OFFICE OF COMMUNICATIONS

Award of available spectrum: 1781.7-1785 MHz paired with 1876.7-1880 MHz

This document consults on the proposed grant in 2005 – 06 of wireless telegraphy licences to use this spectrum and the associated auction process

Consultation

Publication date: **16 September 2005**

Closing Date for Responses: **28 July 2005**

Contents

Section 1

Executive summary

1.1 As part of its plans to implement its strategy of ensuring optimal use of the radio spectrum, Ofcom has a programme of awards of wireless telegraphy licences which is designed to put unused or under-used spectrum into the market. One such award is the award of wireless telegraphy licences to use the spectrum bands 1781.7-1785 MHz paired with 1876.7-1880 MHz (the "Spectrum Bands", which have previously been referred to as the GSM/DECT guard bands). The Spectrum Bands are currently unused (except for some use by the Ministry of Defence) and are no longer required as guard bands.

1.2 This consultation document sets out in detail Ofcom's proposals for the award of wireless telegraphy licences to use the Spectrum Bands in the light of the responses it received to the Spectrum Framework Review: Implementation Plan consultation document published in January 2005. Ofcom's aim remains to hold the award by end of its financial year 2005-06.

An overview of key proposals

1.3 Ofcom proposes to hold an auction for the award of a limited number of low power wireless telegraphy licences to use the Spectrum Bands.

1.4 The key elements of the proposed spectrum packaging and licensees' rights and obligations are as follows:

- The licences on offer will be restricted to low power use (a maximum EIRP of 23 dBM per carrier) but otherwise will be technology and application neutral;
- Between 5 and 10 licences will be awarded, with the exact number determined through the auction;
- Licensees will have concurrent rights which means that all licensees will have equal rights and obligations to use equipment to transmit in the Spectrum Bands, i.e. to use the same frequencies on a shared basis in the whole of the UK: no one licensee will have priority over any other;
- Licensees will have to comply with a spectrum mask based on GSM specifications, but there will be no restriction as to technology or application;
- Licensees will have obligations to coordinate their use with other licensees in the Spectrum Bands and to develop a Code of Practice to facilitate this;
- The licences will have an indefinite term with a minimum period of ten years (during which time Ofcom's powers to revoke will be limited);
- The licences will be tradeable.

1.5 The key elements of the proposed award process are as follows:

- The auction will take the form of a single round sealed bid auction – each bidder will complete and submit a single bid form; the submitted bid forms will be analysed by the auctioneer, and the result of the auction determined. Each bidder will therefore have only one chance to bid in the auction;

- Each bidder will be bidding to win a maximum of one licence;
- Because the exact number of licences to be awarded will not be known in advance, bidders will be able to make up to six separate but parallel bids (on the same bid form), one for each of the different numbers of licences that could be awarded between 5 and 10 (in each case they will be bidding to win exactly one of the available licences);
- The winning option (as to the number of licences to be awarded) will be that option which receives the highest aggregate amount bid for the number of licences to be awarded under that option (with ties between options broken in favour of the largest number of licences);
- The winning bidders (within the winning option) will be those that submitted the highest bids for the winning option (with ties between bidders broken by the drawing of lots);
- The auction will therefore perform two roles simultaneously: first it will determine the number of licences to be awarded; and second it will determine who are the successful bidders for those licences;
- Winning bidders will pay the amount they bid for the licences comprised in the winning option.

Next steps

1.6 This consultation closes on 16 September 2005. Ofcom plans to hold a seminar on its proposals for interested parties in early September.

1.7 Subject to the outcome of this consultation, Ofcom plans to hold the award of wireless telegraphy licences to use the Spectrum Bands towards the end of 2005-06. In order to do that, after considering the responses to this consultation, Ofcom expects to publish the following key documents by December 2005:

- a short statement on this consultation;
- an Information Memorandum, describing in detail the relevant information for the award such as the award procedure and rules, prospective licence conditions and other information likely to affect use of the Spectrum Bands;
- draft regulations setting out the auction rules;
- draft regulations to allow spectrum trading for these licences.

1.8 Following these publications, Ofcom will consider any comments it receives on the draft regulations before finalising them. The auction regulations will then be made to allow Ofcom to hold the auction. Before the auction is held it expects to hold further “questions and answers” sessions on the auction rules in particular to ensure that the bidders understand the process.

Detailed summary of Ofcom's proposals

1.9 The table below sets out in summary form Ofcom's proposals for this award.

Table 1.1 – Summary of Ofcom's proposals

Spectrum Packaging	**Ofcom's proposals**
Usage restrictions	Low power, concurrent use, technology neutral licences will be offered. Accordingly: - all licensees will have equal rights and obligations to use equipment to transmit in the Spectrum Bands, i.e. to use the same frequencies on a shared basis in the whole of the UK; - any use which respects the low power spectrum mask will be allowed; - any use which exceeds the low power limit specified will not be allowed except following a licence variation from Ofcom.
Number of licences	There will be a limited number of licences awarded. The number will be 5, 6, 7, 8, 9 or 10. Bids in the auction will determine the exact number.
Wireless Telegraphy Rights & Obligations	**Ofcom's proposals**
Transmission rights	Licensees will have to comply with the following technical restrictions: - a maximum EIRP of 23 dBm per carrier; - a mask based on GSM specifications for out-of-block emissions; - up-link and down-link: 1876.9 – 1879.9 MHz – Base transmit and 1781.9 – 1784.9 MHz – Base receive; - a maximum out-door transmitter antenna height of 10 metres above ground level.
Engineering coordination[1] obligations	Licensees will have obligations to coordinate their use with other licensees and to develop a Code of Practice within 6 months of obtaining the licence. Ofcom will retain back stop powers should these provisions prove unsuccessful.
Licence term	Licences will have an indefinite duration, with a minimum term of 10 years during which Ofcom's powers to revoke will be limited. Ofcom will have the power to revoke for spectrum management reasons on not less than 5 years' notice after the minimum period, which could lead to the licence being terminated the day after the expiry of the 10 year minimum period or any time thereafter.
Licence fees	The auction will determine the fee payable for each licence. After the expiry of the minimum period, if the licensee continues to hold the licence, there may be additional charges in line with Ofcom's policy on spectrum pricing at that time.
Spectrum trading	The licences will be tradeable but only outright total transfers will be permitted.

[1] The term "engineering coordination" is henceforth used to describe the process of reaching agreements between licensees where they take such steps as locating base stations and selecting channels and adopting other engineering solutions and exchanging information in order to minimise the probability of causing mutual interference.

Spectrum Packaging	**Ofcom's proposals**
Interference from adjacent users	Prospective licensees should note the possibility of interference from adjacent band users. Ofcom has set out the technical characteristics of the current adjoining uses (GSM, DECT, etc.) to provide guidance.
Sitefinder	Sitefinder is a national database of mobile phone base stations which Ofcom administers on behalf of the Government. The Government would like to invite all licensees in the Spectrum Bands if they use one of the technologies covered by Sitefinder at present (GSM, UMTS or TETRA) to provide relevant information on a voluntary basis.
Award Mechanism & Rules	**Ofcom's proposals**
Basic auction format	The auction format for the Spectrum Bands will be a single round sealed bid 'menu' auction. Bidders will be able to make up to six separate but parallel bids (on the same bid form), one for each of the different numbers of licences that could be awarded between 5 and 10 (options on the 'menu').
Determining the number of licences	The winning option (number of licences to be awarded) will be that option which receives the highest aggregate amount bid for the number of licences to be awarded under that option (with ties between options broken in favour of the largest number of licences).
Determining the successful bidders	The winning bidders will be those that submitted the highest bids for the winning option (with ties between bidders broken by the drawing of lots).
Pricing rule	Winning bidders will pay the amount they bid for their licence.
Transparency	There will be a registration process for participation in the auction, and the identities of all those registered will be made public.
Prohibitions on bidder association and collusion	There will be specific rules to prohibit collusion and bidder association.
Reserve price	The reserve price will be £50,000 per licence.
Deposits	Bidders will be required to submit a deposit in the form of a bank guarantee with their bid. The level of the deposit will be set at 50% of the largest amount the bidder is bidding for a licence under any option.
Payment terms	Winning bidders will be required to pay 100% of the fee before the licence is issued.
Unsold licences	It is possible that after the auction licences will remain unsold. If this occurs Ofcom has a number of options available to it including cancelling the licences, awarding in the future on a first come first served basis, or awarding through a further auction. If this circumstance arises Ofcom will determine its approach at the relevant time.

Question 1: *Do stakeholders agree with these proposals for the award of the Spectrum Bands or have any other comments on the contents of this document?*

Section 2

Introduction

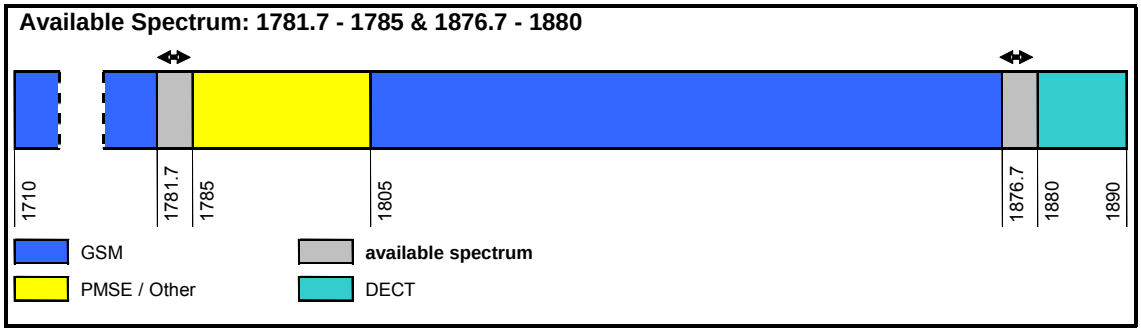
Background

2.1 This document consults on Ofcom's plans to award wireless telegraphy licences in the radio spectrum bands 1781.7 to 1875 MHz paired with 1876.7 to 1880 MHz (the "Spectrum Bands"). The proposals follow Ofcom's Spectrum Framework Review: Implementation Plan ("SFR:IP") consultation document[2], which sought stakeholders' views on an outline of options and timing for the award of licences to use these bands; the consultation closed on 24 March 2005.

2.2 As indicated in the SFR:IP, no wireless telegraphy licences have been assigned for any station or apparatus using the Spectrum Bands, however there is some use by the Ministry of Defence. The Spectrum Bands fall within the operating range of standard GSM mobile phones. When the original spectrum arrangements for GSM 1800 were determined, the technical advice at the time (based on the conclusions of ERC Report 31 "Compatibility Between GSM and DCS 1800"[3]) was to keep the band 1876.7 – 1880 MHz clear to protect GSM 1800 services from interference from Digital Enhanced Cordless Telecommunications (DECT) systems and vice versa. However, more recent technical work (based on the conclusions of ERC Report 100 "Compatibility Between Certain Radiocommunications Systems Operating in Adjacent Bands - Evaluation of DECT / GSM 1800 Compatibility"[4]) has indicated that it is no longer necessary to keep the Spectrum Bands clear provided that certain technical constraints are imposed.

2.3 Figure 1 below shows graphically how the available spectrum fits within the neighbouring sections of the UK Frequency Allocation Table.

Figure 1. Band Plan



2.4 The proposals outlined in this consultation build upon those in the SFR:IP and provide detailed information on how Ofcom proposes (subject to feedback from this consultation exercise) to award wireless telegraphy licences which will permit use of the Spectrum Bands. Its aim is to provide and consult on as comprehensive a description as possible of Ofcom's proposals for the award of wireless telegraphy licences and to inform potential bidders of the proposed spectrum package and auction mechanism. It also shows how Ofcom proposes to implement Ofcom's general approach to spectrum management as it applies to these Spectrum Bands. This

[2] http://www.ofcom.org.uk/consult/condocs/sfrip/ - published 13/01/05
[3] http://www.ero.dk/documentation/docs/docfiles.asp?docid=1656&wd=N
[4] http://www.ero.dk/documentation/docs/docfiles.asp?docid=1656&wd=N

general approach has been set out in a number of documents published by Ofcom over the past year, including:

- the Spectrum Framework Review consultation document published in November 2004 ("SFR") and Statement published in June 2005 ("SFR Statement")[5];
- the Spectrum Trading consultation document published in November 2003 ("Trading Consultation Document") and Statement published in August 2004 ("Trading Statement")[6];
- the Spectrum Liberalisation consultation document published in September 2004 ("Liberalisation Consultation Document") and Statement published in January 2005 ("Liberalisation Statement")[7];
- the approach is also summarised in the SFR:IP consultation document (section 3).

2.5 The award of licences outlined in this consultation forms part of a wider programme of awards which was proposed in the SFR:IP. Ofcom's general approach to other awards in this programme is outlined in the Interim Statement on the SFR:IP published today alongside this consultation. Ofcom expects to publish more detailed documents with specific plans for each award as the programme advances: this is the first such document in the series.

2.6 In this case, Ofcom's proposal is to award by auction a limited number of concurrent, low power, technology and application neutral wireless telegraphy licences. "Concurrent" means that all licensees will have equal rights and obligations to use equipment to transmit in the Spectrum Bands, i.e. to use the same frequencies on a shared basis in the whole of the UK: no one licensee will have priority over any other. The licences for award in the Spectrum Bands will be distinct licences and each licensee will independently hold its rights and obligations. The number of licences will be limited but Ofcom's intention is to use an auction format that allows the market to determine the optimal number of licences (within an upper and lower bound set by Ofcom).

2.7 It should be noted that other wireless telegraphy licences granted in future, as part of Ofcom's ongoing award programme, may permit the provision of services that could compete with those that may be offered using these Spectrum Bands. Ofcom is not proposing to place any limitation as a function of this award process on the scope for it to license other providers to use spectrum to offer such services. Such licensing may occur by means of the award of new licences to use spectrum in other bands, by means of decisions as to licence exemptions or via the removal of unnecessary restrictions on the use of bands that have already been licensed. As set out in the SFR (and other documents mentioned at paragraph 2.4 above), Ofcom's general policy is to move towards technology and application neutral licensing that provides much greater flexibility for the use of spectrum to respond to demand and to be economically efficient.

2.8 Subject to this consultation, Ofcom intends to proceed with this award in the financial year 2005-06 as quickly as possible consistent with a well-ordered process.

Document structure

2.9 This document logically falls into a number of parts.

[5] http://www.ofcom.org.uk/consult/condocs/sfr/
[6] http://www.ofcom.org.uk/consult/condocs/spec_trad/
[7] http://www.ofcom.org.uk/consult/condocs/liberalisation/

2.10 The first part provides a background to the award proposals and consists of:

- Section 2 – this Introduction;
- Section 3 – which provides a summary of Ofcom's powers and duties relevant to this award; and
- Section 4 – which details Ofcom's objectives for, and general approach to, the award.

2.11 The second part provides details of the actual award proposals and consists of:

- Section 5 – which details how Ofcom intends to package the Spectrum Bands;
- Section 6 – which describes the specific conditions that will apply to the licences and other issues relevant to the rights in the licences;
- Section 7 – which sets out the proposed auction design; and
- Section 8 – which details the auction rules that Ofcom proposes to apply.

2.12 Section 9 sets out the next steps leading up to the award.

2.13 Section 10 and Annexes A to C set out further information about Ofcom's consultation principles and the process for responding to this consultation.

2.14 Other Annexes provide further background information relevant to the award.

- Annex D provides an overview of other regulation relating to electronic communications networks and services which may be relevant to potential licensees.
- Annex E sets out a summary of relevant responses to the SFR:IP.
- Annex F sets out an example in draft of the type of licence which will be offered.
- Annex G describes the characteristics of the use of the bands adjacent to the Spectrum Bands.
- Annex H sets out an impact assessment in accordance with Ofcom's statutory requirement.
- Annex I provides a glossary of key terms.

Section 3

Ofcom's duties and functions

3.1 This section is intended to provide a brief overview of the main UK and European legislative provisions relevant to wireless telegraphy licensing and to the proposed award process. This section does not provide a comprehensive statement of all legal provisions which may be relevant to Ofcom's functions and to the award of wireless telegraphy licences for the use of the Spectrum Bands.

Ofcom's general duties

3.2 Under section 3(1) of the Communications Act 2003 it is the principal duty of Ofcom in carrying out its functions:

a. to further the interests of citizens in relation to communications matters; and

b. to further the interests of consumers in relevant markets, where appropriate by promoting competition.

3.3 In doing so, Ofcom is required to secure (under section 3(2)):

a. the optimal use for wireless telegraphy of the electro-magnetic spectrum;

b. the availability throughout the UK of a wide range of services;

c. the availability throughout the UK of a wide range of TV and radio services which (taken as a whole) are both of high quality and calculated to appeal to a variety of tastes and interests;

d. the maintenance of a sufficient plurality of providers of different television and radio services;

e. the application in the case of all television and radio services of standards that provide adequate protection to members of the public from the inclusion of offensive and harmful material, unfair treatment in programmes and unwarranted infringement of privacy;

and to have regard to certain matters which include:

1. principles of better regulation (section 3(3));

2. the desirability of promoting competition (section 3(4));

3. the desirability of encouraging investment and innovation (section 3(4)(d));

4. the desirability of encouraging availability and use of broadband services throughout the UK (section 3(4)(e));

5. the different needs and interests of persons in different parts of the UK (section 3(4)).

3.4 As the management of the UK radio spectrum is governed by the European Communications Directives, which aim to harmonise the regulation of electronic communications networks and services throughout the European Union, section 4 of the Communications Act 2003 requires Ofcom when carrying out its spectrum functions to act in accordance with the "six community requirements" set out in that section when managing the wireless spectrum in the UK. Of relevance are the following:

a. The requirement to promote competition (section 4(3));

b. The requirement to secure that Ofcom's activities contribute to the development of the European internal market (section 4(4));

c. The requirement to promote the interests of all persons who are citizens of the European Union (section 4(5));

d. The requirement to act in a technology neutral way (section 4(6));

e. The requirement to encourage to such extent as appropriate the provision of network access and service interoperability (section 4(7)); and

f. The requirement to encourage such compliance with international standards as is necessary for (a) facilitating service interoperability; and (b) securing freedom of choice for the customers of communications providers (sections 4(9) and (10)).

Ofcom's duties when carrying out spectrum functions

3.5 In carrying out its spectrum functions it is the duty of Ofcom (under section 154 of the Communications Act 2003) to have regard in particular to:

a. the extent to which the spectrum is available for use or further use, for wireless telegraphy;

b. the demand for use of that spectrum for wireless telegraphy; and

c. the demand that is likely to arise in future for the use of that spectrum for wireless telegraphy.

It is also the duty of Ofcom to have regard, in particular, to the desirability of promoting:

a. the efficient management and use of the spectrum for wireless telegraphy;

b. the economic and other benefits that may arise from the use of wireless telegraphy;

c. the development of innovative services; and

d. competition in the provision of electronic communications services.

3.6 Where it appears to Ofcom that any of its duties in section 154 conflict with one or more of its general duties under sections 3 to 6 of the 2003 Act, priority must be given to its duties under those sections.

Granting wireless telegraphy licences

3.7 Ofcom's legal power to grant wireless telegraphy licences is set out in the Wireless Telegraphy Act of 1949. Section 1(1) of that Act makes it an offence for any person to establish or use any station for wireless telegraphy or to install or use any apparatus for wireless telegraphy except under and in accordance with a licence granted by Ofcom under that section (a wireless telegraphy licence).

3.8 Section 1(2) of that Act gives Ofcom the power to grant wireless telegraphy licences subject to such terms as Ofcom thinks fit.

3.9 However, Ofcom's broad discretion in relation to the terms that can be imposed in a wireless telegraphy licence is subject to the rule that Ofcom must impose only those terms that it is satisfied are objectively justifiable in relation to the networks and services to which they relate, not unduly discriminatory, and proportionate and transparent as to what they are intended to achieve (section 1D(9)).

Providing for an auction for wireless telegraphy licences

3.10 Under Article 5(2) of the Directive on the authorisation of electronic communications networks and services 2002/20/EC (the "Authorisation Directive"), when granting rights of use of radio frequencies (wireless telegraphy licences in the UK context), Member States must do so through open, transparent and non-discriminatory procedures.

3.11 Under Article 7(2) of the Authorisation Directive where the number of rights of use of radio frequencies needs to be limited, Member States' selection criteria must be objective, transparent, non-discriminatory and proportionate. (Section 164 of the Communications Act 2003 requires Ofcom to make an order setting out the criteria.)

3.12 Within that context, Ofcom has power under section 3 of the Wireless Telegraphy Act 1998 (having regard to the desirability of promoting the optimal use of the electro-magnetic spectrum) to make regulations providing that applications for the grant of wireless telegraphy licences must be made in accordance with a procedure which involves the applicants making bids for licences (for example an auction).

3.13 Ofcom has broad powers in section 3(3) to make provision in regulations for the form of the licences and the auction bidding procedure.

Charging fees for wireless telegraphy licences

3.14 Ofcom also has power, under section 1 of the Wireless Telegraphy Act 1998, to prescribe in regulations fees that are payable in respect of wireless telegraphy licences. Under section 2 Ofcom may prescribe sums which are greater than necessary for the purpose of recovering costs, if it thinks fit in the light (in particular) of the matters to which they are to have regard under section 154 of the Communications Act 2003.

3.15 The fees for most wireless telegraphy licences are set out in such regulations (including those fees which are set by Ofcom in order to incentivise the use of the spectrum). The current regulations are the Wireless Telegraphy (Licence Charges) Regulations 2005 (SI 2005/1378).

3.16 Under Article 13 of the Authorisation Directive, any fees imposed for rights of use of radio frequencies shall reflect the need to ensure the optimal use of the resources. Such fees must be objectively justifiable, transparent, non-discriminatory and

proportionate in relation to their intended purpose (and take into account the objectives set out in Article 8 (Policy objectives and regulatory principles) of Directive 2002/21/EC[8] (the "Framework Directive")).

3.17 In the following sections of this consultation, Ofcom sets out its analysis of its proposals against its statutory duties and the general requirements applicable to licensing processes and licence conditions.

[8] the Directive of the European Parliament and the Council on a common regulatory framework for electronic communications networks and services (2002/21/EC)

Section 4

Ofcom's objectives and general approach to the award

4.1 This section sets out Ofcom's objectives for the award of wireless telegraphy licences to use the Spectrum Bands. It also discusses the choice of assignment mechanism, the case for a licence exempt approach, and the proposed timing of the award.

Objectives for the award

4.2 The main objective of the award is to further the interests of citizens and consumers by promoting the optimal use of the electro-magnetic spectrum, in particular the Spectrum Bands 1781.7 to 1785 MHz paired with 1876.7 to 1880 MHz. In preparing proposals to secure this objective, Ofcom also expects to have regard, in particular, to the availability of, and demand for, the spectrum and to the desirability of promoting:

a. the efficient management and use of the spectrum;

b. the economic and other benefits that may arise from use of the spectrum;

c. the development of innovative services; and

d. competition in the provision of electronic communications services.

4.3 Ofcom has carried out a strategic review of spectrum management and has recently published the SFR Statement which sets out the general approach Ofcom proposes to take to spectrum management. This approach can be summarised in the Ofcom Spectrum Vision which is that:

1. Spectrum should be free of technology and usage constraints as far as possible. Policy constraints should only be imposed where they can be justified;

2. It should be simple and transparent for licence holders to change the ownership and use of spectrum; and

3. Rights of spectrum users should be clearly defined and users should feel comfortable that they will not be changed without good cause.

4.4 The SFR Statement identifies that in many circumstances the use of auctions is likely to be the most appropriate means of assigning spectrum that is not currently assigned, and where demand exceeds supply. The SFR Statement also sets out the general view that wireless telegraphy licences to use spectrum should be auctioned in a technology and usage neutral way. To the extent that it is necessary to package the rights to use the spectrum in a manner that allows it to be auctioned, this should be done by reference to the likely uses that have been identified. As discussed further below and in sections 5 and 6, the proposals in this document follow the general approach set out in the SFR Statement.

Choice of assignment mechanism

Licence exemption

4.5 Ofcom has considered whether it would be likely to promote optimal use of the spectrum to make the Spectrum Bands available by means of licence exemption. Ofcom has also considered its duty (under section 1AA of the Wireless Telegraphy Act 1949) to make regulations exempting from the requirement to be in accordance with a licence the establishment, installation and use of any station or apparatus, where such use is not likely to involve undue interference with wireless telegraphy.

4.6 Ofcom's further technical analysis of the potential uses of the Spectrum Bands is contained in a separate report (Low-power concurrent use in the spectrum bands 1781.7 – 1785 MHz paired with 1876.7 – 1880 MHz[9], the "Technical Report") published today alongside this consultation. As discussed elsewhere, the most likely potential uses of this spectrum include low power use and high power wide area use for the provision of a variety of mobile services, likely to involve the use of GSM or possibly other mobile technologies such as cdma2000 1x. Ofcom's technical assessment suggests that licence exempt use of the Spectrum Bands would be likely to result in significant interference in a number of locations. Services might feasibly be offered in these locations if there were engineering coordination[10] amongst service providers, as operators would then be able to mitigate the interference. They could do this by taking steps such as locating base stations and selecting frequency channels in a way that minimised the probability of mutual interference. However a licence exempt approach is not likely to offer sufficient protection for service providers in relation to the likelihood of interference and the rapidity with which it may occur. This is because engineering coordination between users is not likely to be feasible as little or no information would be available about the identity of other users. Even if users could identify each other, engineering coordination might involve large numbers of users and be frustrated by bargaining inefficiencies and high transactions costs. This is because in the case of licence exemption, there is no restriction on who can operate licence exempt equipment and this is likely to involve large numbers of both companies and members of the public. An example of such licence-exempt use of spectrum is that of the 2.4 GHz band for so-called wi-fi equipment, allowing such things as wireless internet connection in the home or the office.

4.7 It might be possible for Ofcom to reduce the likelihood of interference to some extent by imposing additional technical requirements, such as Dynamic Frequency Selection ("DFS"). However, Ofcom's assessment is that additional technical requirements of this kind would not have such a significant mitigating effect on the potential for interference as to justify a licence exempt approach. Moreover, additional technical requirements would reduce the freedom of users to select the technology that best suits their needs. Ofcom does not consider that there is a sufficiently strong justification to depart from the principle of technology neutrality in this way.

4.8 Ofcom therefore considers that a licence exempt approach would be likely to involve undue interference and would be likely to lead to less than optimal use of the Spectrum Bands. This is because the potential for efficient use of the Spectrum Bands on a licence-exempt (and therefore uncoordinated) basis can be expected to be significantly less than if there were a feasible mechanism for engineering coordination.

[9] See the Technical Report published today alongside this consultation document.
[10] The term "engineering coordination" is used to describe the process of reaching agreements between licensees where they take such steps as locating base stations and selecting channels and adopting other engineering solutions and exchanging information in order to minimise the probability of causing mutual interference.

Award of a limited number of licences

4.9 Ofcom has considered whether, if the Spectrum Bands are to be licensed, it is necessary to limit the number of licences available. In the SFR:IP, Ofcom set out its initial view that licence exemption was not appropriate, and that the number of licences should be limited in the interests of efficient use of the spectrum. Ofcom has now reviewed these matters again in the light of further technical work and the responses to the SFR:IP. (Section 5 and Annex E set out a discussion of the responses on this point.)

4.10 In principle, it would be possible to license use of the Spectrum Bands, but to do so without imposing a limit on the number of licensees. This would provide a mechanism for capturing information as to the identity of users, thereby creating a basis for engineering coordination. There is a precedent for an approach similar to this in Ofcom's licensing of the 5.8 GHz band, which requires registration of the location of terminals. An approach on these lines would also impose lower barriers to entry within the framework of licensing for users of the Spectrum Bands and, other things being equal, therefore be likely to facilitate competition in the provision of electronic communication services.

4.11 However, Ofcom considers that an approach on these lines would not be sufficient to ensure effective engineering coordination between the licensees and, in the absence of a robust engineering coordination mechanism, there remains a high risk of inefficient use of the Spectrum Bands. In the absence of any limit on the number of licences, the number of licensed users of the Spectrum Bands could be very high. Any one of these licensed users might fail to coordinate effectively with others, imposing significant costs on those other users. Also, costs of transacting and bargaining with other users could be high, frustrating efficiently coordinated use. Ofcom could in principle take steps to enforce engineering coordination by licensees, but this is not likely to be the most efficient way of ensuring optimal use of the Spectrum Bands, given the costs, delays and uncertainties of the enforcement process. If there is no limit on the number of licences, Ofcom considers that the incentives to coordinate are likely to be insufficient and the costs of engineering coordination are likely to be too great to promote the optimal use of the spectrum.

4.12 Ofcom has therefore concluded that it is appropriate to limit the number of licences that should be awarded. Ofcom also considers that the requirements for engineering coordination suggest that the number of licences issued should be such as to make engineering coordination readily feasible. The question of exactly how many licences should be issued, and the type of use that should be allowed, are discussed further in section 5.

Award through an auction

4.13 Ofcom has considered what mechanism for awarding a limited number of licences for the Spectrum Bands is likely to result in the most efficient outcome for the use of the Spectrum Bands. It set out its general view in the Interim Statement on the SFR:IP and in the SFR Statement that an auction mechanism is likely to be Ofcom's preferred tool for assigning licences to use unused spectrum, in particular where demand for the licences is likely to exceed supply. Having considered the particular circumstances of the Spectrum Bands, Ofcom has concluded that an auction mechanism should be used.

