OFFICE OF COMMUNICATIONS

The award of available spectrum:1452-1492 MHz

Technical conditions and auction design relating to the proposed grant of wireless telegraphy licences to use the 1452-1492 MHz spectrum

Consultation document

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Section 1

Introduction

1.1 Ofcom, in March 2006, consulted on its proposals for the award of available spectrum in the 1452 – 1492 MHz frequency band[1]. In that consultation document, Ofcom set out a number of factors relevant to the spectrum award.

1.2 Following that consultation, in order to address some of the issues raised by respondents, on 15 February 2007 Ofcom published two discussion documents relating to the award of the 1452-1492 MHz band. One document addressed aspects of the auction design and the other considered aspects of the technical licence conditions.

1.3 The "Discussion document on the award of available spectrum 1452 – 1492 MHz: Auction design"[2] proposed rules for a combinatorial auction design for the LBand award. The purpose of the document was to explain the key features of the combinatorial clock auction format and set out how such an auction format may be expected to work in practice. It also summarised the two auction formats set out in the consultation document and compared these with the combinatorial clock auction format.

1.4 In the "Discussion document on the award of available spectrum 1452 – 1492 MHz: Technical aspects"[3] Ofcom laid out a number of alternative approaches to the technical conditions associated with the award of the 1452 – 1479.5 MHz sub band. The revised technical conditions proposed in the document were designed to give the market greater certainty while not unduly inhibiting alternative technologies.

1.5 Specifically the technical conditions document put forward for consultation four proposals.

- Proposal 1 – A spectrum mask approach based on an augmented Maastricht mask, as referred to in the consultation document.
- Proposal 2 – A spectrum mask approach based on the European Telecommunications Standards Institute (ETSI) critical mask
- Proposal 3 – A Spectrum Usage Rights (SURs) approach based on an augmented Maastricht mask
- Proposal 4 – A SURs approach based on the ETSI critical mask

[1] "Award of available spectrum: 1452-1492 MHz", Ofcom, 31 March 2006, http://www.ofcom.org.uk/consult/condocs/1452-1492/
[2] http://www.ofcom.org.uk/consult/condocs/1452design/
[3] http://www.ofcom.org.uk/consult/condocs/1452tech/

Developments since the consultations

1.6 The consultation on these discussion documents closed on 12 April 2007 and the full non-confidential consultation responses are available on the Ofcom website, however some of the points arising from the responses are summarised below.

1.7 Most respondents to the auction design consultation supported the combinatorial clock auction, although some indicated that they wanted more detail about the auction design. Some respondents also suggested that Ofcom should look for ways to ensure that different network designs were co-ordinated through the auction.

1.8 Reponses to the consultation on the technical aspects were mixed with the general view that the ETSI critical mask was preferred to the Maastricht mask. However views were split between whether the SURs or the spectrum mask approach should be followed.

1.9 The most common issue raised by respondents was that there still was not enough certainty about adjacent users, particularly as to how high and low power networks would co-exist, and therefore there was a significant risk of Adjacent Channel Interference (ACI), and uncertainty over the ability to use coordination measures successfully.

1.10 Given that material concerns still appear to exist Ofcom has again considered what can be done to address those issues. In order to do that this document makes proposals in two areas; firstly revised technical conditions and secondly modifications to the proposed auction design.

1.11 The proposed revised technical conditions consist of two types of licence for the sub-band, split by a guard band, one for high power-low density network deployments and the other for low power-high density network deployments:

- an SUR derived with values appropriate for indoor, portable, mobile multimedia services and operating in line with the ETSI critical mask. Additionally a restriction on the maximum density of transmitters is proposed, limiting use to high power, low density networks.

- a second SUR, based on the same parameters. Additionally an upper limit on the Equivalent Isotropically Radiated Power (EIRP) of transmitters deployed in the network is proposed, limiting use to lower power, higher density networks.

1.12 The modified auction design is a combinatorial clock auction format that allows successful bidders to guarantee through the auction that they are adjacent to either:

- the top or the bottom of the band; or

- users who want to roll out a similar network to their own i.e. either high power-low density or a low power-high density; or

- a guard band of 2 lots (3.4 MHz) between high power-low density and low power-high density networks

1.13 This combination of technical conditions and auction design will give users greater certainty about the potential for interference from the networks of adjacent users. Under this approach, the market could either choose an outcome that allows a single

usage right to cover the entire band (and in this case there will be no guard band) or an outcome where different network designs co-exist.

1.14 As before, much of the content of this discussion document relating to auction design is based on work that has been commissioned by Ofcom from DotEcon and Professor Peter Cramton.

1.15 In addition concerns have been raised regarding possible inefficient hoarding of spectrum in this band. Ofcom has considered the issues relating to this but considers that it would not be appropriate to include a licence condition that relates to inefficient hoarding in the 1452-1492 MHz licences.

International developments

1.16 Following the Electronic Communications Committee (ECC) meeting on 2-4 July 2007 32 administrations have agreed and signed a partial revision to the Maastricht 2002 Special Arrangement (MA02). This includes the majority of the Member States of the European Union including the UK and all of the UK's near neighbours.

1.17 In general terms the partial revision of MA02 allows additional flexibility for administrations to use the 1452-1479.5 MHz band. In particular it supports:

- the application of an envelope concept i.e. that the plan entries in MA02 could be used for terrestrial mobile multimedia services with characteristics that may be different from those appearing in the Plan but within the envelope of their T-DAB Plan entry; and

- the aggregation of the blocks to accommodate mobile multimedia services with wider bandwidths than T-DAB.

1.18 The European Commission (EC) is considering making a binding decision to harmonise the use of the 1452-1479.5 MHz band. It is not planning to make the decision before the October 2007 meeting of the Radio Spectrum Committee (RSC) scheduled for 4-5 October 2007 and there is a significant risk that this could be delayed until the December 2007 meeting.

Purpose of this document

1.19 The purpose of this document is threefold.

- Firstly to set out revised technical conditions for two proposed SURs for the 1452-1479.5 MHz sub-band, one set of rights for a high power-low density network and another set of rights for a low power-high density network.

- Secondly to set out details of a combinatorial-clock auction design that allows bidders to guarantee, through the auction, that they have adequate frequency separation from other users with different SURs.

- Thirdly to discuss issues relating to possible inefficient hoarding of spectrum in this band.

1.20 This document does not seek to fully address all of the points made by respondents to the previous consultations or to revisit the other areas relevant to the award of the available spectrum which were addressed in the consultation document, e.g. options for packaging the available spectrum or the associated technical and regulatory

conditions specific to the wireless telegraphy licences. As such this document should be read in conjunction with the previous consultation documents. Ofcom's decision on all of these issues will be set out in its Statement on this award.

1.21 Stakeholders have repeatedly emphasised to us that it is important to award this spectrum as soon as possible. Therefore, as these issues have already been consulted on, this consultation will only last for 7 weeks. Following this Ofcom is planning to publish its statement, information memorandum and draft regulations after the October 2007 RSC meeting. Subject to the international constraints, this will allow Ofcom to aim for an award of the spectrum as soon as possible thereafter.

1.22 Ofcom would welcome comments or views on any aspect of this document by 12 September 2007. In particular:

Question 1: Do stakeholders agree with proposals that compliance with SUR aggregate PFD limits is determined by use of modelling? Do stakeholders agree with the proposal to use ITU Rec 1546 version 3 with clutter and terrain information at a 50m resolution? Do stakeholders have a view as to the terrain and clutter map database to be specified?

Question 2: Do stakeholders agree with the proposal for 95% of locations to be used for specifying aggregate PFD emission restrictions?

Question 3: Do stakeholders agree that the SUR PFD limits for channels LO and LP should be increased to be consistent with the SUR PFD limits for channels LA to LN? Do stakeholders agree that no further restrictions other than those detailed in the SURs need to be applied to LO and LP in order to protect the upper 12.5 MHz sub-band from ACI?

Question 4: Do stakeholders agree with the proposal for additional density limit restrictions for inclusion on the high power licence and is the proposed density limit appropriate?

Question 5: Do stakeholders agree with the proposal for additional EIRP limit restrictions for inclusion in the low power licence and is the EIRP value proposed appropriate?

Question 6: Do stakeholders agree that 3.4 MHz (2 lots) is a suitable separation between holders of the two types of licence?

Question 7: Do stakeholders agree that there should be no right to transmit in the guard bands? If stakeholders consider that there should be some transmission rights in the guard bands what would be an appropriate level?

Question 8: Do stakeholders agree that transmitter EIRP masks are not required in licences for this award?

Question 9: Do stakeholders agree with the proposal to develop two industry codes of practice on engineering co-ordination to control ACI?

Question 10: Do stakeholders agree that Ofcom should award the 1452-1492 MHz band using a combinatorial clock auction design that:

i) allows each bidder to express their preference for one of two usage rights;

ii) allows usage rights to be varied across different packages (but not within a single package); and

iii) guarantees that a guard band is maintained between the different usage rights?

Question 11: Do you agree with Ofcom's assessment that it would be inappropriate to include a licence condition to address inefficient hoarding concerns in the 1452-1492 MHz spectrum award?

Structure of this document

1.23 Section 2 of this document summarises the proposed technical licence conditions. It presents the parameters of the two SURs, and describes additional technical conditions proposed for this award. Section 3 explains the key modifications of the combinatorial clock auction format and sets out how it may be expected to work in this award. Section 4 considers issues relating to an inefficient hoarding licence condition. Section 5 summarises the proposed timing and next steps.

1.24 Annex 1 sets out the process for responding to this document, with Annex 2 setting out Ofcom's consultation principles. Annex 3 contains a consultation coversheet, with Annex 4 setting out the question to which Ofcom is seeking stakeholders' responses. Annex 5 describes in detail the proposed SURs and the assumptions used to calculate them. Annex 6 describes the assumptions and inputs used in the SUR modelling tool. Annex 7 contains an impact assessment considering the inefficient hoarding of spectrum. Annex 8 describes the detailed auction rules and procedures proposed for the award of 1452-1492 MHz. Annex 9 contains example draft licences.

Section 2

Technical Licence Conditions

Spectrum Usage Right Aggregate Emission Restrictions

2.1 As a modification to the proposals put forward in the February 2007 discussion document[4] and presented at the stakeholders event held in March 2007[5], Ofcom proposes spectrum usage rights based on:

- the ETSI critical mask as an appropriate basis for reducing the probability of interference occurring in an uncoordinated deployment, while not placing excessive constraints on equipment performance. This transmit mask was also specified in Proposals 2 and 4, outlined in the discussion document.
- increased in-band and out-of-band aggregate power flux density (PFD) limits, based upon provision of portable indoor coverage for mobile multi-media services.
- modelling as a basis for testing compliance with the SUR emission limits.

2.2 These are discussed further below. The SUR emission limit values and their derivation are presented in Annex 5, and are also contained in the example draft licences in Annex 9. Annex 9 specifically contains two example draft licences for the 1465.8 – 1467.512 MHz block (Block LI) one for a high power-low density network and the other for a low power-high density network.

Higher emission limits

2.3 In the discussion document an in-band PFD was proposed based on the T-DAB planning criteria used in the Maastricht, 2002, Special Arrangement (MA02) which assumes a service aimed at mobile outdoor reception. Some respondents stated that this level was insufficient as it was widely expected that mobile multimedia services would be aimed at providing portable indoor reception.

2.4 Therefore Ofcom proposes to increase the in-band PFD limit to that appropriate for provision of "good" portable indoor coverage in urban areas (Class B reception mode) as defined in the European Broadcasting Union's publication EBU – TECH 3317: Planning parameters for hand-held reception[6].

2.5 In order to provide the greatest flexibility Ofcom proposes that the least restrictive planning parameters for good, portable indoor reception in this band are used. This equates to the planning parameters for T-DMB hand-held reception, Class B, which provides for a minimum median equivalent field strength of 78.4 dBµV/m at 1.5 metres (equivalent noise bandwidth of 1.536 MHz) as defined in EBU – TECH DOC 3317.

2.6 Full details of the resultant emission limits proposed are given in Annex 5.

[4] http://www.ofcom.org.uk/consult/condocs/1452tech/
[5] http://www.ofcom.org.uk/radiocomms/spectrumawards/awardspending/award_1452/260307/
[6] EBU – TECH 3317. Planning parameters for hand-held reception http://www.ebu.ch/CMSimages/en/tec_doc_t3317-2006_tcm6-48865.pdf

Modelling as a basis for compliance

2.7 In the consultation on SURs, Ofcom proposed testing compliance with aggregate emission limits by making measurements, but suggested that licence holders could agree to use modelling with an agreed modelling tool as a basis should they wish.

2.8 In this award, the discussion document also proposed measurements as the basis for testing compliance with SUR emission limits. Whilst measurements could possibly require significant resources to undertake, they ensure that licence terms directly restrict the real-world interference levels experienced by licensees.

2.9 However, in response to proposals on this, and other SUR related consultations, a preference for modelling has been expressed by stakeholders on the basis that this would be likely to be simpler and would enable testing at a greater number of points across the test area for statistical certainty.

2.10 Ofcom agrees that this is likely to be a simpler and less costly means by which compliance with the aggregate emission limits can be established. It is therefore proposed that modelling is used to establish compliance in this case, using a planning tool with agreed and specified parameters. This will need to include specification of an appropriate propagation model, and potentially terrain and clutter databases.

2.11 Ofcom proposes that ITU Rec 1546 version 3 be used for testing compliance with the aggregate emission limits contained in the licence. Version 3 of this model incorporates changes to enable path loss predictions below the previous minimum limit of 1km.

2.12 Furthermore a decision must be made on what terrain and clutter database information should be included in the compliance modelling. An agreed terrain and clutter database must be specified to ensure consistency between stakeholder expectations and Ofcom's modelling process. There are a number of proprietary providers of such information, and these databases come at a range of resolutions.

2.13 Ofcom proposes that 50 metres is an appropriate resolution for such information. This is a balance between the accuracy required to demonstrate compliance over the test area, and computational complexity and cost.

2.14 Ofcom has no preference at this stage over the provider. Clearly it is desirable to use a database of sufficient quality to arrive at accurate results. There are a number of potential suppliers of such data, for example Infoterra, Computamaps and others. Ofcom would welcome stakeholder views on this issue.

Question 1: Do stakeholders agree with proposals that compliance with SUR aggregate PFD limits is determined by use of modelling? Do stakeholders agree with the proposal to use ITU Rec 1546 version 3 with clutter and terrain information at a 50m resolution? Do stakeholders have a view as to the terrain and clutter map database to be specified?

2.15 In the previous discussion document, PFD limits were given which should not be exceeded at more than 50% of locations. The figure of 50% was based upon measurement, rather than modelling, being the basis of determining compliance. A figure of 50% was chosen since it enabled a practicable number of measurements to be made to establish compliance.

2.16 If modelling is to be used to determine compliance with aggregate emission restrictions, then a higher percentile, closer to the likely service provision, may be desirable. This issue was raised by a number of stakeholders in response to previous consultations involving SURs. A higher figure was cited as desirable to give increased confidence that emissions would not be exceeded across the service area. This higher percentile of locations will require a greater number of points to be tested to establish compliance with a suitable statistical certainty. Since modelling is proposed, there is little penalty in increasing the number of points in a test grid which are tested. Therefore Ofcom proposes that a figure of 95% is appropriate for this award.

Question 2: Do stakeholders agree with the proposal for 95% of locations to be used for specifying aggregate PFD emission restrictions?

SURs for channels LO and LP

2.17 In response to the discussion document, some stakeholders commented that the SUR PFD levels for channels LO and LP may be unduly restrictive, as the requirement for such protection ultimately depends on the system or service to be deployed in the sub-band 1479.5 – 1492 MHz.

2.18 In this consultation Ofcom proposes to increase the SUR limits of LO and LP to match those of the other channels in the sub-band 1452 – 1479.5 MHz, i.e. in-band PFD of -48 dBW/m2/MHz and out-of-band PFD limits as defined in Table 2 of Annex 5. LO and LP can be considered for either of the licence types, namely, high power-low density or low power-high density (as described below). There will be no other restriction on LO and LP other than those defined by the PFD levels (see Annex 5) although there will continue to be a requirement to comply with international agreements.

2.19 Ofcom recognises that the proposed increased PFD levels to LO and LP may impact the upper 12.5 MHz sub-band. Ofcom does not intend to impose any further restriction to LO and LP, other than that noted above, as it is felt that there are several options available for the potential licensee of the upper 12.5 MHz to mitigate against ACI. These include using part of the 12.5 MHz as a guard band or bidding on LO and LP to use these as a guard band if the whole of the upper sub-band is required.

Question 3: Do stakeholders agree that the SUR PFD limits for channels LO and LP should be increased to be consistent with the SUR PFD limits for channels LA to LN? Do stakeholders agree that no further restrictions other than those detailed in the SURs need to be applied to LO and LP in order to protect the upper 12.5 MHz sub-band from ACI?

