of this consultation, that on balance it would not and that an auction is still to be preferred.

8.51 In the following paragraphs we set out analysis in support of each of these views.

Justification for exclusion of O2 and Vodafone

8.52 Our assessment of the option of partial mandatory spectrum release (in Section 5), and our resulting preference for one block mandatory release, is made on the basis that the incumbent holders of 900 MHz spectrum are excluded from the award of the released 900 MHz spectrum. This is because in order for such a policy to be effective, and for the benefits identified with such a policy to be realised, it is necessary to ensure that the incumbent holders of 900 MHz spectrum, O2 and Vodafone, do not re-acquire that spectrum. To achieve this we consider it necessary to exclude O2 and Vodafone from the award of that spectrum.

8.53 We believe this proposal to be proportionate since we can see no better way of ensuring that the released 900 MHz spectrum is not re-acquired by either O2 or Vodafone. This proposal is not discriminatory since O2 and Vodafone are clearly in a different position to the other parties as regards their holdings of 900 MHz spectrum.

Choice of award mechanism

8.54 We have considered whether our statutory objectives might be better fulfilled by using an alternative to an auction for the award of released 900 MHz spectrum. In particular, we have considered whether an alternative competitive award mechanism may be better suited to achieve our duty to promote competition and hence bring benefits for consumers through lower prices, improved quality and choice.

8.55 One such alternative award mechanism would be a comparative selection process (a "beauty contest"). It would be possible, for example, to invite applications for the released 900 MHz spectrum, with applicants required to set out how they would use the spectrum, the benefits to consumers that would flow as a result, and the commitments that the applicant is willing to make to the delivery of those benefits. We would then assess each of these applications against pre-specified criteria, targeted at the fulfilment of our statutory duties: for example, the promotion of competition and efficient use of spectrum. Whichever application we judged to be the best by reference to these criteria would be the winner, and would be assigned the released 900 MHz spectrum. In order to keep applicants honest, and ensure that the benefits claimed by the winning applicant in their application are at least partially realised, it would likely be necessary to include conditions in the awarded licence that required the licensee to deliver the commitments that they had offered in their application. There would also ideally be some proportionate penalty specified for failure to meet those commitments.

8.56 Such an approach would seem to offer the opportunity for us to further promote competition and the efficient use of spectrum, through the commitments that applicants would offer, and the winning applicant would commit to, through this process. There are, however, a number of problems with this approach:

8.56.1 It would require us to make judgements about the relative merits of different outcomes in a way that is unlikely to be entirely transparent, and has a material risk of regulatory failure (mis-judgement);

8.56.2 If the process is to be credible, we would need to impose enduring obligations on the winning applicant, which would require us to monitor compliance, and which may turn out to be inappropriate in the medium to long term, potentially leading to sub-optimal use and so requiring further regulatory action by us to change.

8.57 The additional benefits of such an approach are also, in our judgement, likely to be relatively small. Our analysis indicates that the greatest part of the benefits of re-allocation of the 900 MHz band will flow from the re-award of the first block of 2x5MHz of spectrum. While any additional access to 900 MHz spectrum or network capacity is likely to bring benefits, those benefits are unlikely to be as great as those flowing from access by the first additional operator. Furthermore, as noted in our cost-benefit analysis in Annex 7, we think it plausible that a single released block of 900 MHz spectrum, awarded by auction, would in practice be acquired by a pair of operators intending to build a shared network.

8.58 Weighing these different costs and benefits in the balance, our assessment remains that the benefits of using a comparative selection process to award released 900 MHz spectrum are unlikely to outweigh the costs, and consequently that an auction is still to be preferred.

8.59 There are of course a number of other aspects of auction design, that do not affect our assessment of the overall approach to liberalisation of 900 MHz spectrum, but that we will need to consider in a further consultation, once our overall approach has been decided upon. For example, one respondent to our initial consultation asked how any bidder asymmetries would be dealt with. We will consider this and other issues when we consult on the detailed auction design.

Terms of released 900 MHz spectrum

8.60 In our September 2007 consultation we proposed that the released spectrum would have terms similar to those already established for other newly awarded spectrum. That is to say, they would have an indefinite term with a minimum term of 15 years, subject to five years' notice of revocation for spectrum management reasons.