4.14 As explained further in section 5 (see paragraphs 5.15 to 5.32 and Annex E, Ofcom has gathered a good deal of evidence to suggest that there is likely to be significant

demand for these licences, with a wide range of parties indicating an interest in potentially acquiring a licence. It is not clear whether this demand will exceed the number of licences on offer in all circumstances. However Ofcom considers that it is prudent to adopt a mechanism for assigning the licences that allows for this possibility. Ofcom also considers that an auction mechanism is likely to be a more efficient process in terms of outcome than other processes such as "first come first served" or a beauty contest and therefore better promote the optimal use of the spectrum. Subject to the details of its design, the auction should allow the market - which has more information available to it - rather than the regulator to determine who are most likely to be the most efficient users of the Spectrum Bands, by assigning licences to users with the highest valuation.

4.15 Ofcom considers that the clear and simple criteria to identify the winning bidders in an auction offer the most open, transparent and non-discriminatory method out of those available for determining the licensees of the Spectrum Bands among a number of candidates. This is because in auctions, a bidding process is used to award licences to those bidders prepared to pay most for them. Auctions are therefore likely to lead to the spectrum rights being assigned to users that value them most highly which will generally be those who are likely to use the spectrum most efficiently (absent downstream competition concerns). By contrast, in Ofcom's view, other assignment mechanisms are unlikely to be as efficient in promoting optimal use of the spectrum for this award. Alternative assignment mechanisms include "first come first served" processes, where licences are assigned to applicants in the order of their application, and comparative selection processes, where licences are assigned to the applicants that, in the regulator's judgement, best satisfy the selection criteria that it has set. A "first come first served" process would not be appropriate for the Spectrum Bands as demand for spectrum use is likely to exceed supply and the first applicants may not be those who would make the most efficient use. A comparative selection process would not be appropriate in this case because of risks to objectivity and to the likelihood of the licences being obtained by those best able to use them to maximum economic advantage, both in defining selection criteria and in assessing candidates' submissions.

4.16 Ofcom's decision to use an auction as the method for assignment, and Ofcom's other proposals relating to the details of the auction design, are derived from the objectives for the award, and in particular the aim of securing optimal use of the spectrum. It is not Ofcom's objective to raise revenue by means of spectrum auctions nor, given Ofcom's statutory duties, is this a consideration that Ofcom has taken into account.

4.17 Sections 7 and 8 of this document set out Ofcom's detailed proposals for the design of the auction process for the Spectrum Bands.

Future assignments in the Spectrum Bands

4.18 In this document, Ofcom presents its proposals for the assignment of wireless telegraphy licences for the use of the Spectrum Bands which should result in a number of licences being awarded. Ofcom has no present plans to offer other licences for use of the Spectrum Bands, or to permit use of the Spectrum Bands by licence exemption. However, it is possible that Ofcom may be required to take one or more of these steps in order to comply with international obligations that do not presently exist. In principle, Ofcom may also use its discretion to assign additional wireless telegraphy licences for use of the Spectrum Bands either of the same character or of a different character to those described in these proposals. In considering any further assignments, Ofcom would consult stakeholders on possible plans and would not expect to award any additional licence before a reasonable period of time has passed after the award

described in the present consultation, subject to international obligations. At this time and based on information currently available to Ofcom, that period would probably be a minimum of five years.

4.19 Similarly, if in the future there were reasons to consider allowing licence exempt use of the Spectrum Bands in conjunction with the licensed use proposed in this document, Ofcom would consult stakeholders on its plans, as part of its assessment of the case for such use. Again, subject to international obligations, Ofcom would not expect to allow licence exempt use in the Spectrum Bands until a reasonable period of time (probably no less than five years) had passed after the award described in this document.

Timing of the award & other matters

4.20 In the SFR:IP, Ofcom proposed that licences for use of the Spectrum Bands should, if possible, be awarded in 2005-06.

4.21 A number of respondents to the SFR:IP commented specifically on the timing of this award, including BT, FMS Solutions, Intellect, ip.access, Nortel, NWP Spectrum and Teleware. Five of these expressed strong support for an early award or awarding the Spectrum Bands as soon as possible. BT argued that there was a "window of opportunity" to make use of the Spectrum Bands and that this could be missed if the award did not take place quickly. The window is related to the fact that a large volume of GSM handsets can utilise these frequencies, but GSM technology is expected to have a finite life. FMS Solutions and Teleware argued that, for similar reasons, it was important to release the Spectrum Bands in 2005.

4.22 Some other respondents commented that a number of conditions needed to be met before the Spectrum Bands could be released to the market in an appropriate manner. O2, for example, argued that Ofcom needed to provide clarity on how aspects of the wider regulation of electronic communications would apply to licensees, with particular reference to national roaming conditions, conditions relevant to call termination and the General Conditions of Entitlement. More generally, Orange and Vodafone suggested that the case for proceeding with the proposals in the SFR:IP had not been demonstrated, and that further economic study was required before decisions could be made on the release of the Spectrum Bands.

4.23 Ofcom has considered all the points made in response to the consultation carefully. In particular, Ofcom has noted the urgency that many respondents have attached to progressing this award. Ofcom agrees that use in connection with GSM handsets is a plausible use of the Spectrum Bands. As discussed in section 5 in more detail, the Spectrum Bands are also currently unused, while it has recently become apparent that transmission can be technically achieved with acceptable risks of undue interference to existing users, and Ofcom has received submission to consultations which indicate a considerable level of demand for the use of the Spectrum Bands. Therefore, Ofcom considers that it is desirable to issue licences as soon as practicable consistent with the requirements of due process.

4.24 In response to the points made by O2, Ofcom notes that the regulatory framework for electronic communications services and networks is set out in some detail in the relevant European Directives and the Communications Act. Ofcom does not consider that it is necessary or appropriate to issue any new statements of regulatory policy in relation to the services that might be offered using the Spectrum Bands. This would be inappropriate, not least given the technology and application neutral approach to

spectrum licensing proposed in this document. This approach implies that Ofcom is not in a position to predict with certainty what services will in fact be deployed.

4.25 It is the responsibility of prospective bidders to assess how the regulatory framework would be relevant to any services that they wish to implement. In order to assist in this, but for information purposes only, Annex D to this document contains a brief summary of some aspects of the present framework. This Annex is, however, expressly not intended to be definitive, and it does not provide guidance of any kind as to future regulatory decisions in this or any other area.

4.26 Ofcom has also taken account of the points made by Vodafone and Orange. Ofcom does not consider that a further economic study is required before making decisions on the basis for licensing use of the Spectrum Bands. The proposals in this document follow two previous consultations on the matter (a consultation by the RA[11] and the SFR:IP consultation), as well as extensive economic and technical analysis. In Ofcom's view, the proposals constitute an objectively justifiable, proportionate and non-discriminatory approach to the licensing of the Spectrum Bands. Ofcom also considers the proposals to be transparent as to what they seek to achieve and, therefore, to provide a reasonable and appropriately justified basis for proceeding.

4.27 Ofcom is not therefore minded to delay further the award of licences to use the Spectrum Bands, but to proceed with all reasonable despatch. Ofcom regards this award as a high priority in its wider award programme. It is therefore continuing to plan to make the award in 2005-06. Section 9 sets out in more detail the next steps in the process.

[11] http://www.ofcom.org.uk/consult/condocs/ra_condoc_2g3g_spectrum_old/

Section 5

Spectrum packaging

5.1 In this section, Ofcom describes its proposals and rationale for the packaging of the rights and obligations to be granted under the wireless telegraphy licences available.

5.2 Ofcom's wider principles for spectrum management, as set out in particular in the SFR and SFR:IP, suggest that, in general, decisions on how spectrum is used should be left to the market rather than determined by the regulator. However, spectrum needs to be 'packaged' in some way in order for Ofcom to make it available to the market. It is important that this is done in a way that facilitates efficient use, as benefits from use of the spectrum are likely to be maximised if it can be used efficiently from the outset.

5.3 In order to achieve this, Ofcom needs to have an understanding of the most likely uses of the spectrum, and to consider how this can be reflected in the packages offered to the market.

5.4 The proposals below have been prepared in light of the objectives identified for the award and in light of Ofcom's statutory duties. They take into account all the relevant evidence that is available to Ofcom, including the outcome of two previous consultations (consultation by the RA in 2003 and the consultation on the SFR:IP). The proposals have been based on an assessment of the options identified in the SFR:IP for the use of the Spectrum Bands. This section considers, in particular, the three major issues relevant to spectrum packaging:

- Type of use, as between high and low power;
- The issue of technology neutrality; and
- The relevant number of licences.

Overview of proposals outlined in the SFR:IP

5.5 In the SFR:IP, Ofcom consulted on a range of options for the future use of this spectrum. In general Ofcom identified two main alternatives for the likely use of the Spectrum Bands:

a. traditional high power wide-area use along similar lines to current 2G cellular systems; and

b. use by low power services, a number of which are not presently offered commercially and would therefore be innovative.

5.6 Ofcom's view, set out in the SFR:IP, was that there was unlikely to be enough spectrum for a new entrant to offer a stand-alone high power wide-area 2G cellular type service in competition to the existing 2G operators. However the spectrum might be a useful addition to the existing operators to provide extra capacity.

5.7 Ofcom's technical analysis for the SFR:IP consultation concluded that purely uncoordinated low power (i.e. licence-exempt) systems would not be viable. There would be a significant risk of undue interference between users over a wide area if deployment were not managed.

5.8 Various scenarios for packaging the rights of use under the wireless telegraphy licences were considered in the SFR:IP, with an assessment of the advantages and disadvantages of each. This assessment is presented below.

a. Maintaining the spectrum unassigned. A 'do nothing' option would delay this spectrum being used for productive purposes for many years resulting in a loss to the UK economy.

b. One high or low power (at choice of the licensee) UK licence. Technically this scenario is viable from the interference management point of view. There is likely to be good demand for the spectrum for either congestion relief by an MNO or for innovative applications by an MNO or new entrant. However, in the low power scenario competition would be limited unnecessarily by the existence of only one licence. The choice within the market between high and low power applications may be affected by asymmetry between different potential bidders, which may lead to less than optimal use of the spectrum.

c. One high or low power (at choice of the licensee) UK licence and one low power (due to power constraints above 1878 MHz) UK licence split by frequency. Technically this scenario is viable from the interference management point of view but planning in business districts may be difficult. There is likely to be less demand for such a proposition than for a single national licence due to the additional complexity and the limited amount of spectrum (particularly if high power use is chosen for one of the licences).

d. One high or low power (at choice of the licensee) UK licence and two or more concurrent low power (due to power constraints above 1878 MHz) UK licences split by frequency. The interference management implications of this arrangement are likely to be problematic, particularly in business districts. The degree of difficulty in managing interference will depend on the number of concurrent licensees but coordination amongst the parties will be a material consideration on the viability of some of the business cases. This scenario provides potential for new entrants to obtain low power concurrent licences but coordination issues are significant and may undermine interest in the spectrum.

e. Regional licences, one high or low power (at choice of the licensee) licence per region. Interference management would only be problematic at regional borders. However for high power use there may be a need for significant separation distances at borders thus potentially denying services to some parts of the UK. There is unlikely to be demand from the MNOs or new entrants on this basis. National coverage is likely to be a key issue for business cases and a regional approach may leave less attractive licences unsold.

f. Two or more concurrent low power UK licences (i.e. all licensees having equal access to all the available spectrum). Interference management will depend critically on the number of licensees, and will require coordination amongst the parties. The more licensees the more difficult engineering coordination will be, particularly in business districts. The low power stipulation will however, ease the coordination burden. There is likely to be good demand for the spectrum for innovative low power applications.

5.9 Having outlined the scenarios Ofcom proposed to auction the spectrum, on the basis of the last scenario, i.e. to grant a small number of UK low power (23 dBm) licences. The precise number was not specified but it was indicated that it would probably be within the range of 3 to 6. The licences would be concurrent, i.e. licensees will be able to use equipment to transmit on the same basis as others using the same frequencies on a shared basis: no one licensee will have priority over any other. An engineering coordination regime would encourage licensees to locate base stations, select frequency channels and engineer equipment in a manner which minimises the probability of causing undue interference to other licensees operating in the close vicinity. Licences would not contain restrictions as to service provision or technology other than the power limit. The terms of the licences might allow conversion to high power use if they were all acquired by one organisation. Ofcom proposed that the licences should be technology neutral, tradable and free of restrictions as to the applications which could be implemented.

Options a, c, d and e

5.10 Ofcom has reconsidered the options outlined in the SFR:IP in the light of the responses and its further analysis of the issues. It has concluded that the key choice is between options b and f as set out above, and this choice is discussed in detail below. Ofcom believes that the other options should be disregarded, since as suggested in the SFR:IP they are likely to lead to inefficiency in the use of spectrum.

5.11 None of the respondents to the SFR:IP expressed any support for options a, c or d.

5.12 Option a (maintaining the spectrum unassigned) would prevent the optimal use of the spectrum and the delivery of the significant benefits that could come from productive use of the spectrum. Option c (one national high or low power licence and one low power licence) would provide two licensees with a limited amount of spectrum. This might adversely affect the viability of services as the spectrum would have to be split between licensees, and would limit the number of low power licences. Option d (one UK high or low power licence and two or more UK low power licences) might also adversely affect viability by splitting the spectrum, and would also generate more requirements for engineering coordination.

5.13 Two respondents to the SFR:IP favoured regional or local licensing along the lines suggested by option e (one regional licence, high or low power, per region in the UK). BAA and another respondent were of the view that licences should be made available specifically for the locations at which they considered offering services, for instance airports. However, Ofcom considers that regional licensing would be particularly difficult to implement because of the uncertainty over the optimal split of licences by region. Licensing on a local or regional basis is also more likely to make it difficult to deploy services flexibly across geographies. This may make it more difficult to serve areas with modest or low demand, creating an unnecessary barrier to deployment and to a wide geographical spread of services. Ofcom therefore considers that regional or local licensing is unlikely to promote optimal use of the spectrum, and should not be pursued.

Options b & f

5.14 Ofcom considers that, of the options discussed in the SFR:IP, the most credible for promoting optimal use of the spectrum are options b and f. That is, there is a choice between offering two or more concurrent licences for low power operation only (option f) or offering a licence for low or high power operation (option b). In both cases, licences should be UK-wide. In order to decide on the optimal approach to packaging

Ofcom has assessed the evidence available on what is likely to be the optimal use of the spectrum. Ofcom has also extended the analysis contained in the SFR:IP by considering whether the choice between high and low power configuration could be left to the market.

Likely demand for the spectrum

5.15 Ofcom has considered the evidence available on what is likely to be the most efficient use of the Spectrum Bands, taking account of what is known about likely demand. Ofcom is of the view that relative demand for particular uses is likely to be a key indicator of which use is likely to be the most efficient. This section reviews that evidence: the technical analysis by Ofcom; the responses to the two previous consultations, one by the RA and the other by Ofcom; and an economic study by NERA. Ofcom believes that this evidence, considered in the round, suggests that use for low power mobile services is likely to be the most efficient use. These low power services include innovative mobile communications services such as corporate networks, integrated cordless and mobile consumer services, and entertainment and information services in self-contained areas such as theme parks and museums.

Technical analysis

5.16 The full details of Ofcom's technical analysis are contained in the accompanying Technical Report. Section 6 of this document provides a synopsis of the technical analysis where it has been used as the basis for establishing particular licence conditions. As explained in section 4, Ofcom has concluded that low-power licence exempt use is not a viable option. The analysis also shows that, subject to engineering coordination, licensed use of the spectrum in a low-power configuration is viable.

5.17 As indicated in ERC Report 100, use of the spectrum in a high power configuration is also technically feasible provided that certain technical constraints are respected. The spectrum under consideration forms part of the overall GSM 1800 spectrum, 1710 – 1785 MHz paired with 1805 – 1880 MHz. According to ERC Report 100, interference into DECT receivers by use in the adjacent spectrum can be mitigated by imposing an EIRP limit of 54 dBm above a frequency of 1879.1 MHz and using the standard GSM mask above a frequency of 1879.9 MHz (based on a 54 dBm carrier). No additional conditions (other than applying the existing GSM licensed power levels below a frequency of 1879.1 MHz and applying the standard GSM mask) should be necessary to protect existing GSM and DECT uses from other high power technologies.

NERA study

5.18 This study (GSM Guard Bands – Economic Impact Study[12]) was commissioned by the RA and carried out by NERA in 2004. The study sought to quantify the potential net economic benefits of allocating the Spectrum Bands to high power use, for wide area mobile services, or to low power use. A number of potential low power applications were modelled based on interviews with potential providers of low power services. The consultants recognised that the innovative nature of low power use introduced uncertainty into forecasting the evolution of the market, particularly the growth in the number of subscribers and the willingness of consumers to pay for services. For this reason the consultants produced three scenarios, a base scenario and an upper and lower bound, which were mainly differentiated by the rate of growth of subscribers.

5.19 The key results from the NERA study are presented in the two tables below. The ranges of the results reflect the distribution of outcome by probability. The base

[12] http://www.ofcom.org.uk/consult/condocs/ra_condoc_2g3g_spectrum_old/gms.pdf

scenario is the most likely result, and accords best with the relevant past experience and the available evidence. The upper and lower bounds represent the limits of what could be reasonably expected and their probability is lower than the base scenario.

Table 5.1 - Net benefits of use of the Spectrum Bands including university service, £million NPV over 10 years

	Lower bound	**Base scenario**	Upper bound
Low power use	558	943	1468
High power use	41	128	552

Table 5.2 - Net benefits of use of the Spectrum Bands excluding university service, £million NPV over 10 years

	Lower bound	**Base scenario**	Upper bound
Low power use	151	307	547
High power use	41	128	552

5.20 Table 5.1 above shows that the welfare benefits from low power use could in some scenarios greatly outweigh the benefits from high power use. Ofcom recognises the results in the first table rely heavily on the contribution of one out of the five types of low power services modelled by NERA. Table 5.2 therefore shows the effect of excluding this service entirely from the calculation. In this case, the welfare benefits of low power use would still be significantly higher than for high power on the base scenario. There would however be a smaller difference between the two ranges, and the upper bounds would effectively be equal. The complete exclusion of benefits from this application is a conservative assumption.

5.21 It is possible that some technical issues may require a solution before some low power services could be provided (for instance to resolve issues such as seamless network selection when subscribers move between wide area and low power networks, and to allow calls to wide area network subscriptions to be able to terminate on a low power network). The costs of these have not been included in the model but it should be noted that these costs are not applicable to all potential low power uses. It is difficult to estimate the size of these costs as the solutions depend critically on the service offerings which may vary considerably. However the evidence available to Ofcom suggests that these costs, where applicable, are not such as to alter the conclusion that the benefits of low power use are likely to be larger than those of high power use.

5.22 Ofcom does not regard the NERA study as conclusive. However, it suggests that on a reasonably cautious interpretation of the evidence, low power use is likely to generate more benefits than high power use.

Consultations on the Spectrum Bands

5.23 Based on the conclusions of ERC Report 100, which was published in 2000, it is no longer considered necessary to keep this spectrum vacant to provide a guard band between adjacent GSM and DECT services, provided certain technical constraints are imposed. Since this conclusion was reached, Ofcom and the RA have consulted stakeholders on two separate occasions about the options for assigning this spectrum.

Responses to the RA consultation in 2003

5.24 In April 2003, the RA issued a consultation focusing on 3 options for the Spectrum Bands:

- scenario 1 - to award licences for the use of the Spectrum Bands available, on a national or regional basis, to either the existing GSM operators or to new entrants for the provision of public mobile telecommunication services;
- scenario 2 - to make the Spectrum Bands available for short-range, low-power use on a licence-exempt basis; and
- scenario 3 - to retain the guard bands and leave the Spectrum Bands unassigned, in order to assist migration of GSM 1800 to future IMT-2000 use and to facilitate Test and Development licensing[13].

5.25 There were 28 responses to the RA consultation. In general there were two types of response:

- those who favoured scenarios 1 or 3 (9 respondents). These were mainly GSM/UMTS operators who were already present in the UK mobile market, and certain equipment manufacturers; and
- those who favoured scenario 2 (17 respondents). These were mainly parties interested in potentially entering the UK mobile market. These were principally small businesses, and also BT.

5.26 A copy of the consultation, and a summary and text of the non-confidential responses can be found on the Ofcom website at: http://www.ofcom.org.uk/consult/condocs/ra_condoc_2g3g_spectrum_old/.

5.27 As set out in section 4, Ofcom has concluded that licence exempt use is not an appropriate use of the spectrum. However, the responses to this consultation showed keen interest in the commercial potential for low power use. In general, the level of interest in low power use shown by respondents was greater than the level of interest shown in the potential for high powered use, or in Test and Development Licensing. Responses favouring the latter options did not identify any specific proposals for using the spectrum in these configurations, nor did they identify any particular commercial imperative.

Responses to the SFR:IP

5.28 The options considered in the SFR:IP are summarised above at paragraph 5.8. The preferred proposal was to award a limited number of low power licences.

5.29 Ofcom's proposals received broad support from the 30 respondents who commented on the Spectrum Bands, with the exception of the four UK mobile network operators (MNOs) with 2G networks and the UMTS Forum.

5.30 Of those who commented on the type of use, a large majority supported the proposals: 20 respondents were in favour of low-power use, while 3 MNOs and the UMTS Forum were not in favour or supported high power use. These 20 respondents include

[13] Test and Development licences allow temporary non-operational use of spectrum for the purposes of the development and testing of radio equipment. They are offered on the basis that they must not cause interference to and cannot claim protection from interference from other authorised users of the spectrum.

existing UK telecoms operators (BT, Pipex), 10 prospective new operators, prospective major customers or self-providers (BAA, UKSPA), representative bodies (Intellect, Wales Broadband Stakeholder Group, CSS Spectrum) and a number of manufacturers (Nortel, Siemens Communications, Siemens Traffic Controls). Ten of these organisations expressed clear interest in developing low-power services for commercial deployment while the others supported use of the spectrum for this purpose.

5.31 On the other hand, Orange indicated that the most appropriate allocation of the spectrum may be one national licence, for high power services. Both Orange and Vodafone argued that Ofcom should present further analysis to explain why low power use was likely to be more efficient. O2 questioned the evidence provided by the NERA study on the relative benefits of high and low power use, and described the study as "flawed". Ofcom has critically reviewed the study and presented its interpretation of results above (see paragraphs 5.18 to 5.22). It considers that the study, whilst not conclusive, suggests that low power use is likely to generate more benefits than high power use.

5.32 In summary, the consultation responses to the SFR:IP showed much stronger interest in low power use than in high power use of the Spectrum Bands, and the information that was supplied by those favouring low power use was considerably more detailed, with a number of examples of potential commercial applications. Only a small number of respondents argued against low power use or favoured high power use. Little or no interest was expressed in options not mentioned in the SFR:IP such as Test and Development Licensing.

Conclusion on likely efficient use of the Spectrum Bands

5.33 Ofcom has not received any other evidence to suggest that this spectrum is likely to be more efficiently used for high power services than for low power.

5.34 Having taken all the evidence available carefully into account, and having attached particular weight to the responses received to two successive consultations, Ofcom has therefore concluded that low power services are likely to be a more efficient use of the spectrum than high power.

5.35 Ofcom considers that use for low power services is also likely to be consistent with the objectives identified for the award in section 4. In addition to the evidence available about efficient use of the spectrum, the responses received to the consultation and the other analysis undertaken suggest that use for low power services could generate significant economic benefits. It could also promote the development of innovative services, given that low power services of the kind described by respondents are not presently available in the UK. It could also promote competition in the provision of electronic communication services, as the assignment process will provide additional opportunities for operators to provide electronic communications services.

Could an auction efficiently determine the choice between high and low power use?

5.36 It is appropriate to consider whether the assignment process for the spectrum could allow the choice between high and low power use to be made by the market. In principle it would be desirable for this choice to be made by the market, as more information should be available to the market than to the regulator. Ofcom has therefore considered carefully whether in this particular case an auction could be designed that would allow bidders to choose efficiently between high or low power use as part of the primary assignment process. Ofcom has considered this issue with

independent expert auction advisers, and has concluded for the reasons set out below that there is a material risk that such an assignment process would not be efficient.

5.37 Ofcom's judgement is that the risk (and potential adverse consequences) of a distorted and inefficient assignment process is greater than the risk (and potential adverse consequences) of high power use in fact being more efficient than low power use. In making this judgement, Ofcom has taken into account not only the analysis of auction efficiency set out below, but also the evidence available for the relative efficiency of high and low power use. Ofcom has also taken into account the potential for the optimal use of the spectrum to change over time, and for low power use to change to high power use by means of licence variation.

5.38 Ofcom has therefore concluded that the award process should be designed to offer low power licences only to the market.

5.39 Ofcom has identified two particular difficulties in using an auction to determine use of the spectrum as between high and low power use. These are:

- A potential to facilitate the foreclosure of competition in the provision of low power services;
- Potential distortions that could be caused in this assignment process by wide asymmetries between different types of bidder for different types of licence.

5.40 In order to allow the auction process to determine in a straightforward manner between use of the spectrum for high and low power use, it would be necessary to offer to the market a licence that would allow high power use as well as one or more licences that allow low power use. The analysis set out earlier in this section shows that, in the high power scenario, there is only enough spectrum for one licence sensibly to be offered. An auction might therefore be designed that offered one high power licence, and two or more low power licences.

5.41 However, as discussed in more detail later in this section, Ofcom considers that it is appropriate to set a minimum number of licences in the low power configuration that reflects the desirability of promoting competition in the provision of any new low power services. Ofcom has proposed to set this minimum number at five. If this policy is adopted, an auction that offered both low and high power licences could therefore take the form of offering a single high power licence and a minimum of five low power licences.

5.42 Ofcom considers that this would be an anomalous structure that could lead to a number of undesirable consequences. For example, any bidder who wished to offer low power services, but not to face competition, could bid for the single high power licence, and thereby sidestep the minimum constraint on number of low power licences. There would be no requirement for the bidder actually to operate the spectrum in a high power configuration, as the power level is a limit rather than a requirement. Ofcom's powers under competition law and sectoral legislation could be used after the auction to address any distortions of competition, but Ofcom considers that it is undesirable to design the award process so that it could have this consequence. It is also possible that different competitive conditions in providing low and high power services could affect the outcome of the auction in these circumstances. For example, if bidders anticipated more intense competition in providing low power services than high power, this would tend to favour the high power outcome in the auction.

5.43 The second issue relates to the potential effect of asymmetries between the bidders for different types of licence. Bidder asymmetry is an issue in auction design that has been discussed at length in the economic literature. 'Asymmetry' in this context refers to bidders' awareness that there are predictable differences between them in the probability of success in an auction. In any market, whether or not it is effectively competitive, existing operators will tend to have an advantage over new entrants. The sources of this advantage may be varied, but will typically reflect superior access to information and possible first mover advantages. Asymmetries can create inefficiencies in the outcome of an auction when they affect the relative willingness of different bidders to participate in an action, and when they differentially affect the propensity of bidders to bid amounts close to their willingness to pay for a particular resource. Broadly speaking, an auction is more likely to be efficient if a wide range of parties are encouraged to participate, and if their bids reveal their willingness to pay, as this will make it more likely that the resource is assigned to the person who can make most efficient use of it.

5.44 In this case, the evidence available to Ofcom suggests that there could be large asymmetries between potential bidders for a single high power licence and for multiple low power licences. The bidders for a single high power licence might include operators already in the fixed or mobile telecoms sectors. The bidders for multiple low power licences may include some of these parties, but also seem likely to include many smaller businesses and potential new entrants to the sector. Auction theory and practice suggest that, in general, large asymmetries between bidders can lead to inefficient outcomes. This is because 'weaker' bidders (typically smaller businesses and new entrants) are likely to perceive a threat that their 'stronger' rivals would always outbid them. This may deter them from bidding even if they could in fact make more efficient use of the spectrum, given the time and resources required to participate in an auction.

5.45 Asymmetry between bidders can be addressed to some extent through the details of auction design, for example through the use of sealed bid auctions and restricting transparency (such as not revealing the identity or number of bidders). Measures such as these may carry some cost, but the net effect may often be beneficial. However, Ofcom's view is that measures such as these are not likely to be sufficient to counter the asymmetry that may arise from allowing bids for a single high power licence in parallel with bids for low power licences.

Conclusion – proposal to specify low power usage (option f)

5.46 Ofcom has set out above its assessment of the available evidence on the likely efficient use of the Spectrum Bands. Ofcom has also set out its view that, in this particular case, there are likely to be difficulties with using an auction as the mechanism for choosing between high and low power uses. Accordingly, it has concluded that specifying low power usage is the most appropriate basis on which to grant rights under wireless telegraphy licences to use the Spectrum Bands. It therefore proposes to package the spectrum in line with option f, i.e. 2 or more low power concurrent UK licences.

5.47 Further, Ofcom submits that this approach meets its objectives in relation to the award and is consistent with the things that it is required to secure and to have regard to under its statutory duties as set out in section 3.

5.48 Awarding wireless telegraphy licences in a way which is most likely to allow the successful provision of low power services is likely to lead to the optimal use of the spectrum, and to encourage investment and innovation. The evidence of existing

demand and the possible economic benefits which different uses could generate both suggest that low power use is likely to be optimal. Such a use is also likely to lead to the provision of new services thereby promoting innovation and competition. By contrast the provision of high power services is likely at best simply to extend the provision of existing mobile services.

5.49 Similarly, the availability of a wide range of services in the UK is likely to be best secured and the development of innovative services taken into account if low power services are enabled. To date, the innovative low power services mentioned in paragraph 5.15 could be offered by existing licensees but have not been developed and it seems likely that high power use would only enable further capacity to be provided for existing services.