Additional measures to address adjacent channel interference and 'hole punching'

2.20 The emission limits proposed above provide a number of measures to limit ACI as described. However, practically achievable emission limits alone cannot prevent receivers nearby a neighbouring licensee's transmitters experiencing interference, (often referred to as holes being "punched" in the network coverage).

2.21 Beyond improving receiver performance, to best mitigate ACI it is necessary to either co-locate transmitters or provide a guard band between adjacent users in order to reduce the areas where holes are "punched" into each licensee's coverage.

2.22 In responses to the discussion document and in comments received at the stakeholder event in March 2007, stakeholders continue to raise concerns regarding the difficulty in coordination of highly different network deployments. Ofcom accepts stakeholder comments that it is difficult to coordinate when there are fundamental differences in network topology, such as when the respective network densities are significantly different.

2.23 Ofcom recognises that there is still a degree of uncertainty in the extent and levels of ACI that potential bidders might expect from neighbours at the time of the award, arising principally from the possibility of highly different network topologies being deployed in neighbouring channels of the award. Further conditions, in addition to the PFD levels, are proposed to address this and are discussed below.

2.24 To address this problem of coordinating different networks Ofcom proposes that two types of licence should be available for award in the sub-band:

- one appropriate for high power-low density deployments; and
- a second, appropriate for low power-high density network deployments.

It should be noted that although the former SUR is referred to as high power-low density the restriction is to the density of transmitters. Any EIRP can be used, from low power up to high power. Similarly, for the low power-high density SUR the restriction is to the maximum EIRP and there is no limit to the density of deployment of transmitters.

2.25 A guard band will separate the holders of the different types of licence. This will limit the extent of hole punching between the different network deployments immediately adjacent to the guard band, where coordination measures are not practicably possible.

2.26 Licences for the high power-low density users would contain a restriction on the number of transmitters that may be deployed in any area. Licences for the low power-high density users would contain a restriction on the maximum EIRP of individual transmitters deployed in the network.

2.27 Proposals for these additional restrictions are made below. The objective of the additional restrictions is to separate spectrum users who are likely to employ widely disparate network deployments in terms of the power and density of transmitters. As such, Ofcom believes that successful achievement of this objective is relatively insensitive to the precise values specified for each restriction.

2.28 Therefore Ofcom proposes specifying restriction values which are not overly restrictive to potential licensees, but which achieve the objective of separating those licensees who are most likely to interfere.

High power-low density licence – maximum transmitter density restriction

2.29 For operators who anticipate deploying a high power-low density network, a limit on the maximum number of transmitters (including low power gap fillers) that can be

deployed in an area is proposed. There is no upper or lower limit to EIRP for this SUR although restriction at the UK boundary must be met.

2.30 Ofcom has made an estimate of a suitable density limit for the high power-low density licences below. Further detail may be found in Annex 6. However Ofcom appreciates that prospective bidders are likely to have the best view on the definition of this additional licence restriction which depends heavily on the network deployment they foresee, and would welcome feedback on this.

2.31 Ofcom proposes that the restriction on transmitter deployment density will be stated:

> *The number of transmitters in any 50km x 50km square centred on the intersection of any 1km OS grid lines within the licensed area must not exceed X.*

2.32 In the absence of data of deployed networks in this band, Ofcom proposes a value of 80 for X. This is based on the maximum density of transmitters in the existing UK broadcast TV network and the assumption that existing infrastructure may be used to provide a mobile multimedia service.

Question 4: Do stakeholders agree with the proposal for additional density limit restrictions for inclusion on the high power licence and is the proposed density limit appropriate?

2.33 The objective of this restriction is to reduce the risk to potential bidders for the channels in the 1452 – 1479.5 MHz band that they will be unable to coordinate with their neighbours[7]. After the award is made and licensees have knowledge of their neighbours, their deployments and the potential for receiving interference, then neighbouring licensees may agree between themselves that this restriction be amended or removed by Ofcom if they wished. Ofcom would wish to be confident that all affected licensees had been consulted and were in agreement.

Low power-high density licence – maximum transmitter EIRP restrictions

2.34 For operators who anticipate deploying a higher density network, a limit on the maximum EIRP of transmitters in the network is proposed. There is no upper or lower limit to transmitter density for this SUR.

2.35 Ofcom has made an estimate of a suitable EIRP limit for the higher density network deployments based upon existing cellular communications deployments. Ofcom's analysis suggests that with typical cellular deployment densities, transmitter EIRPs of up to 6kW are likely, but in many instances significantly less. This analysis is broadly in agreement with that put forward[8] by the Working Group for Frequency Management of Digital Broadcasting Issues, (Project Team FM PT45), which assumed transmitter configurations with ERPs of 500W – 6 kW for providing portable, indoor coverage for mobile multimedia systems.

2.36 Therefore Ofcom proposes that the restriction on EIRP will be stated:

[7] By neighbours we mean all licence holders who would be affected by any proposed action. Hence, neighbours might include, for example, those immediately adjacent to a licence holder's band and also the next-adjacent.

[8] CEPT Project Team FMPT45, "Technical Issues Relating to the Future Use of the Band 1452–1492 MHz", www.ero.dk Doc. FM PT45(07)007

The EIRP of any transmitter deployed must not exceed 6kW within a single 1.7MHz channel.

2.37 Again, Ofcom appreciates that prospective bidders are likely to have the best view on the most appropriate definition of this additional licence restriction which depends heavily on the network deployment they foresee, and would welcome feedback on this.

Question 5: Do stakeholders agree with the proposal for additional EIRP limit restrictions for inclusion in the low power licence and is the EIRP value proposed appropriate?

2.38 The objective of this restriction is to reduce the risk to potential bidders for the channels in the 1452MHz – 1479.5MHz band that they will be unable to coordinate with their neighbours. After the award is made and licensees have knowledge of their neighbours, their deployments and the potential for receiving interference, then neighbouring licensees may agree between themselves that this restriction be amended or removed by Ofcom if they wished. Ofcom would wish to be confident that all affected licensees had been consulted and were in agreement.

Number of channels required for the guard-band

2.39 Analysis by Ofcom has quantified the likely extent of the hole-punching problem between significantly differing network deployment densities. In this instance coordination measures are not readily achievable, or are prohibitively expensive to be practicable. A guard band of sufficient size must therefore be employed to limit the area of coverage affected assuming the neighbouring network deployments to be uncoordinated.

2.40 Ofcom has undertaken calculations to establish the suitable size of the guard band. Assumptions used in this analysis are presented in Annex 6. From this, Ofcom has concluded that a guard band consisting of two 1.7 MHz channels is likely to be sufficient.

2.41 The calculations suggest that a two channel guard band will limit the total area affected by hole-punching to around 0.5% of the total coverage. This assumes licensees on either side of the guard band aiming to provide the same service (e.g. indoor, portable, multi-media services), but with highly different network deployments.

Question 6: Do stakeholders agree that 3.4 MHz (2 lots) is a suitable separation between holders of the two types of licence?

Usage rights in the guard-band

2.42 In the event that there were two guard blocks Ofcom intends that the guard blocks would be assigned, one each, to the two adjacent winning bidders. In order to reduce the risk of interference Ofcom is proposing that there should be no right to transmit in the guard blocks but that the licensee would have the ability to ask Ofcom to change those rights after reaching an agreement with affected licensees.

Question 7: Do stakeholders agree that there should be no right to transmit in the guard bands? If stakeholders consider that there should be some transmission rights in the guard bands what would be an appropriate level?

The need for licences with SUR and transmitter mask restrictions

2.43 In response to stakeholders concerns about ACI Ofcom suggested previously that SUR restrictions with an additional spectrum mask might be one means to address this issue. This would limit the emissions of each transmitter, and give neighbours sufficient knowledge of every transmitter in adjacent network deployments to plan to mitigate ACI.

2.44 As a result of further consideration in this area, Ofcom has not proposed additional spectrum masks for the high and low power licences proposed here. Ofcom now believes that the proposals outlined in this section are sufficient to address the concerns regarding ACI as the restrictions for EIRP on the low power licence and transmitter density on the high power licence, along with the aggregate in band and out of band PFD levels derived from the ETSI critical mask, will limit the extent of ACI sufficiently

2.45 However, Ofcom is keen to understand whether stakeholders agree, or whether they perceive there to be additional benefits of inclusion of a transmitter EIRP mask in the licences to be awarded.

Question 8: Do stakeholders agree that transmitter EIRP masks are not required in licences for this award?

Industry code of practice

2.46 Ofcom has previously proposed that to help to manage the co-ordination of transmitters, licensees should agree 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.

2.47 Ofcom stated that it expected that, in developing the code, at a minimum, the following principles should be considered:

- Efficient frequency use of the spectrum;
- Possible conditions on limiting transmission powers to that just necessary to effectively provide service;
- Selection of sites in a manner that will minimise the probability of mutual interference; and
- Identifying the type of information that needs to be communicated between licensees and the arrangements for its exchange.

2.48 In light of the proposals made in this Section Ofcom is proposing that licensees should develop two industry codes of practice, one between all licensees that have high power-low density licences and the other between all licensees that have a low power-high density licences.

Question 9: Do stakeholders agree with the proposal to develop two industry codes of practice on engineering co-ordination to control ACI?

International issues

2.49 The revised Maastricht, 2002, Special Arrangement has been endorsed by the Electronic Communications Committee and was adopted at the 17th ECC meeting in Constanta, Romania in July 2007. The United Kingdom has acceded to the revised Special Arrangement which includes, *inter alia*, provisions to aggregate adjacent T-DAB frequency blocks in order to accommodate systems with necessary bandwidths wider than 1.536 MHz. This revised Special Arrangement will come in to force on 1 September, 2007.

2.50 The European Radiocommunications Office (ERO), acting in its role of the Plan Management Body for the Maastricht, 2002, Special Arrangement revised Constanta 2007, (MA02revCO07) has produced the Calculation Test Points for each allotment as referred to in Annex 4 of the Special Arrangement. These calculation test points will be available in Part 2 of the updated MA02 Plan in due course. The official text of the MA02revCO07 Special Arrangement and the updated Plan can be found on the ERO website[9].

2.51 Licensees must respect all relevant international obligations relating to the spectrum band. This includes respecting obligations regarding outgoing interference as defined in MA02revCO07. Operators must bear these constraints in mind when designing their networks.

[9] www.ero.dk Follow the links for Topics/Projects, Broadcasting, T-DAB

Section 3

Key features of the proposed combinatorial-clock auction format

Introduction

3.1 The auction design discussion document published in February 2007 set out the key features of a combinatorial clock auction in this award. This Section explains how Ofcom is proposing to adapt the auction design so that bidders can bid for the alternative usage rights described in Section 2. In particular the auction is designed so that each bidder will only have the possibility of acquiring the specific packages of spectrum that they have bid for and each successful bidder will be guaranteed that they will be adjacent to either:

- the top or the bottom of the band; or
- users who want to roll out a similar network to their own i.e. either high power-low density or a low power-high density; or
- a guard band of 2 lots (3.4 MHz) between high power-low density or a low power-high density networks

3.2 Ofcom has also made some changes to the terminology used in the February 2007 discussion document to more clearly describe the auction. The most significant of these changes are that 'primary bid rounds' is used instead of 'clock stage'; 'supplementary bids rounds' is used instead of 'best and final offers (BAFO) stage'; and 'supplementary bids' instead of best and final offers.

3.3 In response to previous consultations, some stakeholders felt that there could be some benefit to providing more of the specific details of the auction design and process. As a result summarised below are the proposals for the four key stages of the auction and Annex 8 contains Ofcom's latest views on the detailed rules and procedures for this auction design. Stakeholders should be aware that this is not a final version of these rules, that they are provided at this time for information and that they are subject to change. However, Ofcom will consult on the detailed rules when it publishes the draft regulations and Information Memorandum.

3.4 This auction design has, in part, been influenced by the work that is being undertaken on two other Ofcom spectrum awards – the 10-40 GHz awards[10] and the award of the 2.6 GHz and 2010 MHz bands[11] – that are also expected to use combinatorial clock auction formats. The terminology used and many of the procedures described in Annex 8 are common across all these awards, although the detailed rules are tailored to the specific circumstances of each band. Further refinements of the combinatorial clock format developed in the context of the 10-40 GHz award or the 2.6 GHz and 2010 MHz award may be relevant to the auction design for the 1452-1492 MHz award

[10] http://www.ofcom.org.uk/radiocomms/spectrumawards/awardspending/award_10_40/
[11] http://www.ofcom.org.uk/radiocomms/spectrumawards/awardspending/award_2010/

Combinatorial clock auction

3.5 As set out in the February 2007 discussion document, Ofcom has assumed that the 40 MHz of available spectrum would be packaged into 17 specific lots: 16 lots, each of approximately 1.7 MHz, that correspond to spectrum blocks LA to LP and one block of 12.5 MHz for the 1479.5 – 1492 MHz band[12].

3.6 The proposed combinatorial clock auction design has four stages which are briefly summarised below. These are:

- the application stage;
- the qualification stage;
- the auction stage; and
- the grant stage.

3.7 The key stage for the purposes of this consultation document is the auction stage which consists of two separate phases. The first phase is the primary bid rounds. This is a multiple round process that follows a clock auction format in which bidders have the opportunity to bid for a package of lots *and usage rights* in each round at prevailing round prices.

3.8 The second phase of the auction stage is the supplementary bids round, which follows the primary bid rounds. This is a combinatorial sealed bid auction where bidders have a final opportunity to submit bids for all packages of lots *and usage rights* that they are willing to buy, subject to restrictions determined by their bidding activity during the primary bid rounds.

3.9 The remainder of this Section summarises the four stages of this combinatorial clock auction design and how the auction format would work in this case.

Application stage

3.10 Prospective bidders submit their applications to participate in the award process, including initial deposit.

Qualification stage

3.11 Ofcom determines which applicants are qualified to bid. The determination is based on a check of the applications and initial deposits, and assessment of bidder groups. Ofcom announces the number and identity of the bidders. If there is only one bidder, the bidder will be entitled to select the frequency lots it wishes to purchase and the award will then progress directly to the Grant Stage. If there is more than one bidder, then a bidding process is required.

Auction stage

3.12 As noted above the auction stage would consist of two phases, the primary bid rounds and the supplementary bids round.

[12] The detailed rights of use associated with each block is described in the Maastricht 2002 Special arrangement (as revised in Constanta in July 2006), the March 2006 consultation and in Section 2 of this document.

The primary bid rounds

3.13 There are 17 clocks running simultaneously during the primary bid rounds, one for each of the available lots. In addition there are two sets of usage rights, as set out in Section 2 above:

- High power-low density; and
- Low power-high density

3.14 This phase of the auction proceeds over multiple primary bid rounds. In each primary bid round, the auctioneer announces prices for each of the 17 lots. Bidders submit a bid for a single package of lots at the prevailing prices and nominate a usage right that would apply to all lots in that package (except lot LQ if included in the package). In each primary bid round, bidders may nominate either a high power or low power usage right, but cannot mix the two; they may, however, nominate different usage rights in different rounds. An activity rule, based on eligibility points for each lot, is used to determine how each bidder's bidding rights evolve over successive rounds. All bids submitted represent a binding commitment to buy the lots selected at the prevailing price in the event that that bid is selected as a winning bid.

3.15 As discussed in Section 2, in the event that spectrum is awarded to both low and high power uses it will be necessary to separate the two uses by two lots to address interference concerns. This separation will be imposed as part of the winner determination process. Reflecting this, the primary bid rounds will continue until there is a round in which there is no excess demand for any lot AND there are sufficient 'unsold' lots between remaining bidders with different usage right nominations to provide an adequate guardband.

3.16 In order to prolong the primary bid rounds until such point that all new bids are compatible, the auction system will automatically increase demand for a lot by exactly one unit if

- demand for that lot is exactly one; and
- there is a usage nomination for an adjacent lot that is not the same as the usage nomination for that lot; or
- demand for an adjacent lot is zero, but the usage nomination of the next lot along is not the same as the usage nomination of the lot.

3.17 This has the effect that, under these circumstances, the primary bid rounds will continue regardless of whether there was excess demand on any of the other lots. Consider the following example:

- In round 15, Adam bids on lots LD, LE, LF and LG and nominates them all for high power use, and Beth bids for lots LG, LH, LI and LJ and nominates them for low power use. Assume that no other bidders bid for these lots. These bids are illustrated in Table 3.1. Under these conditions, the auction system would make guard block bids on LF and LH, as there is just one bid each on these lots and they are adjacent to bids for different uses. Note that no guard block bid is required on lot LG, as there are already two bids on this lot.
- In round 16, the prices of lots LF, LG and LH are increased and other lot prices stay the same. Adam maintains his demand for the same four lots, but Beth stops

bidding for lot LG, as illustrated in Table 3.2. The auction system makes guard block bids on lots LG and LH, as these two adjacent lots have different usage nominations.