8.61 We now propose that the terms of the licence for the released 900 MHz spectrum be the same as those that apply to the licences for the retained 900 MHz spectrum, except in so far as they relate to the spectrum fees that will apply. In the case of the released spectrum, these will be set through the proposed auction, whereas in the case of the retained spectrum, they will continue to be set administratively (although the outcome of the proposed auction of the 900 MHz released spectrum will inform the decision about the future level of such spectrum fees).

8.62 Our principal objective in proposing the mandatory release of some 900 MHz spectrum for re-assignment is to allow another party the opportunity to access 900 MHz spectrum on a comparable basis to the existing licensees, so that that other party (and potentially others if access is shared) can compete with those existing licensees in the provision of services using this spectrum, and similarly exploit any efficiency benefits that derive from its use. To achieve these ends, it seems sufficient that the acquirer of the released spectrum have access to it on comparable terms to those of the existing licensees; it does not seem necessary that they be given any enhanced rights. This approach also has the significant added benefit that in future, as today, all of the licences for 900 MHz spectrum will be on essentially the same terms, which reduces the risk of issues arising in future as a result of differences in terms.

8.63 We recognise that this approach differs from that which we have adopted in respect of other auctioned licences, but the circumstances also differ. When auctioning licences for the use of unused or underused spectrum bands our approach has been to give the acquirers of those licences enhanced certainty about the minimum period of time that they will be allowed to exploit that spectrum, by constraining the

circumstances in which we may revoke the licence during an initial period of generally 15 or 20 years, so as to preclude us from revoking the licence for spectrum management reasons during this period. We have done this principally to remove one element of regulatory uncertainty from these licences, with the intention of promoting investment in the use of the spectrum.

8.64 But in the case of the released 900 MHz spectrum, we judge the incentives to invest in the use of this spectrum to be sufficiently strong for it to be unnecessary for us to give additional certainty to the acquirer about the minimum period of time during which they will be able to exploit the spectrum. It continues to be the case that we could not revoke the licence without objective justification, and without the action being proportionate, transparent and non-discriminatory. We also propose that we would have to give a minimum of five years' notice of revocation for such reasons (which would in practice have the effect of meaning that the acquirer of the licence should have access to the spectrum for at the least five years, but in all likelihood significantly longer).

8.65 At the same time, as mentioned above, we judge the symmetry of having all licences for the use of 900 MHz spectrum on essentially the same terms to be of value, for reasons of both competitive neutrality and administrative convenience.

8.66 Our proposal, therefore, is that the licence(s) for the released 900 MHz spectrum should be indefinite in duration, but revocable for spectrum management reasons on a minimum of five years' notice. In theory, it would be possible for such notice to be given the day after the licence is issued, although in practice we would expect not to give such notice for quite some time, if ever.

Summary of proposals for implementation

8.67 In relation to the implementation of Option C for the 900 MHz spectrum, our proposals are:

- The licences for 900 MHz spectrum to be liberalised at soon as practicable.
- The 900 MHz licences to be made tradable at the point of liberalisation, with trades to be subject to a competition review before they are approved.
- The notice period in the licences for the retained 900 MHz spectrum to be varied in a similar way to other licences which have been liberalised and made tradable. Accordingly, the licences would remain indefinite but would be subject to five years' notice of revocation for spectrum management reasons.
- AIP would continue to be payable on the retained 900 MHz spectrum. The level of AIP payable would be revised at the same time as, or as close as possible to, liberalisation.
- The incumbent holders of 900 MHz spectrum to be given two years' notice to clear one block of 900 MHz spectrum in total (i.e. 2x2.5 MHz each) and make it available for use by third parties (for example, release in 2011 following a decision in 2009).
- The released 900 MHz spectrum to be awarded via an auction.
- The licence for the released 900 MHz spectrum to be indefinite in duration, but revocable for spectrum management reasons on a minimum of five years' notice.