5.50 Both the consultation responses and the NERA study also illustrate a significant demand for the use of spectrum for low power services, whereas demand for high power use seems less clear. There should also be alternatives for the provision of high power mobile services, as Ofcom has proposed in the SFR:IP to make available for high power licensed use a wide range of bands in the next few years.

5.51 Finally, Ofcom recognises that there is a small risk that the high power use of the spectrum might in fact be the economically most efficient use, although this appears low from the available evidence. In this case the possibility exists that the low power licences could be purchased in the secondary market. A licence variation to high power use could then be requested. Ofcom would, of course, consider such a request on its merits at the relevant time.

Technology neutrality

5.52 As set out elsewhere (see in particular: SFR, SFR:IP and Liberalisation Statement) and consistent with its statutory duties, Ofcom's preferred approach is to remove restrictions in existing wireless telegraphy licences that are no longer proportionate or objectively justified, enabling users to make better use of the spectrum and to introduce a wider range of services and technologies. Equally, when granting new wireless telegraphy licences Ofcom is of the view that, since technologies can change and develop over time, any prescription about the permitted use of the spectrum must be justifiable and proportionate. Ofcom does not wish to constrain future use of spectrum by being unnecessarily prescriptive in licence terms, where this is not necessary for spectrum management reasons. This suggests being as non-prescriptive as possible in licences about the permitted use of spectrum.

5.53 Ofcom considers that this approach is also supported by the fact that the Framework Directive requires that national regulatory authorities take the utmost account of the desirability of making regulations technologically neutral. As a consequence, Ofcom is required in section 4 of the Communications Act 2003 to meet a number of duties relating to "community requirements". One of these is a requirement to act in a technology neutral way.

5.54 Consistent with this general approach, Ofcom intends to release unused bands to the market with only those technology and usage restrictions that are the minimum necessary for the efficient management of the radio spectrum and the avoidance of interference, and compliance with Ofcom's statutory duties and international obligations.

5.55 Ofcom's technical analysis, highlighted in section 6, indicates that it is not necessary to place any technology or usage restrictions on the Spectrum Bands other than power

level (per carrier), antenna height and out-of-block emissions. In particular, Ofcom has analysed the impact of deploying a typical wideband system (based on cdma2000 1x) on a typical narrowband system (based on GSM) in neighbouring office buildings. The conclusion was that use of a typical wideband system would not substantially alter the probability of interference from the deployment of two narrowband systems. Ofcom therefore does not consider that it is necessary to specify the use of any one technology over any other provided the restrictions in section 6 are respected.

5.56 Most respondents to the SFR:IP supported the release of the Spectrum Bands in a technology and application neutral way. A few argued in favour of the GSM technology being mandated for low power uses to minimise interference concerns and favoured the use of Dynamic Frequency Selection and Automatic Power Control were suggested as means of adapting emissions to minimise interference (see Annex E for further details). Ofcom's technical work suggests that this is not necessary and therefore it does not believe it is appropriate to impose such restrictions (see the Technical Report).

5.57 Some respondents, specifically existing MNOs, generally expressed the view that the flexibility allowed by technology and application neutral licences which would allow mobile use in new spectrum licences would be unduly discriminatory. Ofcom does not believe that this would be the case and the issue is discussed in section 6 (paragraphs 6.51 to 6.59) and in Annex E.

5.58 Another relevant issue is the application of the relevant ECC Decision. As already indicated, the spectrum under consideration forms part of the overall GSM 1800 spectrum, 1710 – 1785 MHz paired with 1805 – 1880 MHz. This spectrum was identified in ERC Decision (95)03[14] for the provision of mobile telephony services based on GSM technology[15]. ERC Decision (95)03 does not however prevent this spectrum from being offered on a technology and application neutral basis given that:

- the UK has already made available the vast majority of spectrum (2 x 71.7 MHz) covered by the Decision available for GSM 1800 use; and
- the Decision itself only requires 2 x 20 MHz of spectrum to be made available for GSM 1800 (by 1 January 1998).

5.59 In making this spectrum available in a technology neutral way, licensees will have the freedom to deploy GSM technology if they wish. They will not however be required to do so. Ofcom considers that this is a proportionate and objectively justifiable approach, that provides the most appropriate means of meeting Ofcom's objectives for the award and its duties under UK and European law. It is not unduly discriminatory and it is transparent as to what it seeks to achieve.

Number of concurrent low-power licences

5.60 As explained in section 4, Ofcom considers that it is necessary given its technical analysis, to limit the number of licences. Accordingly, Ofcom has identified three main options for setting the number of concurrent low power licences to award:

[14] ERC Decision of 1 December 1995 on the frequency bands to be designated for the introduction of DCS 1800, available at http://www.ero.dk/documentation/docs/docfiles.asp?docid=1492&wd=N

[15] Please note that ERC Decision (95)03 uses the term DCS 1800. Since the adoption of this Decision use of the term GSM 1800 has essentially replaced this and for all intents and purposes GSM 1800 and DCS 1800 are the same.

a. setting a fixed number of licences, allowing bidders to bid for only one licence each;

b. setting a fixed number of licences, allowing bidders to bid for more than one licence (i.e. aggregating licences within the primary auction); or

c. setting a minimum and maximum number of licences, using an auction format that allows the market to determine the number of licences within this range.

5.61 There are three key factors that need to be taken into consideration when setting the number of licences (or the range as in option (c) above):

i. competition between low power users;

ii. the costs of engineering coordination between licensees; and

iii. issues relating to auction design, in particular the complexity of process and consequences of the pricing rule.

5.62 The main benefit from making available a large number of licences is the potential for greater competition in downstream markets, which can normally be expected to increase economic benefits. Having more licences also offers the advantage of accommodating a larger proportion of demand, which in turn can normally be expected to maximise the scope for innovation in the development of low power services.

5.63 However, the main downside of having a large number of licences is the increase in engineering coordination costs because of the risk of undue interference. The increased costs are likely to provide a financial disincentive to businesses such that there could be less efficient use of the spectrum. Though most respondents to the SFR:IP who expressed an interest in providing low power services appeared to have little concern about the impact of engineering coordination costs, Ofcom's own analysis indicates that such engineering coordination is likely to be a significant issue if the number of licensees in the Spectrum Bands is large, and that this may have been underestimated by some respondents. One other consideration favouring a smaller rather than larger number of licences relates to the ability to aggregate licences in the future if a change from low to high power use becomes desirable. Such a change would require Ofcom's consent to a variation.

5.64 The information available to the regulator makes it difficult for Ofcom to identify precisely the optimal number of licences to be issued. Both the benefits and costs of different numbers of licences depend on the services deployed, and on the market's considered view of the extent of engineering coordination costs. However, the following conclusions can be drawn.

a. There are likely to be diminishing incremental competition benefits from increasing the number of players. In principle, going from two to four players should have a much larger positive impact than, say, six to eight.

b. The incremental costs of coordinating additional providers are likely to be more complex. With two players, engineering coordination is likely to be relatively simple, so a shift to four licences would make a big difference. By contrast, with say eight licences, multilateral procedures for coordinating many parties would need to be in place, so extending these to ten may make a less significant difference, particularly if all operators

were not operating simultaneously at any given location. However, the cost of engineering coordination will continue to increase as the number of operators increases.

5.65 The other relevant consideration in deciding between these options is that of the responses to the SFR:IP. Comments on the number of licences to be awarded largely pointed towards greater numbers than Ofcom envisaged in the SFR:IP proposals (a maximum of 6). Twelve respondents were in favour of 6 or more licences being awarded, with varied suggestions from 6 to as many as possible, or even an unlimited number of licences. However, a majority of respondents who provided comments on the number of licences supported the award of between 6 and 14 licences. Only five respondents suggested 6 or fewer licences; of those five, two favoured the award of a single national licence.

5.66 In the light of these considerations Ofcom's assessment of the merits of the three options in paragraph 5.60 is as follows.

a. The first option looks undesirable. Given the uncertainty over the trade off between costs and benefits with the number of players, it is unlikely that the regulator would be successful in picking the optimal number of players and therefore this option suffers from a material risk of regulatory error.

b. The second option provides more flexibility but is still problematic. If Ofcom offers too many licences, then it would be possible for bidders to reduce the number of licences by aggregating licences in the auction (if allowed by the auction rules). However, this does not address the problem if Ofcom offers too few. Also, if one bidder buys two concurrent licences, they would likely be paying double the price, but their usage rights and engineering coordination benefits would be the same as a bidder who acquired only one licence. Any reduction in engineering coordination costs would benefit all users, not just the user buying the additional licence. Therefore, this approach would not provide efficient incentives for bidders to purchase multiple licences to mitigate engineering coordination costs.

c. The third option appears to be the most attractive. It would avoid the need to set a fixed number of licences and would allow the market greater freedom to efficiently identify the number of concurrent licences within a defined range, with the minimum number being set to address competition considerations. An auction mechanism would need to be constructed that would allow the benefit of reducing engineering coordination costs to be traded off effectively against the increased scarcity that this creates.

5.67 Ofcom has therefore undertaken extensive work, with its independent expert auction advisers, on the scope for designing an auction along the lines of the third option. The details of the proposed auction design are set out in sections 7 and 8 of this document.

5.68 In the rest of this section, Ofcom considers the remaining question in relation to the number of licences, which is the specification of the lower and upper bounds.

5.69 In Ofcom's view, it is necessary to set lower and upper bounds. This is for several reasons. These include the need for a limitation on the number of licences in order to ensure that engineering coordination is feasible and therefore to promote efficient use of the spectrum. It is also important that the award process is itself a robust and practical process that does not involve undue complexity for bidders. This points towards defining a range of options for bidders that is readily comprehensible, while

reflecting the evidence available as to the parameters most likely to optimise use of the spectrum. Ofcom has also taken these considerations into account in addressing what the upper and lower bounds on the range should be. In particular, Ofcom has also paid regard to the desirability of promoting competition, and to the evidence of demand that has emerged from responses to the SFR:IP. In principle, it is desirable to offer the opportunity to meet such demand, to the extent that it is compatible with efficient spectrum use and the avoidance of excessive engineering coordination costs. It is also desirable in principle to offer the market a wider rather than narrower range of options (subject to other considerations above) so that the scope for a market-determined outcome is enlarged.

5.70 Ofcom proposes that the lower limit on the number of licences awarded should be five. This proposal reflects a number of considerations in particular:

- the responses to the SFR:IP consultation, which suggested strong demand for the award of six or more licences, assuming the spectrum was for low power services. In Ofcom's view, it is possible (as discussed at paragraph 5.63) that engineering coordination costs may be somewhat higher than respondents had at that stage identified. However, in Ofcom's view, the responses to the SFR:IP offer strong support for awarding a minimum number of licences that is not much below six;
- the promotion of competition. It is not clear (especially given the technology and application neutral nature of the award) in what economic market(s) the services supplied by licensees will fall. However it is possible that they will constitute one or more new economic markets. It would be possible to rely on relevant powers under sectoral and competition law to address competition issues that may arise. However, Ofcom also considers that it is a reasonable use of its discretion to put weight on the promotion of competition in deciding on the licensing structure for the Spectrum Bands. Given the information received in response to successive consultations as to likely applications, and the scope for offering multiple concurrent low power licences, Ofcom considers that it is reasonable to set a minimum number of licences for award that is likely to have benefits by way of promoting competition. Ofcom considers that this objective should be met by setting a minimum of five licences more assuredly than by setting a lesser number as the minimum;
- the implications of the pay what you bid pricing rule. Ofcom believes that the most appropriate pricing rule for this auction is a 'pay what you bid' approach (see section 8, paragraphs 8.2 to 8.13, for details on the proposed pricing rule). However, a possible side effect of this rule is that it may create a modest bias towards fewer licences being awarded than would be efficient. As the number of licences available increases the expectation of the value of the marginal losing bid will fall and therefore bidders would expect to be able to bid less to obtain a licence more cheaply (relative to their valuation) as there is less competition within the auction. Conversely, stiffer competition between bidders within the auction for fewer licences is likely to lead to bids that are closer to bidders' valuations. This creates a potential bias towards too few licences being awarded. This suggests setting a higher rather than a lower minimum bound of licences to reduce the risk that the auction awards fewer licences than would be optimal.

5.71 For this combination of reasons, Ofcom proposes that the lower limit should be set at five licences. Ofcom does not consider that there is any evidence to suggest that a minimum greater than five is required on competition grounds. The risk of inefficiency for the award process by preventing the eventual number of licences at award from being four or less seems low compared with the likely benefits on competition and innovation in the provision of services and promotion of optimal use of the spectrum if

the minimum number of licences for award is five. Also a lower minimum number would lead to a greater risk of inefficiency in the award process given the slight bias towards fewer licences which is created by the pay what you bid pricing rule. Finally, with candidates being invited to bid for one licence within five or more, the risk of adverse effects arising due to asymmetries between bidders should also be reduced.

5.72 In considering the upper limit on the number of licences for award, Ofcom has taken into account a number of considerations including:

- the need to reduce undue complexity in the auction process. The higher the upper bound the larger the number options that will be available and therefore the more scenarios bidders will have to consider and value. This may affect the decision of interested parties to participate in the auction. An aim of the process is to make it as simple as possible as that is likely to facilitate participation in the auction and so encourage entry so as to facilitate an efficient outcome; this suggests not setting an upper bound that is too high;
- the need for the number of licences awarded to be workable in terms of managing interference. While the purpose of the menu bidding auction design is to allow the market to assess the extent of the coordination costs, Ofcom considers that it is appropriate to bound that assessment. This is to guard against the possibility that the auction leads to the award of too many licences for the engineering coordination to be managed successfully which would then lead to the spectrum either being used inefficiently or not at all. This is a particular concern since Ofcom will have limited powers (see section 6) to revoke licences during the minimum term;
- the responses to the SFR:IP and the overall level of demand expressed. As described in paragraph 5.65, a number of respondents to the SFR:IP expressed support for more than 6, or 14 or fewer licences. This suggests the upper bound should lie within that range.

5.73 Taking these factors into account, Ofcom considers that it should set an upper bound of 10 licences. It believes that this represents an appropriate balance between the desire to accommodate as much demand as possible and the need to guard against unworkable outcomes and to reduce uncertainty and complexity in the auction process.

5.74 Accordingly, Ofcom is proposing to set a range of between five and ten licences for this award.

Section 6

Wireless Telegraphy licence conditions & other spectrum rights and obligations

6.1 This section sets out the proposed technical and regulatory conditions specific to the concurrent wireless telegraphy licences that Ofcom proposes to award for use of the Spectrum Bands. The underlying principle has been to keep restrictions on the use of the Spectrum Bands to the minimum necessary for efficient use of the spectrum and the avoidance of undue interference. Many of the technical conditions Ofcom proposes are based on the conclusions of detailed technical analysis of power limits, interference, engineering coordination, etc. that Ofcom has conducted. For details of this technical analysis please see the Technical Report separately published today. Responses to the SFR:IP relevant to licence conditions are also addressed at Annex E.

6.2 A draft licence including the proposed licence conditions is included in Annex F.

Power level

6.3 In setting an optimum power level for concurrent low power use, Ofcom has had to balance a number of competing factors. The technical analysis Ofcom has conducted covers in-building networks providing services to corporate customers, outdoor networks to provide services to campus type environments and residential services in homes.

6.4 Ofcom proposed a power level of 23 dBm Equivalent Isotropically Radiated Power (EIRP) (200 mW EIRP) for the low power use of the Spectrum Bands in the SFR:IP consultation. No respondents suggested that a different level should be considered for low power use.

6.5 In order to provide service to a floor in a typical office building, the power level must be sufficient to provide coverage over the expected range of floor areas. It must also be sufficient to provide coverage to a typical campus environment with adequate penetration to reach users inside buildings on campus. On the other hand the power level needs to be restricted so that the distance over which one low power system could potentially interfere with another is kept to a minimum.

6.6 Ofcom's analysis indicates that setting a power level of 23 dBm EIRP is sufficient to provide an in-building coverage radius of just over 50 metres. This power level is also sufficient for an external cell to provide coverage to a depth of 40 metres within nearby buildings up to approximately 50 metres away (or to a depth of 30 metres for buildings up to approximately 140 metres away). A power level of 0 dBm EIRP (1 mW EIRP) is sufficient to provide coverage inside a typical residential property. As a simple comparison a power level of 23 dBm EIRP (200 mW EIRP) is similar to that of a DECT cordless phone base unit and approximately 1000 times lower than a typical GSM macro cell.

6.7 In an example multi-storey office scenario (with an area of 50 x 120 metres per floor), two 23 dBm GSM pico cells per floor would meet the coverage requirements and could meet the typical traffic demand for approximately 300 people per floor (assuming that each pico cell uses 1 radio channel providing 7 user timeslots). A seven floor

frequency reuse plan would provide a call success probability above 97% for the building.

6.8 Ofcom has also analysed the typical distances over which interference between uncoordinated low power systems might be expected.

6.9 A probabilistic analysis of interference between neighbouring office buildings with in-building GSM pico cells operating on the same radio channel indicates that a 97% probability of call success inside each office would require a 550 metre separation between buildings for a 50 metre radius serving cell if there were no obstructions between them. A probabilistic analysis of interference from an in-building cdma2000 1x pico cell system into a neighbouring co-frequency in-building GSM pico cell system indicates that achieving a 97% probability of call success inside the office would require a 250 metre separation distance between the buildings if there were no obstructions between them.

6.10 In an example residential scenario, a probabilistic analysis of interference in a row of terraced houses with indoor GSM pico cells operating on the same radio channel indicates that a 97% probability of call success inside each house could be achieved with a separation of two houses.

Conclusion

6.11 The maximum power level should be restricted to 23 dBm EIRP per carrier. This is sufficient to provide reasonable coverage in typical scenarios whilst minimising the potential for interference over a wider area.

Antenna height

6.12 Ofcom's technical analysis indicates that unobstructed transmission paths from outdoor installations have the potential to cause interference to in-building systems over a wide area. This provides a compelling case to restrict the maximum height of outdoor antenna instillations.

6.13 An analysis of interference between a 23 dBm outdoor GSM cell and a 23 dBm indoor GSM pico cell operating on the same radio channel indicates that to maintain a 97% probability of call success for the indoor pico cell would require a 10 km separation. This separation distance can be reduced significantly if there are obstructions in the path. Adding a single 15 metre tall building in the path reduces the required separation distance to less than 800 metres for an antenna height of 10 metres. With two buildings in the path the call success probability of the pico cell system never drops significantly below 97% over the ranges modelled (190 – 540 metres).

6.14 The results indicate that building clutter is very effective at limiting co-channel interference and that inadvertent interference to a victim system is reduced significantly if the interfering transmitter height is below the level of surrounding clutter.

Conclusion

6.15 The maximum height of outdoor antenna installations should be restricted to 10 metres above ground level. This will increase the probability of buildings or other obstructions appearing in the path. An antenna height restriction need not apply to in-building installations due to the additional building losses.

Out-of-block emission mask

6.16 There are three issues that need to be addressed when considering the technical conditions that should be placed on the use of the Spectrum Bands to protect neighbouring spectrum users:

- out-of-band interference into the GSM band below 1876.7 MHz;
- out-of-band interference into the DECT band above 1880 MHz; and
- DECT receiver blocking due to out-of-band DECT receiver performance.

Interference into GSM in 1805 – 1876.7 MHz

6.17 In the 1805 – 1876.7 MHz GSM band, it is recognised that adjacent channel operation requires coordination between operators. In practice operators are likely to maintain a guard channel to reduce the risk of mutual interference at any specific location. The level of emissions that can be expected within an operator's block is known because the adjacent operators are using GSM, which has a mask defined in the standard (GSM 05.05).

6.18 In order to maintain this situation and avoid the risk of increased interference into the adjacent GSM block, the following is proposed:

- 1876.7 – 1876.9 MHz should be left unassigned;
- below 1876.9 MHz a mask based on the standard GSM mask should apply.

Interference into DECT in 1880 – 1900 MHz

6.19 Out-of-band interference from the spectrum band 1876.7 – 1880 MHz can be limited by applying a mask based on the GSM standard mask above 1879.9 MHz, noting that GSM radio channels are on multiples of 200 kHz and the mask begins 100 kHz away from the carrier frequency.

DECT receiver blocking

6.20 According to ERC Report 100, blocking of an in-building DECT receiver by an outdoor GSM system can be mitigated by imposing an EIRP limit on part of the 1876.7 – 1880 MHz band. Drawing on the analysis in ERC Report 100, a maximum capacity reduction (averaged across the DECT band) is 3.2% for a 54 dBm EIRP GSM system operating in the band 1879.1 – 1879.9 MHz.

6.21 Given that Ofcom is proposing a maximum power of 23 dBm EIRP per carrier DECT receiver blocking will not be significant.

Conclusion

6.22 The following out-of-block emission mask is based on the emissions from a macro cell employing a transmitter power of 42 dBm[16] and an antenna gain of 18 dBi. These emissions have been expressed relative to the maximum carrier power of 23 dBm which has been proposed for the Spectrum Bands. This emission profile is sufficient to protect the adjacent band.

[16] Source: ERC Report 100

Table 6.1 - Proposed out-of-block emissions for the Spectrum Bands

Offset from edge of block	Maximum permitted level	Measurement bandwidth
0 MHz to 0.3 MHz	-103 × Δ*f* dBc	30 kHz
0.3 MHz to 0.5 MHz	-17.5 - (45 × Δ*f*) dBc	30 kHz
0.5 MHz to 1.1 MHz	-40 dBc	30 kHz
1.1 MHz to 1.7 MHz	-43 dBc	30 kHz
1.7 MHz to 6 MHz	-45 dBc	100 kHz

where Δ*f* is the frequency offset in MHz
and the block edges are defined as 1876.9 MHz and 1879.9 MHz.

Licence exemption for user stations

6.23 The technical conditions outlined above only cover the case of emissions from the base station (transmitting in the band 1876.9 – 1879.9 MHz). Ofcom expects user handsets (transmitting in the band 1781.9 – 1784.9 MHz) to be covered by licence exemption regulations and these will have conditions that essentially mirror those already applied to GSM 1800 handsets (though with no constraints on use or the choice of technology).

Engineering coordination between concurrent licensees for interference management

The need to coordinate

6.24 The Spectrum Bands fall within the operating range of standard GSM mobile phones. Though Ofcom plans to make the spectrum available on a technology neutral basis, it is quite possible that licensees will utilise GSM technology to provide low power services in order to tap into the wide availability of existing and new GSM handsets. However, use of alternative technologies (e.g. cdma2000 1x) cannot be ruled out.

6.25 In order to explore the potential for systems to share the spectrum, Ofcom has conducted technical analysis of the interference potential between two low power narrow band users (based on GSM) of the Spectrum Bands and between a low power narrow band user (GSM) and a wideband user (based on cdma2000 1x).

6.26 The results of this analysis indicate that there is potential for systems in neighbouring buildings to interfere with each other over distances of up to approximately 500 meters and that an outdoor system could interfere with an indoor system up to approximately 10 km away (if there are no obstructions between them). The distances over which adjacent systems cause significant interference reduce if there are obstructions (such as other buildings) between them; nevertheless, there is still a risk of interference.

6.27 These results are based on maximum powers of 23 dBm EIRP per channel. In order to mitigate against the extended influence of outdoor systems Ofcom is also proposing a maximum antenna height of 10 metres for such systems. Ofcom's conclusion is that use of a typical wideband system would not substantially alter the probability of interference compared to deploying narrow band systems.

6.28 Thus, on a technology neutral basis and even with the power and external antenna height restrictions, engineering coordination between licensees will be necessary to reduce the probability of mutual interference between systems within a reasonable vicinity of each other.

Proposed approach to engineering coordination

6.29 Licensees will be under a general obligation to coordinate on a best endeavours basis and to negotiate in good faith where interference occurs.

6.30 In principle, Ofcom proposes to allow concurrent low power licensees to manage the engineering coordination process amongst themselves. There may be a need for licensees to exchange information on the location and characteristics of base stations and to come to local arrangements on sharing spectrum, siting of transmitters, power levels, etc. Exactly what information is exchanged (if any) and how this is managed should be left up to the industry to agree. The arrangement relating to this engineering coordination should be formalised by the establishment of an industry Code of Practice.

6.31 Ofcom proposes to require all concurrent low power licensees to agree such a Code of Practice within 6 months after the licences are awarded. The Code should deal with the procedural and technical issues with managing engineering coordination. This Code of Practice will need to set out clearly defined principles which will allow the licensees and Ofcom to judge whether an individual licensee is complying with the Code.

6.32 The objective of the Code should be to promote efficient use of the Spectrum Bands so that, as far as possible, systems are deployed in a manner that will allow similar and competing services to be deployed alongside each other (e.g. in neighbouring premises and locations, including on different floors of the same building). In developing the Code, Ofcom would expect that, as a minimum, the following principles should be considered[17]:

a. Efficient frequency use of the Spectrum Bands (e.g. not using more channels than is absolutely necessary to provide an effective service to customers);

b. Possible conditions on limiting transmission powers (below the licensed limit) to that just necessary to effectively provide service;

c. Selection of sites and the siting of equipment within customer premises and elsewhere in a manner that will minimise the probability of mutual interference; and

d. Identifying the type of information that needs to be communicated between licensees and the arrangements for its exchange.

6.33 Mitigation techniques such as automatic power control and dynamic frequency selection may be considered for inclusion in the Code of Practice where they can be implemented on a technology neutral basis.

6.34 Licensees should be aware that the Code, and the activities of the licensees in connection with engineering coordination, need to comply with the requirements of competition law and any other relevant legal requirements.

6.35 The proposed licence will also give Ofcom the power to impose an engineering coordination procedure if absolutely necessary (e.g. where licensees either fail to

[17] This does not necessarily imply that the Code should contain conditions related to all of these principles.

agree the Code or where it is clear that the objective sought by the Code is not being achieved either through lack of cooperation or shortcomings in the Code itself).

6.36 As a matter of policy, Ofcom will not have a role in resolving individual engineering coordination disputes. Ofcom will only become directly involved where the objectives sought by the Code of Practice are clearly not being secured. Such involvement will be limited to the imposition by Ofcom of a Code of Practice setting out a relevant engineering coordination procedure rather than the micro-management of individual coordination requests. Where a licensee fails to abide by a Code of Practice that has been imposed by Ofcom, this will be treated like any other breach of licence conditions and therefore it is possible that it could lead to Ofcom revoking the licensee's licence.

Licence term

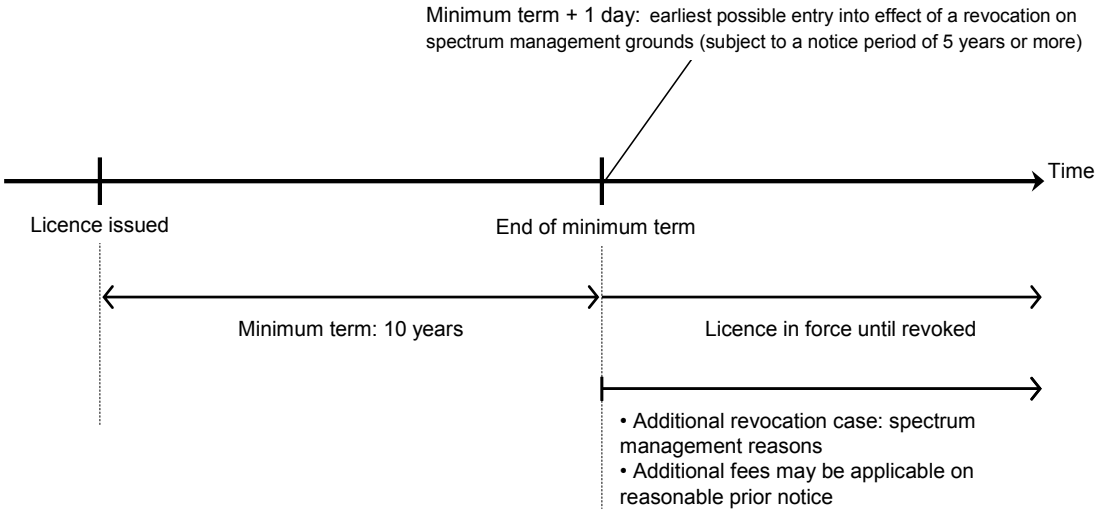
6.37 It was proposed in the SFR:IP that new licences to be awarded by auction should generally have an indefinite term with a minimum period. During the minimum period the grounds for revocation by Ofcom would be very restrictive and would not include a general right to revoke for spectrum management reasons. After the end of the minimum term, the grounds for revocation by Ofcom would be wider, and would include the ability to revoke the licence for spectrum management reasons, provided that a minimum notice of 5 years was given. Ofcom also proposed that notice of revocation for spectrum management reasons could be given so that the licence ended the day after the expiry of the minimum term.

6.38 The aim of these proposals was to provide licensees with a minimum period during which they would have high security of tenure, and grounds for revocation would be limited to a narrowly defined set of conditions. The period of the minimum term should be linked to a reasonable view of the period required to earn a return on the investment anticipated for efficient use(s) of the spectrum. The aim of proposing an indefinite duration was to give the licensee the opportunity to continue operating its business beyond the minimum term. However, during this period Ofcom would be able to recover the spectrum by serving a notice of revocation in a similar manner to many other spectrum licences, if this step was justified on spectrum management grounds.

6.39 Consistent with the Interim Statement on the SFR:IP, Ofcom proposes to take the following approach to the award of the Spectrum Bands.