- In round 17, the prices of lots LG and LH increase and other lot prices stay the same. Adam stops bidding for lot LG, but demand is otherwise unchanged, as illustrated in Table 3.3. Demand for lot LG has now fallen to zero, but the adjacent blocks have different usage nominations. Therefore, the auction system makes a guard block on lots LF and LH.

- In round 18, Beth stops bidding for lot LH, but demand is otherwise unchanged, as illustrated in Table 3.4. As a result, there are now two lots with no bids between the different usage nominations, so no guard block bids are required.

Table 3.1: Illustration of guard block bidding I

Lot:	LD	LE	LF	LG	LH	LI	LJ
High power bids	1	1	1	1			
Low power bids				1	1	1	1
Guard block bids			**1**		**1**		
TOTAL	1	1	2	2	2	1	1
Price up next round?	No	No	Yes	Yes	Yes	No	No

Table 3.2: Illustration of guard block bidding II

Lot:	LD	LE	LF	LG	LH	LI	LJ
High power bids	1	1	1	1			
Low power bids					1	1	1
Guard block bids				**1**	**1**		
TOTAL	1	1	1	2	2	1	1
Price up next round?	No	No	No	Yes	Yes	No	No

Table 3.3: Illustration of guard block bidding III

Lot:	LD	LE	LF	LG	LH	LI	LJ
High power bids	1	1	1				
Low power bids					1	1	1
Guard block bids			**1**		**1**		

TOTAL	1	1	2	0	2	1	1
Price up next round?	No	No	Yes	No	Yes	No	No

Table 3.4: Illustration of guard block bidding IV

Lot:	LD	LE	LF	LG	LH	LI	LJ
High power bids	1	1	1				
Low power bids						1	1
Guard block bids							
TOTAL	1	1	1	0	0	1	1
Price up next round?	No	No	No	No	No	No	No

3.18 At the end of each primary bid round, the auctioneer will assess all of the bids received and identify for which lots there exists excess demand (and the extent of this excess demand). If there is excess demand for any lots, then the auctioneer will raise the price on those lots (the amount of such increase may vary with the level of excess demand) whilst the price of lots for which there is no excess demand remains the same (but does not fall). In the next primary bid round each bidder has the opportunity to respond to the new prices by submitting a new bid.

3.19 The primary bid rounds end at the first (lowest) price point at which there is no excess demand on any lot (including the guard lots) i.e. where there is only one bidder on any lot or where a lot is unsold at that price (demand is zero at that price).

The supplementary bids round

3.20 Following the primary bid rounds there will be a supplementary bids round. The supplementary bids round consists of a single round combinatorial sealed bid auction, which is open to all bidders from the primary bid rounds. As in the primary bid rounds, for each package of lots, the bidder will be required to nominate a usage right, which may be either high power or low power. It is not permitted to make a bid for a mixture of high power and low power lots although it will be permitted to make two separate supplementary bids for the same package of lots, one for all high power and the other for all low power. In other respects the supplementary bids round is as described in the February 2007 discussion document on auction design.

Winner determination

3.21 Once all of the supplementary bids have been submitted, Ofcom will assess all of the bids received through both the primary bid rounds and the supplementary bids round and identify the winning combination of bids. The winning combination of bids are those that maximises the total amount bid; whilst at the same time ensure that:

- no more lots are awarded than are available;

- at most one bid is accepted from each bidder[13]; and
- if lots are awarded for both high power and low power usage rights, there are at least two lots between them that are unallocated.

3.22 The bidders that made those bids are the winning bidders.

3.23 In the event that there were two guard blocks one each will be assigned to the two adjacent winning bidders.

The pricing rule

3.24 Ofcom will compute the price to be paid by each individual winning bidder. This price is calculated according to a second price rule. The characteristics of this second price rule are that:

- the total amount of money paid is minimised; but at the same time
- no losing bidder or combination of bidders (including combinations of losing and winning bidders) would, on the basis of their bids, be willing to pay more.

Grant Stage

3.25 The winning bidders, upon payment of a licence fee equal to the price calculated according to the second price rule, will be granted a licence for the use of the specific frequency lots contained in their winning bid. Following the completion of the process, a full record of auction bids and results will be published.

Question 10: Do stakeholders agree that Ofcom should award the 1452-1492 MHz band using a combinatorial clock auction design that:

i) allows each bidder to express their preference for one of two usage rights;

ii) allows usage rights to be varied across different packages (but not within a single package); and

iii) guarantees that a guard band is maintained between the different usage rights?

[13] All bids from a bidder are mutually exclusive.

Section 4

Inefficient hoarding of spectrum

Introduction

4.1 As summarised in the March 2006 consultation document[14] Ofcom has a number of duties and functions that are relevant to the award of the 1452-1492 MHz spectrum. These include securing the optimal use of spectrum. Ofcom has made a number of proposals that are designed to help to secure the optimal use of this spectrum. Amongst these are proposals to auction the spectrum with licences that have an indefinite licence term with an initial period of 15 years during which time it is proposed Ofcom would not have the power to revoke licences for spectrum management reasons.

4.2 Concerns have been raised in relation to the 1452-1492 MHz award specifically and Ofcom's spectrum awards more generally on the issue of inefficient hoarding of spectrum by successful bidders. In light of these concerns, Ofcom has considered whether, in order to help secure the optimal use of spectrum, it would be appropriate for it to retain the power to revoke the licences to be awarded in the circumstances where there was inefficient hoarding of the spectrum, even if this was within the initial 15 year period.

A condition which prohibits the inefficient hoarding of spectrum

4.3 Ofcom's policy towards spectrum management, set out in the Spectrum Framework Review: Implementation Plan (SFR:IP)[15], is that the market is best placed to secure the optimal use of the spectrum. Moreover, Ofcom expects that the market will generally ensure that spectrum is put to good use, as an input to providing services for end-users. As such, Ofcom does not expect that spectrum will be left idle or be under-utilised for long periods of time if it is efficient to do so (Ofcom recognises that there are legitimate circumstances in which it can be appropriate for spectrum to be left idle or be under-utilised and that this can be beneficial).

4.4 However some parties have expressed the view that Ofcom could fail to meet its statutory duties to secure the optimal use of the spectrum in the event that the 1452-1492 MHz spectrum (and by implication spectrum being awarded in other valuable spectrum bands) is bought by a bidder that is not interested in providing services using the spectrum, but is interested in holding the spectrum for a significant period of time, with the intention of then selling it on the secondary market at a significant profit. If such speculative behaviour were to occur, some have argued that this may not be in the best interests of citizens and consumers.

4.5 In light of these concerns, Ofcom has considered whether it might be appropriate for it to maintain powers to intervene in the market in specific circumstances. These circumstances might be where:

- the spectrum has lain idle or significantly under-utilised for a significant period of time since it was awarded; and
- there is clear evidence of a (significantly more) valuable use of the spectrum; and

[14] http://www.ofcom.org.uk/consult/condocs/1452-1492/
[15] http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/sfr-plan.pdf

- the current holder of the spectrum has no credible plans to bring the spectrum into effective use within a reasonable period of time.

4.6 Were Ofcom to maintain powers to intervene in such circumstances it is envisaged that Ofcom would first bring its concerns to the attention of the licensee and urge it to find ways to bring the spectrum into effective use as quickly as possible. This could be either directly themselves or through transfer of the rights of use to another party.

4.7 If nonetheless the situation persisted and Ofcom continued to have strong grounds to believe that the spectrum could be put to significantly more valuable use within a reasonable period of time, Ofcom could then take action to revoke the licence on spectrum management grounds in accordance with the procedures set out in paragraphs 6 and 7 of Schedule 1 to the Wireless Telegraphy Act 2006 ("WT Act").

4.8 Ofcom recognises that such a policy would differ from the policy that has been adopted in earlier Ofcom spectrum awards. However, the likely greater economic and social significance of forthcoming spectrum awards (including the 1452-1492 MHz spectrum) places a greater imperative on Ofcom to ensure that it is used to good effect.

Likelihood of inefficient hoarding of spectrum occurring

4.9 Ofcom is not aware of any instances of speculative hoarding taking place. Indications from some other regulators are that they do not see hoarding as an issue in their respective markets. Ofcom is also not aware of any specific intentions to inefficiently hoard the 1452-1492 MHz spectrum.

Costs and benefits of a condition which prohibits the inefficient hoarding of spectrum

4.10 To inform the decision on whether to include within the 1452-1492 MHz spectrum award a licence condition which prohibits the inefficient hoarding of the 1452-1492 MHz spectrum, Ofcom has considered the costs and benefits associated with such a condition. These are discussed further in the impact assessment in Annex 7.

Potential benefits of the inclusion of such a condition in 1452-1492 MHz licences

4.11 Such a condition would maintain Ofcom's power to intervene in specific circumstances to address inefficient hoarding of spectrum, where this was found to be a concern.

Potential costs of the inclusion of such a condition in 1452-1492 MHz licences

4.12 While the potential benefits of the inclusion of such a condition are straightforward there are also costs associated with such a condition that may lead to an inefficient use of spectrum.

4.13 The most significant concern is the introduction of regulatory uncertainty; particularly that the inclusion of such a condition will likely introduce significant uncertainty for all bidders, including those that intend to make productive and immediate use of the spectrum. Such uncertainty will increase the risks faced by bidders and likely introduce barriers to potential bidders raising capital. As a result the likelihood of the spectrum being put to efficient use is reduced.

4.14 A specific consequence of the uncertainty that would likely be created in this award is that it could reduce the likelihood of some services being deployed. The indication that Ofcom has received from stakeholders is that the business case for some services is very uncertain. Any increase in the risk associated with the acquisition of this spectrum could quite easily tip the balance against the business case for the deployment of particular services in the UK. Ofcom intends this spectrum award to be service and technology neutral therefore any condition that could discourage particular services would need to have a strong justification.

4.15 For example there are some indications from stakeholders that the decision to deploy mobile TV in the 1452-1492 MHz spectrum band may be marginal due to relatively high costs of rolling out a network compared to the comparative costs in the UHF spectrum bands. Introducing a condition that could potentially address inefficient hoarding may lead to a situation where operators choose not to seek to deploy Mobile TV services in 1452-1492 MHz spectrum, preferring, for example, to wait until UHF spectrum becomes available.

4.16 In addition the condition would prohibit behaviour which may be entirely economically rational. Speculative behaviour by financial institutions in asset and commodity markets can provide liquidity to secondary markets and they are often better placed than other potential bidders to manage risks, including the risks associated with market uncertainties. Therefore, regardless of the precise nature of a condition, any prohibition on such institutions playing this role in spectrum markets might jeopardise the efficiency of the markets.

Ofcom's conclusion on a condition which prohibits the inefficient hoarding of spectrum

4.17 After weighing up the costs and benefits, Ofcom considers that it would not be appropriate to include such a condition within the WT Act licence(s) to be awarded for the 1452-1492 MHz band. For the avoidance of doubt, if such a licence condition were not included then Ofcom would not have the power to intervene in cases of inefficient spectrum hoarding. However this would not affect Ofcom's other statutory powers, including those to address anti-competitive behaviour.

Question 11: Do you agree with Ofcom's assessment that it would be inappropriate to include a licence condition to address inefficient hoarding concerns in the 1452-1492 MHz spectrum award?

Section 5

Timing and next steps

5.1 As discussed in Section 1 the Maastricht 2002 Special Arrangement was revised following the July 2007 meeting of the ECC to allow the 1452-1479.5 MHz band to be used for wider range of mobile multimedia services. The revised Special Arrangement can be obtained from the ERO website (http://www.ero.dk/)

5.2 However the European Commission (EC) is considering making a binding decision to harmonise the use of the 1452-1479.5 MHz band. It is not planning to make the decision before the October 2007 meeting of the Radio Spectrum Committee (RSC) scheduled for 4-5 October 2007 and there is a significant risk that this could be delayed until the December 2007 meeting. Given this uncertainty about the content and form of any EC decision it is not possible for Ofcom to make its final decisions about the award of this band in the UK immediately.

5.3 As a result Ofcom will not plan to publish a statement, information memorandum and draft regulations until after the RSC meeting in October 2007. Ofcom plans to hold the award as soon as possible thereafter.

5.4 Please note that you can register to receive free mail updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 12 September 2007**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at http://www.ofcom.org.uk/consult/condocs/1452_1492/howtorespond/form, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email anirban.roy@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Anirban Roy
Floor 3
Spectrum Policy Group
Riverside House
2A Southwark Bridge Road
London SE1 9HA

A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views.

Further information

A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Anirban Roy on 020 7783 4677.

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt (when respondents confirm on their response coversheet that this is acceptable).

A1.9 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 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.

A1.10 Ofcom reserves its power to disclose any information it receives where this is required to facilitate the carrying out of its statutory functions.

A1.11 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use in order to meet its legal requirements. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Ofcom's consultation processes

A1.12 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.13 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.14 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Vicki Nash, Director Scotland, who is Ofcom's consultation champion:

Vicki Nash
Ofcom
Sutherland House
149 St. Vincent Street
Glasgow G2 5NW

Tel: 0141 229 7401
Fax: 0141 229 7433

Email vicki.nash@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened version for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will normally allow ten weeks for responses to consultations on issues of general interest. This consultation is shorter than the standard period as Ofcom has previously conducted consultations in these areas and as stakeholder have made it clear that it is important to award this spectrum as soon as possible.

A2.6 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 organizations 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.

A2.7 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

A2.8 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 3

Consultation response cover sheet

A3.1 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.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality by allowing you to state very clearly what you don't want to be published. We will keep your completed coversheets confidential.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.

A3.5 Please put any 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 coversheet only so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

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?	

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 4

Consultation questions

A4.1 Ofcom would welcome comments or views on any aspect of this consultation document by 12 September 2007. In particular:

Question 1: Do stakeholders agree with proposals that compliance with SUR aggregate PFD limits is determined by use of modelling? Do stakeholders agree with the proposal to use ITU Rec 1546 version 3 with clutter and terrain information at a 50m resolution? Do stakeholders have a view as to the terrain and clutter map database to be specified?

Question 2: Do stakeholders agree with the proposal for 95% of locations to be used for specifying aggregate PFD emission restrictions?

Question 3: Do stakeholders agree that the SUR PFD limits for channels LO and LP should be increased to be consistent with the SUR PFD limits for channels LA to LN? Do stakeholders agree that no further restrictions other than those detailed in the SURs need to be applied to LO and LP in order to protect the upper 12.5 MHz sub-band from ACI?

Question 4: Do stakeholders agree with the proposal for additional density limit restrictions for inclusion on the high power licence and is the proposed density limit appropriate?

Question 5: Do stakeholders agree with the proposal for additional EIRP limit restrictions for inclusion in the low power licence and is the EIRP value proposed appropriate?

Question 6: Do stakeholders agree that 3.4 MHz (2 lots) is a suitable separation between holders of the two types of licence?

Question 7: Do stakeholders agree that there should be no right to transmit in the guard bands? If stakeholders consider that there should be some transmission rights in the guard bands what would be an appropriate level?

Question 8: Do stakeholders agree that transmitter EIRP masks are not required in licences for this award?

Question 9: Do stakeholders agree with the proposal to develop two industry codes of practice on engineering co-ordination to control ACI?

Question 10: Do stakeholders agree that Ofcom should award the 1452-1492 MHz band using a combinatorial clock auction design that:

i) allows each bidder to express their preference for one of two usage rights;

ii) allows usage rights to be varied across different packages (but not within a single package); and

iii) guarantees that a guard band is maintained between the different usage rights?

Question 11: Do you agree with Ofcom's assessment that it would be inappropriate to include a licence condition to address inefficient hoarding concerns in the 1452-1492 MHz spectrum award?

Annex 5

SUR emission restrictions for the 1452-1479.5 MHz band

Aggregate PFD emission restrictions

A5.1 In "Discussion document on the award of available spectrum 1452 – 1492 MHz: Technical aspects"[16] (the discussion document) aggregate in-band PFD levels were derived based on planning assumptions from the Maastricht 2002 Special Arrangement. This was based on provision of outdoor mobile T-DAB services, and assumed a minimum median equivalent field strength of 59dBuV/m at 1.5m above ground level.

A5.2 Some respondents stated that this level was insufficient as it was widely expected that mobile multimedia services, including T-DMB, DVB-H and MediaFLO, as well as T-DAB would be aimed at providing portable indoor reception.

A5.3 Therefore Ofcom proposes to increase the in-band PFD limit to provide "good" portable indoor coverage in urban areas (Class B reception mode) as defined in the European Broadcasting Union's publication EBU – TECH 3317: Planning parameters for hand-held reception.