8.68 In relation to the implementation of Option A for the 1800 MHz spectrum, subject to the responses to this consultation, our proposals for implementation are:

- The licences for 1800 MHz spectrum to be liberalised at soon as practicable.
- To make the 1800 MHz licences tradable at the point of liberalisation.
- To vary the notice period of the licences for the 1800 MHz spectrum in a similar way to other licences which have been liberalised and made tradable. Accordingly, the licences would remain indefinite, but subject to five years' notice of revocation for spectrum management reasons.
- AIP would continue to be payable on 1800 MHz spectrum, with the level of AIP payable revised at the same time as, or as close as possible to, liberalisation.

Section 9

Changes to 2100 MHz licences

Introduction

9.1 In this section we consider issues relating to the 2.1 GHz spectrum, currently used to provide 3G services in the UK. The section covers:

- background on the current 2.1 GHz licences;
- comments raised on the term of the 2.1 GHz licences; and
- our current intention to liberalise and make tradable the 2.1 GHz licences.

Background

9.2 The current 2.1 GHz licences were awarded by auction in 2000. The auction is often referred to as the '3G auction' as, at the time, the spectrum awarded was specifically intended to be used for providing 3G services.

9.3 On offer were three types of licences:

- Licence A - reserved for a new entrant, included 2x15 MHz of paired spectrum + 5 MHz of unpaired spectrum;
- Licence B - 2x15 MHz of paired spectrum;
- Licences C - E - each 2x10 MHz of paired spectrum and 5 MHz of unpaired spectrum.

9.4 The auction awarded all five licences. Four of the licences were won by the existing 2G incumbents and the fifth licence, reserved for a new entrant, went to TIW, which was subsequently acquired by Hutchison 3G.

9.5 The main terms of the licences are as follows.

- **Fixed Term.** The licences have a fixed term of 21 years and will expire in 2021. The grounds on which the licences may be varied or revoked by Ofcom within that period are limited. Variation of the licences is however permitted with the consent of the licensees.
- **Technology specific.** The licences are technology specific, permitting use of UMTS, 3G mobile phone standard, equipment only. At the same time, there is no European or other legal restriction in force which prevents the licences from being varied so as to remove the existing technology restrictions which apply to them.
- **Non Tradable.** The licences are currently non tradable. This reflected spectrum management policy at the time of the 3G auction. Whilst trading had been discussed through such documents as *Managing spectrum through the Market*[157], it had not been introduced to the UK before the auction took place.

[157] Radiocommunications Agency, *Managing spectrum through the Market*, 8 October 1998.

The information memorandum for the 3G auction did state that once spectrum trading was introduced in the UK it might be extended to include the 2.1 GHz licence[158]. Since the time of the 3G auction, spectrum management policy has changed and licences awarded at auction are typically made tradable at the same time as they are awarded. Trading was introduced for a selected number of licence classes in 2004, through the W*ireless Telegraphy (Spectrum Trading) Regulations 2004*. Amendments to those regulations have extended trading to a number of additional licence classes, including all of those licences that have been auctioned by Ofcom since 2004. Our proposals outlined in Section 8, are for the 2G licences to be made tradable as well.

- **Rollout obligation.** The 3G licences contain a rollout obligation requiring licence holders to provide UMTS 3G services to 80% of the population by the end of 2007 and maintain such coverage thereafter. As of May 2008 all licence holders had met this rollout obligation[159].

Term of the 2.1 GHz licences

9.6 One respondent to the September 2007 consultation, H3G, raised the issue of the future of the 2.1 GHz spectrum beyond 2021. Since this consultation, O2 has also raised this issue as part of their response to the Digital Dividend Cleared award consultation. Ofcom agrees that there are benefits in clarifying the future of this spectrum significantly in advance of the expiry of the current licences and will seek to do so well before 2021. We note that the Government's recent Digital Britain Interim Report suggested that, as part of a structured spectrum trading framework to resolve the future of the 2G spectrum, the existing time-limited licences could be made indefinite and subject to AIP beyond the end of the current term. We however are not making any proposals in this regard at this current time. We will keep the situation under review.

Application of spectrum trading and liberalisation to licences for 2.1 GHz spectrum

9.7 The September 2007 Consultation considered extending liberalisation and trading to the current 2.1 GHz licences.

9.8 At the time of the consultation we considered there to be no pressing need to liberalise the 2.1 GHz spectrum. In particular there is no European requirement to liberalise this spectrum. At the same time, in line with our general view on the benefits of spectrum liberalisation, we considered that it would be in the long-term interest of consumers for this spectrum ultimately to be liberalised.