- The licences will have an indefinite duration.
- The licences will have a minimum term of 10 years.
- The licences may be revoked before the expiry of the minimum term on the limited grounds set out below in paragraph 6.44.
- The licence may be revoked from any point after the expiry of the minimum term on the grounds set out in paragraph 6.44. It may also be revoked for spectrum management reasons subject in this case to giving 5 years notice. Notice of revocation may be issued during the minimum term, for revocation to take effect after the minimum term.

Figure 2. Graphical illustration of the licence term



Tenure during the minimum term

6.40 The proposed minimum term is designed to provide licensees with a high security of tenure for investment planning purposes. As described at paragraph 6.44, during that period, Ofcom will have limited powers to revoke licences and will not be able to do so for spectrum management reasons.

6.41 In determining the length of the minimum term, Ofcom has considered the relevant period that is appropriate for the likely services and provides a reasonable chance for likely businesses in the Spectrum Bands to make a return on their investment. This is based in particular on assessments of-

- initial fixed costs and operating costs to exploit the spectrum;
- the time likely to be needed to roll-out an operational service;
- a reasonable estimate of the time that may be required to earn a return on investment.

6.42 Ofcom has reviewed the evidence at its disposal for the purposes of judging the appropriate minimum term. The analysis in the NERA study suggests that a payback period of up to 8 years might be necessary for low power concurrent services to recover their investment, depending on the particular applications deployed. Ofcom has taken account of the fact that, subject to appropriately incentivising investment, it would be desirable to keep the minimum term as short as possible in order to avoid unduly constraining future spectrum management.

6.43 However, Ofcom considers that the disadvantages of setting a minimum term that is shorter than necessary are likely to be greater than the disadvantages of setting a period that is longer than necessary. This is because an excessively short period may adversely affect investment incentives. Ofcom is therefore inclined to set a longer period than 8 years. Taking all these factors into consideration, Ofcom proposes a minimum term of 10 years.

6.44 During this minimum term the licence may only be revoked for the following reasons:

- With the consent of the licensee;

- For non-payment or late payment of the relevant licence fee;
- If there has been a breach of any of the terms of the licence;
- If the licensee has not complied with any requirement of any relevant trading regulations;
- If the licensee has not complied with the auction regulations under which the licence was awarded including any financial provisions including guarantees;
- In accordance with section 4(5) of the Wireless Telegraphy Act 1998. That section provides that notwithstanding any terms or provisions in a WT Act licence which restrict the exercise by Ofcom of its power to revoke licences, Ofcom may at any time, by notice in writing, revoke or vary licence terms if it appears to be requisite or necessary or expedient to do so in the interests of national security, or for the purposes of complying with a Community obligation of the UK or with any international agreement or arrangements to which the UK is party;
- If it appears requisite or necessary or expedient to do so for the purpose of complying with a direction by the Secretary of State to Ofcom under section 5 or section 156 of the Communications Act 2003.

After the minimum term

6.45 Once the minimum term has expired, the licence will remain in force and continue to be held by the licensee. Two additional conditions will then also apply. These are:

- one providing an additional power for Ofcom to revoke the licence on spectrum management grounds as described above; and
- one allowing Ofcom to apply annual licence fees.

6.46 It is important to note that after the expiry of the period of the minimum term it is possible that Ofcom may apply an annual licence fee. Whether or not a fee is charged will depend on Ofcom's general approach to fees for the use of spectrum at that time and how that general approach relates to these licences. Such fees could be set at a level to recover a share of the costs of regulation; it may alternatively be based on Administrative Incentive Pricing (AIP). This provision will allow for the potential application of AIP to the licensed use of the spectrum after the end of the minimum term if this is appropriate in the context of Ofcom's statutory duties. AIP presently plays an important role in incentivising efficient spectrum management, and Ofcom has stated that it expects to continue applying AIP after introducing spectrum trading in order to promote efficient use of the spectrum.

6.47 Ofcom does not consider that it is necessary or appropriate to specify now the level of the annual licence fees, if any, may be applied to the Spectrum Bands after the end of the minimum term. Ofcom would expect to bring forward proposals on this matter to a timescale that gave licensees reasonable notice of any relevant fees before they became payable.

6.48 Ofcom believes that it is necessary to include these additional licence conditions in relation to the licence period after the minimum term because of the need for the regulator to be able to intervene if required to promote efficient use of the spectrum. Ofcom has a high degree of confidence that the auction, including the payment of the auction fee, will secure efficient use of the spectrum during the minimum term. However, it is less clear that this objective will be met after the minimum term, or indeed for the entire indefinite duration of the licence. The longer the period over which

the regulator is required to look forward, the greater the uncertainty that exists. At present, the ability to revoke licences on spectrum management grounds, and the ability to charge fees (including to promote optimal use of the spectrum) are important mechanisms in the regulator's toolkit. Ofcom considers that it would be proportionate and objectively justifiable to include provisions allowing the regulator to take these steps after the end of the minimum term of these licences. Ofcom also considers that the inclusion of these provisions is transparent as to what it seeks to achieve and does not unduly discriminate against any person.

6.49 It is important to note that Ofcom would expect to give prior notice at the time of any specific proposal to use the power of revocation, or the charging of fees, and to consult as appropriate.

Summary of licence conditions

6.50 Ofcom has set out above its view of the appropriate terms to include in the licences for this spectrum and in summary these are:

- The maximum power level should be restricted to 23 dBm EIRP per carrier;
- The maximum height of outdoor antenna installations should be restricted to 10 metres above ground level;
- An out-of-block emission mask based on the GSM standard (GSM 05.05);
- Licensees will be under a general obligation to coordinate with each other on a best endeavours basis and to negotiate in good faith where interference occurs;
- Licensees will be required to agree a Code of Practice on engineering coordination within 6 months after licences are awarded;
- Ofcom will have the power to impose a Code of Practice where licensees either fail to agree an industry Code of Practice or where it is clear that the objective sought by the Code of Practice is not being achieved either through lack of cooperation or shortcomings in the industry Code itself;
- The licences will have an indefinite duration with a minimum term of 10 years;
- Licences may only be revoked for a limited set of reasons during the minimum term. After the minimum term licences could also be revoked for spectrum management reasons subject to 5 years notice which may be served during the minimum term;
- The licence fee will be determined by the auction and an annual licence fee (which may be based on AIP) may apply after the minimum term.

6.51 Ofcom believes that the proposed conditions meet the statutory requirements, set out in section 3, in particular the requirements only to impose terms that are objectively justified, non-discriminatory, proportionate and transparent.

6.52 In setting these terms, Ofcom has taken into account the available technical and economic evidence on the likely use of the Spectrum Bands and believes that these terms represent those necessary to ensure efficient use of the radio spectrum and therefore they are objectively justified. For the reasons explained in Section 5, Ofcom believes that specifying low power use is likely to ensure the most efficient use of the Spectrum Bands and on the basis of its Technical Report its view is that the power limit of 23 dBm EIRP per carrier, the antenna height and the emission mask (set out above) represent the requirements which are likely to allow the most efficient low power uses to develop. The Technical Report also makes clear that the Spectrum

Bands will only be efficiently used if the licensees carry out appropriate engineering coordination and therefore obligations are proposed to require that. The licence term specified is appropriate for services likely to be deployed, in particular as it gives the licensees sufficient security of tenure to invest, based upon the available evidence of the likely time for such businesses may require to earn a return on their investment, while preserving Ofcom's discretion on notice to revoke the licence for spectrum management reasons, after the minimum term, if it becomes necessary to do so. The proposed provisions on licence fees are objectively justified because they will either be determined by the bidders themselves in the auction (see section 8 for details) or if, as indicated above, following the expiry of the minimum term other licences fees are payable, these will be required to ensure continued efficient use of the Spectrum Bands or to recover a share of the regulatory costs.

6.53 Ofcom also believes that these licence conditions are proportionate since they are, in Ofcom's view based on the evidence available, the minimum set of restrictions which are required to promote efficient use of the Spectrum Bands and the promotion of competition. The proposed licence terms are also transparent in that they are clear as to the purpose in each case and will be set out in the licence, a working draft of which is included in Annex F.

6.54 Ofcom has also considered carefully whether the proposed licence terms will discriminate unduly against any other person, including existing licensees in other spectrum. Ofcom has concluded that the proposals do not involve undue discrimination. The reasons for this are discussed in more detail below, alongside discussion of a number of other points made by the mobile network operators.

Comments by mobile network operators on undue discrimination and certain other matters

6.55 The MNOs commented in some detail in response to the SFR:IP consultation, and in some cases commented in detail on matters affecting the licensing of the Spectrum Bands. Certain MNO respondents argued that offering new spectrum licences to the market, along the lines proposed in the SFR:IP, could give rise to undue discrimination against existing licensees. These points were made by some existing 2G MNOs in particular. In some cases, these comments were linked to other objections to Ofcom's proposals, such as the need for a number of pre-conditions to be met before any further spectrum auctions could reasonably proceed.

6.56 Those MNOs who raised the issue of undue discrimination pointed to various licence characteristics such as those proposed in this document (technology- and use-neutrality, indefinite term, tradability and absence of roll-out obligations). They argued that the inclusion of terms on these lines in any new licence could unduly discriminate against existing 2G and 3G licensees because the existing licences contain terms that are less advantageous. The existing 3G licences, for example, contain an obligation to roll-out to 80% of the UK population by the end of 2007. The 2G and 3G licences contain different provisions as to licence term, but in neither case does the licence have the same term as that proposed for the Spectrum Bands. Moreover, the existing 2G and 3G licences contain provisions constraining the technology that may be used, and the type of use of the spectrum.

6.57 The proposals in this document are for licences in the Spectrum Bands that are technology- and use-neutral, have an indefinite duration, and do not contain roll-out obligations. This document also proposes to extend spectrum trading to the Spectrum Bands.

6.58 The MNOs commented in varying degrees of detail on the specific case of these Spectrum Bands. O2 commented that the auction of this spectrum should not take place before 2007, and that various conditions should be met before the auction should proceed. O2 also suggested that the licences must include a moratorium on trading and liberalisation to 3G, unless Ofcom has previously decided to make such a facility available to all 2G licensees by the same time. O2 also suggested that if the licences in the Spectrum Bands are tradable, the existing 2G licences should be tradable, and that if new licences have an expectation of becoming rolling licences (i.e. with an indefinite duration), this should also apply to existing 2G licences.

6.59 T-Mobile commented on the release of new spectrum for 3G services at this juncture. It observed that this would be highly discriminatory as new spectrum would be available without any roll-out obligations, and as the release would occur while the existing 2G licence holders were not permitted to use their 2G spectrum for 3G use. T-Mobile also suggested that any spectrum licences offered to the market before 2012 should contain a prohibition on the provision of 3G services until the end of 2012, as by this period the current 3G operators would have had an opportunity to recoup their investment in licence fees and infrastructure.

6.60 Orange and Vodafone commented in less detail on issues that might be raised by the award of licences in the Spectrum Bands. Vodafone suggested that the award of new licences should contain (for a defined period) restrictions on their use for 3G services. Orange took a similar approach.

6.61 Ofcom has considered these comments carefully. Ofcom has addressed the issue of the timing of this award process, and the conditions that need to be met before it can proceed in Section 4 of this document and in the discussion of next steps. Ofcom notes that the spectrum is presently largely unused, but that it may be of substantial value if brought to productive use, and that there is significant evidence of demand. Ofcom considers that the suggestion made by some MNOs, that the award process should be further delayed, is inappropriate and inconsistent with Ofcom's statutory duties.

6.62 As discussed elsewhere in this section, Ofcom considers that a technology- and use-neutral approach to licensing the Spectrum Bands is proportionate, objectively justifiable and transparent, and it is the approach that best meets the requirements of the European legislative framework and of Ofcom's statutory duties. Ofcom considers that additional regulatory obligations on licensees in the Spectrum Bands, such as roll-out obligations or a requirement to use a specific technology, would not be objectively justified or proportionate.

6.63 As for the concern about undue discrimination, Ofcom considers that undue discrimination can 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.

6.64 Ofcom does not consider that the proposals in this document for licensing the Spectrum Bands involve any undue discrimination against the holders of 2G and 3G licences, or any other existing licence. This is because the licences that Ofcom proposes to offer in the Spectrum Bands are different in numerous respects from existing 2G, 3G and other licences. By way of example, the licences in these proposals are for concurrent use; they concern a limited quantity of spectrum; they are low-power; and they will be awarded by way of auction, as new licences.

6.65 By way of contrast, the existing 2G and 3G licences differ from the licences proposed for the Spectrum Bands in many material respects. For example, neither the 2G nor the 3G licences require concurrent operation. Both 2G and 3G licences allow high-power operation (but they do not preclude low power operation using 2G or 3G technologies). The 2G and 3G licences also both confer rights to transmit in much larger blocks of spectrum than the Spectrum Bands.

6.66 It is also relevant that the 2G and 3G licences differ in some respects from each other. As discussed in detail in the SFR:IP, the licences differ in relation to term and the conditions allowing revocation. The licences also differ from each other in relation to the conditions under which they were awarded. They have different provisions as to the permitted technologies and types of use, and the payment of fees. Ofcom has discussed these differences at some length in the SFR:IP, and has noted that they raise a number of complex issues that are sui generis to these licence classes.

6.67 Given the many differences between the existing 2G licences, the existing 3G licences, and the licences proposed for the Spectrum Bands, Ofcom does not consider that proceeding with its proposals for the Spectrum Bands can discriminate unduly against the existing 2G and 3G licensees, or against any other person.

6.68 The licences proposed for the Spectrum Bands constitute a different type or class of licence from those already that exist for 2G and 3G services, with rights that are different from and in some material respects inferior to the existing 2G and 3G licences. Ofcom considers that there can therefore be no undue discrimination against existing 2G or 3G licensees.

6.69 Ofcom notes two further points in this context. First, Ofcom is not proposing to place any restrictions on the holders of 2G or 3G licences (or for that matter any other person) from participating in the auction and competing to acquire one of the licences. Second, there can be no undue discrimination between holders of the licences proposed for the Spectrum Bands, as the same terms and conditions will apply to all.

Other coordination and interference management issues

Coordination with licence holders of neighbouring spectrum

6.70 The spectrum mask for out-of-band emissions should ensure that no specific coordination is necessary. However, if any interference with the neighbouring GSM licence holder is reported, Ofcom will expect concurrent low power licensees to cooperate with the neighbouring GSM licence holder to resolve the issue.

6.71 Due to its licence exempt nature, coordination with the neighbouring DECT users will not be practical. However, interference issues between the two bands are not expected to be a problem.

MoD use

6.72 There is some military use within the Spectrum Bands of which potential licensees should be aware.

6.73 In accordance with the UK Frequency Allocation Table, the Ministry of Defence ("MoD") operates transmitting earth stations at one or more of the following sites: Menwith Hill (Yorkshire), Oakhanger (Hampshire) and Colerne (Wiltshire) in or close to the band 1781.7 – 1785 MHz. Commercial operations in this band will have to accept any interference caused by these earth stations. In order to estimate the impact on

commercial operations, the following information about the levels of emissions from these sites within the band 1781.7 – 1785 MHz can be provided:

6.74 Menwith Hill:

- Maximum effective radiation in the horizontal plane: -25.8 dBW/Hz. There is a higher power emission outside the band, approximately 0.5 MHz below 1781.7 MHz.

6.75 Colerne:

- Maximum effective radiation in the horizontal plane: +14.5 dBW/Hz.

6.76 Oakhanger:

- Maximum effective radiation in the horizontal plane: +18.5 dBW/Hz.

6.77 MoD has informed Ofcom that the above figures are worst-case conditions in normal circumstances. In exceptional circumstances, these powers may be exceeded. MoD will seek to avoid such occurrences and, when they occur, to keep the duration to a minimum. Any interference at these times will have to be accepted.

Interference between UK and neighbouring countries

6.78 The UK has entered into cross-border coordination agreements that cover this band with both France and the Republic of Ireland. These agreements are based on GSM use and on the principle of preferred and non-preferred channels. They specify the field strength at the border that can be radiated into the territory of the neighbouring country. Permitted field strengths are higher for preferred channels than for non-preferred channels.

6.79 Given the proposed 23 dBm EIRP power limit and the 10 m restriction on outdoor antenna installations, it is extremely unlikely that the field strengths specified in the cross border coordination agreements will be breached. Nevertheless, Ofcom would expect concurrent low power licensees to respect the field strength requirements, including for non-preferred channels, contained in these and any future agreements negotiated with neighbouring countries.

6.80 Where licensees in neighbouring countries are operating within the terms of the cross-border coordination agreements, Ofcom cannot offer any protection to concurrent low power licensees operating in border areas (though the chances of interference are considered to be low).

6.81 It should be noted that internationally (in the ITU Radio Regulations), the Spectrum Bands under consideration are allocated to the FIXED and MOBILE Services. Although Ofcom's intention is to offer the spectrum on a technology and application neutral basis, licensees who intend to offer services outside the FIXED and MOBILE definitions should be aware that they will be operating under article 4.4 of the Radio Regulations which enshrines the principle that such use shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Radio Regulations. Therefore, if any use in the Spectrum Bands other than FIXED or MOBILE caused interference to users in other countries respecting the ITU allocation, Ofcom may have to take appropriate steps; also, if licensees in the Spectrum Bands, with uses other

than FIXED or MOBILE, suffered interference from services abroad that complied with the ITU allocation, they may have to accept such interference.

Spectrum trading

6.82 Ofcom has started the implementation of spectrum trading for selected licence classes in 2004, through the Wireless Telegraphy (Spectrum Trading) Regulations 2004[18]. The changes, described in the Spectrum Trading Statement, published in August 2004, introduced the possibility for licensees in specific classes to carry out:

- outright total transfers;
- concurrent total transfers;
- outright partial transfers; or
- concurrent partial transfers.

6.83 In the case of the Spectrum Bands, Ofcom proposes to amend the Wireless Telegraphy (Spectrum Trading) Regulations to allow the following type of transfer:

- outright total transfers, i.e. transfers of all of the rights and obligations arising under a licence to a third party.

6.84 Under an outright transfer, the rights and obligations being traded are transferred in their entirety from one party to another. Thus the original licensee (that traded the spectrum) no longer has any rights to use the traded spectrum.

6.85 The licences for award in the Spectrum Bands will not be concurrently held by all licensees as a result of the auction. They are distinct licences, but with identical rights and obligations for the concurrent use of identical frequencies nationally. Each licensee independently holds its rights and obligations.

6.86 Ofcom is minded not to allow transfers which would increase the number of licensees in the Spectrum Bands. These include:

- concurrent total transfers, i.e. transfers (of all of the rights and obligations arising under a licence) to a third party which result in a concurrent holding of those rights and obligations by the transferor and the transferee(s);
- outright partial transfers, i.e. outright transfers of some of the rights and obligations arising under a licence to a third party; and
- concurrent partial transfers, i.e. transfers of some of the rights and obligations arising under a licence to a third party which results in a concurrent holding of those partial rights and obligations by the transferor and the transferee(s).

6.87 The concern, in relation to the Spectrum Bands, with the above three types of transfers is that they would allow one licensee unilaterally to increase the number of licensees and so the number of parties with whom all the other licensees would have to coordinate and hence their engineering coordination costs. This position will however be kept under review.

6.88 Ofcom believes that allowing outright total transfers of their rights and obligations for licensees in the Spectrum Bands is objectively justified, as it will enhance the

[18] Statutory Instrument 2004 No. 3154

opportunities to make efficient use of the spectrum. It is also proportionate and transparent as to what it seeks to achieve, and it does not unduly discriminate against any person. It does not discriminate against any licensee in the Spectrum Bands, and it does not discriminate against any other licensee in any other band, as the proposed wireless telegraphy licences are distinct from existing ones, for the reasons discussed in sections 4, 5 and 6.

Liberalised use of the Spectrum Bands & Spectrum Quality Benchmarks

6.89 In January 2005, Ofcom published a statement on spectrum liberalisation, describing changes in the way licensees of particular licence classes can use the spectrum. These changes, programmed for the year 2005, are being implemented in stages to facilitate the optimal use of the spectrum. The full statement and associated documents can be found at: http://www.ofcom.org.uk/consult/condocs/liberalisation/?a=87101 and http://www.ofcom.org.uk/radiocomms/ifi/trading/libguide/?a=87101.

6.90 The spectrum liberalisation process described in the statement includes changes to three licensing sectors in 2005 – Business Radio, Fixed Wireless Access and Fixed Links – and the use of two mechanisms for liberalisation of spectrum use – through individual licence variation, following a request by a licensee, or through a generic licence change applied by Ofcom. The licences to be proposed for award in the Spectrum Bands will bear conditions similar in principle, in terms of technology neutrality and possible change of use, to those that Ofcom would aim to introduce through a generic change to existing licences in a given class or sector.

6.91 In the SFR:IP, Ofcom indicated its plan to award the Spectrum Bands without restrictions as to service provision or technology other than the power limit. The spectrum mask specified to that effect, described in paragraph 6.22, allows licensees in the Spectrum Bands to transmit whilst minimising the risk of causing interference to adjacent licensed users. Concurrent low-power licensees will be free to deploy the technologies of their choice and change their use of the spectrum or these technologies within the spectrum mask, without requiring Ofcom's approval.

6.92 In order to give prospective licensees some guidance as to the likelihood of interference from adjacent band users, Annex G describes the relevant technical characteristics (i.e. maximum permissible power and permissible out-of-block emissions) of the adjacent spectrum users. This information can be construed as defining the elements of a Spectrum Quality Benchmark (SQB) as described in the Liberalisation Statement. In other spectrum bands where trading and liberalisation have been implemented, SQBs are used to define the standard of spectrum quality that licensees can expect to experience and are based on current spectrum planning assumptions. SQBs are used in assessing requests for licence variations and investigating and resolving interference complaints.

6.93 Any change by licensees in the Spectrum Bands that would depart from their respective licence conditions (e.g. power level and out-of-block emission mask) will be subject to prior approval by Ofcom. The same will apply to any change by licensees in adjacent bands that would depart from the conditions in those licences. Ofcom will consider any requests for change on their merits at the time.

Sitefinder

6.94 Sitefinder is the national database of mobile phone base stations. It was established in response to one of the recommendations of the Group of Independent Experts led by

Sir William Stewart which investigated possible hazards posed by mobile phone technologies on behalf of the Government and which reported in May 2000. The Group recommended that reliable and openly available information about the location and operating characteristics of all base stations should be provided by Government. Sitefinder fulfils this recommendation. Ofcom has inherited the responsibility for providing the database on behalf of the Government from the Radiocommunications Agency, which was formerly part of the Department of Trade and Industry.

6.95 The database provides information on all operational GSM, UMTS and TETRA base stations in England, Scotland, Wales and Northern Ireland. Indoor sites in public places such as airports, shopping centres and railway stations are included. The database is provided in the form of an internet website (http://www.sitefinder.radio.gov.uk/) utilising a map driven interface which allows users to see graphically the position of base stations nearest to any location of interest. Brief technical details of each base station can be obtained by clicking on the base station's icon on the map.

6.96 Sitefinder relies on operators voluntarily providing Ofcom with detailed information about each of their sites on a regular basis (currently this is approximately every quarter). The type of information supplied includes:

- the transmit power (dBW);
- location (in the form of a 10 digit NGR and a postcode);
- height of the antenna above ground level (m);
- the frequency band of operation (e.g. 1800 MHz);
- the technology (i.e. GSM, UMTS, TETRA), etc.

6.97 Ofcom has asked the Government for its views on the relevance of Sitefinder to potential licensees in the Spectrum Bands. The Government has advised that it continues to view Sitefinder as an important resource for consumers. Provision of information about the location of base stations is useful in the planning system, but also helps to inform the public and encourage discussion about mobile technology based on factual evidence.

6.98 The Government has also advised that it considers that holders of concurrent licences who use one of the technologies currently covered by Sitefinder should be invited to participate voluntarily in the database.

6.99 Consistent with this advice, it is therefore Ofcom's intention to invite all those holders of concurrent licences to participate on a voluntary basis in providing information about their base stations for inclusion on Sitefinder where they are using one of the technologies currently covered (i.e. GSM, UMTS or TETRA). It is possible that the Government might in future seek the agreement of licence holders, including in this spectrum, to expand the scope of Sitefinder to include technologies beyond those currently included.

Section 7

Auction format

7.1 Ofcom has set out in section 4 its view that an auction is the most appropriate way of awarding this spectrum. This Section sets out the particular auction design which Ofcom proposes to use for the auction of licences for the use of the Spectrum Bands and the following section sets out the more detailed rules. Ofcom has developed these proposals with advice from its independent expert auction advisers, DotEcon.

7.2 Ofcom believes that the most appropriate auction format for the award of concurrent low power licences for use of the Spectrum Bands is a simultaneous, sealed bid, menu auction. Ofcom has carefully taken into consideration the conditions that may prevail in this auction and believes this format is more suitable than an open, simultaneous multi-round format which has been used for previous UK spectrum auctions. The following sections explain the issues that Ofcom considered and the reasons for its choice.

7.3 In awarding spectrum, Ofcom's aim is to ensure that so far as possible it facilitates the achievement of the award objectives outlined at section 4. In general, assuming that markets are efficient, how much someone is willing to pay for spectrum is likely to be the best guide to who can use the resource most efficiently. An auction can be a robust way to elicit this information, and Ofcom considers that in general it is likely to be superior to alternative mechanisms such as beauty contests or assigning on a 'first come first served' basis, as discussed in section 4.

7.4 However, an auction may produce more or less efficient outcomes depending on the details of the auction design and the context within which the auction takes place. The economic literature on auctions suggests that in auction design, as in other areas of regulatory policy, it is especially important to address issues such as encouraging entry into the auction, and reducing the potential for predatory and collusive behaviour. Some examples of issues which need to be taken into account in auction design are as follows:

a. There may be asymmetries between potential bidders in the auction, as a result of differences in their current market position and the information available to them about the market opportunity offered by the spectrum, or because of differential access to finance (possibly as a result of capital market inefficiency). This may encourage perceptions that some bidders (e.g. incumbent operators) are 'strong' and others (e.g. prospective entrants) are 'weak', even if in some cases, a 'weak' bidder actually has the strongest business case. Where asymmetries are significant, weak bidders may be reluctant to invest time and effort in entering the auction, with the consequence that the auction may be less competitive and effective than it might have been. Auction theory and practice has demonstrated that open, multi-round auctions tend to discourage entry by 'weak bidders', who fear that they will simply be overbid until they lose. By contrast, the use of sealed bids and/or restrictions on transparency can help to ease the impact of asymmetries, as 'weak' bidders perceive themselves to have a better chance of winning. This may encourage competition within the auction.

b. Some auction designs may be vulnerable to strategic behaviour by bidders attempting to influence the auction outcome in their favour. For

example, (especially in auctions with pricing rules other than pay what you bid) it may sometimes be possible for strong bidders to collude, tacitly or otherwise, to fix the number of licences or influence the price that they pay. Similarly, in multiple round auctions, it is sometimes possible for bidders to use their bids to signal their intentions to each other, creating potential scope for tacit collusion to share resources or to constrain prices.

7.5 Where bidders have a high degree of common value on licences, they are potentially exposed to the problem of 'winner's curse'. This arises because those bidders who over-estimate the value of licences are likely to win. Rational bidders should respond to this problem by reducing their bids relative to their best estimates of value. Nevertheless, the common value uncertainty faced by bidders can result in ex post inefficiencies, either because differences in the assessment of common value may swamp small differences in the true value across bidders or else because winner's curse affects weak bidders more greatly than strong bidders, exacerbating their disadvantages. Common value uncertainty can be eased by using open, multi round auctions and high transparency, as bidders can learn from the bidding behaviour of competitors. However, this may not be true if there are significant bidder asymmetries, as 'weak' bidders may then be deterred from participating.

7.6 Policy makers have a number of choices at their disposal in defining how the auction should be designed, and these choices will affect how susceptible the auction is to these and other problems. Policy makers have to set both the format of the auction and design the rules for running the auction and deciding on the winners. The choice of auction rules will often depend upon the format chosen. The format of the auction is the basic design of the auction and covers issues such as whether:

a. the bidders can see each others bids (called an open auction) or whether each bid is secret (sealed bid auction);

b. bidders can bid at the same time or have to bid in turn (simultaneous vs. sequential bidding);

c. bidders bid for one item, several unrelated items, or pre-defined combinations of items (known as combinatorial or package bidding).

7.7 The auction rules cover issues such as:

a. determination of who the winning bidders are – for example how winners will be chosen if there is a tie;

b. how much the winning bidders have to pay - sometimes an auction is better at eliciting how much people are willing to pay if they know that they will not have to pay what they bid, but some other value such as the what the highest loser bids;

c. the size of the deposit required – deposits are a useful way of encouraging bidders not to bid amounts that they cannot afford in the auction and subsequently default on their bids;

d. the reserve price – this needs to be set at a level that reflects the objectives of the auction.

7.8 The sections below discuss the options for setting the auction format and then, in the light of Ofcom's preferred format, the choice of auction rules is discussed in section 8.

Sequential or simultaneous bidding

7.9 As the concurrent licences are perfect substitutes, it is important that the auction format does not unduly expose bidders to substitution risks (e.g. winning a licence at a particular price but subsequently discovering that an alternative licence that is a substitute is available at a lower price; or passing up an opportunity to buy a licence at an attractive price in the hope of buying a substitutable alternative more cheaply, but then discovering that subsequent prices are higher). For this reason, there is a clear case for using simultaneous bidding (i.e. selling all the licences together) rather than sequential bidding (i.e. selling licences one after another). This approach is common to most spectrum auctions involving multiple licences, as these often involve significant substitution risks.