A5.4 In order to provide the greatest flexibility to potential bidders, it is proposed that the planning parameters for T-DMB hand-held reception, Class B, are used. This would provide for a minimum median equivalent field strength of 78.4 dBµV/m at 1.5 metres (equivalent noise bandwidth of 1.536 MHz).

A5.5 This represents an increase of 19.4dB in the minimum median equivalent field strength to that considered in the discussion document, resulting in a corresponding increase in the SUR emission restrictions. In table A5.1, below, the levels for in-band and out-of-band PFD are given, applicable for both the high and low power licences. Further information on the technical derivation of these numbers, undertaken by Transfinite Systems, is given in the following section.

A5.6 As described in section 2, the previous discussion document presented aggregate emission restrictions which should not be exceeded at more than 50% of locations. Here we propose aggregate emission restrictions which should not be exceeded at more than 95% of locations.

[16] http://www.ofcom.org.uk/consult/condocs/1452tech/1452tech.pdf., February 2007

Channel	Centre (MHz)	Average in-band PFD at a height 1.5m above ground level (dBW/m^2/MHz)
LA	1452.908	-48
LB	1454.672	-48
LC	1456.384	-48
LD	1458.096	-48
LE	1459.808	-48
LF	1461.52	-48
LG	1463.232	-48
LH	1464.944	-48
LI	1466.656	-48
LJ	1468.368	-48
LK	1470.08	-48
LL	1471.792	-48
LM	1473.504	-48
LN	1475.216	-48
LO	1476.928	-48
LP	1478.642	-48

Table A5.1: In-band SUR restrictions for the 1452 – 1479.5 MHz sub band. The average in-band PFD at a height of 1.5m above ground level should not exceed these values at more than 95% of locations in any test area. Note PFD restrictions are raised to the next highest integer dB.

A5.7 Table A5.2 gives the revised out-of-band PFD emission restrictions based upon the ETSI critical mask for channels LA - LP.

Inner offset from channel edge (MHz)	Outer offset from channel edge (MHz)	Out-of-band PFD Channel LA	Out-of-band PFD Channels LB-LM
0.000	0.200	-88	-77
0.200	0.400	-103	-101
0.400	0.600	-112	-110
0.600	0.800	-121	-119
0.800	1.000	-128	-127
1.000	1.200	-128	-128
1.200	1.400	-128	-128
1.400	1.600	-128	-128
1.600	1.800	-128	-128
1.800	2.000	-128	-128
2.000	2.200	-128	-128
2.200	2.400	-128	-128
2.400	2.600	-128	-128
2.600	2.800	-128	-128
2.800	3.000	-128	-128
3.000	3.200	-128	-128
3.200	3.400	-128	-128
3.400	3.600	-128	-128
3.600	3.800	-128	-128

Inner offset from channel edge (MHz)	Outer offset from channel edge (MHz)	Out-of-band PFD Channel LA	Out-of-band PFD Channels LB-LM
3.800	4.000	-128	-128
4.000	4.200	-128	-128

Table A5.2: Out-of-band SUR restrictions for the 1452 – 1479.5 MHz sub band. The average out-of-band PFD at a height of 1.5m above ground level should not exceed these values at more than 95% of locations in any test area. Note PFD restrictions are raised to the next highest integer dB.

Derivation of SUR aggregate PFD emission levels

A5.8 The parameters were collected from the following sources:

- Final Acts of the CEPT T-DAB Planning Meeting (4) Maastricht, 2002 – Annex 2: Technical Bases for T-DAB Planning
- International interference analysis for future use of 1452 - 1492MHz range, Final Report for Ofcom, Analysis & Masons
- EBU-TECH 3317: Planning parameters for hand-held reception, Geneva 2006

A5.9 The parameters for an urban indoor T-DMB network were extracted as in the previous document, and used in the modelling, namely:

Field	Value	Comments
Carrier bandwidth	1.536 MHz	From T-DAB frequency plan
Channel bandwidth	1.712 MHz	From T-DAB frequency plan
Centre frequency	1 470.080	Nearest frequency to the 1 470 MHz used in Maastricht Annex 2
Service type	Indoor Portable 95 % locations	From this derive following: 13.3 dB location variation using standard deviation of 8.1 dB 27 dB height loss 11 dB building penetration loss
Minimum field strength required at 10 m for 50% of the time and 95% of locations	105.4 dBμV/m	Based upon above and required field strength of 54 dBμV/m at receive location
Transmitter separation	1 km	High density urban deployment for in-door applications
Transmit antenna height	30 m	High density deployment comparable to base station heights
Transmit EIRP	33 dBW	Planning prediction suggests would just provide required coverage of 105.4 dBμV/m across service area
Receive pattern	Isotropic	Mobile user
Receive antenna height	10 m	Reference height consistent with assumptions above
Propagation Model	ITU-R Rec.P.1546-2	Assumed path 100% over land and calculated at 50% of time and 50% locations. Used Ofcom standard adjustments for paths shorter than 1 km. Receive location variability standard deviation = 5.5 dB

Table A5.3: System Parameters

A5.10 Figure A5.1 below shows the field strength derived across the reference network using the assumptions above.

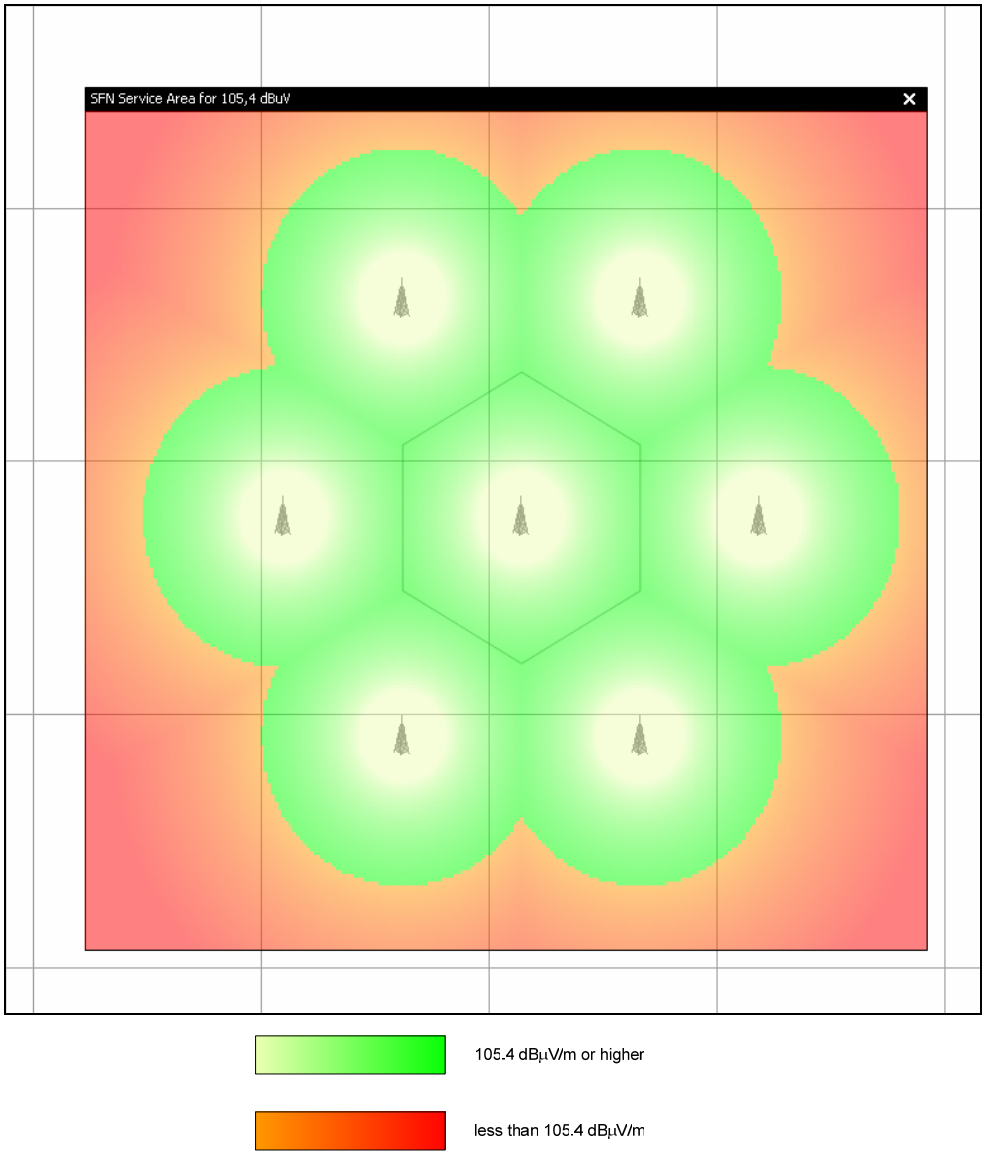


Figure A5.1: Field Strength of strongest transmitter across Reference Network area

A5.11 It can be seen that the EIRP selected would just provide the required field strength across the reference network area.

T-DMB Analysis

A5.12 The scenario was modelled using the reference network one as configured in the previous section. A set of 975 test points were deployed on a regular grid every 30m across the central area as in figure A5.2 below.

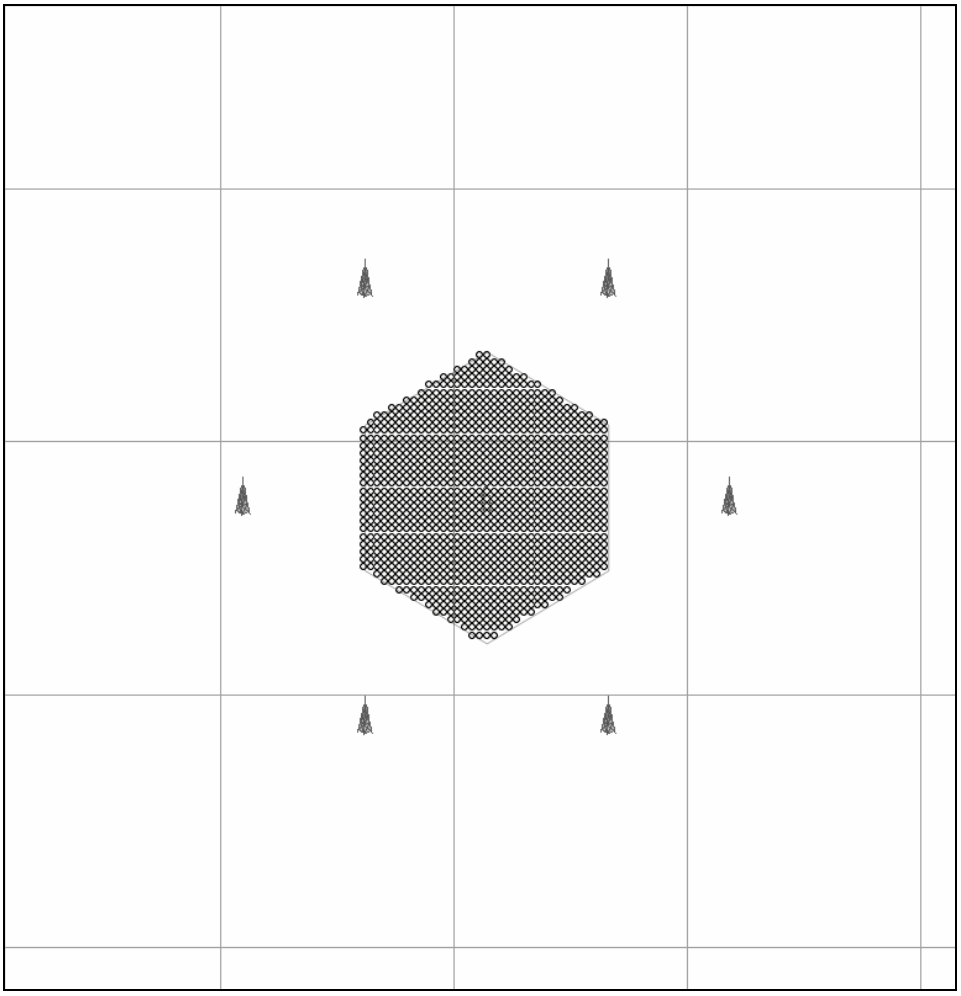


Figure A5.2: Deployment of T-DAB test points

A5.13 A Monte Carlo analysis was done by which at each of 10,000 samples:

- A test point was selected at random within the cell
- The propagation loss to that test point from each of the transmitters was calculated assuming ITU-R Rec. P.1546 for 50% of time 50% of locations
- A location variation was added using a standard deviation of 5.5 dB
- Given the above the aggregate PFD was calculation in dBW/m^2/MHz

A5.14 This process generated a cumulative distribution function (CDF).

A5.15 Five such CDFs were created and used to generate a mask that just exceeded curves all, as in the graph below. Note that with 10,000 samples there was only minor difference between curves.

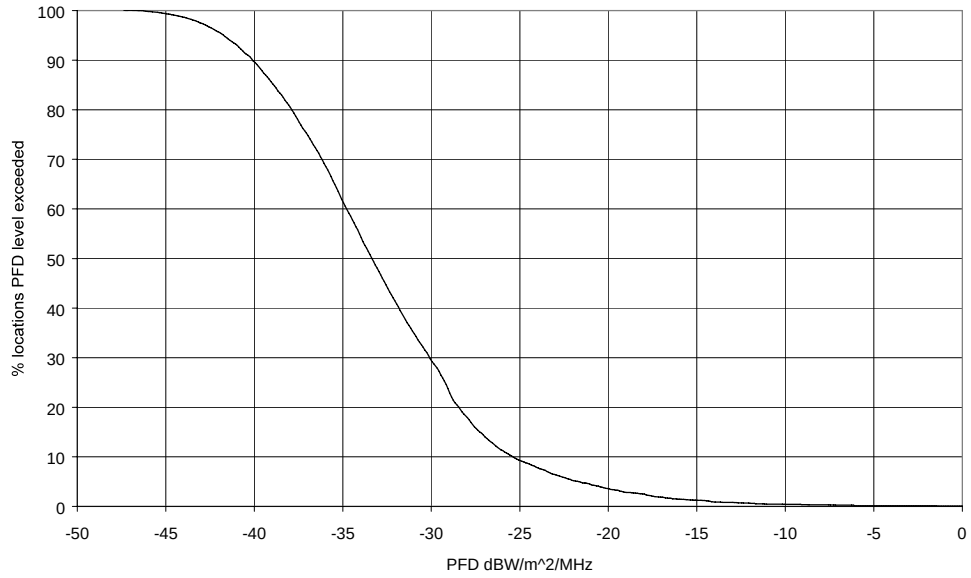


Figure A5.3: CDF of aggregate in-band PFD at 10m above ground level

A5.16 The PFD exceeded at 5% of locations for 50% of time was determined to be -21.7 dBW/m^2/MHz.

A5.17 The assumptions in the previous section were that there is:

- 27 dB between the 1.5 m and 10 m PFD levels

A5.18 Hence the 50 % of time 5% of locations PFDs are as follows:

Measurement height (m)	1.5	10
In-band PFD (dBW/m^2/MHz)	-48.7	-21.7

Table A5.4: T-DMB PFD Values

Cross Check

A5.19 In order to cross-check the results, a simple link budget approach was used to derive a first order approximation for the PFD for 5% of locations for this scenario. This analysis is shown in the table below:

Distance to corner of hexagonal cell (m)	577.4
Total area of hexagonal cell (m^2)	866,025.4
Percent locations of interest (%)	5.0
Area of locations of interest (m^2)	43,301.3
Distance to transmitter for locations of interest (m)	117.4
Spreading loss (dB/m^2)	52.4
Transmitter EIRP (dBW)	33.0
Bandwidth (MHz)	1.536
PFD at location of interest (dBW/m^2/MHz)	-21.2

Table A5.5: Cross Check of PFD Calculation

A5.20 The results are close to the values calculated in the full Monte Carlo simulation that convolves the two propagation effects. This not only builds confidence in the results but also suggests that the propagation within such small cells is dominated by free space path loss.

Impact of Propagation Variation

A5.21 The objective of the modelling was to predict the PFD levels that would be measured across the reference area. To be accurate the simulations should therefore model the various effects that can cause variations in signal strength.

A5.22 For broadcasting networks the transmit power is set at a constant level and so the variation in PFD can be assumed to be due to differences in the propagation of radio waves across the test area. This section gives more information about propagation model used in the analysis, namely ITU-R Rec. P.1546.

A5.23 The core model in ITU-R Rec. P.1546 predicts the median field strength i.e. the most likely value that would be measured at a certain distance from the transmitter. This decreases in distance as in the figure below.