9.9 So far as competition is concerned, we considered it unlikely that competition concerns would arise as a result of the liberalisation of the 2.1 GHz spectrum, given the relatively wide and even distribution of this spectrum amongst five players.

9.10 Stakeholders were generally supportive of liberalising the 2.1 GHz licences and making the licences tradable:

- Vodafone supported making the 2.1 GHz licences technology neutral and tradable in 2008.

[158] Radiocommunications Agency, Third Generation - The Next Generation of Mobile Communications, Information Memorandum, 1 November 1999, page 18.
[159] http://www.ofcom.org.uk/media/news/2008/05/nr_20080502a

- T- Mobile supported making the 2.1 GHz licences technology neutral and tradable as soon as practicable subject to Ofcom having sufficient resources for higher priority reforms.

- Orange supported making the 2.1 GHz licences technology neutral and tradable.

- O2 supported making 2.1 GHz licences tradable as part of their 'wait and see approach' to mobile spectrum.

- H3G supported making the 2.1 GHz licences technology neutral and tradable on the same timescale as the 900 MHz and 1800 MHz spectrum.

9.11 We believe that making the 2.1GHz licences technology neutral and tradable will benefit consumers and citizens in the long term because these changes will make it easier for the market to deliver optimal use of the spectrum. In particular these changes will, in the long term, facilitate both the deployment of new technologies and the efficient redistribution of this spectrum between parties. The costs for stakeholders or consumers as a result of making these changes are likely to be low.

9.12 In light of support from stakeholders for these proposed changes, and in line with our general duty to secure the optimal use of spectrum, we are currently minded, subject to any new evidence or arguments that we receive in response to this consultation, to decide to liberalise and make tradable the 2.1 GHz licences. Implementation of these decisions will require further consultation on the details of the licence changes to be made, and the regulations necessary to extend trading to the 2.1 GHz licences. We will consult on these changes once our decision is made, and as other priorities allow.

Section 10

Conclusions and Next Steps

Summary of proposals for consultation

10.1 Ofcom's main proposals in relation to 900 MHz spectrum are:

- To require the incumbent holders of 900 MHz spectrum (O2 and Vodafone) to release one block of spectrum to Ofcom, which we would re-award (Option C - partial mandatory spectrum release). We propose giving two years' notice of the requirement to release, e.g. release in 2011 following a decision in 2009.
- To re-award the released spectrum using an auction.
- For the 900 MHz spectrum retained by the incumbents to be liberalised and made tradable (subject to a competition review) as soon as practicable following our decision. The licences to be varied to clarify that they are indefinite but subject to five years' notice of revocation for spectrum management reasons.
- To revise the level of AIP payable on 900 MHz spectrum as close as possible to the time of liberalisation.

10.2 Ofcom's main proposals in relation to 1800 MHz spectrum are:

- To liberalise and introduce trading as soon as practicable following our decision. The licences to be varied to clarify that they are indefinite but subject to five years' notice of revocation for spectrum management reasons.
- To revise the level of AIP payable on 1800 MHz spectrum as close as possible to the time of liberalisation.

Summary of conclusions subject to consultation

10.3 Subject to any new evidence or arguments that we receive in response to this consultation, we are minded to:

- reject the option of mandatory full spectrum release (Option D) for 900 MHz spectrum.
- reject the option of mandatory full spectrum release (Option D) for 1800 MHz spectrum.
- implement liberalisation and trading for the 2100 MHz spectrum, subject to further consultation on the details of implementation.

Next steps

10.4 We would welcome stakeholders' comments on the proposals and conclusions contained in this document and the detailed analysis which supports them. We would also welcome any evidence that stakeholders are able to provide in support of their comments.

10.5 We currently intend to issue a statement setting out our decision on our policy in the summer of 2009, subject to the European legislative position being resolved in a manner which enables us to do so.