Sealed bid or open (multi round) processes

7.10 Ofcom has considered the merits of both sealed and open formats for this auction. They offer different advantages and disadvantages as described in the summary table at the end of this section. An open process has been shown theoretically to produce more efficient outcomes than sealed bids where bidders face common value uncertainty[19] and bidders are reasonably symmetric. These conditions were seen to apply to previous spectrum auctions in the United Kingdom, where open, simultaneous multiple-round auction (SMRA) processes were used.

7.11 However, this assessment breaks down in cases where there are significant bidder asymmetries.[20] In this case, there may be inefficiencies associated with the use of open, multi-round processes:

- Weaker bidders may tend to be more cautious than 'strong' bidders in bidding, as they perceive themselves to be more vulnerable to winner's curse. These effects may be intensified in an open, multi-round process, as strong and weak bidders can readily observe each others' behaviour, and they will know that the winner's curse affects each other differently. This may lead to 'weak' bidders bidding very cautiously or not participating at all; even though they may ultimately be the most efficient use of the spectrum, this may go untested. Lack of competition could also lead to winning bidders acquiring spectrum at prices below the true opportunity cost of their spectrum use.
- 'Weak' bidders may be deterred from participating because they anticipate that 'strong' bidders will simply follow a bid strategy of always bidding more than them. The opportunities to engage in exclusionary strategies are greater in open auction processes.

7.12 Both these problems could potentially be eased by using a sealed bid. In this case, the differential impact of winner's curse will be less apparent, as bidders cannot learn from each others' bids. 'Strong' bidders cannot simply rely on overbidding their rivals, but must attempt to judge their relative strength. As a consequence, participation

[19] Where bidders have similar or related aims for an auctioned good, they are said to share a common value. Where there is uncertainty of the value of spectrum for a new service, open auction enables to bidders to update their valuation, learning from the bids made in the auction and this can significantly increase the efficiency of the auction outcome.

[20] The existence of bidder asymmetries, e.g. differences in scale of the bidders, has been recognised as a problem in many previous spectrum auctions where entrants have competed with incumbents. See Maskin E. and Riley J (2000) "Asymmetric auctions", Review of Economic Studies, 67(3), pp413-438 and also Klemperer P.D. (1998) "Auctions with Almost Common Values: The 'Wallet Game' and its Applications", European Economic Review, 42(3-5), 757-769.

incentives for 'weak' bidders are enhanced as their chances of securing a licence are raised.

7.13 The responses to the SFR:IP consultation and the market analysis conducted by Ofcom's advisers have shown that bidder asymmetries are likely to be a significant issue in this auction. Potential bidders range from start up companies, to small manufacturers, to large operators both fixed and mobile. Moreover the majority of the stakeholders interested in bidding for licences appear to be potential new entrants.

7.14 On balance, Ofcom has concluded that bidder asymmetries are a greater threat to an efficient auction outcome than common value uncertainty. Ofcom therefore plans to adopt a sealed bid auction. This will also facilitate menu bidding as discussed below.

Combinatorial or 'menu' bidding

7.15 With either a simple sealed bid or an SMRA, Ofcom would have to fix the number of licences for award. As discussed in section 5, Ofcom does not consider this desirable.

7.16 In principle, it would be possible to allow limited market determination of the number of licences by allowing bidders to purchase multiple licences. Allowing bidders to make multiple package bids for different numbers of licences would, in part, enable them to take into account engineering coordination costs in their bids. This could occur within a conventional simultaneous multiple round auction by allowing bids on more than one licence. It could also be enabled by allowing bidders to make bids for combinations of licences, which is entirely compatible with the use of a sealed bid auction. For example, it would be possible for a bidder to make multiple bids for various combinations of licences as part of a sealed bid process. However, the fundamental difficulty with any of these approaches is that bidders purchasing multiple licences would be exposed to a 'free-rider' problem arising from the concurrent nature of the licences. If licences are concurrent, holding one licence confers the same rights as holding several licences. Purchasing multiple licences would reduce engineering coordination costs by reducing the concurrent users, but these benefits would be shared across all users. On the other hand, the purchaser of multiple licences would bear the entirety of the cost of facilitating engineering coordination by reducing the number of concurrent users. Therefore, schemes that allow bidders to purchase multiple licences are highly unlikely to efficiently de-centralise the choice of the number of concurrent users from the regulator to the bidders.

7.17 This problem can be resolved by using "menu" bidding, in which bidders have the opportunity to make multiple bids each contingent on there being a particular number of licensees. This allows bidders to express the differences in the value of a licence depending on the number of concurrent users also awarded licences. The number of licences awarded and the winners of these licences are simultaneously determined within the auction process from the menus of bids submitted by each bidder. This approach overcomes the free-rider problem discussed above as bidders can express their preferences for there being various numbers of concurrent users without needing to purchase multiple licences. This approach is likely to be more efficient because bidders should be in a better position to judge engineering coordination costs and licence values than Ofcom.

7.18 Ofcom also believes that menu bidding offers a simpler solution which is therefore more likely to result in an efficient assignment outcome.

7.19 The following table illustrates with a simple example how, with menu bidding, bidders are invited to express their valuation of holding one licence within a total of n concurrent licences, with n varying in this example from 5 to 7.

Table 7.1 – Illustration of menu bidding

Menu options: total number *n* of licences awarded	A's bids	B's bids	C's bids	D's bids	E's bids	F's bids	G's bids	*n* highest bids	Cumulated value of *n* highest bids	Winning option
5	8	6	10	7	4	6	5	C, A, D, B, F	37	
6	8	5	10	2	4	6	5	C, A, F, B, G, E	38	6 licences
7	7	2	3	1	3	2	5	A, G, C, E, B, F, D	23	

7.20 For each option to award n concurrent licences, the bids are ranked in order, then the highest n bids for each option are added up; these are the provisional winning bids. For the option in which n licences are awarded, the provisional winning bids are the highest n bids for that option. If an option receives less than n bids, all the bids received for that option are provisional winning bids and they are added up.

7.21 The winning option is the one which receives the highest total value of provisional winning bids. The provisional winning bidders of this option then become the winning bidders.

7.22 Ofcom believes that, using a menu bidding format, the auction can be designed to achieve reasonably efficient outcomes. Providing there are no competition failures with regard to services derived from these licences, bidders' valuations should reflect the social value they can generate from a licence, taking account of the likely costs of engineering coordination given the number of other concurrent users. This auction format allows bidders to express differences in the valuation they place on a licence depending on the number of other concurrent users. This means that the number of licences will be determined on the basis of bidders' information about externalities such engineering coordination costs, rather than by Ofcom trying to determine the appropriate number of licences with limited information. Additionally, the auction rules can be set to minimise the incentives for participants to manipulate the auction in ways that might lead to sub-optimal outcomes. These issues are discussed in the next section.

Summary of auction format options

7.23 Four main options can be synthesised from the discussion above. The following table summarises the advantages and disadvantages of each of the options.

Table 7.2 – Advantages and disadvantages of different auction formats

Auction format	Advantages	Disadvantages
Simple sealed bid	May facilitate entry into the auction, as mitigates impact of bidder asymmetries Fast and cost-effective to run	Does not allow flow of information to reduce the impact of common value uncertainty during the auction Requires Ofcom, not market, to judge optimum number of licences given externality problem of increasing engineering coordination costs
SMRA	Bidders can learn from observing bids of competitors thus reducing the impact of common value uncertainty	Requires Ofcom, not market, to judge optimum number of licences given externality problem of increasing engineering coordination costs and free-rider problem May discourage entry into the auction because stronger bidders can easily overbid competitors May accentuate winner's curse problem where there are strong asymmetries between bidders Slower and more expensive to run than sealed bid
Menu bidding - sealed bid	**Same as simple sealed bid plus:** **Allows market, not regulator to address the externality problem by determining the number of licences and avoids free rider problem**	**Does not allow flow of information to reduce the impact of common value uncertainty**
Menu bidding – SMRA	Same advantages as standard SMRA, plus: Fixes externality problem and free rider problem Market decides number of licences Avoids Ofcom having to fix number of licences	May discourage entry into the auction because stronger bidders can easily overbid competitors May accentuate winner's curse problem where there are strong asymmetries between bidders Complicated (and costly) to implement and explain to bidders

Conclusion

7.24 Ofcom's proposed approach is to use a sealed bid, menu format. Ofcom is of the view that, like a standard sealed bid, this is transparent, efficient, simple and cost-effective to implement, and should encourage wider participation in the auction. Further, by using a menu format in which bidders place bids contingent on the number of concurrent licences to be awarded, it is possible to allow the market to decide the number of licences. This addresses the externality problem where granting additional concurrent licences for the same Spectrum Bands increases the engineering coordination costs of others. The proposed format does so in a way that allows the market, rather than Ofcom, to resolve the issue (within certain bounds).

Section 8

Auction rules & process

8.1 This section sets out Ofcom's proposed auction pricing rules and its current thinking for how some of the key other auction rules will be specified. It also outlines Ofcom's current expectations for how the auction process is likely to be conducted. As explained in section 9 Ofcom will hold a specific consultation on the auction rules in full prior to the auction.

Auction pricing rules

8.2 This section focuses on one aspect of the auction design, the rule for determining what the winning bidders pay in the auction i.e. the pricing rule. The choice of pricing rule will affect bidders' strategies in the auction, and these effects will differ depending upon the circumstances particular to the auction, for example whether there are large bidder asymmetries. Choosing the most appropriate pricing rule, therefore, is fundamental to achieving an economically efficient outcome to the auction and securing the other objectives for the award.

8.3 There are a variety of pricing rules possible in sealed bid auctions, such as:

- pay what you bid – each winner actually pays the amount it bid in the auction (equivalent to a first price rule in an auction for a single unit).
- uniform pricing - the winners pay the price of the lowest winning bid;
- Vickrey pricing - the winners pay the highest losing bid made in the winning option (equivalent to a second price rule in an auction for a single unit).

8.4 A pay what you bid rule introduces some "strategic complexity" into the bidding process because each bidder has to give more consideration to what other participants may be willing to pay in the auction. Ideally, bidders will want just to beat the highest losing bid in order to minimise what they would pay if they won the auction. This can lead to inefficient outcomes because they depend not just on the relative values of bidders, but also on their assessment of the competition they are facing from other bidders. Inefficiency can be a particular concern when uncertainty is great or bidders are asymmetric

8.5 This concern suggests that there may be efficiency benefits from using Vickrey auctions, where bidders can do no better than to bid their estimate of valuation. The uniform pricing approach has been used in some licence auctions elsewhere in the EU and has incentive properties intermediate between the Vickrey auction and pay what you bid. However, these pricing rules are not without their own problems. For example, the Vickrey pricing rule can create particularly strong incentives for pre-auction mergers and collusion.

8.6 In the proposed menu bidding auction, both the Vickrey and uniform pricing rules have a fundamental failing in that they allow easy manipulation of the number of licences awarded. They may also create strong incentives for pre-auction mergers and collusion. The potential for manipulation of the auction arises directly from the fact that the winners of the licences would not necessarily pay what they bid, though their bids still determine the option that would be selected. Therefore, particularly if there are asymmetries between bidders, one or several participants could submit very high bids

for a particular outcome in the menu bidding format, safe in the knowledge that they are unlikely to pay what they bid unless they are the lowest winning bidder. If the number and identity of the participants is known, the risk to strong bidders from bidding for certain outcomes may be very small. Therefore, regardless of any attractions that either the Vickrey or uniform pricing rules could have in a simple multiple unit auction, they are entirely inappropriate for the proposed menu bidding auction.

8.7 It is possible to construct a variant of a Vickrey auction for the proposed menu bidding auction that retains the desirable property that bidders can do no better than bid their valuations, but which is less susceptible to manipulation. A pricing rule in which each bidder pays an amount equal to the opportunity cost of its bid (a so-called Vickrey-Clarke-Groves mechanism) leads to such an outcome. The amount to be paid is often the highest losing bid, as the opportunity cost is the value of a licence to the bidder prevented from winning by accepting a true winning bid. However, where the bidder has a pivotal effect on selecting the winning option, the bidder will need to pay more than this amount to reflect the fact that his or her bid prevented another option from occurring, which raises the opportunity cost of accepting this bid. Although such a pricing rule has some theoretical attractions, it also has some serious drawbacks in the context of the proposed sealed bid menu auction:

- it requires considerable sophistication on the part of bidders to incorporate the pricing rule correctly into their bid strategies, and this is unlikely to be the case in practice.
- similarly to the basic Vickrey auction, it is susceptible to the inefficiencies that bidder asymmetry may create.

8.8 In Ofcom's view, these considerations are sufficient to eliminate such a rule as a practical proposal.

8.9 The discussion above suggests that, despite the strategic complexity inherent in a pay what you bid rule, it is a simple, practical way of avoiding creating strong incentives for bidders to manipulate the outcome of the auction. Furthermore, where bidders are not symmetric, pay what you bid pricing can have substantial benefits over alternatives (including the Vickrey-Clarke-Groves mechanism). Under these alternatives, the existence of strong bidders is more likely to deter weak bidders from participating in the auction, because strong bidders have a greater incentive to bid aggressively, if they are unlikely to have to pay the full amount bid. Weak bidders are likely to be more cautious, for reasons already discussed. This risks reducing competition within the auction and creating possible inefficiency in the auction outcome.

8.10 One potential problem with the pay what you bid pricing rule is that it may create a bias towards a smaller number of licences than is efficient. It is reasonable to assume that bidders will expect more competition for licences the fewer licences are awarded. They may take this into account in their bid strategies by bidding more aggressively relative to their valuations when few licences are awarded and relatively more conservatively when many licences are awarded. This gives rise to a bias towards few licences being awarded. As more licences are awarded, the magnitude of this bias can be expected to diminish progressively (i.e. the bias against 6 licences and in favour of 5 licences will be greater than the bias against 10 licences and in favour of 9 licences). Ofcom has considered this issue of possible bias in the number of licences awarded and judges that the potential inefficiency is acceptable given the additional complexity that would be caused by modification of the auction format in an attempt to remove this bias. Rather, this factor has been taken into account as an input to determining the minimum number of licences that can be awarded.

8.11 Ofcom believes that the negative consequences which could arise from strategic bidding and the presence of bidder asymmetries with a uniform pricing rule outweigh any inefficiencies that may arise from the additional strategic complexity of pay what you bid pricing. Therefore Ofcom proposes that a pay what you bid pricing rule is used to determine what the winners should pay in the auction.

8.12 One consequence of pay what you bid pricing is that bidders may pay different amounts for identical licences. This may lead to some concern after the auction if successful bidders are seen to have bid widely differing amounts for identical rights. However, any rule that resulted in every winner paying the same amount gives rise to possible incentives for strategic manipulation of the number of licences awarded; bidders anticipating paying less than their bids may have an incentive to raise their bids to try to favour a certain number of licences being awarded. Moreover, similar criticisms can however be made of other pricing rules – for example a second price rule may allow some bidders to buy a licence for much less than they have bid. The reasons for adopting a pay what you bid pricing rule are set out clearly above. Ofcom considers that a pricing rule of this kind would be a fair and transparent approach, that links what licensees pay very directly to what they have bid on their own responsibility.

8.13 In conclusion, Ofcom is proposing that the winners of the auction pay what they bid because it believes that this rule, in conjunction with other elements of the auction design, will help achieve its aim to optimise the use of the spectrum in this auction, and the other objectives of the auction.

Other Auction rules

Transparency of the bidding process

8.14 Ofcom proposes that the auction format should be transparent, meaning that:

- the identity of all registered bidders will be published before the auction; and
- full information about the results of the auction and all bid submitted will be published following completion of the single round.

8.15 In some auction situations, it is appropriate to restrict transparency in order to reduce the impact of bidder asymmetries and to restrict opportunities for collusion or strategic bidding. However, in this case, Ofcom believes that its proposed rules on pricing and bidder association should be sufficient to address such problems.

8.16 Making the auction transparent also offers a number of advantages. In the case of a sealed bid, pay what you bid auction, bid levels are determined not only by bidders' own valuations but also their perception of competition. Providing bidders with information about the identity of competitors will make it easier for them to judge the appropriate bid level, thus reducing the risk of an inefficient outcome (i.e. one where the bidders with the highest value fail to win a licence). It would also be more difficult to apply bidder association rules if bidders are not permitted to know the identity of other bidders in the auction.

Bidder association rules

8.17 Ofcom proposes that bidder association should be prohibited in this auction. Associated bidders will be defined as any two entities in which a common shareholder has more than a 15% interest in both entities.

8.18 Each bidder will be required to certify that it is not associated with any other bidder after the list of provisional bidders is published (see paragraph 8.34 and Table 8.3 below). If, after the auction, it is found that one or more of the successful bidders were associated all parties involved would forfeit their deposits and any licence fees paid (also remaining liable for the balance of the outstanding fee), and no licence would be issued to them or if the licence had been issued it would be revoked.

8.19 The main reasons for imposing bidder association restrictions are to prevent the following types of strategic behaviour which could reduce the efficiency of the auction:

- Cascading defaults - a group of associated bidders could make multiple bids with the intent of defaulting on higher bids, so that the licence reverts to its next highest bid and so on until one bidder in the group wins the licence at the minimum possible price.
- Reduction of competition - because the proposed minimum number of licences issued is higher than one, it is possible that a bidder could use an associated bid vehicle in order to bypass this restriction, so that if associated bidders are aggregated, the total number of licensees is less than the minimum number of licences.

8.20 Ofcom believes that it is proportionate to impose bidder association rules and that its proposed method for implementing the rules will not impose significant costs on the auction process.

Rules on collusion

8.21 Notwithstanding the use of a sealed bid auction format with a pay what you bid pricing rule and the general prohibition on collusion under the Competition Act it is still possible that bidders could collude to try to gain an advantage over other bidders by coordinating their bids. This suggests that there should be specific auction rules prohibiting collusion. These rules are likely to apply from the point at which the list of provisional bidders is announced (see further Table 8.3 below). The sanction for breach of the rules is likely to be same as for breach of the bidder association rules.

Reserve prices

8.22 Ofcom proposes that a uniform reserve price is set across all options and that the level of the reserve price is set at £50,000 for any licence. Ofcom's primary objective in the auction is to promote the optimal use of the spectrum. Ofcom considers that the main function of the reserve price is to deter frivolous bidders and it should be set at the minimum level necessary to do this without deterring genuine bidders.

Deposits

8.23 Deposits are upfront payments that will be forfeit if a bidder breaks specific auction rules or a winning bidder defaults on its payment. They help to deter frivolous bidders, similarly to reserve prices, and to reduce strategic incentives for default.

8.24 Deposits will be required in the form of a bank guarantee and bidders will be required to submit these at the same time as the bid form (see further Table 8.3 and paragraphs 8.40 to 8.41 below). If a bidder does not provide a bank guarantee for its bids (by the relevant deadline), its bids will be declared invalid.

8.25 Ofcom proposes to set the level of the deposit at 50% of the largest amount bid from the menu submitted by each bidder. Given that Ofcom is uncertain about the value that bidders place on licences, setting a deposit based on the proportion of the amount bid appears the only way to ensure that the deposit is sufficient to deter strategic default but not excessively onerous on bidders in the auction.

Payment terms & default

8.26 Ofcom proposes that winning bidders will pay 100% of the fee for their licence by a specified time and licences will only be issued after payment has been received. This will encourage bidders to consider their bids and the business plans behind them carefully and will discourage default on the licence. If a bidder defaults on payment for the licence it will forfeit its deposit and remain liable for the outstanding balance and of course it will not be granted a licence.

8.27 Also if default occurs then the licence will be offered to unsuccessful bidders for that option in rank order of their bids, at the price bid by the bidder who defaulted. However, if no bidder takes up the option, the licence will be unsold and Ofcom will reserve its rights on what to do in such a situation (see paragraphs 8.38 to 8.39 below).

Auction procedure

8.28 This section provides a summary of the bidding process and key auction rules and gives some examples of how the winners will be determined in the auction and provides an example of how Ofcom expects the auction process to work. Finally it discusses some more detailed aspects of the bidding process relating to issues such as proposed procedures for dealing with unsold licences and examples of invalid bids.

Summary of the bidding process and rules

8.29 The proposed format for the auction is a sealed bid, menu auction. The bidding process and rules is as follows.

- The identity of all registered bidders will be published before the auction. Associated bid vehicles and collusion between registered bidders will be prohibited.
- There is only one round of bidding.
- Bidders submit a single bid form which consists of a menu of the number of licences to be awarded.
- There will be six options on the menu ranging from a minimum of five licences to a maximum of ten licences to be awarded.
- Participants can submit one bid for a single concurrent licence for each of the options on the number of concurrent licences awarded. However, bidders are not required to submit bids for every option.
- Only one bid per bidder can be successful, i.e. each bid is exclusive.
- Bids will be in whole pounds sterling and a minimum bid reserve price of £50,000 will be set per licence for all options.
- The winning option is the one that receives the highest aggregate amount bid across the highest bidders for the number of licences available.
- The winning bidders are those that submitted the highest bids for the winning option.

- A tie between options is settled in favour of the option with the larger number of licences.
- A tie between bidders is settled by the drawing of lots.
- Winning bidders pay the amount of their winning bid.
- Full information about the identity of the winning bidders, the amounts paid, and the amount and identity of all other bids submitted will be published following completion of the auction.

Example - determining the winning option and bidders

8.30 This section presents two examples which illustrate how a pay what you bid pricing rule would be implemented in the context of the sealed bid menu auction format which Ofcom proposes.

8.31 Table 8.1 below shows an example of how the process would work. The light shading shows the highest bids for each option. The darker shading shows the winning option which is the one that receives the highest aggregate amount bid for the number of licences available. The winning bids are shaded the same as the winning option. Eight licences would be awarded, as this option attracts the highest aggregate level of bids for the number of licences available (£101 for 8 licences). The winning bidders are the eight highest bidders for this option: Abi, Ben, Col, Hal, Kay, Seb, Tim and Val.

Table 8.1 – Illustration of menu bidding (no ties)

		Abi	Ben	Col	Dee	Hal	Jim	Kay	Roy	Seb	Tim	Val	**Total**
Number of Licences	5	16	12	16	12	14	10	18	13	11	20	13	**84**
	6	15	12	16	11	14	9	18	10	11	18	13	**94**
	7	13	12	14	10	13	9	17	10	10	17	11	**97**
	8	11	12	14	-	12	9	16	9	10	16	10	**101**
	9	9	12	12	-	10	8	15	9	10	13	9	**99**
	10	7	12	11	-	9	7	13	8	9	11	9	**96**

The total is the sum of leading bids, based on the number of licences available.

8.32 Table 8.2 below shows another example auction, this time with the added complication of ties between both winning options and winning bidders. As in the previous table, the light shading shows the highest bids for each option and the darker shading shows the winning option and the winning bids. The tied bids are illustrated by double outlined boxes.

8.33 The options for six and seven licences are tied. Ofcom is proposing that ties between options are settled in favour of the option with the higher number of licences on the basis that this is pro-competitive, therefore the winning option would be seven licences. There are six clear winners, Abi (£13), Ben (£12), Col (£14), Hal (£12), Kay (£16) and Tim (£16) and three tying bidders Dee, Roy and Val who each bid £11. Ofcom is proposing that this kind of tie is settled by lottery, and in this illustration Dee wins the lottery and is awarded the seventh licence.

Table 8.2 – Illustration of menu bidding (ties between options and bidders)

		Abi	Ben	Col	Dee	Hal	Jim	Kay	Roy	Seb	Tim	Val	**Total**
Number of Licences	5	16	12	16	12	14	10	18	13	11	20	13	**84**
	6	15	12	16	11	14	9	18	11	11	18	13	**94**
	7	**13**	**12**	**14**	**11**	**12**	9	**16**	11	10	**16**	11	**94**
	8	11	12	12	9	10	9	14	9	10	14	10	**93**
	9	9	12	10	7	8	7	12	8	9	12	9	**89**
	10	7	10	9	6	7	7	10	8	9	10	8	**85**

The total is the sum of leading bids, based on the number of licences available.

Overview of the key steps in the auction process

8.34 The following table provides an overview of how Ofcom currently expects the key steps for the award from the entry into force of the auction regulations.

Table 8.3 – Key steps in the proposed auction process

	Step or event
Step 1	Final auction regulations come into force and Ofcom announces the start of the auction process and invites applications.
Step 2	Interested parties submit applications to participate in the auction. A small administrative application fee may be required. Ofcom announces the list of provisional bidders in the auction. Collusion rules will apply from this point in time. Provisional bidders are required to complete legal notice of compliance with bidder association rules.
Step 3	Provisional bidders submit legal notices certifying compliance with bidder association rules. - Association: provisional bidders declare that none of their shareholders with a stake in excess of 15% also holds more than 15% shares in any other provisional bidders and that this will not change before the end of the auction.
Step 4	Ofcom publishes the list of registered bidders and bidder association rules come into force. (Particular arrangements would apply if the number of registered bidders were lower than 10 or lower than 5.)
Step 5	Bidding begins. Registered bidders each submit one menu of up to 6 bids to hold one licence and the corresponding bank guarantee before a specified date. Each bank guarantee must be for (at least) 50% of the amount of the highest bid in a menu; any bid of a value greater than twice the amount of the bank guarantee for the menu of bids will be invalid.
Step 6	Determination of the result Ofcom processes valid bids and determines the results of the auction. - Determination of the number of licences: the winning option (between 5 and 10 licences) will be that option which receives the highest aggregate amount bid for the number of licences to be awarded under that option (with ties broken in favour of the largest number of licences). - Determination of the winning bidders: the winning bidders will be those that submitted the highest bids for the winning option (with ties broken by the drawing of lots).
Step 7	Payment due Winning bidders pay the full amount of their licence fees by a specified date.
Step 8	Ofcom grants licences. (Particular arrangements will apply if there are unsold licences.)
Step 9	Ofcom publishes full results of the auction.

Possible changes to the bidding options following registration of bidders

8.35 In Section 5, Ofcom set out its proposals to invite bidders to place bids for the possibility of holding one of between 5 to 10 licences. Although it seems unlikely, Ofcom needs to consider what would happen if fewer parties than expected qualify as registered bidders. Two scenarios should be addressed:

a. if fewer than 5 parties qualify as registered bidders;

b. if fewer than 10 but more than 5 parties qualify as registered bidders.

8.36 In the case of (a) above, Ofcom proposes to award a minimum of 5 licences through the auction and resulting unsold licences would be treated as set out in paragraph 8.39 below. It does not believe that it would be appropriate to change the award mechanism at this point in time as it might affect the demand for the licences and be unfair to bidders who chose not to register in this process.

8.37 In the case of (b), Ofcom could leave the auction rules unchanged i.e. include six options of 5 to 10 licences on the bid menu as previously proposed. Yet this would create the risk of having unsold licences. Alternatively, the maximum number of licences in the menu of options could be reduced to match the total number of registered bidders. Ofcom proposes that, in such a case, it will reduce the number of options and invite bids for the possibility to hold one among 5 to m licences, where m is the number of registered bidders in the award process.

Procedures for unsold licences

8.38 There are two main ways in which unsold licences might occur. First it could arise through default and second it is possible that after the auction, even in the absence of default, licences will remain unsold. For example, consider the possibility that only four companies bid for the option of five licences and this turns out to be the winning option.

8.39 If licences are unsold, for this or any other reason, Ofcom has a number of options available to it including cancelling the licences, awarding them in the future on a ‘first come first served’ basis, or award through a further auction. If this circumstance arises, Ofcom will determine its approach at the relevant time.

Examples of invalid bids or bids that would not be taken into account

8.40 For illustrative purposes, the following are examples of bids which would be in breach of the proposed rules. Such bids would not be taken into account in determining the winning option and the winning bid.

a. Any menu of bids received by the auctioneer outside the relevant period.

b. Each bid in a menu that is strictly less than £50,000, i.e. the reserve price.

c. Any whole menu of bids for which no bank guarantee has been received by the auctioneer before the relevant deadline.

d. Any bid in a menu of which the value is in excess of twice the amount of the bank guarantee issued for it.

e. Any whole menu of bids submitted by a bidder found to be in breach of the rules on collusion or association during the auction process.

f. Any whole menu of bids submitted by an entity who is not a registered bidder for the auction.

g. Any whole menu of bids for which no legal notice regarding association and collusion has been received by the auctioneer before the relevant deadline.

h. All whole menus of bids which are submitted by one and the same bidders or bidders who are known to be in breach of association rules at the time of receipt or consideration of their bids.

Examples of interested parties which would not qualify as registered bidders

8.41 For illustration purposes, the following are examples of interested parties which would not qualify as registered bidders under the proposed rules, despite possible submissions to Ofcom relating to their intention to take part in the award process. Any bid they may submit would not be taken into account in determining the winning option and the winning bid.

a. Any party who has not submitted a valid application to become a provisional bidder in the auction before the relevant deadline.

b. Any party who has not submitted a valid application to become a registered bidder before the relevant deadline.

c. Any party who has not submitted valid legal notices with respect to association and collusion with other bidders before the relevant deadline.

d. Any party who is found to be in breach of the association and collusion rules, from the moment the breach is identified.

Section 9

Next Steps

9.1 This section sets out the next steps for the award, subject to the present consultation.

Analysis of responses

9.2 Ofcom will carry out an analysis of all responses received by the closing date for this consultation on 16 September 2005 and consider representations against its statutory duties to finalise the award process.

Publication of the draft auction regulations and information memorandum and the auction

9.3 Ofcom would aim to publish an information memorandum for the award, presenting the conclusions of this consultation in the form of a detailed award process and references to the main regulatory conditions to which prospective candidates for use of the Spectrum Bands should have regard.