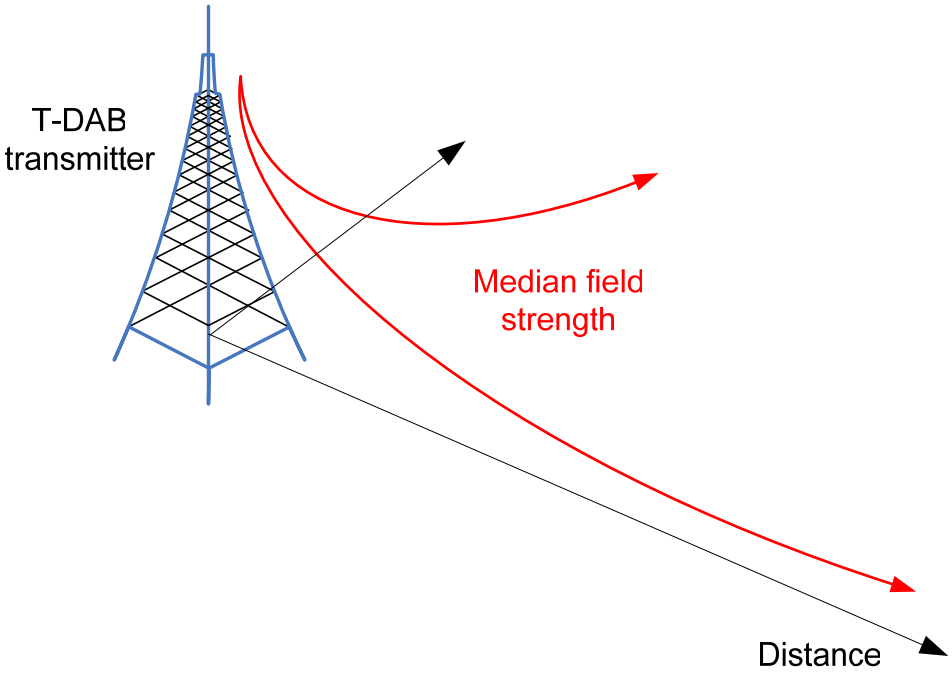


Figure A5.4: Variation in Field Strength due to Distance

A5.24 In practice the field strength would not decrease smoothly with distance and there is likely to be differences between the field strength at two measurement points even if they are the same distance from the transmitter.

A5.25 For example in one direction there could be a large building between the transmitter and the measurement point which would reduce the field strength, while in another direction the measurement point could be at the end of a street that points at the transmitter so that reflections off the buildings increase the received signal.

A5.26 Hence in practice the actual field strength is likely to vary significantly from the smooth curves above, and be more realistically shown as in the figure below.

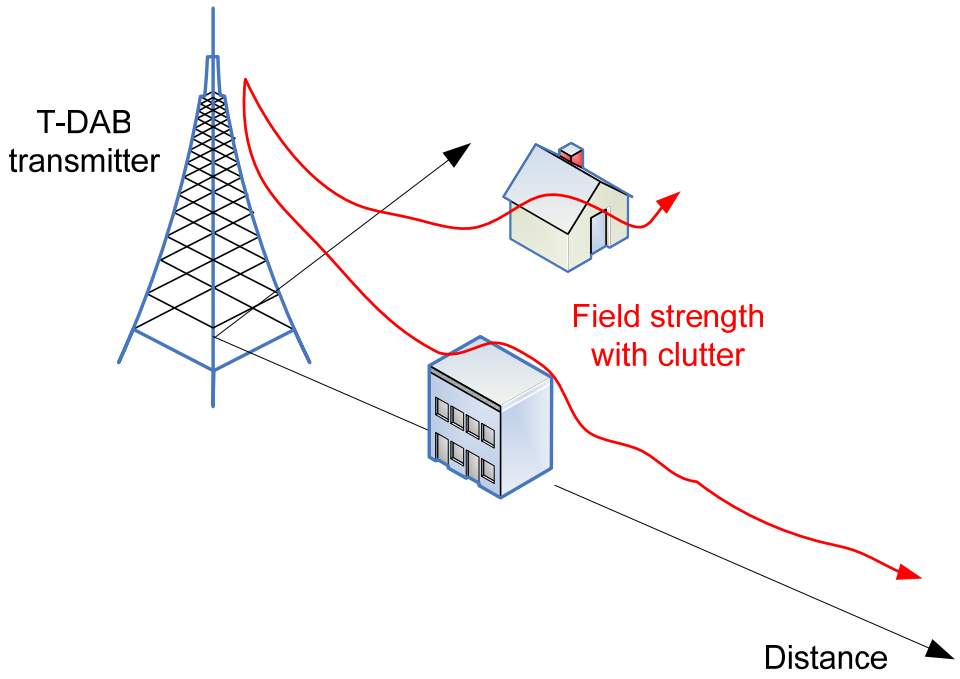


Figure A5.5: Variation in Field Strength due to Clutter and Distance

A5.27 In ITU-R Rec. P.1546 this effect is modelled using a location variation term with log-normal distribution and standard deviation that can vary by environment. The median loss and the location variation are shown graphically in the figure below.

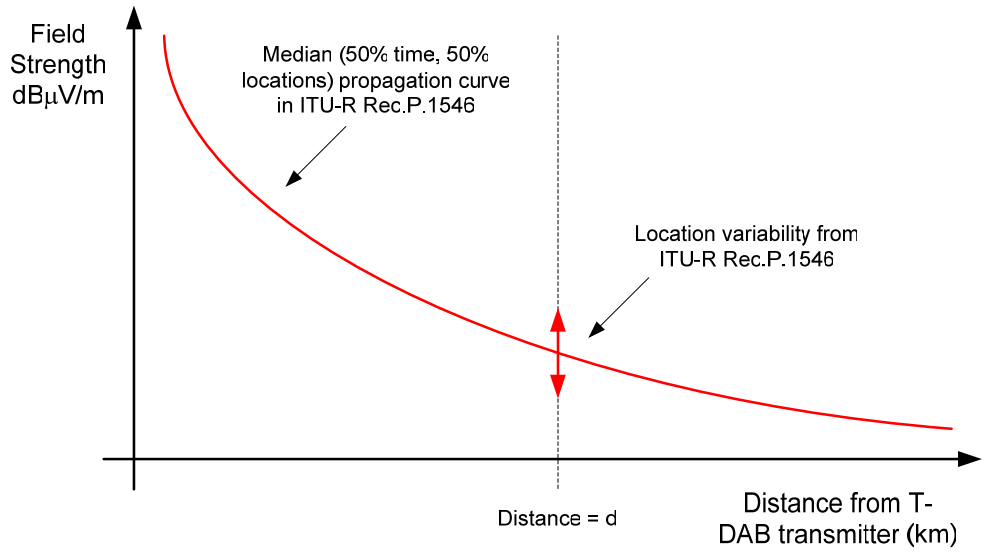


Figure A5.6: Rec.P.1546 Median Loss and Location Variability

A5.28 The signal strength measured at a certain distance from the transmitter would depend upon the characteristics of the environment around the measurement point (i.e. clutter etc): some values would be below the median and some above.

A5.29 The location variability is included in planning procedures to determine the required transmit power. So to ensure 95% of locations can receive the required service at distance, d, a factor of 1.64 times the standard deviation must be added to the target median field strength.

A5.30 For indoor urban applications the standard deviation is 8.1 dB. This was used for the planning exercise to select the EIRP required using a location correction factor of 13.3 dB. The standard deviation for outdoor scenarios – which would be more applicable to the expected approach to measurement – is 5.5 dB.

A5.31 To model measurement across a service area it was therefore necessary to include both types of variation (by distance and by location at a specified distance) using a mathematical method called convolution.

A5.32 This analysis was done to create a cumulative distribution function (CDF) of probability of PFD against the probability of measuring the value across the service area, as in the figure below.

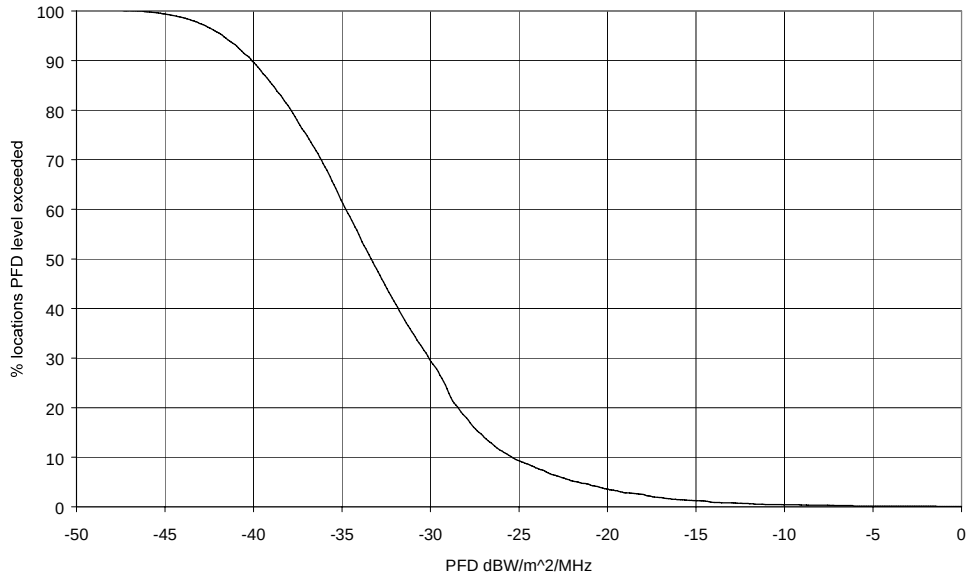


Figure A5.7: CDF of aggregate in-band PFD at 10m above ground level

A5.33 From this curve the PFD that would be exceeded at 5 % of locations could be identified (and conversely the PFD that should not be exceeded at 95% of locations).

Annex 6

Additional restrictions for the 1452-1479.5 MHz band

Guard band size

A6.1 Since network deployments on either side of the guard band will be of different deployment densities, coordination measures are not viewed as practicable to address the problem of ACI for receivers close to neighbouring transmitters.

A6.2 A guard band must be determined which offers sufficient protection to enable the area affected by hole punching between such uncoordinated networks to be acceptably small. The size of the guard band required will therefore be determined by the measure of what is acceptably small, and by the receiver selectivity that is practicable.

A6.3 The guard band can be any integer multiple of the channels in the 1452-1479.5 sub-band, although it is desirable to minimise its size to ensure efficient use of the spectrum to be awarded.

A6.4 There is little information available from which to derive the receiver selectivities that will likely be achieved by mobile terminals in mobile multi-media networks in this band. To derive the rejection of ACI that is achievable across a guard band practically measured protection ratios for DVB-T have been assumed.

A6.5 The total area affected by hole punching between two uncoordinated networks is a function of:

- the receiver protection ratio (which varies with frequency offset); and
- the difference between the aggregate PFD levels, or minimum median equivalent field strengths for the victim and interfering networks

A6.6 Table A6.1 shows indicative estimates of the total area of coverage that may be affected by hole punching for a range of protection ratios. This is based on a simplistic calculation outlined below, which assumes the licensee's on each side of the guard band are aiming to provide the same application, and thus minimum median field strength, in this instance that assumed for indoor, portable mobile multimedia services.

Assumed protection ratio	Area affected by hole punching
25 dB	22.9%
27dB	17.7%
30 dB	12.0%

Assumed protection ratio	Area affected by hole punching
35 dB	6.3%
40 dB	3.2%
45 dB	1.7%
50 dB	0.9%
56 dB	0.4%
63 dB	0.2%

Table A6.1 An indication of the total area affected by hole punching for different assumed protection ratios

A6.7 Protection ratios that might be achieved with a 1, 2 and 3 channel guard band have been assumed to gain an indication of the total area affected by hole punching for different sizes of guard band. This is presented in table A6.2.

Guard band channels	Assumed protection ratio	Area affected by hole punching
0 (adjacent channel case)	27dB	17.7%
1	45dB	1.7%
2	56dB	0.4%
3	63dB	0.2%

Table A6.2 An indication of the total area affected by hole punching for different guard band sizes

A6.8 From this indicative information Ofcom has concluded that a two channel guard band is likely to provide adequate limits on the total area affected by hole punching between uncoordinated networks.

Modelling and assumptions used in derivation of a suitable guard band size

A6.9 A simplistic planning level model has been used to estimate the total area of coverage where receivers are likely to be affected by ACI from a neighbour's transmissions. This total area affected by "hole punching" is then used as a metric to establish an appropriate guard band size. The model and its assumptions are described in outline here.

Assumptions

Parameters have been used from the following sources:

- Protection ratios - 2nd ECC TG4 MEETING, Paris, 19 – 21 March 2007, TG4(07)044 - Annex 3
- Minimum median field strength - EBU – TECH 3317. Planning parameters for hand-held reception http://www.ebu.ch/CMSimages/en/tec_doc_t3317-2006_tcm6-48865.pdf

Table A6.3 below shows the key parameters:

Parameter	Value	Comments
Service type	Indoor Portable 95% locations	From EBU Tech 3317, as described in section 2.
Minimum field strength required at 1.5 m for 50% of the time and locations	78.4dBμV/m	at 1.5m, outdoor, 50% locations
Antenna pattern	Isotropic	Portable receiver
Antenna height	30m	Reference height consistent with assumptions above
Propagation Model	Okumura-Hata	Hata's approximations for urban areas assumed
Protection ratio (adjacent channel)	27dB	Measured DVB-T protection ratio in presence of DVB-H
Protection ratio (n+2)	45dB	Measured DVB-T protection ratio in presence of DVB-H
Protection ratio (n+3)	56dB	Measured DVB-T protection ratio in presence of DVB-H
Protection ratio (n+4)	63dB	Measured DVB-T protection ratio in presence of DVB-H
Protection Margin Correction$_{50\%-95\%}$	18.9dB	Assumes a received signal indoors which is log normally distributed, with a standard deviation of 8.1dB (as per EBU Tech 3317). Equates to a standard deviation of C/I of $\sqrt{2}$.8.1dB for uncorrelated signals. Correction from 50% to 95% of locations is thus 1.64. $\sqrt{2}$.8.1dB = 18.9dB

Table A6.3: Key parameters assumed in calculations

A6.10 The model compares received signal strength from a wanted network in the presence of an interfering network. A network is deployed across flat terrain with a perfect hexagonal cell pattern. Transmitters are distributed which just achieve the

minimum median field strength required at the cell edge. This is referred to here as the “wanted network”.

A6.11 A second uncoordinated network is deployed, assumed to be a network in a neighbouring channel whose emissions are likely to cause interference to the wanted network. This is referred to here as the “interfering network”.

A6.12 A protection ratio is assumed for the receivers of the wanted network, depending on the guard band size considered. Field strengths from the two networks are compared at points across the coverage area to establish the carrier to interference ratio (C/I). If the C/I meets the required detection criterion shown in the formula below, that point is marked as “clear”, denoting a receiver of the wanted network would be likely to receive the wanted signal. Otherwise the point is marked as “blocked”, denoting a receiver of the wanted network being unlikely to receive the wanted signal due to interference from the interfering network. The ratio of the points which are blocked to those which are clear gives a measure of the total area of coverage where receivers are likely to be affected by ACI.

$$C/I > \text{Protection Margin}$$

$$\text{where Protection Margin} = \text{Protection Ratio} + \text{Correction}_{50\%\text{-}95\%}$$

$$= \text{Protection Ratio} + 18.9\text{dB}$$

A6.13 An example output indicating areas likely to be affected by ACI is shown in figure A6.1. Blue squares show location of wanted network transmitters, Magenta squares show location of interfering network transmitters, black circles show points at which wanted receivers are likely to experience interference.