10.6 Also subject to developments at the European level, we aim to consult on the detail of specific implementation measures within similar timescales. This would include, where appropriate, consultations on:

- The appropriate licence variations for 900 MHz, 1800 MHz and 2100 MHz licences.
- Spectrum Trading regulations for 900 MHz, 1800 MHz and 2100 MHz licences.
- Details of an award for released 900 MHz spectrum (if any).
- Review of AIP for 900 MHz and 1800 MHz spectrum.

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 1 May 2009**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at http://www.ofcom.org.uk/consult/condocs/spectrumlib/howtorespond/form, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email justin.moore@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Justin Moore
Floor 3
Spectrum Policy Group
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Fax: 020 7981 3990

A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Justin Moore on 020 7783 4167 or Alberto Fernandes on 020 7783 4418.

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether

all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A1.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A1.11 Following the end of the consultation period, Ofcom intends to take forward the issues as set out in Section 10 of the consultation document.

A1.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Ofcom's consultation processes

A1.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.14 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk. We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Vicki Nash, Director Scotland, who is Ofcom's consultation champion:

Vicki Nash
Ofcom
Sutherland House
149 St. Vincent Street
Glasgow G2 5NW

Tel: 0141 229 7401
Fax: 0141 229 7433

Email vicki.nash@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing ☐

Whole response ☐

Part of the response ☐

Name/contact details/job title ☐

Organisation ☐

If there is no separate annex, which parts?

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name

Signed (if hard copy)

Annex 4

Consultation questions

Anyone with an interest in these matters is invited to comment on any aspect of our proposals, conclusions and supporting analysis. We would also welcome any evidence that interested parties are able to provide in support of their comments.

Annex 5

Impact Assessment

Introduction

A5.1 The analysis presented in this annex represents an impact assessment, as defined in section 7 of the Communications Act 2003 (the Act).

A5.2 You should send any comments on this impact assessment to us by the closing date for this consultation. We will consider all comments before deciding whether to implement our proposals.

A5.3 Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making. This is reflected in section 7 of the Act, which means that generally we have to carry out impact assessments where our proposals would be likely to have a significant effect on businesses or the general public, or when there is a major change in Ofcom's activities. However, as a matter of policy Ofcom is committed to carrying out and publishing impact assessments in relation to the great majority of our policy decisions. For further information about our approach to impact assessments, see the guidelines, Better policy-making: Ofcom's approach to impact assessment, which are on our website: http://www.ofcom.org.uk/consult/policy_making/guidelines.pdf

The Citizen and Consumer Interest

A5.4 UK consumers and citizens already enjoy significant benefits from mobile services. In the UK, the mobile sector is now larger by revenue than the fixed voice and fixed broadband sectors combined, with total retail revenues of £15.1bn in 2007, with mobile services available to, and used by, almost the entire population[160]. Our goal is to ensure that UK consumers and citizens continue to enjoy the greatest possible benefit from the use of these and other frequency bands, as demand, technology and the services offered, continue to develop and evolve.

A5.5 Implementing liberalisation of 2G licences will allow the deployment of 3G technology and potentially other future technologies in the 900 MHz and 1800 MHz spectrum bands. This could lead to significant benefits for consumers and citizens in terms of provision of mobile broadband services. In particular:

- improvement in the quality of 3G networks, for example higher data rate services (e.g. full mobile web browsing, gaming and music downloads); and
- extension of the coverage of such services, including achieving good coverage inside buildings, particularly in main population areas in the UK.

A5.6 In time liberalisation could also provide additional capacity for mobile broadband, helping operators to offer more Mbytes per month to more consumers, and, in the case of 900 MHz spectrum in particular, to improve the coverage and performance for high speed mobile broadband services. Such changes could bring considerable benefits to consumers of communications services, by significantly improving mobile broadband services without requiring many more mobile phone masts.

[160] See *Mobile Citizens Mobile Consumers*, 28 August 2008

A5.7 Liberalisation of the 900 MHz band in particular also has the potential to maintain and promote competition in the provision of mobile broadband services. This is because access to 900 MHz spectrum may offer the only cost effective way of offering some higher quality mobile broadband services. If liberalisation allows increased access to 900 MHz spectrum, it has the potential to increase the number of players offering similar quality services to the market. Increased competition in the mobile broadband services market is likely to bring about benefits for consumers.