9.4 The corresponding draft regulations will present the proposals to enshrine the award process in a statutory instrument, according to section 403 of the Communications Act 2003 and section 3 of the Wireless Telegraphy Act 1998, subject to consultation.

9.5 According to Ofcom's provisional timetable, both the information memorandum and the draft regulations should be published at the same time by December 2005. The final version of the regulations would then be laid before Parliament in 2006 to allow the auction to take place by the end of 2005-06.

Other regulations and documents for publication

9.6 As part of the preparations for this award and before prospective bidders are invited to consider participating in the award process, Ofcom will publish new regulatory documents and amend existing regulations to incorporate the conclusions of this consultation where appropriate.

9.7 This will include:

a. amending the spectrum trading regulations (Statutory Instrument 2004 No. 3154) before the award process to include the relevant transfer for the Spectrum Bands;

b. publishing an interface requirement for the Spectrum Bands before the award process to reflect the technical conditions to be adopted for the licences;

c. amending the order limiting the number of licences for certain categories (Statutory Instruments 2003 No. 1902) at the next relevant regular update to include the new assignments for the time being if appropriate;

d. amending the UK Frequency Allocation Table at the next relevant regular update and UK Frequency Allocation Plan after the award to include the new assignments for the Spectrum Bands.

Events and communications on the award

9.8 Ofcom intends to give a presentation to stakeholders interested in this award to publicise and explain the details in September before the end of the consultation period.

9.9 There are likely to be further events to assist potential bidders in understanding the auction rules before the auction takes place.

Section 10

Responding to this consultation

How to respond

10.1 Ofcom invites written views and comments on the issues raised in this document, to be made by **5.00 pm on 16 September 2005.**

10.2 Ofcom strongly prefers to receive responses as e-mail attachments, in Microsoft Word format, as this helps us to process the responses quickly and efficiently. Please can you send your response to brice.lecannu@ofcom.org.uk.

10.3 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Brice Le Cannu
Competition & Markets
3rd Floor
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Tel: 020 7783 4503
Fax: 020 7783 4333

10.4 Note that we do not need a hard copy in addition to an electronic version. Also note that Ofcom will not routinely acknowledge receipt of responses.

10.5 It would be helpful if your response could include direct answers to the question asked in this document, which is listed at Annex C. It would also help if you can explain why you hold your views, and how Ofcom's proposals would impact you.

Further information

10.6 If you have any questions about the issues raised in this consultation, or need advice on the appropriate form of response, please contact Brice Le Cannu on 020 7783 4503.

Confidentiality

10.7 Ofcom thinks it is important for everyone interested in an issue to see the views expressed by other consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, as soon as possible after the consultation period has ended.

10.8 All comments will be treated as non-confidential unless respondents specify that part or all of the response is confidential and should not be disclosed. Please can you place any confidential parts of a response in a separate annex, so that non-confidential parts may be published along with the respondent's identity.

10.9 We would be grateful if you could speed up our response-handling processes by completing a response cover sheet (see Annex B) to indicate whether or not there are

confidentiality issues. The cover sheet can be downloaded from Ofcom's website from the page where this consultation document appears.

10.10 Please also note that copyright in responses will be assumed to be relinquished unless specifically retained.

Next steps

10.11 These have been set out in section 9.

10.12 Please note that you can register to get automatic notifications of when Ofcom documents are published, at http://www.ofcom.org.uk/static/subscribe/select_list.htm.

Ofcom's consultation processes

10.13 Ofcom is keen to make responding to consultations easy, and has published some consultation principles (see Annex A) which it seeks to follow, including on the length of consultations.

Complex consultations

10.14 Ofcom will generally allow 10 weeks for complicated policy issues. This is slightly shorter than the Cabinet Office guidelines on consultation (12 weeks). But Ofcom thinks this is appropriate given the speed with which the communications industry changes. Ofcom will also aim to speak informally to a number of people and organisations before the 10-week period to test our thinking and to listen to their thoughts.

Shorter consultations

10.15 Some formal consultations will need to be shorter than 10 weeks. In those cases Ofcom will usually aim to allow five weeks. However, the time may vary depending on the issue. Consultations may be shorter than 10 weeks if:

- the issue or community involved is small or only affects a particular group, which has been identified ahead of time;
- a proposal will have a limited effect on a market;
- a proposal is only a limited amendment to existing policy; or
- an issue needs to be looked at urgently.

10.16 We may also run a shorter formal consultation process if:

- the law says Ofcom must act within a specific time period;
- the organisations involved in a specific consultation agree they want a faster timetable; or
- this is the second consultation on the same issue.

10.17 In this instance Ofcom has adopted a seven week consultation period because the proposal is a limited amendment to existing policy, and the proposals set out in the consultation need to be implemented urgently.

10.18 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, whose views are less likely to be obtained in a formal consultation.

10.19 If you would like to discuss these issues, you can alternatively contact Tony Stoller, Director, External Relations, who is Ofcom's consultation champion:

Tony Stoller
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3585
Fax: 020 7981 3333
E-mail: tony.stoller@ofcom.org.uk

Annex A

Ofcom's consultation principles

Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A.1 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

A.2 We will be clear about who we are consulting, why, on what questions and for how long.

A.3 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 version for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A.4 We will normally allow ten weeks for responses to consultations on issues of general interest.

A.5 There will be a person within Ofcom who 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. This individual (who we call the consultation champion) will also be the main person to contact with views on the way we run our consultations.

A.6 If we are not able to follow one of these principles, we will explain why. This may be because a particular issue is urgent. If we need to reduce the amount of time we have set aside for a consultation, we will let those concerned know beforehand that this is a 'red flag consultation' which needs their urgent attention.

After the consultation

A.7 We will look at each response carefully and with an open mind. We will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex B

Consultation response cover sheet

B.1 In the interests of transparency, we will publish all consultation responses in full on our website, www.ofcom.org.uk, unless a respondent specifies that all or part of their response is confidential. We will also refer to the contents of a response when explaining our decision, without disclosing the specific information that you wish to remain confidential.

B.2 We have produced a cover sheet for responses (see below) and would be very grateful if you could send one with your response. This will speed up our processing of responses, and help to maintain confidentiality by allowing you to state very clearly what you don't want to be published. We will keep your completed cover sheets confidential.

B.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 cover sheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

B.4 We strongly prefer to receive responses in the form of a Microsoft Word attachment to an email. Our website therefore includes an electronic copy of this cover sheet, which you can download from the 'Consultations' section of our website.

B.5 Please put any confidential parts of your response in a separate annex to your response, so that they are clearly identified. 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: Award of available spectrum: 1781.7-1785 MHz paired with 1876.7-1880 MHz

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

What do you want Ofcom to keep confidential?

Nothing	☐	Name/contact details/job title	☐
Whole response	☐	Organisation	☐
Part of the response	☐	If there is no separate annex, which parts?	

If you want part of your response, your name or your organisation to be confidential, 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. It can be published in full on Ofcom's website, unless otherwise specified on this cover sheet, and I authorise Ofcom to make use of the information in this response to meet its legal requirements. 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 C

Consultation questions

Question: *Do stakeholders agree with these proposals for the award of this spectrum or have any other comments on the proposed award?*

The table below sets out in summary form Ofcom's proposals for this award.

Spectrum Packaging	Ofcom's proposals
Usage restrictions	Low power, concurrent use, technology neutral licences will be offered. Accordingly: - all licensees will have equal rights and obligations to use equipment to transmit in the Spectrum Bands, i.e. to use the same frequencies on a shared basis in the whole of the UK; - any use which respects the low power spectrum mask will be allowed; - any use which exceeds the low power limit specified will not be allowed except following a licence variation from Ofcom.
Number of licences	There will be a limited number of licences awarded. The number will be 5, 6, 7, 8, 9 or 10. Bids in the auction will determine the exact number.
Wireless Telegraphy Rights & Obligations	**Ofcom's proposals**
Transmission rights	Licensees will have to comply with the following technical restrictions: - a maximum EIRP of 23 dBm per carrier; - a mask based on GSM specifications for out-of-block emissions; - up-link and down-link: 1876.9 – 1879.9 MHz – Base transmit and 1781.9 – 1784.9 MHz – Base receive; - a maximum out-door transmitter antenna height of 10 metres above ground level.
Engineering coordination[21] obligations	Licensees will have obligations to coordinate their use with other licensees and to develop a Code of Practice within 6 months of obtaining the licence. Ofcom will retain back stop powers should these provisions prove unsuccessful.
Licence term	Licences will have an indefinite duration, with a minimum term of 10 years during which Ofcom's powers to revoke will be limited. Ofcom will have the power to revoke for spectrum management reasons on not less than 5 years' notice after the minimum period, which could lead to the licence being terminated the day after the expiry of the 10 year minimum period or any time thereafter.
Licence fees	The auction will determine the fee payable for each licence. After the expiry of the minimum period, if the licensee continues to hold the licence, there may be additional charges in line with Ofcom's policy on spectrum pricing at that time.
Spectrum trading	The licences will be tradeable but only outright total transfers will be permitted.
Ministry of Defence use in band	Prospective licensees should note that there is some MoD use in the Spectrum Bands and they will have to accept any interference caused by this use.
Interference from adjacent users	Prospective licensees should note the possibility of interference from adjacent band users. Ofcom has set out the technical characteristics of the current adjoining uses (GSM, DECT, etc.) to provide guidance.
Sitefinder	Sitefinder is a national database of mobile phone base stations which Ofcom administers on behalf of the Government. The Government would like to invite all licensees in the Spectrum Bands if they use one of the technologies covered by Sitefinder at present (GSM, UMTS or TETRA) to provide relevant information on a voluntary basis.

Award Mechanism & Rules	**Ofcom's proposals**
Basic auction format	The auction format for the Spectrum Bands will be a single round sealed bid 'menu' auction. Bidders will be able to make up to six separate but parallel bids (on the same bid form), one for each of the different numbers of licences that could be awarded between 5 and 10 (options on the 'menu').
Determining the number of licences	The winning option (number of licences to be awarded) will be that option which receives the highest aggregate amount bid for the number of licences to be awarded under that option (with ties between options broken in favour of the largest number of licences).
Determining the successful bidders	The winning bidders will be those that submitted the highest bids for the winning option (with ties between bidders broken by the drawing of lots).
Pricing rule	Winning bidders will pay the amount they bid for their licence.
Transparency	There will be a registration process for participation in the auction, and the identities of all those registered will be made public.
Prohibitions on bidder association and collusion	There will be specific rules to prohibit collusion and bidder association.
Reserve price	The reserve price will be £50,000 per licence.
Deposits	Bidders will be required to submit a deposit in the form of a bank guarantee with their bid. The level of the deposit will be set at 50% of the largest amount the bidder is bidding for a licence under any option.
Payment terms	Winning bidders will be required to pay 100% of the fee before the licence is issued.
Unsold licences	It is possible that after the auction licences will remain unsold. If this occurs Ofcom has a number of options available to it including cancelling the licences, awarding in the future on a first come first served basis, or awarding through a further auction. If this circumstance arises Ofcom will determine its approach at the relevant time.

Annex D

Other relevant regulation

D.1 This Annex presents a brief summary of some aspects of the regulatory framework context for the electronic communications sector that may be relevant to licensees using the Spectrum Bands, other than conditions relating to wireless telegraphy.

D.2 It is the responsibility of parties interested in using the Spectrum Bands to provide electronic communications services to consider what regulation relating to electronic communications networks and services may be relevant to the services that they propose to provide. The same is also true of all other aspects of regulation, such as broadcasting regulation and competition law. This Annex does not provide a comprehensive description of legal provisions that may be relevant and it is provided for information only.

SFR:IP responses on matters other than wireless telegraphy

D.3 One respondent in particular addressed issues relating to Electronic Communications Services and Networks. O2 was of the view that Ofcom should provide some clarity before the award of the Spectrum Bands on the application of regulation relating to Electronic Communications Services and Networks (ECS and ECN). In particular, O2 expected Ofcom to indicate its position, for the new services in the Spectrum Bands developed under the licences for award, with regards to:

a. the imposition of access and interconnection conditions to MNOs (national roaming conditions);

b. the regulation of call termination;

c. the application of either the general conditions of entitlement or the conditions of entitlement for “new voice services”.

D.4 Ofcom plans to award licences to use spectrum that do not include conditions as to the technologies that can be used or the applications that may be deployed. Ofcom cannot therefore judge what aspects of the regulatory framework may be relevant to licensees. It is in any event for prospective licensees to satisfy themselves as to the relevance of the regulatory framework, though some background information may be of assistance.

Electronic Communication Services and Networks

Conditions of entitlement

General conditions of entitlement

D.5 All providers of ECS and ECN in the UK are covered by the General Conditions of entitlement. Out of 21 conditions, some apply to particular categories of ECS or ECN providers, mainly depending on whether they provide public services or networks and whether they provide publicly available telephone services or public telephone networks.

D.6 It is the responsibility of any undertaking involved in the provision of ECS or ECN to identify which conditions apply to them and to ensure that it complies with them.

Further information can be found at http://www.ofcom.org.uk/telecoms/ioi/g_a_regime/gce/gcoe/?a=87101 and the General conditions of entitlement can be found at http://www.ofcom.org.uk/static/archive/oftel/publications/eu_directives/2003/condac0703.pdf.

D.7 An overview of the conditions is provided in the table below. It identifies the types of provider to whom the conditions apply, including ECN providers, ECS providers, providers of publicly available telephone services PATS and providers of public telephone networks (PTN).

Condition	All providers of ECNs and ECSs	Providers of public ECNs and ECSs	Providers of PATS or PTN
1. General access and Interconnection obligations	Paras 1.2 and 1.3 only	Yes (network providers)	Yes (network providers)
2. Standardisation and specified interfaces	Yes	Yes	Yes
3. Proper and effective functioning of the network			Yes (but excludes mobile networks)
4. Emergency call numbers			Yes
5. Emergency planning			Yes
6. Public pay telephones	Providers of public pay telephones		
7. Must carry obligations	Providers of “Appropriate networks” used for receiving TV		
8. Operator assistance, directories and directory enquiries			Yes
9. Requirement to offer contracts with minimum terms		Yes	Yes
10. Transparency and publication of information			Yes
11. Metering and billing		Paras 11.1 and 11.2 only	Yes (subject in part to turnover threshold)
12. Itemised bills			Yes
13. Non-payment of bills			Yes (but excludes mobile services)
14. Codes of practice and dispute resolution		Yes	Yes
15. Special measures for end users with disabilities			Yes
16. Provision of additional facilities			Yes
17. Allocation, adoption and use of telephone numbers	Yes	Yes	Yes
18. Number portability	Yes	Yes	Yes
19. Provision of directory information	Yes	Yes	Yes
20. Non geographic numbers	Yes	Yes	Yes
21. Quality of service		Yes	Yes

D.8 In September 2004, Ofcom published a consultation document on new voice services, following the emergence of voice services using Voice over IP. More details on the consultation can be found at http://www.ofcom.org.uk/consult/condocs/new_voice/anew_voice/.

D.9 This document discusses the application of the General Conditions to new voice services. It identifies the high importance of access to emergency services for end-users, and the need to ensure that consumers are well-informed (at point of purchase, and subsequently) if new services differ in key respects from those to which they are used.

Market reviews

D.10 It is part of Ofcom's duties to carry out regular reviews of particular communications markets, at retail and wholesale level, in accordance with the Framework Directive 2002/21/EC and Commission Recommendation 2003/311/EC. Further details on market reviews may be found on the Ofcom website at http://www.ofcom.org.uk/telecoms/ioi/mrs/?a=87101 and http://www.ofcom.org.uk/bulletins/crt/compreg_telecoms/. In general, the law requires Ofcom to impose at least one obligation on a party that is found to have Significant Market Power (SMP) in a market following a market review.

D.11 The following markets identified in the Commission Recommendation may be of particular relevance to services that could be developed in the Spectrum Bands:

a. access and call origination on public mobile telephone networks;

b. voice call termination on individual mobile networks; and

c. the wholesale national market for international roaming on public mobile networks.

D.12 In the case of market (a), Oftel carried out a review in 2003 and found that the mobile network operators (MNOs) did not have SMP, either individually or in combination, as described in the corresponding statement (see http://www.ofcom.org.uk/static/archive/oftel/publications/eu_directives/2003/mobileaco0803.pdf).

D.13 In the case of market (b), Ofcom found in June 2004 each of the 6 MNOs in the UK to have SMP for wholesale voice call termination provided via their network (see http://www.ofcom.org.uk/consult/condocs/mobile_call_termination/wmvct/wmvct.pdf). Remedies were imposed on each of the 6 MNOs, as required by the European framework. The remedies varied to some extent between the 6 operators, reflecting considerations of proportionality and taking into account the conditions of each network that were relevant at the time.

a. O2, Orange, T-Mobile and Vodafone are subject to charge controls for 2G voice call termination until 31 March 2006;

b. O2, Orange, T-Mobile and Vodafone are subject to an access obligation for 2G voice call termination;

c. O2, Orange, T-Mobile and Vodafone are subject to an obligation not to discriminate unduly in relation to 2G voice call termination;

d. O2, Orange, T-Mobile and Vodafone are subject to obligations to notify 2G voice call termination charges in advance and to publish Access Contracts;

e. H3G is subject to a transparency obligation to notify charges for 2G voice call termination, and to notify 2G and total call volumes[22]; and

f. Inquam was subject to a transparency obligation to notify charges for call termination in advance until it ceased to be an ECS provider and its wireless telegraphy licence was revoked.

D.14 In June 2005, Ofcom proposed in a consultation to extend the charge controls for 2G call termination for a further 12 months to 31 March 2007. The other remedies imposed in 2004 remain in place. Ofcom has also published a separate consultation document initiating a further market review of voice call termination on individual mobile networks, and plans to conclude this review before March 2007. For these two documents, see: http://www.ofcom.org.uk/consult/condocs/wholesale/ and http://www.ofcom.org.uk/consult/condocs/termination/.

D.15 In the case of market (c), Ofcom is currently conducting its analysis, working with other members of the European Regulators Group. Ofcom will provide further information on the review as the work and international cooperation progress, probably in the second half of the financial year 2005-06.

D.16 It is possible that, if licensees in the Spectrum Bands choose to offer public ECSs, these services may be considered as part of Ofcom's regular reviews of the markets described above.

D.17 Ofcom also has the discretion under the Communications Act to review electronic communications markets other than those described above, and to take action as appropriate

Other provisions

D.18 Ofcom also has the power under the Communications Act to impose access-related conditions. These may include obligations to secure end-to-end connectivity, so that end-users of public ECS may communicate with each other. These obligations may be imposed in some circumstances without a prior finding of SMP.

D.19 To date, Ofcom has not imposed any access-related conditions under the new regulatory regime on any UK mobile network operator, though it has the power to do so if the conditions set out in the legal framework are met.

D.20 If licensees in these bands wish to purchase access and interconnection from existing networks for services in markets where they do not have SMP, Ofcom's expectation is that these should be negotiated commercially. If a dispute arises between providers of electronic communications networks and services, this may be referred to Ofcom. Ofcom has published guidelines on the handling of disputes. These indicate that in general where disputes do not involve questions of SMP, or do not relate to regulatory conditions, Ofcom would expect the matter to be resolved commercially, or if necessary through Alternative Dispute Resolution.

Network identification codes and number resources

D.21 Ofcom allocates mobile telephone service numbers and mobile network codes ("MNCs") to those who control mobile communications networks and who, in the case of mobile telephone service numbers, need public numbering for their customers.

[1] H3G has appealed Ofcom's decision. The case is before the Competition Appeal Tribunal and judgment is pending at the time of publication of this document.

D.22 MNCs are allocated individually in accordance with the National Telephone Numbering Plan ("the Plan") and ITU-T Recommendation E.212. Mobile telephone service numbers are allocated in units of 100,000 numbers for services in accordance with the Plan and ITU-T Recommendations E.212 and E.164. Definitions of these numbers and related services are set out in the Plan published by Ofcom.

D.23 Ofcom would expect to allocate an MNC to a network provider with Wireless Telegraphy Act licensed spectrum who qualifies for an MNC in accordance with the Plan. It is understood that this could mean that up to 10 MNCs may therefore need to be allocated to these licensees over the next few years.

D.24 Ofcom would also expect to only allocate mobile telephone numbers to network providers holding a Wireless Telegraphy Act licence. Those licensed network providers would be responsible for the sub-allocation of numbering, in appropriate units, to local service providers where this is appropriate. Ofcom is mindful of the need to ensure that best use is made of telephone numbers and, as the unit of allocation for mobile telephone service numbers is 100,000, Ofcom believes this must mean that allocation should, other than where there is demonstrable high demand and network autonomy, be as a sub-allocation from the relevant network provider rather than from Ofcom directly.

Competition in communications markets

D.25 In addition to its sectoral powers conferred by the Communications Act 2003, Ofcom can also act in relation to communications matters under the Competition Act 1998, to address agreements preventing, restricting or distorting competition or to address an abuse of a dominant position, and the Enterprise Act 2002, to address such matters as suspected adverse effects on competition.

D.26 Further information about how Ofcom has used these powers can be found on the Ofcom website, in particular at http://www.ofcom.org.uk/bulletins/comp_bull_index/ and http://www.ofcom.org.uk/bulletins/crt/.

Annex E

Summary of SFR:IP responses relevant to this award

E.1 This annex sets out a summary of responses made to the Spectrum Framework Implementation Plan which are relevant to the spectrum award discussed in this document.

Responses to SFR:IP Consultation Document on the band

E.2 In the SFR:IP consultation, out of a number of options, Ofcom indicated its preferred option was to award by auction the spectrum bands 1781.7-1785 MHz paired with 1876.7-1880 MHz for low-power concurrent use by a number of licensees to be determined, probably between 3 and 6, without constraints on technology or use other than a spectrum mask.

E.3 30 respondents provided comments on the proposals for the award. They broadly agreed with the proposals, with the exception of O2, Orange, the UMTS Forum and Vodafone The views of the respondents who requested confidentiality were taken into account, however they are not identified in this document and their responses are not published on the Ofcom website.

E.4 Ofcom's responses to the specific issues raised are set out in the following table, although it should be noted that the earlier sections of this document also contain Ofcom's responses for some issues.

Issue raised	Comments	Ofcom's response
Low-power or high power licences	A large majority of respondents expressed their preference for low-power licences. 3 respondents either expressed doubts about the low-power option or indicated their preference for the high-power option or for both the high-power option to be considered alongside the low-power option. Some respondents also restated the importance of not releasing the spectrum on a licence-exempt basis, to leave options open for future wide area type uses.	Ofcom proposes to award a limited number of low-power licences only. This proposal is discussed in greater detail in section 5 (see paragraphs 5.14 to 5.51 in particular).
Technology neutrality – specification of GSM (other issues	2 respondents commented on the possible risks to efficient use of the spectrum posed by technology neutrality for this band. 3 respondents favoured	Ofcom is of the view that it should award rights and obligations to use the Spectrum Bands on a technology and application neutral basis. The reasons for this are

on technology neutrality are considered below)	the prescription of GSM technology. Teleware supported technical restrictions on power output only.	explained in section 5 (see paragraphs 5.52 to 5.59). Further issues relating technology neutrality, in particular whether it would constitute undue discrimination are considered below and in section 6 (see paragraphs 6.51 to 6.69).
Number of low-power licences	12 respondents indicated that there should be 6 or more low-power licences, with varied proposals from 6 to 20 licences. 3 respondents favoured 3 or less licences. 2 respondents favoured between 3 and 6 licences. T-Mobile suggested the use of combinatorial auctions to determine the number of licences at the award.	The proposed menu format allows bidders to determine the actual number of licences awarded, between a total of 5 to 10 licences. This proposal is discussed in section 5 (see paragraphs 5.60 to 5.74).
Interference and engineering coordination issues	BT, Intellect and ip.access suggested the use of Dynamic Frequency Selection to minimise the risk of interference and the need for coordination. Oak Global and Zynetix pointed out the risk of interference from concurrent use in these bands.	Ofcom's technical analysis suggests that engineering coordination between concurrent licence operation in neighbouring locations would be necessary in some cases. However, it does not believe that it is necessary to mandate the use of Dynamic Frequency Selection to achieve engineering coordination as this could be unnecessarily restrictive. Instead Ofcom has set out proposal which will require the licensees in the first instance to agree and abide by a Code of Practice for engineering and procedural solutions to manage interference. If all licensees agree such a code could include the use Dynamic Frequency Selection in certain circumstances. Ofcom will have back stop powers to intervene if necessary.
Band management	O2 suggested that a band manager could reduce engineering coordination costs and act as the most efficient	Ofcom's proposals do not rule out the possibility of band management in the Spectrum Bands if that turns out to be a viable business model for the

	user of this spectrum. A respondent indicated its willingness to act as band managers in the frequencies. The Communication Management Association referred to the possible role of a spectrum management organisation to manage interference problems.	Spectrum Bands. Ofcom is currently evaluating ways in which band management can operate in the current regulatory environment and expects to publish further details on this later in the year before the award is made.
Asymmetries between bidders	5 respondents expressed concerns about award designs which could be used by bidders to deter some entities from entering the auction or to preclude them from winning a licence ("toe-hold" effect). Some respondents suggested preventing MNOs from winning licences or reserving licences for new entrants. O2 questioned whether the auction proposals were meant to try and mitigate some unidentified market power of the MNO incumbents.	These issues have been discussed in sections 7 and 8 above. In summary Ofcom believes that the proposed design takes account of likely bidder asymmetries and that in particular the auction format and the pricing rule will address these concerns. Ofcom does not believe that it would be justified to prevent MNOs from winning licences or in reserving licences for new entrants. Such approaches would typically need to be based on clear evidence of market power in relevant downstream markets and a view that the competition issues could not be adequately addressed after the auction using other powers. The circumstances of this award are different.
Auction design	O2 argued that the proposed award was "rigged" against existing 2G operators by preventing high power use. T-Mobile commented that a combinatorial auction would be particularly appropriate for the bands, to give the chance to interested operators not to be "held to ransom by the holder of one of many licences".	Ofcom's proposals do not prevent any company from taking part in the auction provided they fulfil the auction rules. As set out in Section 5, Ofcom believes it is proportionate and objectively justified to only allow low power use at the award stage. Ofcom believes that the proposed menu bidding format is appropriate for the award of this spectrum. The format enables bidders to take account of externalities in their bids, while also taking into account such issues as competition between

		licensees in the band and asymmetries between bidders.
Reserve price	O2 argued that the reserve price should be referenced to the net present value, over the minimum term of the licence, of the GSM AIP fee per channel.	Ofcom believes that the role of the reserve price in this award is to deter frivolous bidding. It is not an attempt to value the spectrum. GSM AIP levels are not relevant as the proposed licences are different in many respects.
Licence conditions on use of the spectrum	Coffee Telecom proposed including conditions to prevent hoarding of spectrum. One respondent suggested that penalties should be imposed when the spectrum is under-used and rewards given when it is used properly.	Ofcom believes that neither a 'use it or lose it' condition nor measures relating to the quality of use would be appropriate. Ofcom believes that the market mechanisms of the auction process itself and the scope for secondary trading will be more effective in securing optimal use of the spectrum than the suggested regulatory obligations. Furthermore such regulatory obligations may have unintended consequences which lead to sub-optimal decisions. Also concerns relating to spectrum hoarding can be addressed through Ofcom's competition powers.
Downstream market regulation	O2 argued that Ofcom should provide clarity on downstream market regulation (national roaming conditions, call termination market for the new licensees, general conditions of entitlement) before the award.	It is the responsibility of prospective bidders to assess which regulations are relevant to the services they envisage offering and how they would apply. Ofcom is not in a position to investigate such matters as national roaming conditions or call termination before licensees develop their services. Ofcom will ensure that the regulatory framework relating to electronic communications networks and services is applied in line with its statutory duties. Further details on relevant regulations are provided in Annex D.
Licensing process	One respondent suggested that local licences be made available by Ofcom.	The proposed award of national licences has been designed, in the light of technical and market analysis, to facilitate as efficient an assignment as possible. The option of regional licences is discussed in section 5 (see

		paragraph 5.13).
Need for further economic and technical analysis	Vodafone indicated that Ofcom should provide further explanation as to why the benefits of the low power option are at least as great as a wide area option. Orange thought that Ofcom should commission further economic and technical advice into the most appropriate assignment method for this spectrum.	Ofcom believes that the NERA study, whilst not conclusive, provides together with the other available information a sufficient basis for an assessment of options for spectrum packaging. Ofcom's analysis of this issue is discussed in detail in section 5 (see paragraphs 5.18 to 5.22).
Timing of the award	BT indicated that the award should occur in early 2005 and that there was a window of opportunity. Intellect supported the award of this spectrum at the earliest opportunity. O2 expressed concern about the timing of the auction.	Ofcom believes that the bands should be made available as soon as practically possible to promote the optimal use of the Spectrum Bands and Ofcom, subject to the outcome of this consultation, plans to hold the auction by the end of this financial year.
Restrictions on mobile use in new spectrum licences – differences in licence terms with 2G licences	O2 commented that terms of new spectrum licences which are internationally identified for GSM should be the same as 2G terms in order to avoid undue discrimination (or existing licensee terms should be changed to match terms of new licences). It suggested that a premier class of 2G licences would be created if one party could acquire all low power licences and change its use to standard GSM specification. The differences identified were: the ability to trade; change of use was facilitated; and more security of tenure was provided than in the case of the existing 2G licences as the notice period would be longer and greater certainty over spectrum management reasons for revocation was given.	Ofcom does not consider the proposed licence terms for the award of the Spectrum Bands to be unduly discriminatory. Undue discrimination can only arise if 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. There are many differences between the proposed licences for the Spectrum Bands and the 2G licences and the provisions of the proposed licences are objectively justified for the reasons set out in sections 5 and 6. It will not be the case that a single licensee will be able to acquire all the proposed licences and create a licence to use standard GSM specification but with greater