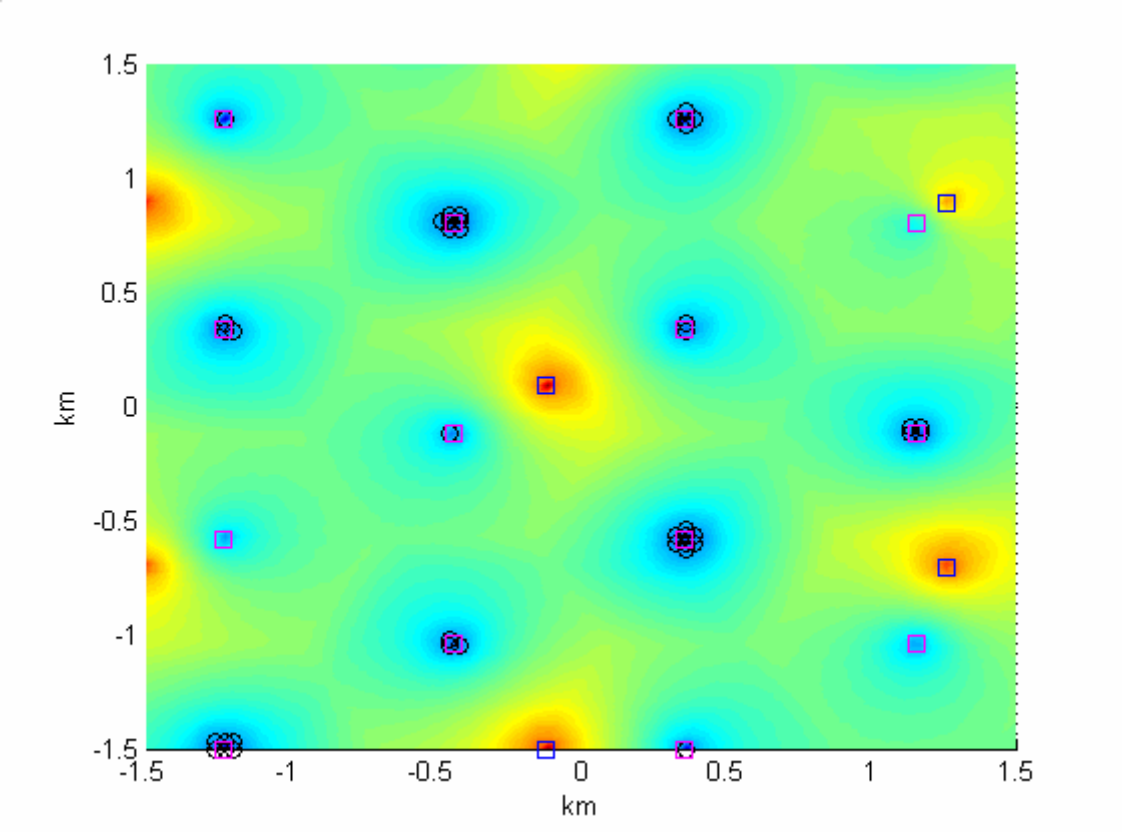


Figure A6.1: Example output from the model showing C/I of wanted network (red/yellow=high C/I, green/blue=low C/I).

Annex 7

Impact assessment

Introduction

A7.1 In accordance with government practice, where a statutory regulation is proposed, a Regulatory Impact Assessment (RIA) must be undertaken. The analysis presented in this Annex represents a Regulatory Impact assessment, as defined in section 7 of the Communications Act 2003 (the "2003 Act") for the proposal not to include a licence condition to address inefficient hoarding concerns in the 1452-1492 MHz spectrum award.

A7.2 The issues raised in this RIA are discussed in a similar fashion in Section 4 of this document and this RIA should be read together with the rest of this document.

A7.3 You should send any comments on this impact assessment to us by the closing date for this consultation. We will consider all comments before deciding whether to implement our proposals.

A7.4 RIAs provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policymaking. This is reflected in section 7 of the 2003 Act, which means that generally Ofcom will carry out impact assessments where proposals would be likely to have a significant effect on businesses or the general public, or when there is a major change in Ofcom's activities. However, as a matter of policy Ofcom is committed to carrying out and publishing impact assessments in relation to the great majority of our policy decisions. In accordance with section 7 of the 2003 Act, in producing this RIA, Ofcom has had regard to such general guidance as it considers appropriate including related to Cabinet Office guidance. For further information about our approach to impact assessments, see the guidelines, "Better policy-making: Ofcom's approach to impact assessment", which are on our website: http://www.ofcom.org.uk/consult/policy_making/guidelines.pdf

Background

A7.5 Concerns have been raised in relation to the 1452-1492 MHz award specifically and Ofcom's spectrum awards more generally on the issue of inefficient hoarding of spectrum by successful bidders. In light of these concerns, Ofcom has considered whether, in order to help secure the optimal use of spectrum, it would be appropriate for it to retain the power to revoke the licences to be awarded in the circumstances where there was inefficient hoarding of the spectrum, even if this was within the initial 15 year period.

A7.6 Ofcom's policy towards spectrum management, set out in the Spectrum Framework Review: Implementation Plan (SFR:IP)[17], is that the market is best placed to secure the optimal use of the spectrum. Moreover, Ofcom expects that the market will generally ensure that spectrum is put to good use, as an input to providing services for end-users. As such, Ofcom does not expect that spectrum will be left idle or be under-utilised for long periods of time if it is efficient to do so (Ofcom recognises that there are legitimate circumstances in which it can be appropriate for spectrum to be left idle or be under-utilised and that this can be beneficial).

[17] http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/sfr-plan.pdf

A7.7 However some parties have expressed the view that Ofcom could fail to meet its statutory duties to secure the optimal use of the spectrum in the event that the 1452-1492 MHz spectrum (and by implication spectrum being awarded in other valuable spectrum bands) is bought by a bidder that is not interested in providing services using the spectrum, but is interested in holding the spectrum for a significant period of time, with the intention of then selling it on the secondary market at a significant profit. If such speculative behaviour were to occur, some have argued that this may not be in the best interests of citizens and consumers..

Proposal

A7.8 This RIA refers to the proposal not to include a licence condition to address inefficient hoarding concerns in the 1452-1492 MHz spectrum award.

The citizen and/or consumer interest

A7.9 If spectrum is left unused then it will not be being used to deliver services that could provide benefits to consumers. However in some cases it may be beneficial for a licensee to choose to leave spectrum unused for a period of time (e.g. while it rolls out a network) and where the service that is ultimately deployed will provide a greater benefit to consumers.

A7.10 As discussed further below, the introduction of a licence condition to address inefficient hoarding concerns would create uncertainty which may mean that services that consumers value (e.g. Mobile TV) may be delayed.

Ofcom's policy objective

A7.11 Ofcom has a number of duties and functions that are relevant to the award of this spectrum and these are summarised in Section 3 of an earlier Ofcom consultation[18] on 1452-1492 MHz band. With respect to this proposal Ofcom's key policy objective is to secure the optimal use of spectrum.

Options considered

A7.12 The key options open to Ofcom are as follows:

- To include a licence condition to address inefficient hoarding concerns in the 1452-1492 MHz spectrum award; or
- Not to include a licence condition to address inefficient hoarding concerns in the 1452-1492 MHz spectrum award.

Analysis of the different options

Potential benefits of the inclusion of such a condition in 1452-1492 MHz licences

A7.13 Such a condition would maintain Ofcom's power to intervene in specific circumstances to address inefficient hoarding of spectrum, where this was found to be a concern.

[18] http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/sfr-plan.pdf

Potential costs of the inclusion of such a condition in 1452-1492 MHz licences

A7.14 While the potential benefits of the inclusion of such a condition are straightforward there are also costs associated with such a condition that may lead to an inefficient use of spectrum.

A7.15 The most significant concern is the introduction of regulatory uncertainty; particularly that the inclusion of such a condition will likely introduce significant uncertainty for all bidders, including those that intend to make productive and immediate use of the spectrum. Such uncertainty will increase the risks faced by bidders and likely introduce barriers to potential bidders raising capital. As a result the likelihood of the spectrum being put to efficient use is reduced.

A7.16 A specific consequence of the uncertainty that would likely be created in this award is that it could reduce the likelihood of some services being deployed. The indication that Ofcom has received from stakeholders is that the business case for some services is very uncertain. Any increase in the risk associated with the acquisition of this spectrum could quite easily tip the balance against the business case for the deployment of particular services in the UK. Ofcom intends this spectrum award to be service and technology neutral therefore any condition that could discourage particular services would need to have a strong justification.

A7.17 For example there are some indications from stakeholders that the decision to deploy mobile TV in the 1452-1492 MHz spectrum band may be marginal due to relatively high costs of rolling out a network compared to the comparative costs in the UHF spectrum bands. Introducing a condition that could potentially address inefficient hoarding may lead to a situation where operators choose not to seek to deploy Mobile TV services in 1452-1492 MHz spectrum, preferring to wait until UHF spectrum becomes available.

A7.18 In addition the condition would prohibit behaviour which may be entirely economically rational. Speculative behaviour by financial institutions in asset and commodity markets can provide liquidity to secondary markets and they are often better placed than other potential bidders to manage risks, including the risks associated with market uncertainties. Therefore, regardless of the precise nature of a condition, any prohibition on such institutions playing this role in spectrum markets might jeopardise the efficiency of the markets.

The preferred option

A7.19 After weighing up the costs and benefits, Ofcom considers that it would not be appropriate to include such a condition within the WT Act licence(s) to be awarded for the 1452-1492 MHz band. For the avoidance of doubt, if such a licence condition were not included then Ofcom would not have the power to intervene in cases of inefficient spectrum hoarding. However this would not affect Ofcom's other statutory powers, including those to address anti-competitive behaviour.

Annex 8

Auction rules and procedures for the award of 1452-1492 MHz

Overview

A8.1 This document provides Ofcom's latest views on the proposed rules and procedures for Ofcom's auction of spectrum in the 1452-1492MHz band. A description of the lots available in the auction is provided in Table A8.1.

Table A8.1: Description of lots available in the auction

Lot	Spectrum endowment (MHz)	Frequency range (MHz)	Eligibility points	Reserve price
LA	1.816	1452.00-1453.82	1	£50,000
LB	1.712	1453.82-1455.53	1	£50,000
LC	1.712	1455.53-1457.24	1	£50,000
LD	1.712	1457.24-1458.95	1	£50,000
LE	1.712	1458.95-1460.66	1	£50,000
LF	1.712	1460.66-1462.38	1	£50,000
LG	1.712	1462.38-1464.09	1	£50,000
LH	1.712	1464.09-1465.80	1	£50,000
LI	1.712	1465.80-1467.51	1	£50,000
LJ	1.712	1467.51-1469.22	1	£50,000
LK	1.712	1469.22-1470.94	1	£50,000
LL	1.712	1470.94-1472.65	1	£50,000
LM	1.712	1472.65-1474.36	1	£50,000
LN	1.712	1474.36-1476.07	1	£50,000
LO	1.712	1476.07-1477.78	1	£50,000
LP	1.716	1477.78-1479.50	1	£50,000
LQ	12.5	1479.50-1492.00	3	£150,000

A8.2 The auction proceeds in four stages:

- Application Stage. Prospective bidders submit their applications to participate in the award process, including initial deposit.

- Qualification Stage. Ofcom determines which applicants are qualified to bid. The determination is based on a check of the applications and initial deposits, and assessment of bidder groups. Ofcom announces the number and identity of the qualified bidders. If there is only one bidder, the bidder will be entitled to select the frequency lots it wishes to purchase and the award will then progress directly to the Grant Stage. If there is more than one bidder, then a bidding process is required.

- Auction Stage. There are two phases of bidding, which determine the specific frequencies that will be awarded to each winning bidder and the split between low power and high power use:

i) **Primary bid rounds.** The first phase is the primary bid rounds, which follow a clock auction format. Qualified bidders top up their deposits and the amount

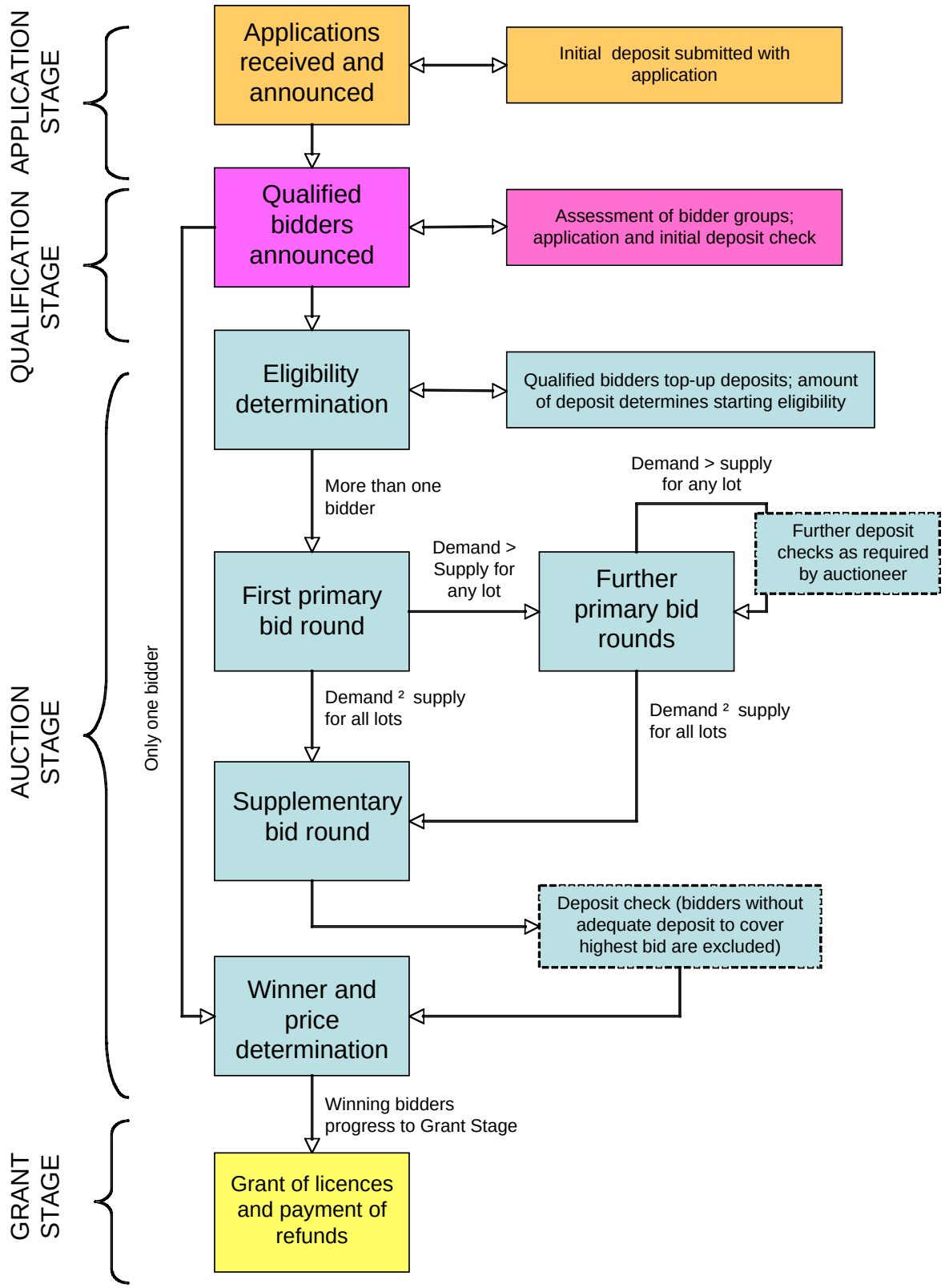
determines their eligibility to bid in the auction. Bidders make a single bid in each round for a package of one or more specific lots, and nominate their preferred usage (high power or low power). The prices of lots with excess aggregate demand (i.e. two or more bids) are increased in the next primary bid round, and the rounds continue until there is no excess demand for any lot.

ii) **Supplementary bids round.** The second phase is the supplementary bids round, which always follows the primary bid rounds. This is a single round sealed bid, in which bidders have the opportunity to make multiple, mutually exclusive bids for packages of lots (including usage nominations), subject to constraints created by their primary round bids. The auctioneer then identifies the highest value combination of bids that can be accommodated, drawing on all valid bids from the primary and supplementary bids rounds and taking at most one bid from each bidder. If both low power and high power use are amongst the winning bids, then these must in all cases be separated with two lots between them being designated as guard blocks. The price for each winning bid for a package of lots is determined using a 'second price' rule.

- Grant Stage. After the conclusion of the Auction Stage, the award progresses to the Grant Stage, in which payments are finalised, licences are granted and the auction results are published.

A8.3 The flow chart in Figure A8.1 provides an overview of the whole process. In the following sections, we explain the auction rules and procedures for each stage in detail.

Figure A8.1: Flow chart showing key stages in the auction process



Application and Qualification Stages

A8.4 The application and qualification stages determine the participants in the auction.

Application Stage

A8.5 Ofcom will publish on its website the day and time by which applications to participate in the auction must be submitted. Applications will only be accepted from bodies corporate. On the application day applicants must pay into Ofcom's bank account an initial deposit of £50,000.

A8.6 Each applicant must provide details of its associates and members of its bidder group who are not associates. An associate is a person who has a material interest in the applicant. A bidder group includes the applicant, its associates and other persons who have access to confidential information. Applicants may add members to or remove members from their bidder groups by notifying Ofcom.

A8.7 Confidential information is information about an applicant or bidder which is not in the public domain and which if disclosed to another applicant or bidder would be likely to affect their decisions in relation to the award process. Disclosure of confidential information by a member of a bidder group outside the bidder group may result in an applicant not being qualified to bid or to a qualified bidder being excluded from the award process and losing its deposit.

Qualification Stage

A8.8 Ofcom will notify each applicant of the names and associates of all other applicants and set a date by which applicants must notify whether any members of their bidder group are also associates of another applicant. Ofcom will itself consider whether any members of one bidder group are also members of another bidder group.

A8.9 Where Ofcom identifies such common membership it will notify the applicants concerned and specify a date by which all the common memberships must be resolved.