Objectives

A5.8 The objective of the policy is to make available the 900 MHz band and 1800 MHz for GSM systems and for UMTS systems as well as for other terrestrial systems capable of providing electronic communications services that can co-exist with GSM systems.

A5.9 Our key duties we have taken into account to achieve this policy objective are outlined in **Section 2** (Introduction), see in particular paragraphs 2.36 to 2.43.

Method of liberalisation of 900 MHz spectrum

Policy options

A5.10 A full assessment of the impact of the policy options outlined for liberalising 900 MHz spectrum is set out in **Section 5** (Assessment of options for 900 MHz), **Annex 7** (Cost benefit analysis), and **Annex 8** (Assessment of impact and likelihood of wider access to 900 MHz spectrum).

A5.11 Given the complexity of the analysis and the detail in which the impacts have been set out in the relevant sections and annexes, we have not provided a further description of these here.

A5.12 Based on the impact analysis in this document, we have stated a preference for Option C – partial release of 900 MHz spectrum. This would involve 1 block release, with each incumbent operator releasing a 2 x 2.5 MHz block of spectrum.

A5.13 We are also minded to reject Option D – full mandatory spectrum release for 900 MHz. A full discussion of the reasons for this is set out in **Section 7** (Further consideration of the full release option for 900 MHz and 1800 MHz spectrum).

Method of liberalisation of 1800 MHz spectrum

Policy Options

A5.14 A discussion of the policy options relevant to liberalising 1800 MHz spectrum is outlined in **Section 6** (Assessment of options for 1800 MHz).

A5.15 Our policy preference is for 1800 MHz spectrum to be liberalised in the hands of the incumbent holders (Option A) for the reasons set out in **Section 6**.

A5.16 We are also minded to reject mandatory full spectrum release (Option D) for 1800 MHz spectrum. A full discussion of the reasons for this is set out in **Section 7** (Further consideration of the full release option for 900 MHz and 1800 MHz spectrum).

Application of spectrum trading to 2G licences

A5.17 We propose to make the current 900 MHz and 1800 MHz licences tradable as soon as practicable. We are of the view that any trades of 900 MHz spectrum should be subject to a competition review. **Section 8** (Implementation of proposals for 900 MHz and 1800 MHz spectrum), in particular paragraphs 8.18 to 8.25, outlines the cost and benefits of this approach.

Application of spectrum trading and liberalisation to licences for 2.1 GHz spectrum

A5.18 We are minded to introduce trading and to liberalise the 2.1 GHz licences. A summary of the benefits and costs of these policy decisions can be found in **Section 9** (Changes to 2100 MHz licences), in particular paragraphs 9.7 to 9.12.

Annex

Glossary

2G

"Two G": Second generation of mobile telephony systems using digital encoding. 2G networks support voice, limited data communications.

2.5G

"Two and a half G": Term used to describe the enhanced data facilities within 2G digital networks known as GPRS and EDGE.

3G

"Three G": Third generation of mobile telephony systems, providing data speeds generally higher than that used in 2G or 2.5G which supports multimedia applications such as full-motion video, video conferencing and Internet access.

AIP

Administered Incentive Pricing or spectrum pricing: fees charged for access to spectrum to reflect its value. AIP applies in bands for which significant demand exists for that spectrum either in its current use, or for an alternative radio service, and acts as an incentive to users to use their spectrum as efficiently as possible.

Assignment

Authorisation given by a licensing authority for a radio station to use a specific radio frequency or channel under specified conditions.

Band

A defined range of frequencies that may be allocated for a particular radio service, or shared between radio services.

Base Station

A radio transmitter with or without a receiver installed to provide a communications service, typically used in mobile or broadcasting radio systems.

CDMA

Code Division Multiple Access: A radio transmission method where individual traffic transmissions use the same frequency, but where user's traffic is separated by means of different codes.

Cell Radius

Term used to describe the geographical limit of reliable transmissions from a particular focused transmission beam at a mobile cellular base station or Point to Multi point radio system.

CEPT

Conference of European Postal and Telecommunications administrations, comprising of over 40 European administrations.

Cave Review

Review of Radio Spectrum Management, by Professor Martin Cave, published March 2002, available at:

http://www.ofcom.org.uk/static/archive/ra/spectrum-review/index.htm

Communications Act

Communications Act 2003, which came into force in 2003 and illustrates how Ofcom will function.