	T-Mobile made similar points in particular suggesting it would be highly discriminatory and distort competition if holders of new licences would have liberalised rights and holders of 2G licences did not. Vodafone said that it did not favour restrictions in new licences relating to mobile use other than 3G but only if the existing 2G licences were put on the same footing: tradeable; undated, subject to 5 years notice (with a minimum term where appropriate). To do otherwise would be discriminatory.	rights than existing 2G licences, as the proposed licences are for low power uses only. Also Ofcom does not believe that the proposed licences would lead to a distortion of competition and no explanation for how this could occur was provided by the respondents.
Restrictions on mobile use in new spectrum licences – differences in licence terms with 3G licences	O2, T- Mobile and Vodafone commented that to award new spectrum licences without roll-out obligations would be discriminatory and distort competition. T-Mobile also argued that the costs of meeting the obligations would take some time to recover and this would not be achieved before 2012. T-Mobile also commented that to award new spectrum licences which allowed the holders to obtain spectrum at significantly less cost than 3G licensees was discriminatory and would distort competition. O2 and T- Mobile also commented that to award new spectrum licences with an indefinite term compared with the fixed term of 3G licences would be discriminatory and distort competition.	Ofcom does not consider that the circumstances in which the proposed licences will be awarded are similar to those relating to the 3G licences and therefore the concerns expressed regarding discrimination are misplaced and moreover the terms of the proposed licences are objectively justifiable in relation to the Spectrum Bands for the reasons discussed in sections 5 and 6. As discussed above, Ofcom does not believe that the proposed licences would lead to a distortion of competition, including in relation to the services offered by the 3G licensees.
Restrictions on mobile use in new spectrum licences – protecting investment by 3G licensees /	H3G commented that restrictions on mobile use should be included in new licences to avoid distorting investment incentives by existing 3G licensees. Vodafone made a similar comment that there was a significant risk that putting large swathes of 3G spectrum	Ofcom does not believe that these concerns are relevant to the award of the Spectrum Bands. Even if it were the case (which remains unproven) that allowing the provision of mobile services in new spectrum could undermine investment in 3G services by the incumbents or hamper their ability

recovery of costs	onto the market would have a disruptive effect in an immature but growing market, and further this might have a long term impact if it prevented market reaching critical mass. A related point was made by T-Mobile who commented that it would be unable to exercise its right of establishment under Article 43 of EC Treaty if its investment in licence fees and infrastructure build in reliance on onerous licence terms (especially roll out obligations) are not protected. T-Mobile also commented that allowing persons other than the existing 3G licensees to offer 3G services would dilute the property in spectrum to which it is entitled and by do so before 2012 prevent it from having a reasonable chance to recoup their investment and so restrict its rights to pursue a business activity.	to recover their costs, it is not clear how this could arise in the case of this award given the characteristics of the award, in particular the quantity of spectrum involved and requirement for concurrent use.
Restrictions on mobile use in new spectrum licences – change to 3G auction position	Orange commented that restrictions needed to be maintained for a transitional period (not specified) as business cases of existing 3G licences were based on regulatory environment described in the 3G auction and consequent number of competitors which is now being undermined by Ofcom. T-Mobile raised similar concerns suggesting that the statements at the time of 3G auction gave a legitimate expectation that market condition applicable at the time would remain stable. Vodafone made similar comments on the need to take full account of the implications of previous regulatory decisions in the 3G auction. H3G also commented that it was premature to be changing the regulatory framework	Given Ofcom's comments in relation to the points above regarding the difference in licence terms with 3G licences and the 3G investment issues, Ofcom does not consider that these concerns are relevant to this award.

	established at the time of the 3G auction. It does not believe there are potential benefits which could be achieved that would outweigh the costs.	
Restrictions on mobile use in new spectrum licences - lack of market analysis	Orange commented that Ofcom had not set out its market analysis justifying its view that to include restrictions would lead to a loss of competitive stimulus.	Ofcom does not believe that it is necessary to set out a specific empirical market analysis to justify this point since it seems clearly to be the case that the imposition of entry barriers (which would be consequence of imposing a restriction) would be likely to lead to less rather than more competition.
Award of further spectrum which can be used for 3G is unnecessary	All MNOs commented to varying degrees that there was no scarcity of spectrum for 3G at present nor was there likely to be on timescales indicated by Ofcom for the award of more spectrum and therefore it would be inefficient to award more spectrum on timescales proposed in the SFR:IP.	As a matter of general policy as set out in the SFR, SFR:IP and SFR: IP Interim Statement Ofcom has explained that it has a general preference for a market based approach to spectrum management. Consistent with this is the view that it is unlikely to be the case that a policy of specifically holding back the release of spectrum until there is “proven demand” is likely to lead to efficient use. In any case in this award there is clearly demand for the spectrum (as evidence by the responses to the SFR:IP) and Ofcom sees no justification for delaying the award.
Linkage with 2G liberalisation	O2 commented that a clear statement on future liberalisation of both current 2G and 3G licences is a pre-condition to future 3G auctions (which it defined to include the award discussed in this document) given the previous administrative statements. It also made a similar comment that the failure to address issues relating to 2G refarming and the availability of all substitutable IMT-2000 spectrum before awarding new spectrum would be contrary to administrative practice as set out in HM Treasury’s Green book	Ofcom does not believe that a resolution of the issues of 2G liberalisation nor establishing a policy on the removal of usage restrictions in the 3G licences are pre-conditions to this award. The rights being awarded to the Spectrum Bands are distinct from existing 2G and 3G rights. Ofcom does not consider that there are any previous statements which would require it to address the issues of 2G liberalisation before proceeding with this award

and lead to inefficient assignments.	and believes that its approach is consistent with its statutory duties.

Annex F

Draft Licence

Please note that the following template licence represents Ofcom's current thinking and may well change as Ofcom's thinking develops and after consideration of responses to this consultation

Wireless Telegraphy Acts 1949 and 1998

Office of Communications (Ofcom)

LICENCE FOR THE USE OF THE SPECTRUM BANDS 1781.9 – 1784.9 MHz PAIRED WITH 1876.9 – 1879.9 MHz

Licence no. **[Insert Licence Number]**

Date of issue: **[Insert Date]**

Fee payment date: **[Insert Date] (annually)**

1. The Office of Communications (Ofcom) grants this licence to

[Insert Licensee's Name and Company Registration Number (if a company)]

("the Licensee")

[Insert Registered Company Address]

Xxxxxxxxxxx

Xxxxxxxxxxxx

Xxxxxxxxxxxx

Xxxxxxx

to establish, install and use radio transmitting and receiving stations and/or radio apparatus as described in the schedule(s) (herein after together called "the Radio Equipment") subject to the terms, set out below.

Licence Term

2. This Licence shall continue in force until revoked by Ofcom in accordance with paragraph 3 below or surrendered by the Licensee.

Licence Revocation

3. Pursuant to section 4 of the Wireless Telegraphy Act 1998 (the "1998 Act") Ofcom may not revoke this Licence under section 1(4) of the Wireless Telegraphy Act 1949 except:

   a. at the request of, or with the consent of, the Licensee;

   b. in accordance with paragraph 8 to 11 ;

   c. if there has been a material breach of any of the conditions of the Licence;

   d. if, in connection with the transfer or proposed transfer of rights and obligations arising by virtue of the Licence, there has been a breach of any provision of regulations made by Ofcom under the powers conferred by section 168(1) and (3) of the Communications Act 2003 ;

   e. if the Licensee has been found to the reasonable satisfaction of Ofcom to have been involved in any act, or omission of any act, constituting a material breach of the Wireless Telegraphy ([Auction]) Regulations [2005] (the "Regulations");

   f. in accordance with section 4(5) of the 1998 Act;

   g. if it appears to Ofcom to be necessary or expedient to revoke the Licence for the purposes of complying with a direction by the Secretary of State given to Ofcom under section 5 or section 156 of the Communications Act 2003; or

   h. for reasons related to the management of the radio spectrum, provided that in such case:

      i. the power to revoke may only be exercised after at least five (5) year's notice is given in writing to the Licensee; and

      ii. such notice must expire after ten (10) years from the date of issue of this Licence.

4. Where Ofcom exercise their power to revoke or vary the Licence in accordance with section 1(4) of the Wireless Telegraphy Act 1949, the Licensee shall be notified in writing.

5. For the avoidance of doubt, and without prejudice to paragraphs 3 and 4 above, Ofcom may only revoke this Licence in accordance with section 1E of the Wireless Telegraphy Act 1949.

Changes

6. The Licence may not be transferred.

7. The Licensee must give immediate notice to Ofcom in writing of any change to the Licensee's name and address from that recorded on the Licence.

Fees

8. The Licensee shall pay to Ofcom the fee(s), in cash and without set-off or counter-claim, described in Schedule 2 of this Licence, on the date(s) also described therein, failing which Ofcom may revoke this Licence.

9. On or after the expiry of ten years from the date of issue of this Licence the Licensee shall pay to Ofcom such sum(s) as may be provided for in regulations made by Ofcom under section 1 and 2(2) of the Wireless Telegraphy Act 1998, failing which Ofcom may revoke this Licence.

10. The Licensee shall also pay interest to Ofcom on any amount which is due under the terms of this Licence or provided for in any regulations made by Ofcom under section 1 and 2(2) of the Wireless Telegraphy Act 1998 from the date such amount falls due until the date of payment, calculated with reference to the Bank of England base rate from time to time. In accordance with section 4A of the Wireless Telegraphy Act 1998 any such amount and any such interest is recoverable by Ofcom.

11. If the Licence is surrendered or revoked, no refund, whether in whole or in part of any amount which is due under the terms of this Licence or provided for in any regulations made by Ofcom under section 1 and 2(2) of the Wireless Telegraphy Act 1998 will be made, except at the absolute discretion of Ofcom in accordance with [regulation X] of the Regulations.

Radio Equipment Use

12. The Licensee must ensure that the Radio Equipment is constructed, established, installed and used only in accordance with the provisions specified in Schedule 1 of this licence. Any proposal to amend any detail specified in Schedule 1 of this licence must be agreed with Ofcom in advance and implemented only after this Licence has been varied or reissued accordingly.

13. The Licensee must ensure that the Radio Equipment is operated in compliance with the terms of this Licence and is used only by persons who have been authorised in writing by the Licensee to do so and that such persons are made aware of, and of the requirement to comply with, the terms of this Licence.

Access and Inspection

14. The Licensee shall permit a person authorised by Ofcom:

    a. to have access to the Radio Equipment; and

    b. to inspect this Licence and to inspect examine and test the Radio Equipment,

    at any and all reasonable times or, when in the opinion of that person an urgent situation exists, at any time to ensure the Radio Equipment is being used in accordance with the terms of this Licence.

Modification, Restriction and Closedown

15. A person authorised by Ofcom may require the Radio Equipment, or any part thereof, to be modified or restricted in use, or temporarily or permanently closed down immediately if in the opinion of the person authorised by Ofcom:

a. a material breach of this Licence has occurred; and/or

b. the use of the Radio Equipment is causing or contributing to undue interference to the use of other authorised radio equipment.

16. Ofcom may require the Radio Equipment to be modified or restricted in use, or temporarily closed down either immediately or on the expiry of such period as may be specified in the event of a national or local state of emergency being declared. Ofcom may only exercise this power after a written notice is served on the Licensee or a general notice applicable to holders of a named class of Licence is published.

Geographical Boundaries

17. This Licence authorises the Licensee to establish, install and use the Radio Equipment only in the United Kingdom.

18. This Licence does not authorise the establishment and use of the Radio Equipment on the Isle of Man or any of the Channel Islands.

Interpretation

19. In this Licence:

a. the establishment, installation and use of the Radio Equipment shall be interpreted as establishment and use of stations and installation and use of apparatus for wireless telegraphy as specified in section 1 of the Wireless Telegraphy Act 1949;

b. the expression "undue interference" shall have the meaning given by Section 19 of the Wireless Telegraphy Act 1949;

20. The schedule(s) to this Licence form part of this Licence together with any subsequent schedule(s) which Ofcom may issue as a variation to this Licence at a later date;

21. The Interpretation Act 1978 shall apply to the Licence as it applies to an Act of Parliament.

Issued by Ofcom

Signed by

For the Office of Communications

SCHEDULE 1 TO LICENCE NUMBER: [Insert Licence Number]

Licence Category: **Licence for the Use of the Spectrum Bands 1781.9 – 1784.9 MHz paired with 1876.9 – 1879.9 MHz**

This schedule forms part of licence no **[Insert Licence Number]**, issued to **[Insert Licensee's name]**, on **[Insert Date]**.

1. Description of Radio Equipment Licensed

In this Licence, the Radio Equipment means any station or apparatus that transmits in accordance with the requirements of paragraphs 7, 8, 9 and 10 of this schedule.

2. Interface Requirements for the Radio Equipment

That Radio Equipment shall comply with one or other of the following Interface Requirements:

[IR XXXX]

[IR XXXX]

These Interface Requirements have been published by Ofcom in accordance with Article 4.1 of Directive 1995/5/EC of the European Parliament and of the Council on radio equipment and telecommunications terminal equipment (RTTE) and the mutual recognition of their conformity."

3. Special Conditions relating to the Operation of the Radio Equipment

a. During the period that this Licence remains in force and for 6 months thereafter, the Licensee shall compile and maintain accurate written records of:

(i) The following details relating to the Radio Equipment:

a. postal address;

b. National Grid Reference, (to 100 Metres resolution);

c. antenna height (AGL) and type;

d. radio frequencies in operation;

(ii) a statement of the number of subscribing customers;

the Licensee must produce the above records when a person authorised by Ofcom requires him to do so.

(iii) without prejudice to this sub-paragraph (a), the Licensee shall furnish Ofcom in such a manner and at such times as reasonably requested, information in the form of documents, accounts, estimates, returns and any other information which may be reasonably required for the purposes of verifying compliance with this Licence and for statistical purposes;

b. The Licensee shall inform Ofcom of the address of the premises at which this Licence and the information detailed at sub-paragraph (a) above shall be kept.

c. The Licensee must submit to Ofcom copies of the records detailed in sub-paragraph (a) above at such intervals as Ofcom shall notify to the Licensee.

4. Site Clearance Requirements

A valid site clearance certificate, issued by Ofcom is required for all Radio Equipment except base transceiver stations incorporating transmitters radiating not more than 17dBW ERP and/or aerial systems, the highest point of which is less than 30 metres above ground level and which does not increase the height of an existing (site cleared) structure by 5 metres or more.

5. Engineering Coordination Code of Practice

a. The Licensee shall use best endeavours to agree within six months of the date of issue of this Licence with the holders of the other licences which are identified to the Licensee by Ofcom engineering coordination principles (to be contained in an industry Code of Practice).

b. The objective of the Engineering Coordination Code of Practice shall be to secure the efficient use of spectrum such that in so far as possible radio stations and apparatus shall be established or installed, sited, used and transmit in a manner that will allow similar and competing services (including those offered by the holders of the licences identified by Ofcom at sub-paragraph (a)) to be employed in neighbouring premises (including premises on different floors on the same building).

c. In developing The Code of Practice licensees shall at a minimum consider principles relating to:

Efficient use of radio frequency channels, by not using more channels than are necessary to service customers;

Avoidance of interference by limiting transmission power to that which is no greater than necessary for service of customers;

Selection of sites in a manner that will minimise the probability of interference arising;

Siting of equipment within customer premises and at other sites in a manner that will minimise the probability of interference arising; and

Arrangements for communicating information between companies to facilitate engineering coordination.

The Code of Practice, when agreed, shall be provided to Ofcom.

d. When agreed, the Licensee shall use its best endeavours to adhere to the Code of Practice when establishing and using stations for wireless telegraphy and installing and using apparatus for wireless telegraphy.

e. If a Code of Practice containing such engineering coordination principles is not agreed within six months in accordance with sub-paragraph (a), or, where the objective sought by the Code of Practice is, in Ofcom's sole opinion not being secured, Ofcom may impose on the Licensee a Code of Practice containing such principles as it in its sole discretion deems necessary for the achievement of the objective and the efficient use of the frequency bands in the United Kingdom.

f. Any material breach of principles imposed by Ofcom under sub-paragraph (e) above shall constitute a breach of this Licence.

6. Cross-border Coordination

The Radio Equipment shall be operated in compliance with such cross-border coordination and sharing procedures as may be considered necessary and notified to the Licensee by Ofcom.

7. Frequencies of Operation

The Radio Equipment may only operate in any of the following frequency bands:

1876.9 – 1879.9 MHz - Base Transmit

1781.9 – 1784.9 MHz - Base Receive

8. Maximum Permissible EIRP

The maximum EIRP per carrier is 23 dBm (200 mW).

9. Antenna Height

The highest point of outdoor antenna systems shall be no more than 10 meters above ground level.

10. Permissible Out-of-Block Emissions

Out-of-block emissions from the Radio Equipment must not exceed the following:

Offset from edge of block	Maximum permitted level	Measurement bandwidth
0 MHz to 0.3 MHz	-103 × Δ*f* dBc	30 kHz
0.3 MHz to 0.5 MHz	-17.5 - (45 × Δ*f*) dBc	30 kHz
0.5 MHz to 1.1 MHz	-40 dBc	30 kHz
1.1 MHz to 1.7 MHz	-43 dBc	30 kHz
1.7 MHz to 6 MHz	-45 dBc	100 kHz

Note: Δf is the offset from the edge of the frequency block in MHz.

11. Interpretation of terms in this Schedule

In this Schedule:

a. "EIRP" means the equivalent isotropically radiated power. This is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain);

b. “ERP” means the effective radiated power. This is the power fed to the antenna multiplied by the maximum gain of the antenna with respect to a half wavelength dipole.

c. “dBW” means the power level in decibels (logarithmic scale) referenced against 1 Watt. (i.e. a value of 0 dBw is 1 W);

d. “dBm” means the power level in decibels (logarithmic scale) referenced against 1 milliWatt (i.e. a value of 0 dBm is 1 mW);

e. “dBc” means the power level in decibels (logarithmic scale) referenced against the carrier power;

f. “Base Transmit” means transmission of frequencies by any Radio Equipment covered by this licence.

g. “Base Receive” means reception of frequencies by any Radio Equipment covered by this licence.

h. “Carrier power” means the average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle taken under the condition of no modulation. This does not apply to pulse modulation or frequency-shift keying.

i. “Maximum EIRP per carrier”. The maximum EIRP in any direction from the base-station should be below this limit for any transmitted carrier. Power for this limit is defined as the mean modulated carrier power time averaged over any suitable time period in which the transmitter is continuously transmitting at its maximum operational power level.

j. “Out-of-block emissions” are defined as radio frequency emissions generated by the system operated by the licensee but radiated into the spectrum adjacent to the licensee’s permitted frequencies of operation;

k. “Maximum permitted level” (of out-of-block emissions) is the maximum power, integrated over the corresponding measurement bandwidth, that may be supplied by the transmitter to the antenna feeder line. Power is defined as the mean radio frequency power time averaged over any suitable time period during which the transmitter is continuously transmitting at its maximum rated power.

SCHEDULE 2 TO LICENCE NUMBER: **[Insert Licence Number]**

Licence Category: **Low Power Operator Licence**

[Licence fees – date of payment and amount of fee]

Annex G

Characteristics of adjacent band use

Below 1781.9 MHz

G.1 GSM systems are used below 1781.9 MHz. This spectrum is used for transmissions from mobile handsets to base station receivers. The maximum power levels specified for GSM handsets are:

GSM power class	Mobile station power
1	30 dBm
2	24 dBm
3	36 dBm

Source: GSM 05.05

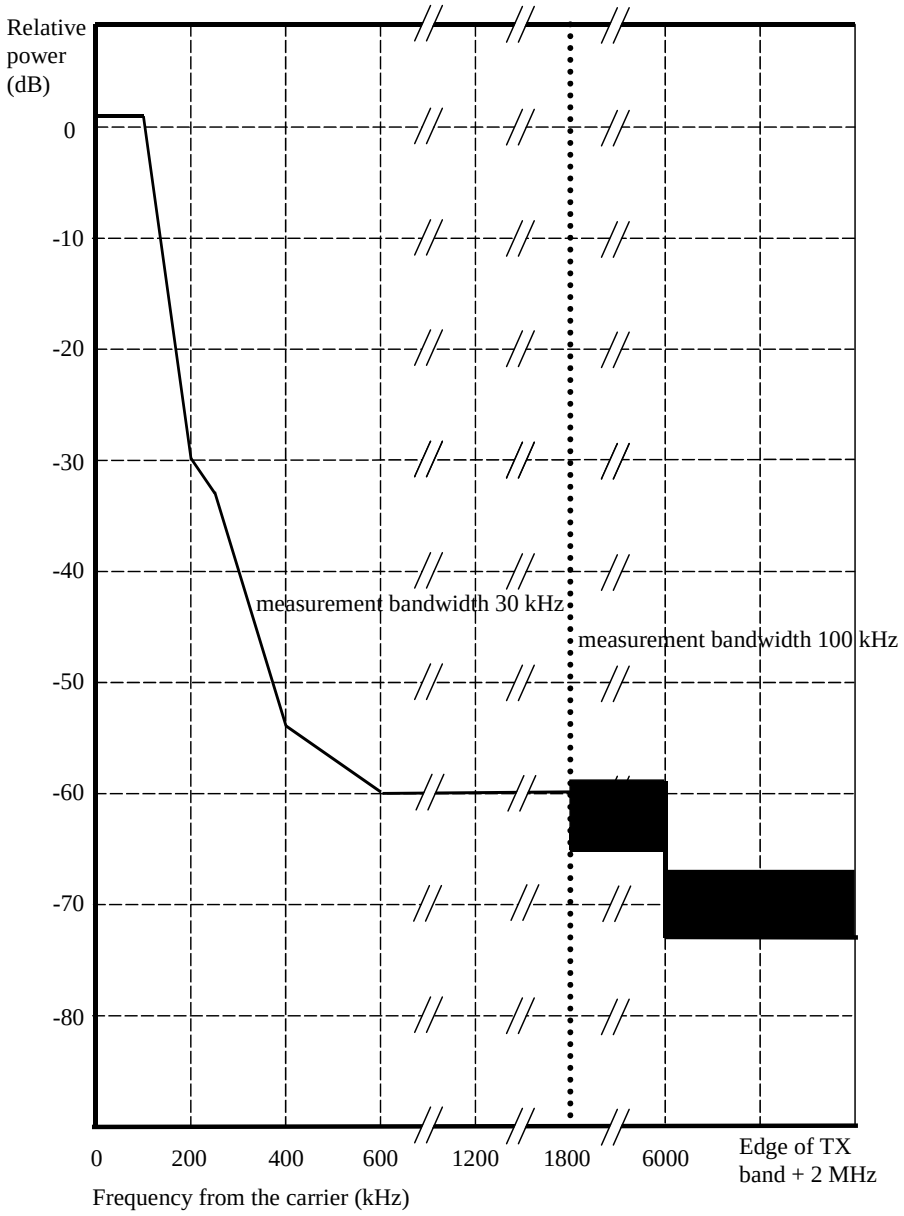
G.2 The above levels are for power into the antenna. Antenna gain is not specified for GSM mobile stations.

G.3 The spectrum mask of a GSM mobile station is defined in the specifications as follows:

Mobile station power	Emission level (dBc) 100 kHz offset	200 kHz offset	250 kHz offset	400 kHz offset	600 - 1800 kHz offset	1800 - 6000 kHz offset	>6000 kHz offset
≥36 dBm	+0.5	-30	-33	-60	-60	-71	-79
34 dBm	+0.5	-30	-33	-60	-60	-69	-77
32 dBm	+0.5	-30	-33	-60	-60	-67	-75
30 dBm	+0.5	-30	-33	-54	-60	-65	-73
28 dBm	+0.5	-30	-33	-54	-60	-63	-71
26 dBm	+0.5	-30	-33	-54	-60	-61	-69
≤24 dBm	+0.5	-30	-33	-54	-60	-59	-67

Notes:
1. Mobile station power is the power into the antenna
2. Offset is relative to the carrier frequency
3. Emission levels are relative to a measurement in 30 kHz on the carrier
4. 30 kHz measurement bandwidth up to 1800 kHz from carrier, 100 kHz measurement bandwidth above
5. Source: GSM 05.05

G.4 The spectrum mask of a GSM mobile station is shown in graphical format as follows (note the graph only corresponds to mobile station powers 30 dBm and below) :



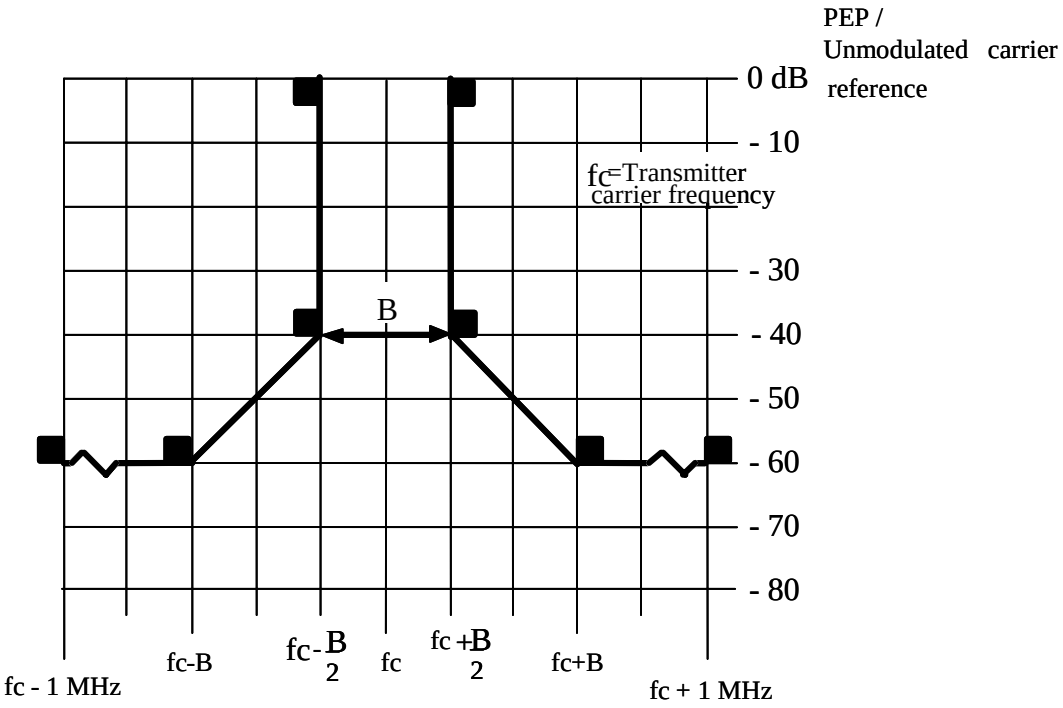
Notes:	1. Upper bound of graph is for 30dBm mobile 2. Lower bound of graph is for 24dBm mobile 3. Graph is based on 8-PSK modulation (EDGE), lower limits apply at certain frequencies for GMSK modulation 4. Source: GSM 05.05

G.5 The highest carrier in use below the 1781.9 to 1784.9 MHz band is assigned to Orange and is centred on 1781.6 MHz. Use of this carrier frequency will be dependent on network deployment.

1785 MHz and above

G.6 Above 1784.9 MHz the spectrum has been authorised for use by digital radio microphones. The maximum power level specified in the standard (ETSI EN 301 840) is 50 mW ERP per carrier.

G.7 The spectrum mask is shown in graphical format as follows:



Notes:	1. B is the declared channel bandwidth. Values defined for B in the specification are: 200 kHz 300 kHz 400 kHz 500 kHz 600 kHz 2. Source: ETSI EN 301 840

Below 1876.9 MHz

G.8 GSM systems are used below 1781.9 MHz. This spectrum is used for base station transmissions to mobile stations. The maximum power level licensed by Ofcom for GSM base stations is 62 dBm EIRP per carrier.