A8.10 Ofcom will next determine which applicants are qualified to bid in the auction. An applicant may not qualify if a member of its bidder group is also a member of another bidder group. Ofcom will also take into account a number of other matters, i.e. whether:

- the grant of a licence to an applicant would be likely to prejudice national security;
- the applicant is a fit and proper person to hold a licence;
- the applicant has submitted false or misleading information;
- the applicant or any member of its bidder group has colluded or attempted to collude or is colluding or attempting to collude with any other person to distort the outcome of the award process, or has acted or is acting to distort the outcome of the award process;
- the applicant or any member of its bidder group, or any person to whom confidential information has been disclosed, has disclosed, or is disclosing or attempting to disclose or has incited or is inciting another person to disclose confidential information to anyone other than to a member of its bidder group,

Ofcom, a provider of finance (where the disclosure was for the purpose of raising finance for the application), or a person considering whether to join the bidder group of the applicant;

- the applicant or any member of its bidder group has received or is obtaining or attempting to obtain confidential information relating to another applicant;

- the applicant or any member of its bidder group is receiving or attempting to receive services in relation to the award process from anyone who has provided or is providing services to Ofcom in relation to the award process (for these purposes the advisers are DotEcon Ltd and Professor Peter Cramton)

- any director or employee of a member of the applicant's bidder group who is also a director or employee of a member of another applicant's bidder group is taking part in the preparation of both bidder groups for participation in the award process or receiving confidential information relating to both bidder groups.

A8.11 Ofcom will notify each applicant of whether it has qualified to bid in the auction and of the last day on which applicants who have qualified may withdraw their application without forfeiting their initial deposit.

A8.12 After the last day for withdrawal, Ofcom will publish on its website the names of all applicants qualified to participate in the auction who have not withdrawn and announce the procedure it will follow for award of the licences (depending on the number of bidders).

If there are no bidders

A8.13 If there are no bidders, there will be no auction and Ofcom will consider an alternative award process.

If there is only one bidder

A8.14 If there is only one bidder, there will be no auction and the bidder will be entitled to select the frequency lots it wishes to purchase. Ofcom will send the bidder a licence selection menu and notify the date and time by which the completed menu must be returned. In the completed menu the bidder must indicate which of the frequency lots it wishes to purchase and nominate a usage right (high power-low density or low power-high density[19]) for each lot. The licence fee will be the sum of the reserve prices for each frequency lot comprised in the licence.

A8.15 The bidder must pay the licence fee into Ofcom's bank account and return the completed licence selection menu by the date and times notified. Where the bidder has not forfeited its initial deposit this will be offset against the licence fee.

A8.16 After Ofcom receives the completed licence selection menu and relevant licence fee, subject to paragraph A8.17, it will grant the bidder a licence for the frequency lot or lots selected. If the selection menu has not been completed in accordance with paragraph A.8.14 or is unclear or illegible Ofcom will ask the bidder for confirmation of the bidder’s intentions.

[19] See explanation in section 2.

A8.17 If the bidder fails, by the date and the times specified, to return the completed licence selection menu to Ofcom or to pay the licence fee, it will forfeit its initial deposit and not be entitled to the grant of a licence.

If there is more than one bidder

A8.18 In the case that there are two or more bidders the award progresses to the Auction Stage.

A8.19 Prior to the Auction Stage, Ofcom will supply bidders with the digital certificates, usernames and passwords necessary to access the electronic auction system (described below). Bidders will be supplied with a user manual for the electronic auction system. Bidders will also receive a set of one-time passwords for authenticating any communication they may initiate with Ofcom during the auction.

Auction Stage

A8.20 The Auction Stage consists of one or more primary bid rounds followed by a supplementary bids round.

The primary bid rounds

A8.21 The primary bid rounds follow a clock auction format. The auction proceeds in discrete rounds, with all bidders making bids within the same fixed time window (subject to provisions for extensions, described below). In any given primary bid round, a single bid for a single package of lots can be made by each bidder, at the prevailing round prices. Bidders complete an electronic bid form specifying the lots they demand at these prices. This bid is for a package of lots; it will be considered in its entirety and will not be subdivided.

A8.22 Each lot in the primary bid rounds represents a specific frequency range, as described in Table A8.1. Unlike some other clock auctions, lots are not sold on a generic basis and there are no categories containing multiple lots. In effect, each lot is a category in its own right.

A8.23 In the first round, bidders must bid for at least one lot. If, in any subsequent primary bid round, a bidder decides that it does not wish to continue bidding it should submit a bid for zero lots; this will avoid the bidder being given an unnecessary extension by the electronic auction system (see below).

Scheduling primary bid rounds

A8.24 Primary bid rounds are scheduled at the discretion of the auctioneer. There is no minimum or maximum round length. However, Ofcom does not anticipate running primary bid rounds of less than 10 minutes or greater than 2 hours. The rounds will be scheduled between 10am and 5pm on UK business days. There is no upper bound on the number of rounds per day, although Ofcom does not anticipate running more than 12 rounds in a single day.

A8.25 Bidders must be notified of the start time of a round at least 15 minutes before it starts. (In practice, the auction software will require that rounds be scheduled at least 16 minutes into the future to allow for network latency.) With the next round start time, each bidder will also be given information about:

- the duration of the round;

- the round prices that will apply to lots in each category;
- their eligibility to bid in the round (expressed as a number of eligibility points) and
- their number of remaining extension rights.

Primary bid round prices and bid increments

A8.26 In the first primary bid round, the price of each lot will be set equal to the reserve price for that lot, as described in Table A8.1. In subsequent rounds, the price for each lot will be increased if, and only if, aggregate demand for that lot in the previous round is two or more. If aggregate demand for a lot is zero or one, the price for that lot is unchanged from the previous round. At no point during the primary bid rounds will the price of a lot fall.

A8.27 Aggregate demand for each lot in any particular primary bid round is the sum of:

- the number of active bids (as a component of a package bid) on that lot[20]; and
- the number of 'guard block bids' made by the auction system for that lot[21] (see below for an explanation of guard block bids).

A8.28 The amount by which prices increase from round to round for those lots where demand exceeded supply in the previous round will be at the discretion of the auctioneer, but subject to a maximum increase of 100% of the previous round price in each case. In practice, we expect to use this discretion to set larger bid increments for lots where there is a greater level of excess demand.

Activity rule and eligibility points

A8.29 Each lot in the auction has an associated number of eligibility points. Specifically, the 16 lots LA through to LP each have one eligibility point and lot LQ has three eligibility points. Any bid for a package of lots also has an associated number of eligibility points which is determined by the sum of the eligibility points associated with all the lots in that package.

A8.30 Ofcom will determine the initial eligibility for each bidder based on the size of their deposit at a fixed date and time prior to the first round of the auction. Each bidder receives 1 eligibility point per whole £50,000 of deposit. For example, a bidder with a deposit of £200,000 would have an initial eligibility of 4 points.

A8.31 The minimum initial eligibility is 1 point, which corresponds to a deposit of at least £50,000 and less than £100,000. Qualified applicants with less than £50,000 deposit at the specified time and date will be excluded from the auction.[22]

A8.32 The maximum initial eligibility is 19 points, regardless of the level of a bidder's deposit. Thus, a bidder with a deposit of £950,000 or any amount larger than this would have an initial eligibility of 19 points. This maximum will apply throughout the auction.

[20] Alternatively, this could be expressed as the number of bidders active on a particular lot in the primary bid round.
[21] This will either be zero or one.
[22] As the initial deposit is set at £50,000, it is only possible for a bidder to be excluded for having inadequate deposit in the case that it has forfeit all or part of its initial deposit.

A8.33 From the second primary bid round onwards, each bidder's eligibility is determined by their activity in the previous round. Specifically, each bidder's eligibility in any round from round 2 onwards is equal to the number of eligibility points associated with their bid in the previous round. For example:

- A bidder had an eligibility of five in round 8. It bids for a package of four lots: LC, LD, LG and LH (all one point each). Consequently, its eligibility in round 9 would fall to four points.

- A bidder had an eligibility of five in round 11. It bids for a package of three lots: LO, LP (both one point each) and LQ (3 points). Consequently, its eligibility in round 9 is unchanged at five points.

A8.34 In any primary bid round of the auction, bidders can only bid for a package of lots with an associated number of eligibility points that is less than or equal to their eligibility in that round. Thus, over successive primary bid rounds, a bidder's eligibility can stay the same or fall, but can never increase.

Usage nominations and guard block bids

A8.35 For each primary round bid, in addition to selecting component lots, bidders must nominate the usage right that they require for those lots. There are two types of usage right:

- high power, low density; and

- low power, high density.

A8.36 The 14 lots LA through LP may be nominated as high power or low power. Lot LQ will always be low power.

A8.37 Eligibility is fungible between high power and low power bids. Bidders may bid for either all high power lots or all low power lots. Bidders may change the usage rights for which they bid from round to round without penalty or restriction. Note, however, that a bid for a lot with a particular usage right (as part of a package bid) is a binding commitment to buy that lot and be subject to that usage right (if the package bid is successful). It is not possible to make a package bid for a mixture of low power and high power lots.

A8.38 In the case that spectrum is ultimately awarded to both low power and high power uses, it will be necessary to have a frequency separation between them of at least two lots (about 3.4MHz) to mitigate potentially harmful interference. To facilitate this, Ofcom intends to assign two lots as 'guard blocks' between any adjacent assignments with different usage rights. These guard blocks will be awarded, one each, to the adjacent licensees, at no additional cost, but will be subject to very constrained usage rights, so as to protect the adjacent high and low power usage rights.

A8.39 The condition that there must be two guard blocks between adjacent assignments with different usage rights is imposed in the winner determination procedure (see below). One implication of this rule is that it would not be appropriate simply to end the primary round phase at the point when aggregate bidder demand for all lots was one or less, as there may still be incompatible uses in adjacent spectrum. Instead, the primary bid rounds should continue until all remaining demand is compatible, so

as to facilitate price discovery and enable bidders to monitor the structure of demand for lots on a high power and low power basis.

A8.40 In order to prolong the primary bid rounds until such point as all bids are compatible, the auction system will make a 'guard block bid' for a lot if (a) aggregate demand for that lot is exactly one; and (b) the lot is located in an area of the band where there is insufficient separation between adjacent high and low power bids. Specifically, the auction system will make a guard block bid for lot n if:

- demand for lot n is exactly one; and
- there is a usage nomination for an adjacent lot that is not the same as the usage nomination for lot n; or
- if demand for an adjacent lot is zero, usage of the next lot along is not the same as usage of lot n.

A8.41 This rule ensures that the price of lot n will increase in the next round (as aggregate demand, including the guard block bid, is two), so the primary bid phase must continue regardless of the number of bids on other lots.

A8.42 Consider the following example:

- In round 15, Adam bids on lots LD, LE, LF and LG and nominates them all for high power use, and Beth bids for lots LG, LH, LI and LJ and nominates them for low power use. Assume that no other bidders bid for these lots. These bids are illustrated in Table A8.2. Under these conditions, the auction system would make guard block bids on LF and LH, as there is just one bid each on these lots and they are adjacent to bids for different uses. Note that no guard block bid is required on lot LG, as there are already two bids on this lot.
- In round 16, the prices of lots LF, LG and LH are increased and other lot prices stay the same. Adam maintains his demand for the same four lots, but Beth stops bidding for lot LG, as illustrated in Table A8.3. The auction system makes guard block bids on lots LG and LH, as these two adjacent lots have different usage nominations.
- In round 17, the prices of lots LG and LH increase and other lot prices stay the same. Adam stops bidding for lot LG, but demand is otherwise unchanged, as illustrated in Table A8.4. Demand for lot LG has now fallen to zero, but the adjacent blocks have different usage nominations. Therefore, the auction system makes a guard block on lots LF and LH.
- In round 18, Beth stops bidding for lot LH, but demand is otherwise unchanged, as illustrated in Table A8.5. As a result, there are now two lots with no bids between the different usage nominations, so no guard block bids are required.

Table A8.2: Illustration of guard block bidding I

Lot:	LD	LE	LF	LG	LH	LI	LJ
High power bids	1	1	1	1			
Low power bids				1	1	1	1

Guard block bids			**1**		**1**		
TOTAL	1	1	2	2	2	1	1
Price up next round?	No	No	Yes	Yes	Yes	No	No

Table A8.3: Illustration of guard block bidding II

Lot:	LD	LE	LF	LG	LH	LI	LJ
High power bids	1	1	1	1			
Low power bids					1	1	1
Guard block bids				**1**	**1**		
TOTAL	1	1	1	2	2	1	1
Price up next round?	No	No	No	Yes	Yes	No	No

Table A8.4: Illustration of guard block bidding III

Lot:	LD	LE	LF	LG	LH	LI	LJ
High power bids	1	1	1				
Low power bids					1	1	1
Guard block bids			**1**		**1**		
TOTAL	1	1	2	0	2	1	1
Price up next round?	No	No	Yes	No	Yes	No	No

Table A8.5: Illustration of guard block bidding IV

Lot:	LD	LE	LF	LG	LH	LI	LJ
High power bids	1	1	1				
Low power bids						1	1
Guard block bids							
TOTAL	1	1	1	0	0	1	1
Price up next round?	No	No	No	No	No	No	No

Deposits and eligibility

A8.43 During the primary bid rounds, Ofcom may at any point and on any number of occasions, announce a deadline by which time bidders must have raised their deposit to a level that is at least equal to their highest primary round bid submitted prior to the announcement that deposits had to be raised. If the announcement is made before 2pm on a business day, then the deposit deadline will be no earlier than midnight on the following business day (e.g. if the announcement was made at 1pm on Tuesday, the deadline for increasing deposits would be no earlier than midnight on Wednesday). If the announcement is made at any other time, the deadline will be no earlier than midnight on the next business day after the following business day (e.g. if the announcement was made at 3pm on Thursday, the deadline would be no earlier than midnight on Monday).

A8.44 If a bidder does not meet a deadline for increasing its deposit, its eligibility will be reduced to zero in the next round after the deadline and it will in consequence not be able to submit any further primary round bids. Such a bidder will, however, still be able to participate in the supplementary bids round, subject to the constraints on bids implied by its eligibility dropping to zero in the relevant primary bid round (see below for further explanation) and subject to meeting the rules on making bid deposits to support its supplementary bids.

A8.45 For example, consider a bidder that had eligibility of 8 points in round 8 but then did not raise its deposit as required by Ofcom. Its eligibility would drop to zero in round 9, that being the next round after the deadline for increasing deposits. In the supplementary bids round, the bidder would still be able to make bids for packages with eligibility between 1 and 8 points inclusive, but its maximum bids for such packages would be capped on the basis of the prices for each lot that applied in round 9. For the avoidance of doubt, the bidder's bids in round 8 would be valid for the purpose of determining bid totals, i.e. the bids are taken into account in determining whether there should be another primary bid round and, if there is another round, whether the round price should be raised in a particular category.

Submitting primary round bids and usage nominations

A8.46 Primary round bids are submitted using the electronic auction system (save in exceptional circumstances, as described below). There is a two-step process for submitting bids:

- in the first step, bidders input their bid for checking by the electronic auction system; and
- in the second step, a bid is formally submitted.

A8.47 To make a primary round bid, bidders are required to:

- select one or more lots that they wish to include in their package; and
- nominate a usage right (high power or low power) to apply to all of those lots.

A8.48 Within the electronic bid form, bidders will be presented with check boxes which they can use to select each lot to be included in their package. Bidders cannot select the same lot twice within a package. Where a bidder does not wish to include a particular lot in its package, the bidder should not check the corresponding check box for that lot.

A8.49 The amount of a primary round bid will be equal to the sum of the current round prices for all lots in the package. It is not possible for bidders to choose the amount of a primary round bid, only the package that will be subject to a primary round bid.

A8.50 Once a bidder has selected the package to be subject to a primary round bid, it must input this for checking by the electronic auction system. The electronic auction system will not allow bidders to submit a primary round bid for a package that has associated eligibility points in excess of a bidder's eligibility. It will also warn bidders if a proposed bid is valid but would result in that bidder losing eligibility in the next round. In either case, bidders will be able to return to the bid entry form to revise their bid.

A8.51 The electronic auction system will not allow bidders to submit a primary round bid that does not have a usage right selected. Bidders are allowed to alter their choice of usage rights from one bid to the next. If this happens, bidders will be warned if their choice of usage rights is different from their bid in the previous round.

A8.52 Once a bid has been checked and has been confirmed as meeting the eligibility requirements, the screen will display the 'bid submission form', which provides a statement of the bid. A bidder can then formally submit this bid. Alternatively, the bidder could return to the bid entry form to revise its bid (in which case the bidder would need to check its bid once more before it could be submitted).

Extensions

A8.53 An extension right allows a bidder additional time in which to submit a primary round bid. In the event that a bidder with non-zero eligibility and one or more remaining extension rights fails to submit a bid during a primary bid round, the round will automatically be extended for that particular bidder and one of its remaining extension rights deducted. The electronic auction system will give that bidder a revised deadline for submitting a primary round bid 30 minutes later than the original round deadline.