Coordination

This term refers to the process under which a new user seeks the agreement of existing users to share access to a particular range of frequencies but avoiding causing them harmful interference.

Decibel (dB)

Decibel (dB): is a logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power) relative to a specified or implied reference level. For the case of a power P the relationship is governed by the equation: dB = 10Log10(P/Pref) where Pref is the reference power.

DCS 1800

Digital Cellular System: term used to describe GSM implementation in frequencies around 1800 MHz. GSM was initially implemented in the 900 MHz band. DCS 1800 is now more commonly known as GSM 1800, see GSM.

EC

European Commission: is one of the five institutions that look after the running of the European Union (EU). It is the main body that handles the day-to-day running of the EU in areas such as Transport and Telecommunications.

ECC

Electronic Communications Committee: a committee that reports to CEPT and overseas the work of the various Project Teams and Working Groups of CEPT

EDGE

Enhanced Data Rates for Global Evolution: is a an access technology that delivers broadband-like data speeds to mobile devices at data speeds faster than is possible with GSM/GPRS.

EU

European Union: Collective of European Member States.

ERC

European Radio Communications Committee: previous name for the ECC, see ECC.

FDD

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

GHz

Gigahertz: a unit of frequency, represented in 1000 million (1×10^9) cycles per second, where 1 Hz is one cycle per second, e.g. 1 GHz = 1,000,000,000 Hz.

GPRS

General Packet Radio Service a method to increase the data capacity of 2G or voice based digital networks to enable data services such as; internet browsing, e-mail, visual communications etc.

GSM

Global System for Mobile communications; a 2G mobile phone technology. This is the technology behind the vast majority of 2G mobile phones used across Europe and is

use by approximately 80% of 2G operators worldwide. Also sometimes referred to under its French interpretation of “Groupe Spécial Mobile".

GSM 900

GSM 900: term used to describe GSM used in the 900 MHz frequency band, see GSM.

GSM 1800

GSM 1800: term used to describe GSM used in the 1800 MHz frequency band. Sometimes also known as DCS 1800, see GSM and DCS 1800.

HSDPA

High-Speed Downlink Packet Access: an add-on access component used to enhance the data speed to the end user on 3G/UMTS networks.

HSUPA

High-Speed Uplink Packet Access: an add-on access component used to enhance the data speed from the end user to the base station on 3G/UMTS networks.

IMT-2000

International Mobile Telephony 2000: a family of global standards for mobile phone networks proposed by the ITU (International Telecommunications Union). Also referred to as 3G (Third generation).

Interference

The effect of unwanted signals upon the reception of a wanted signal in a radio system, resulting in degradation of performance, misinterpretation or loss of information compared with that which would have been received in the absence of the unwanted signal.

ITU

International Telecommunications Union: is an international organization within the United Nations System where governments and the private sector coordinate, discuss and agree the logistically nature of global telecom networks and services.

kHz

Kilohertz: a unit of frequency, represented in thousands (1×10^3) of cycles per second, where 1 Hz is one cycle per second, e.g. 1 kHz = 1,000 Hz.

LTE

Long Term Evolution. Project within the Third Generation Partnership Project (3GPP) to improve the UMTS mobile phone standard. Features include, for example, higher download and upload speeds and greater channel flexibility.

MB

Megabyte. A measurement for data storage capacity equal to 2^20 bytes, where a byte is 8 bits.

Mbps

Megabyte per second. Refers to data transfer speeds.

MHz

Megahertz: a unit of frequency, represented in millions (1×10^6) of cycles per second, where 1 Hz is one cycle per second, e.g. 1 MHz = 1,000,000 Hz.

MNO

Mobile Network Operator. Generally used to refer to one of the five companies that own and operate mobile networks in the UK. These are currently Vodafone, O2, Orange, T-Mobile, Hutchinson 3G.

Ofcom

Office of Communications. Ofcom has taken over the RA's responsibility for spectrum management in the UK in December 2003.

Oftel

Office of Telecommunications, which was the telecommunications regulator, until its functions transferred to Ofcom in December 2003.