G.9 The spectrum mask of a GSM base station is defined in the specifications as:

Base station power rating	Emission level (dBc) 100 kHz offset	200 kHz offset	250 kHz offset	400 kHz offset	≥600-1200 kHz offset	≥-1200-1800 kHz offset	≥-1800-6000 kHz offset	≥6000 kHz offset
≥43 dBm	+0.5	-30	-33	-56	-70	-73	-75	-80
41 dBm	+0.5	-30	-33	-56	-68	-71	-73	-80
39 dBm	+0.5	-30	-33	-56	-66	-69	-71	-80
37 dBm	+0.5	-30	-33	-56	-64	-67	-69	-80
35 dBm	+0.5	-30	-33	-56	-62	-65	-67	-80
≤33 dBm	+0.5	-30	-33	-56	-60	-63	-65	-80

Notes: 1. Base station power rating is the power into the antenna

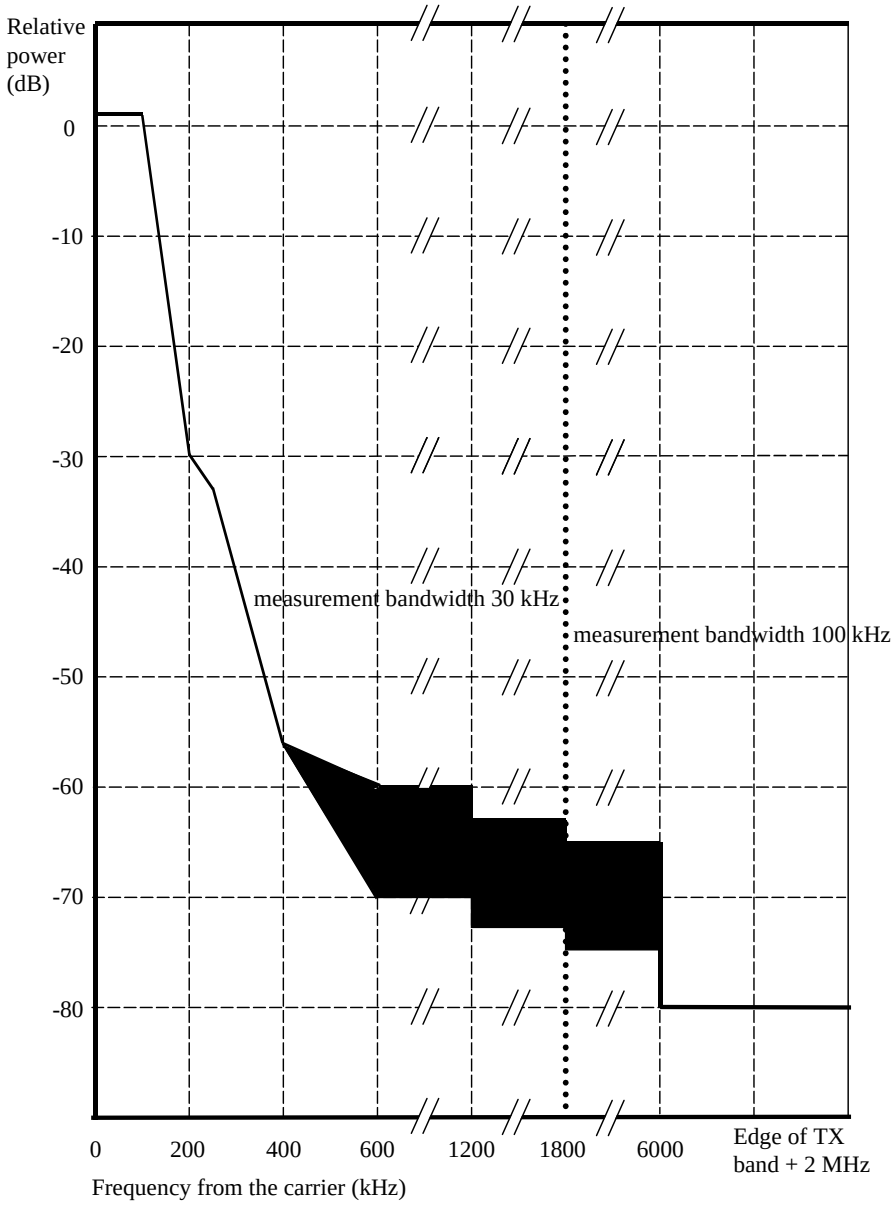
2. Offset is relative to the carrier frequency

3. Emission levels are relative to a measurement in 30 kHz on the carrier

4. 30 kHz measurement bandwidth up to 1800 kHz from carrier, 100 kHz measurement bandwidth above

5. Source: GSM 05.05

G.10 The spectrum mask of a GSM base station is shown in graphical format as follows:



Notes:	1. Upper bound of graph is for 43dBm base station 2. Lower bound of graph is for 33dBm base station 3. Graph is based on 8-PSK modulation (EDGE), lower limits apply at certain frequencies for GMSK modulation 4. Source: GSM 05.05

G.11 The highest carrier in use below the 1876.9 to 1879.9 MHz band is assigned to Orange and is centred on 1876.6 MHz. Use of this carrier frequency will be dependent on network deployment.

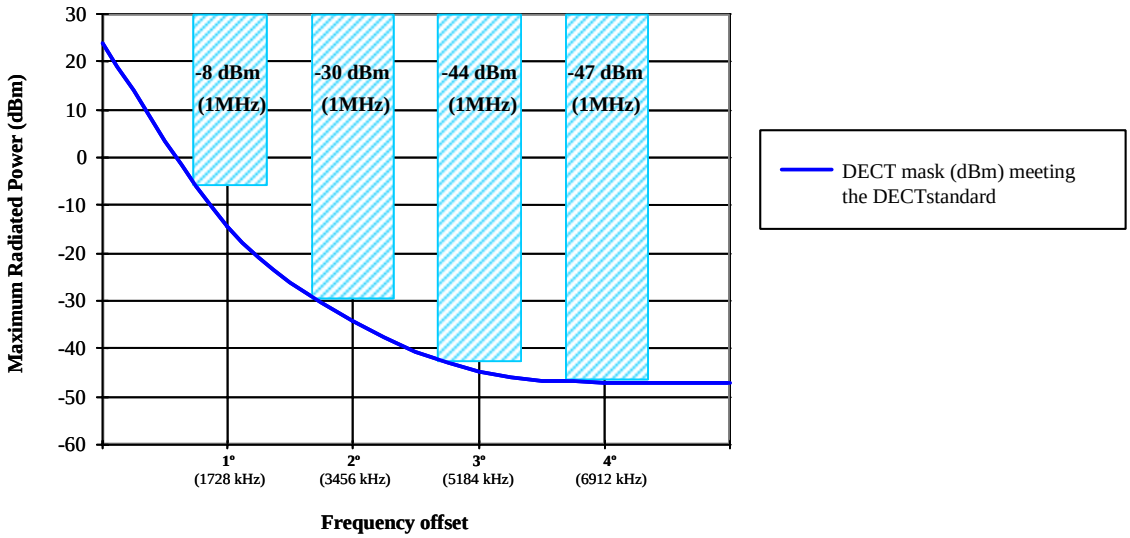
Above 1879.9 MHz

G.12 DECT cordless systems are used above 1879.9 MHz. This spectrum is used by both base stations (DECT fixed part) and handsets (DECT portable part). DECT systems are exempt from licensing provided that they meet the requirements of UK Radio Interface Requirement IR2011. The maximum power permitted by IR2011 for DECT is 24dBm.

G.13 The lowest carrier used by DECT is centred on 1881.792 MHz. DECT cordless systems employ automatic carrier selection and can use any of the 10 carriers in the 1880 to 1900 MHz band.

G.14 The DECT spectrum mask for a carrier on 1881.792 MHz is defined in the specifications as:

G.15 The DECT spectrum mask is shown in graphical format as follows:



Notes:	1. The DECT standard does not provide a power spectrum mask (measured in a narrow bandwidth) as the GSM standard does. 2. ERC Report 100 has derived the above mask based on the DECT adjacent channel performance requirement for emissions due to modulation. 3. The shaded areas represent the requirements from the DECT standard and the line represents the derived mask. 3. Source: ERC Report 100

Annex H

Impact assessment

H.1 This Annex sets out an Impact Assessment (IA) for the proposals in this Consultation Document.

H.2 Ofcom is proposing to award rights to use the spectrum 1781 – 1785 MHz paired with 1876 – 1881 MHz - by auction the end of 2005-06. It is proposing that the award be limited to low power applications, that the award is technology neutral, and that concurrent licences (i.e. licensees have equal access to the entire spectrum on a shared basis, no one licensee having priority over any other) are issued to the winners of the auction. Ofcom is also proposing that the auction takes the format of a sealed bid auction with menu bidding (a full explanation is given earlier in this Consultation) which will allow the market to determine the number of concurrent licences awarded, within a minimum and maximum set by Ofcom.

H.3 Prior to this Consultation, the legacy regulator the Radiocommunications Agency published a Consultation on this spectrum in April 2003. Ofcom commissioned an economic study on the potential uses of the spectrum identified by the respondents to the Consultation which was carried out by the consultants NERA and published in which month? 2004. Finally, Ofcom put forward proposals for the auction of the Spectrum Bands in the Spectrum Framework Review: Implementation Plan (SFR:IP), which was published in January 2005.

H.4 The regulatory impact assessment in the SFR:IP considered four options:

a. leaving the spectrum unassigned to assist migration to 3G;

b. licence exemption;

c. awarding the spectrum for wide area high power use;

d. awarding the spectrum for low power use.

H.5 The assessment rejected the option of leaving the spectrum unassigned because the benefits associated with exploiting the spectrum were predicted to be significant compared to the benefits of not having to clear the spectrum for 3G use at some future stage. Moreover given the large amount of spectrum likely to be made available for 3G use in the coming years, there is unlikely to be a scarcity of spectrum for 3G in the short to medium term.

H.6 Licence exemption was rejected because of the costs of interference are potentially high, and this would outweigh the benefits of low administrative cost. Ofcom believed that engineering coordination would only be effective where the number of licensees was small. Ofcom has reviewed these issues following comments made by respondents to the SFR:IP, but still believes its initial opinion to be correct.

H.7 Ofcom believed that awarding the spectrum for either high or low power use were the best options, however the level of market uncertainty made it difficult to decide which option was the better on economic grounds. It was noted that if the primary market assignment did prove to be inefficient, secondary market trading could lead to a better outcome providing the award was set up to minimise the secondary market transaction costs (e.g. limiting the number of low power licensees). The SFR:IP assessment

concluded that if innovation were a relevant policy objective in this respect then, all other things being equal, this might be a deciding criterion in favour of the low power option.

H.8 This Impact Assessment has taken all the previous work into consideration, plus subsequent analysis performed by Ofcom and by the consultants DotEcon. Of the issues above, it revisits the only one that was left inconclusive in the SFR:IP - high and low power use of the spectrum. It also addresses the auction format and auction design issues which arise in consideration of the specific proposals made in this Consultation.

Low power and high power use

H.9 Ofcom has considered in more detail the technical options for whether to specify power limits for the use of the spectrum that is under offer in the auction. There are two main options:

a. limiting use of the spectrum to low power use which would reduce the coverage area of a cell and enable users to target services on small geographic areas, or individual buildings;

b. allowing the spectrum to be used for high power use (if one entity won all of the licences on award); high power uses would allow wide area mobile services to be provided.

H.10 The table below presents the costs, benefits and risks of the two alternatives.

Option	Benefits	Costs	Risks
Low power	Significant economic benefits could accrue, but the scale is subject to market uncertainty. Potential for innovation indicated by respondents to previous consultations and external studies.	Inefficiency if high power use turns out to be of greater value. This is mitigated by potential for acquisition of licences in secondary market and application for change of use to high power.	If a large number of licences are awarded, the transaction costs may prevent a potential high power user acquiring the licences with the aim of converting to high power.
High power	Substantial economic benefits could accrue, but are most likely to be less than for low power.	Inefficiency if low power use turns out to be of greater value, though spectrum could be acquired in the secondary market if the transaction costs are not high.	Costs of low power users acting together to trade with a high power user might disincentivise re-assignment of spectrum to low power use in secondary market. Including both low and high power options in auction may lead to inefficient outcomes given bidder asymmetries. e.g. weak bidders may be dissuaded from participating, given the costs, because they

			perceive strong bidders are much more likely to win.

H.11 The Impact assessment shows that specifying low power in this spectrum is most likely to promote the optimal use of the spectrum. The key factors that support this conclusion are listed below:

a. the economic study showing that the benefits of low power services are likely to be significantly higher than high power services;

b. evidence from two previous consultations of greater demand and much stronger interest in using the spectrum for low power than high power services;

c. the substantial potential for the development of innovative services which have up to now not been offered by the market;

d. the copious amount of alternative spectrum that will be soon made available for high power services;

e. the significant risk of inefficient outcomes from allowing the choice between high and low power to be decided in the auction due to the effect of asymmetries between bidders and the potential for strategic manipulation.

Technology neutrality

H.12 Ofcom is proposing that the spectrum is awarded on a technology neutral basis. The clear alternative to this policy would be to mandate that GSM technology is used for the spectrum since GSM equipment already works and is available in this frequency range. These two options are considered in the table below.

Option	Benefits	Costs	Risks
Technology neutrality	The potential efficiency of the auction is maximised by allowing bidders the option of using the technology they prefer.	Engineering coordination between different systems may be technically less efficient, although investigation by Ofcom has shown that any additional costs are likely to be small.	The use of technologies in ways not currently anticipated could create unexpected engineering coordination problems.
Mandate GSM	Potentially reduces the complexity of engineering coordination between licensees if they are all using GSM. Also may allow mitigation techniques such as DFS and automatic power control to be used to	Potential efficiency gains are foregone if greater value can be gained from the spectrum by using other technologies.	Nugatory restrictions may be placed on the spectrum if there are no additional engineering coordination costs associated with technology neutrality.

further reduce the problem of engineering coordination		

H.13 As a result of the Impact Assessment, Ofcom concludes that technology neutrality is appropriate, and the case for intrusive regulation to mandate a particular technology is weak. Ofcom's technical studies have shown that other likely potential technologies such as W-CDMA can effectively share the spectrum with GSM. Ofcom believes that the additional engineering coordination benefits from having only GSM operating in this band compared to having different technologies are not likely to outweigh the potential losses in economic benefits from limiting the potential technology choices open to licensees.

Limits on the potential number of licensees - minimum and maximum

H.14 Ofcom proposes that the number of licensees awarded in the auction be limited to a minimum of five and a maximum of ten. The natural alternative is to have no limits on the minimum or maximum. While the table below considers having no minimum as an alternative, having no maximum limit is not included. This is because it is similar in many respects to licence exemption, which has already been considered above and been shown to be inferior to limiting the number of licences. A more appropriate alternative is to consider whether the maximum should be substantially higher, at an intermediate level between a limit of ten and having no limit at all. For this purpose an indicative level of 25 has been chosen.

Option	Benefits	Costs	Risks
Minimum of five	The potential for innovation is higher. Competition problems could arise in the provision of low power services, to the extent that it represents a separate market. Setting a minimum of five limits the scope for anti-competitive behaviour.	Loss in flexibility through restricting the range of bids that can be made though responses to SFRIP; however, consultation responses support the view that engineering coordination costs will be low up to the level of five licences..	If engineering coordination costs for three or four licensees were significantly lower than for five, setting the minimum at five could be sub-optimal. Ofcom believes this is unlikely given responses to the consultation.
No minimum	A wider range of outcomes is possible, therefore the efficiency of the auction may be increased.	May be less competition in market for low power services.	Potential loss in efficiency if competition is distorted and less scope for innovation
Maximum of ten	Engineering coordination costs likely to be manageable allowing all licensees to use the spectrum effectively regardless of bidders' conduct in the auction. Transaction costs for	Potential loss in efficiency if more licensees could effectively use the spectrum.	It is difficult to set the maximum precisely, but the risk that it is too low is mitigated because firms may be able to get access to the spectrum through commercial arrangements with licensees or by trading.

	potential amalgamation of licences post auction are relatively low.		
Maximum of 25 (indicative only)	Scope for even more competitive entry, but incremental benefits relative to 10 licensees likely to be small.	Engineering coordination costs could be substantially greater than for 10 or so licences.	Transaction costs for potential amalgamation of licences post auction may be prohibitive and impede any later reduction in the number of licences. Engineering coordination between licensees may turn out to be unmanageable.

H.15 The assessment above confirms that Ofcom's proposed limits on the number of licensees are the best option. A minimum number of licensees is necessary to alleviate concerns over competition, and the risks of inefficient outcome in setting the maximum at ten appear lower than if the maximum is set a qualitatively higher level. In addition the cost of engineering coordination with a relatively high number of licensees is likely to be significantly higher than for 10 licensees.

Auction format: sealed versus open auction

H.16 There are two key issues in deciding the format of the auction: whether to use a sealed bid or a simultaneous multi-round auction (SMRA) also called an open auction. The second issue is whether to have a simple format in which participants bid on individual licences or to have a menu bidding approach in which the participants can make a series of bids on the basis of the number of players to be in the market - i.e. total number of licences awarded. The table below explores the four combinations of these two issues.

Option	Benefits	Costs	Risks
Menu bidding - sealed bid	Market assesses engineering coordination costs and determines optimum number of licensees. May facilitate entry by mitigating impact of bidder asymmetries because weak bidders have an increased chance of winning. Fast and low cost to run.	Bidders cannot learn from each others' bids and inefficiency may result if some bidders are not sufficiently well informed of the potential value of the spectrum. Bidders may have to invest time in understanding the impact of engineering coordination costs on their bids.	The risk that the auction is inefficient because bidders do not get information from observing others' bid is mitigated by the fact that the common value between bidders may be modest because the potential uses of the spectrum are quite diverse.
Menu bidding - SMRA	Bidders learn from observing other bids. This benefit is likely to be limited because there are several different	Weak bidders more likely to be discouraged from the auction because it is easier for strong bidders to	

	potential applications for the spectrum. The market determines the number of licences.	overbid competitors. Costly to implement, more complex and time consuming for bidders. Bidders may have to invest time in understanding the impact of engineering coordination costs on their bids.	
Simple sealed bid	May facilitate entry by mitigating impact of bidder asymmetries because weak bidders have an increased chance of winning. Fast and low cost to run.	Bidders cannot learn from each others' bids and inefficiency may result if some bidders are not sufficiently well informed of the potential value of the spectrum.	Ofcom will not have enough information accurately to determine the most appropriate number of licensees.
Simple SMRA	Bidders learn from observing other bids. This benefit is likely to be limited because there are several different potential applications for the spectrum. Relatively simple and not expensive to run.	Weak bidders more likely to be discouraged from the auction because it is easier for strong bidders to overbid competitors.	Ofcom will not have enough information accurately to determine the most appropriate number of licensees.

H.17 The Impact Assessment indicates that, on balance, a menu bidding sealed bid format is the best option. The sealed bid option appears attractive in the light of potentially large asymmetries between bidders. The SMRA format does have some advantages because there is uncertainty about the value of the spectrum. However, the uncertainty is more to do with different potential applications of the spectrum, so the actual extent to which bidders would be able to learn from each other's bid would be limited, because other bidders might be planning to provide very different services. On balance, therefore, a sealed bid approach appears more appropriate than an SMRA approach.

H.18 Menu bidding has clear advantages over the simple option of bidding separately for a predefined number of licences because it allows the market to evaluate engineering coordination costs and determine the appropriate number of licences.

Transparency, bidder association, and pricing rules

H.19 As indicated in the main body of the consultation, the issues of transparency and the rules on bidder association are linked. The decisions on one may affect the decisions on another. In this particular auction, the choice of pricing rule (which determines how much the winning bidders have to pay) also affects the options chosen for transparency and bidder association rules. Ofcom is proposing transparency, i.e. that the identity and number of bidders is revealed before the auction, that bidder

association is prohibited and that bidders will have to declare they have complied with this rule and that the pricing rule is such that the winners pay what they bid.

H.20 Ofcom has considered two options for each of the three rules, then assessed which combinations of the options were feasible. The options for each rule are as follows:

a. transparency - the details of the participants are either revealed or not revealed;

b. bidder association - this is either explicitly prohibited or it is allowed;

c. pricing rules - either the winners pay what they bid, uniform pricing rule (all the winners pay the value of the lowest winning bid) or a Vickrey-Clarke-Groves rule.

H.21 The advantages and disadvantages of each of the three choices are presented in the table below.

Option	Advantages	Disadvantages
Transparency	Enables rules prohibiting bidder association to be properly implemented Eases uncertainty for bidders under pay what you bid price rule.	Increases the potential for strategic manipulation of the auction and makes it easier for tacit collusion to occur. Weak bidders more easily discouraged from the auction.
No transparency	Weak bidders do not know who has entered the auction and are less likely to be discouraged.	Difficult to implement rules prohibiting bidder association and collusion if this of concern.
Bidder association prohibited	Makes strategic manipulation of the auction difficult.	Imposes compliance costs on participants and verification costs on Ofcom. Setting the threshold is somewhat arbitrary and it is difficult to implement if there is no transparency. Bidders may have legitimate reasons for multiple bid vehicles which are disallowed.
Bidder association allowed	Allows legitimate multiple bid vehicles, e.g. a bidder wants to trial two different services as separately registered companies for financial reasons.	Vulnerable to strategic manipulation especially when uniform pricing determines what the winners pay.
'Pay what you bid' pricing	Strategic manipulation - which is likely to be more effective when there are bidder asymmetries - is much more costly under this pricing rule. Thus manipulation is less likely and the outcome of the	Inefficient outcomes may arise compared to uniform pricing, because the fear of the winner's curse[23] may lead bidders to be cautious and to underbid.

	auction should be more efficient.	
Uniform pricing	If bidders are reasonably similar, uniform pricing mitigates the winner's curse problem and typically leads to more efficient outcomes, though the winner's curse issue is less significant in cases like this where bidders intend to put the spectrum to different uses and therefore may not share common values for the spectrum .	Uniform price auctions are highly vulnerable to strategic manipulation, particularly where there are asymmetries between bidders. A strong bidder could submit a high bid to influence the choice of a particular outcome and would face a very small chance of having to pay what they bid.
Vickrey-Clarke-Groves pricing	The optimal strategy for bidders is to bid their valuation, which promotes an economically efficient outcome.	The auction rules are difficult to implement in practice, which and difficult for bidders to understand. In practice the incentives on bidders to bid their valuations may not work.

H.22 Clearly the best combination of the above rules depends on the market conditions in the auction. The salient factors are:

a. the level of bidder asymmetry - evidence from the external studies carried out for Ofcom and from the responses to previous consultations suggests that the level of bidder asymmetry could be high;

b. the risk of strategic manipulation - it is difficult to tell whether there are strong incentives for any bidders to manipulate the auction using multiple bid vehicles;

c. the maturity of the technology - GSM technology is mature and the costs of operating low power systems are well understood, this reduces the variability in valuing the spectrum and alleviates the impact of the winner's curse;

d. the possibility of legitimate multiple bid vehicles - although this could not be ruled out, the secondary market offers opportunities for players to gain additional licences should they so wish.

H.23 In the light of these conditions, the following conclusions can be made. Pay what you bid pricing is likely to be preferable to uniform pricing and a Vickrey-Clarke-Groves pricing rule. Pay what you bid is superior to uniform pricing, because concerns of manipulation of the auction are stronger than concerns over an inefficient outcome of the auction due to the winner's curse issue. Pay what you bid is superior to Vickrey-Clarke-Groves because the theoretical advantages of Vickrey-Clarke-Groves are unlikely to be realised in practice.

H.24 Prohibiting bidder association is consistent with the concerns over strategic manipulation of the auction and the alternative ways for achieving the same result as using multiple bid vehicles.

H.25 If bidder association rules are prohibited then transparency is clearly preferable to non-transparency. Moreover, because a pay what you bid pricing rule is the better option, there is no need for non-transparency to address the potential for strategic manipulation of the auction.

Business sectors affected

H.26 The business sectors affected by this proposal may include:

a. fixed and mobile communications service provision;

b. telecommunications equipment manufacturing;

c. hotels;

d. hospitals;

e. tertiary education;

f. sectors connected with public gathering places such as:

i. airports;

ii. railway stations;

iii. conference and exhibition centres;

iv. sports and music stadiums;

v. museums.

H.27 In addition, large business in general may benefit from this proposal as customers of service providers.

Annex I

Glossary

2G: “Two G”: second generation of mobile telephony systems using digital encoding. 2G networks support voice and limited data communications.

3G: The third generation cellular phone system, currently being deployed, which offers higher data rates than previous systems allowing services such as videophones.

AIP: Administrative incentive pricing: a fee charged to users of the spectrum to encourage them to make economically efficient use of their spectrum.

Allocation: The process of identifying specific frequency ranges for specific services; or a frequency band entered in a table of frequency allocations, for use by a particular category of service.

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.

Blocking: A process whereby a radio receiver is desensitised by the presence of a nearby strong signal outside its immediate bandwidth.

CDMA: Code Division Multiple Access: A radio transmission method where individual traffic transmissions use the same frequency, but where users’ traffic is separated by means of different codes.

cdma2000: cdma2000 - a 3G mobile phone standard built on the CDMA technology. One of the IMT-2000 family of standards. See CDMA.

cdma2000 1x: A variant of the cdma2000 standard utilising nominal 1.25 MHz carriers.

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 over 40 European administrations.

Communications Act: Communications Act 2003, which came into force in 2003.

Coordination: This term refers to the process under which users seek to come to a mutual agreement to share access to a particular range of frequencies while avoiding undue interference.

dBm: Decibels above one milliwatt: a logarithmic representation of radio frequency power with respect to one milliwatt.

dBW: Decibels above one Watt: a logarithmic representation of radio frequency power with respect to one Watt.

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.

DECT: Digital Enhanced Cordless Telecommunications: an access technology used in private cordless telephone equipment.

GSM/DECT guard bands: The guard bands between the GSM 1800 radio service and the DECT cordless phone product. See DCS 1800, DECT and Guard Band.

EC: European Commission: 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.

EDGE: Enhanced Data Rates for Global Evolution: an access technology that delivers broadband-like data speeds to mobile devices at data speeds faster than is possible with GSM/GPRS.

EIRP: Equivalent Isotropically Radiated Power: a theoretical measure of the power radiated by a transmitter/antenna - defined as the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna.

EN: European Norm: a prefix attached to ETSI equipment standards that indicates its European position.

Engineering coordination: The process of reaching agreements between licensees where they take such steps as locating base stations and selecting channels and adopting other engineering solutions and exchanging information in order to minimise the probability of causing mutual interference.

ERC: European Radio Communications Committee: a previous committee of CEPT, the functions of which have been taken over by ECC. See ECC.

ERP: Effective Radiated Power: a theoretical measure of the power radiated by a transmitter/antenna - defined as the product of the power supplied to the antenna and its gain relative to a halfwave dipole in a given direction.

ETSI: European Telecommunications Standards Institute: a European based industry group that addresses equipment standards for telecommunications equipment.

EU: The European Union.

Guard band: Frequency range deliberately kept vacant between assignments to give a level of protection to users on either side from interference from each other.

GHz: Gigahertz: a unit of frequency equal to 1000 million (1 x 109) Hz or cycles per second.

GPRS: General Packet Radio Service: a method to increase the data capacity of 2G or voice based digital networks to enable real time 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 used by approximately 80% of 2G operators worldwide. Also sometimes referred to under its original meaning 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.

IA: Impact Assessment: a process undertaken by policy makers to show why a particular decision was made.

IMT-2000: International Mobile Telephony 2000: a family of global standards for mobile phone networks proposed by the ITU Also referred to as 3G.

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 Telecommunication Union: an international organization within the United Nations System where governments and the private sector coordinate, discuss and agree the logistics of global telecom networks and services.

kHz: Kilohertz: a unit of frequency, equal to 1000 (1 x 103) Hz or cycles per second.

Liberalisation: Allowing licence holders to change the use to which they put their spectrum, within constraints to prevent interference.

Licence class: Type of licence issued by Ofcom, for example PAMR. Volume classes refer to those licence classes for which there are significant numbers of licensees, for example on site PBR with 26,000 licensees.

Licence exempt: Allowing anyone to use the spectrum for any application under certain specified restrictions, but typically with maximum power levels. The current regulations are the Wireless Telegraphy (Exemption) Regulations 2003 (SI 2003 No. 74), available at: http://www.legislation.hmso.gov.uk/si/si2003/20030074.htm

MHz: Megahertz: a unit of frequency equal to 1,000,000 (1 x 106) Hz or cycles per second.

MoD: Ministry of Defence.

Macro cell: Term used to describe a standard base station designed to provide coverage over a relatively wide area often with a range of several kilometres or tens of kilometres.

Ofcom: Office of Communications. Ofcom took 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 were transferred to Ofcom in December 2003.

Out-of-block emissions: Emissions cause by use of the spectrum covered by a particular licence that fall immediately outside the spectrum block covered by that licence.

Partial transfer: In a spectrum trading market, licence holders may transfer only a part of the rights and obligations associated with their spectrum licence - whereby the licence can be divided (e.g. partitioned) by geography, frequency and by time.

Pico cell: Term used to describe a small base station with limited power designed to provided coverage over a relatively small area usually no more that a few 100 metres (often in-doors).

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.

Radio spectrum: A section of frequencies of electromagnetic radiation in the range of approximately 10 kHz to 3000 GHz.

RR: Radio Regulations: an international treaty produced by the ITU that sets out at a global level how spectrum should be used by countries. The Radio Regulations are developed and maintained by WRCs. See WRC.

Spectrum bands: The radio spectrum bands 1781.7 – 1785 MHz paired with 1876.7 – 1880 MHz.

Spectrum Framework Review (SFR): Ofcom consultation published in November 2004 and resulting statement published in June 2005 by Ofcom on how spectrum will be managed in the future.

Spectrum Framework Review: Implementation Plan (SFR:IP): Ofcom consultation published in January 2005 by Ofcom on the release of spectrum in 2005 – 08, and on extending spectrum liberalisation and trading to mobile services.

Spectrum mask: A way of specifying the amount of power that a transmitter is allowed to transmit into neighbouring frequency channels.

Spectrum trading: Process through which spectrum licence holders are able to transfer some or all of their rights to a third party.

Trading Regulations: The Statutory Regulations that facilitate spectrum trading.

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 in relation to any wireless telegraphy which is undue and also harmful (as described in section 19(5) and (5A) of the Wireless Telegraphy Act 1949). In summary 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.

WRC: World Radiocommunications Conference: an ITU convened conference, held approximately every two or three years, which updates the International Radio Regulations.

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.

Wireless telegraphy: The means of sending information without the use of a wired system.

Wireless telegraphy licences: Licences issued under the Wireless Telegraphy Act 1949 (as amended).

WT Acts: Wireless Telegraphy Act 1949 and Wireless Telegraphy Act 1998 (both as amended).