Paired spectrum

Used by FDD systems where two frequency bands are used together, one for transmission in the forward or downlink direction (e.g. base station to handset) and another for transmission in the reverse or uplink direction (e.g. handset to base station).

Propagation

The transmission of radio waves. Propagation characteristics depend on frequency and are affected by the environmental conditions, such as terrain and atmospheric conditions, encountered on the path.

RA

The Radiocommunications Agency: a former executive agency of the Department of Trade and Industry, which was responsible for the management of most non-military spectrum in the UK and for representing the UK in relevant international bodies. The RA's functions transferred to Ofcom in December 2003.

RRC

Regional Radio Conference: an ITU convened meeting that address the specific sharing arrangements, between countries, on the use of a number of recognised broadcast (TV and Radio) spectrum bands.

RSC

Radio Spectrum Committee. A regulatory committee of EU member states, chaired by the European Commission, which was established under the EU Radio Spectrum Decision.

SFH

Synthesised frequency hopping is a technique that can be employed in GSM networks to increase the capacity of a network.

Spectrum Framework Review (SFR)

Ofcom produced document on how spectrum will be managed in the future.

Spectrum Mask

The documented radiated limits of a transmitted carrier frequency.

Spectrum Trading

Process through which spectrum licence holders are able to transfer some or all of their rights to a third party.

TACS

Total Access Communication System: An analogue cellular mobile telephone standard originally used in the UK on the first cellular telephony system. TACS operated in the 900MHz frequency band.

TDD

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

Terrestrial

On the ground only.

UHF

Ultra High Frequency: Term used to describe frequencies in the range 300 MHz to 3 GHz.

UMTS

Universal Mobile Telecommunications System – a 3G mobile phone standard built on W-CDMA technology. See W-CDMA. One of the IMT-2000 family of standards. This is the standard being deployed by the vast majority of European mobile phone operators to offer 3G services.

Undue Interference

Interference with any wireless telegraphy that is harmful, as provided by section 183 Communications Act 2003. This includes interference that creates dangers or risks of dangers to the functioning of any radiocommunications service designed for the purposes of navigation or safety services, or if the interference degrades, obstructs or repeatedly interrupts authorised broadcasting or other wireless telegraphy.

Un-paired spectrum

Used by TDD systems where only one frequency band is used for transmitting in both the forward or downlink direction (e.g. base station to handset) and the reverse or uplink direction (e.g. handset to base station).

UTRA

UMTS Terrestrial Radio Access. This term specifically refers to the radio interface standard of UMTS.

UTRA TDD

UTRA TDD: a variant of the UMTS radio interface standard which uses unpaired spectrum in TDD mode, see TDD.

WAPECS

Wireless Access Policy for Electronic Communications Services: an initiative on developing a common policy for the authorisation of electronic communications services in the EU including establishing a minimal, least restrictive set of technical conditions for spectrum access. The bands under consideration by this initiative are:

470-862 MHz;

880-915 MHz / 925-960 MHz (900 MHz bands);

1710-1785 MHz / 1805-1880 MHz (1800 MHz bands);

1900-1980 MHz / 2010-2025 MHz / 2110-2170 MHz (2 GHz bands);

2500-2690 MHz;

3.4-3.8 GHz

WRC

World Radiocommunications Conference: an ITU convened conference, held approximately every three or four years, which makes decisions on the way in which radio spectrum is considered in a global context.

W-CDMA

Wideband – CDMA, a version of CDMA that has a bandwidth wider than that defined in the original CDMA consideration, see CDMA. The term W-CDMA is often used as an alternative to UMTS

WiMAX

Worldwide Interoperability for Microwave Access: Based on the IEEE 802.16 group of standards which defines a packet-based wireless technology that provides high-throughput wireless broadband connections over long distances.

Wireless Telegraphy

The means of sending information without the use of a wired system.

WT Acts

Wireless Telegraphy Act 1949 (as amended by the Wireless Telegraphy Act 1967) and Wireless Telegraphy Act 1998. These Acts are further amended by the Communications Act 2003. WT Acts regulate the use of civil radio spectrum in the UK.

WT Act licences

Licences issued under the Wireless Telegraphy Act 1949 (as amended).