A8.54 The extension period lasts at most 30 minutes, but may terminate earlier once all bidders using extensions have successfully submitted their bids. The extension period only applies to bidders that failed to submit their bid during the normal round time, have one or more available extension rights and non-zero eligibility. Bidders who have submitted a decision already during the round cannot take any further action during the extension period; they will be told that the round has been extended and should wait for the announcement that the extension period has ended. Bidders who have not submitted a bid during the primary bid round and have no remaining extension rights not be able to enter a bid during the extension period; such bidders will lose all eligibility to bid in further primary bid rounds.

A8.55 Each bidder starts the auction with two extension rights, which apply to the primary bid rounds only. Each time the bidder fails to submit a bid in a primary bid round before the deadline and an extension period is triggered for that bidder, the number of extension rights available for that bidder in subsequent primary bid rounds is reduced by one.

A8.56 Additional extension rights may be granted either to all bidders or to individual bidders at Ofcom's absolute discretion. Additional extension rights can ONLY be granted in the periods between primary bid rounds. They cannot be granted during a primary bid round.

A8.57 Extension rights are provided to bidders as an emergency tool in case, owing to unforeseen circumstances, they are unable to submit a bid during a primary bid round. The overall intention of extension rights is to provide a backup against technical failures, rather than to provide bidders with extra time to consider their decisions. For example, if a bidder has problems with its Internet connection and cannot access the auction system, it can use an extension right. In the event of significant problems that prevented a number of bidders accessing the electronic auction system, we would envisage Ofcom using its exceptional powers to reschedule or re-run a primary bid round, rather than relying on extension rights.

A8.58 A bidder may notify Ofcom that it is unable to submit a bid during a primary bid round and is likely to require an extension period; notification is not mandatory but would assist administration of the process, especially where the bidder might be having problems accessing the electronic auction system and needs to make use of the procedures described below.

Submission of primary round bids in exceptional circumstances

A8.59 Where a bidder is unable to submit a primary round bid using the electronic auction system, it should seek in advance Ofcom's permission to submit a bid using either fax or email. A bidder may seek such permission before the start of a round or during a round or during an extension period. Where Ofcom grants permission, the bidder must submit its bid using the agreed mechanism, i.e. either fax or email (in these circumstances bids submitted by the electronic auction system will not be accepted unless Ofcom has expressly agreed) and within the deadline specified by Ofcom. Ofcom may grant such permission for a single round or for all rounds during a day or for a specified period.

A8.60 In the event that a bidder submits multiple bids by fax or email, only the first bid received will be accepted. A bid must specify the number of lots in each category that the bidder offers to purchase at the primary bid round prices prevailing in that round together will its usage right nomination. Any bid made by fax or email will be subject to password verification.

A8.61 If a bid submitted by fax or email exceeds the bidder's eligibility, is illegible or unclear, the bid will be invalid and the bidder's eligibility in the following round will fall to zero and, as a consequence, it will not be able to submit any further primary round bids. However, the bidder will be able to participate in the supplementary bids round, subject to the constraints on bids implied by its eligibility dropping to zero in the relevant primary bid round (see below for further explanation) and subject to meeting the rules on making bid deposits to support its supplementary bids.

Information available during the primary bid rounds

A8.62 At the end of each primary bid round, Ofcom will reveal to each bidder:

- aggregate demand for each lot;
- aggregate demand for high power and low power usage rights for each lot;
- guard block bids, if any, for each lot; and
- information about each bidder's own bids, eligibility in the next round, the amount of that bidder's highest bid in the auction to date, and how many extension rights the bidder has remaining.

A8.63 During the primary bid rounds, bidders will not receive information about the bids made by other bidders, other than through the reporting of aggregate demand across all bidders for each lot.

End of the primary bid rounds

A8.64 The primary bid rounds end when aggregate demand for each and every lot, including any guard block bids, is less than or equal to one. At this point, the auctioneer will announce that the primary bid phase has finished and that the auction will progress to the supplementary bids round.

A8.65 In addition, following the close of a primary bid round, Ofcom may announce that it is terminating the primary bid rounds early (i.e. while demand is still greater than one for some lots). In this case, the auction will proceed directly to the supplementary bids round, as described below and there will be no further primary bid rounds. Ofcom will only terminate the primary rounds early if it believes that proceeding directly to the supplementary bids round at this time is in the general interest of running an efficient award process.

The supplementary bids round

A8.66 In the supplementary bids round, bidders may submit a number of bids for packages of lots, subject to respecting the eligibility restrictions resulting from their bids in the primary bid rounds. This provides an opportunity for bidders to bid for packages of lots that they did not bid for in the primary bid rounds or to raise their existing bids for packages, subject to their eligibility constraints. All bids received from bidders in both the primary bid rounds and the supplementary bids round are then considered together to determine the winners of the Auction Stage.

A8.67 Unlike the primary bid rounds, bidders must choose the amount of any supplementary bids they make. These amounts are subject to a minimum and in some cases a maximum as described below.

Scheduling the supplementary bids round

A8.68 The start time and duration of the supplementary bids round will be announced by Ofcom after the completion of the primary bid rounds. There will be at least one clear business day in between the last primary round and the supplementary bids round. Ofcom has discretion over the time and duration of the round. However, Ofcom anticipates that the round will take place between 10am and 5pm on a single business day, and last for at least 2 hours and no more than 7 hours.

Restrictions on supplementary bids

A8.69 Bidders may submit at most one supplementary bid for any package of lots for which they submitted a primary round bid. Any such supplementary bid must exceed all primary round bids made by that bidder for that package of lots.

A8.70 Bidders may also submit supplementary bids for packages of lots for which they had initial eligibility at the start of the auction but did not make primary round bids. Bidders may submit only one supplementary bid for each such package. Bidders may submit supplementary bids for at most [500] distinct packages of lots not subject to primary bid rounds. (Note that supplementary bids for packages of lots subject to primary bids do not count against this limit.)

A8.71 All supplementary bids must exceed the sum of the reserve prices for the component lots within the package.

A8.72 Some supplementary bids are subject to an upper bound on the amount bid. For the purposes of determining whether upper bound restrictions apply to a bid made by a particular bidder, a distinction is made between:

- packages with associated eligibility points which are less than or equal to the bidder's activity in the final primary bid round; and
- packages with associated eligibility points that exceed the bidder's activity in the final primary bid round.

A8.73 For packages with eligibility points equal to or below this threshold, there is no restriction on the maximum amount bid.

A8.74 For packages with eligibility points above this threshold, the bid amount cannot exceed the sum of the primary bid round prices in the round where the bidder was last eligible to bid on that package.

A8.75 A simple example makes this clear. Suppose that Fred, a bidder, starts the auction with an initial eligibility of seven and only bids for high power lots. During the primary bid phase, he makes bids as described in Table A8.6. Specifically, his bids include the following:

- In round 1, he bids his full eligibility of seven (lots LA, LB, LC, LG, LH, LI and LJ) and he continues to bid at this level of eligibility up to and including round 4.
- In round 5, he drops eligibility to four.
- The last primary bid round in round 10. Fred is still bidding for lots with an eligibility of four in this round.

Table A8.6: Example of selected bids by Fred in the primary rounds

	Prices of lots																Fred's activity	Fred's bid
	LA	**LB**	**LC**	**LD**	**LE**	**LF**	**LG**	**LH**	**LI**	**LJ**	**LK**	**LM**	**LN**	**LO**	**LP**	**LQ**		
Eligibility pts	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3		
Round 1	**50**	**50**	**50**	50	50	50	**50**	**50**	**50**	**50**	50	50	50	50	50	150	7	350
Round 4	90	90	**80**	**80**	**90**	90	90	**80**	90	90	**90**	**80**	**80**	70	70	180	7	580
Round 5	100	100	**90**	**90**	100	**90**	**90**	90	100	100	100	90	90	80	80	180	4	360
Round 10	**130**	140	140	140	150	**130**	**130**	**140**	150	150	150	140	130	110	110	250	4	530

Notes: Fred's bids in each round are highlighted; round prices are purely illustrative.

A8.76 Based on these primary round bids, Fred would be eligible to make the following supplementary bids in the supplementary bids round:

- Any package of lots with eligibility of four points or less, at any amount in excess of their aggregate reserve prices. For example, Fred could:

a) raise his bid (from round 5) on lots LC, LD, LF and LG above 360;

b) raise his bid (from round 10) on lots LA, LF, LG and LH above 530; and

c) bid on a combination of lots that he had not previously bid for, e.g. lots LA, LB and LC, as any price greater than 150.

- Any package of lots with an eligibility between five and seven points inclusive, at a price not more than the lot prices prevailing in round 5. For example, Fred could:

a) raise his bid (from round 1) on lots LA, LB, LC, LG, LH, LI and LJ above 350 up to a maximum of 670;

b) raise his bid (from round 4) on lots LC, LD, LE, LH LK, LM and LN above 580 up to a maximum of 650;

c) bid on a combination of lots that he had not previously bid for, e.g. lots LA, LB and LC, LD and LE, at any price greater than 250 and less than 680.

Fred would not be allowed to bid for packages of lots with eligibility greater than seven.

A8.77 Each supplementary bid must include a usage nomination that applies to all the lots included in that package. Bidders may submit separate bids with different usage rights. They may also submit up to two supplementary bids for the same package of lots, one each with a high power and low power usage right nomination. As in the primary bid rounds, it is not possible to make a package bid for a mixture of low power and high power lots.

Preparing supplementary bids

A8.78 The electronic auction system includes a supplementary bids management tool that bidders can use to maintain and revise a list of provisional supplementary bids throughout the primary bid rounds. This system also provides information about all primary round bids submitted by the bidder and the constraints on supplementary bids deriving from these bids.

A8.79 The management tool is provided purely for the convenience of bidders. No provisional bids entered into the system will be visible to Ofcom or any other bidder.

Submitting supplementary bids

A8.80 Supplementary bids are submitted using the electronic auction system within the specified timing for the supplementary bids round. The submission procedure is a two-step process, which is similar to that for the primary bid rounds:

- in the first step, bidders may prepare a list of supplementary bids which they enter for checking by the electronic auction system; and

- in the second step, bids are displayed on a ‘bid submission form’, which should be formally submitted.

A8.81 Any provisional supplementary bids stored by a bidder using the management tool, together with the bids they made for packages in the primary bid rounds, will be available as a starting point for compiling a list of supplementary bids during the supplementary bids round. A bidder may add, revise or delete its bids as required; though it cannot delete any primary round bids, only increase the amount of such bids, if it wishes. Bidders are also provided with details of any constraints on their

maximum bids for packages with particular eligibility levels. All bids must be in whole pounds sterling.

A8.82 Once a bidder has finalised its list of supplementary bids, it must input these for checking by the electronic auction system. Any errors (such as: a bid below the minimum; a bid less than or equal to a primary bid on the same package; a bid above the maximum; a bid without a usage nomination; or more than [500] supplementary bids on packages not subject to primary round bids) will result in the entire set of bids being rejected by the checking system. In this case, bidders will be able to revise their supplementary bids and re-enter them for checking.

A8.83 Once a list of supplementary bids has been checked and has been confirmed as meeting the requisite criteria, a statement of these bids will be displayed on a bid submission form. A bidder can then formally submit these bids. Alternatively, it could revise its bids and re-enter them for checking. As in the primary bid rounds, submitting bids is a two-step process; supplementary bids are not considered to have been made until they have been submitted; entering bids for checking is not sufficient.

Submission of supplementary bids in exceptional circumstances

A8.84 Bidders experiencing technical problems should contact the auctioneer, either before or during the supplementary bids round; it is recommended that bidders experiencing problems contact the auctioneer at least one hour before the end of the round. The auctioneer may at its discretion.

- permit a bidder to submit its bids by fax or email; and
- extend the bidder's deadline for submission of its supplementary bids.

A8.85 Where Ofcom grants permission, the bidder must submit its bid using the agreed mechanism, i.e. either fax or email (in these circumstances any supplementary bids submitted by the electronic auction system will not be accepted unless Ofcom has expressly agreed with the bidder to use these bids). Any bid made by fax or email will be subject to password verification and must use the template supplementary bid form provided to the bidder by Ofcom. Only the first supplementary bid form received by Ofcom will be considered. On this form, only the first [500] supplementary bids on packages of lots not subject to primary bids from that bidder will be considered. If any of the individual supplementary bids either exceeds the maximum amount that the bidder can bid for that package or is too low or is determined by the auctioneer to be illegible or unclear or does not have a usage nomination, that supplementary bid will be rejected.

A8.86 An extension may be applied where the auctioneer is satisfied that circumstances existed which were beyond the bidder's control which had the effect that the bidder could not, using reasonable endeavours, submit its supplementary bid form using the electronic system so that it was received within the original round time. Such an extension may or may not be granted to a bidder, irrespective of whether they had any extension rights remaining at the end of the primary bid rounds.

Deposit rule for supplementary bids round

A8.87 Before the end of the day on which the supplementary bids round closes, bidders must have on deposit with Ofcom an amount at least equal to their highest bid made across both the primary bid rounds and the supplementary bids round.

A8.88 If a bidder does not meet this deposit obligation, all its bids from the primary and supplementary bid stage will be void and excluded from consideration in the determination of Principal Stage winners and prices. Such a bidder will also forfeit any deposit that it has submitted.

Winner determination

A8.89 Following the close of the supplementary bids round and completion of the deposit checks, the auctioneer will proceed to determine the winning bids. As each lot represents a unique frequency range, this process determines the final assignment of frequencies to bidders.

A8.90 The winning bids are the combination of primary round bids (excluding guard block bids) and supplementary bids of greatest total value amongst all valid bids submitted, subject to the conditions that:

- no more lots are awarded than are available;
- at most one bid is accepted from each bidder; and
- if lots are awarded for both high power and low power usage rights, there are at least two lots between them that are unallocated.

A8.91 A software algorithm will be used to determine the combination of bids that meets these criteria. It is possible that there could be more than one set of bids having the equal highest value. In this case, the tie will be resolved in the following way:

- The combination of bids with the highest number of associated eligibility points will be selected.
- If there is still a tie, with a number of possible combinations of bids having the same total value and the same number of eligibility points, then a random process will be used to select the winning combination of bids.

A8.92 It is possible that the winning allocation could include some unallocated lots, either because bidder demand is deficient or incompatible. In this case:

- If there are two contiguous unallocated lots and these are located between a high power and a low power allocation, then these will be designated as guard blocks, and assigned, one each, to the adjacent winning bidders.
- If there are three or more contiguous unallocated lots located between a high power and a low power allocation, then all these lots will be designated as ‘unsold lots’ and withheld by Ofcom.
- If there are any other unallocated lots, then these lots will be designated as ‘unsold lots’ and withheld by Ofcom.

Price determination

A8.93 Each winning bid has an associated price. This is an overall price for the entire package of lots subject to a winning bid. Therefore, a separate price is determined for each winning bidder. (Notice that we do not determine a price per lot.) There is no price for a bidder who does not win any lots in the Auction Stage.

A8.94 Prices are calculated using a second price rule. This is a single calculation that jointly determines a set of prices – one for each winning bidder. It consists of a number of steps, as described below.

A8.95 First, prices are subject to the condition that the price of a winning bid must be greater than or equal to the total reserve prices of the lots within the package associated with that winning bid.

A8.96 Second, prices are required to satisfy the following condition (which we describe as an algorithm for checking that the condition is satisfied):

- calculate the total amount of the winning bids (call this the “winning bid total” - W);
- for each winning bid, find the difference between the amount of that winning bid and the corresponding price (call this the “price difference” for that winning bidder);
- calculate the total of the price differences for all winning bidders (call this the “total price difference” - P);
- take all of the winning bidders’ Auction Stage bids, and subtract the corresponding price difference for each winner from all bids made by that winner (call these the “modified bids”);
- re-run the determination of winning bids using the method described above, but using (a) the non-winning bidders’ Auction Stage bids; and (b) the winning bidders’ modified bids as reduced by the price differences (call this the “modified winner determination”);
- calculate the total of the winning bids found in the modified winner determination (call this the “modified winning bid total” - MW);
- the sum of the modified winning bid total (MW) and the total price difference (P) is then required to equal the winning bid total (W).

A8.97 There are typically many sets of prices that satisfy these two conditions. However, all have the property that the price of a winning bid is not more than the amount of that winning bid.

A8.98 Amongst all these various sets of prices, we impose a third condition that the sum of the prices across winning bidders is minimised. Therefore, we only allow sets of prices that:

- satisfy the two conditions above; and
- such that there is no other set of prices that also satisfies the two conditions above and where the sum of prices across bidders is lower.

A8.99 Where there is only one set of prices (one price for each winner) satisfying these three conditions, this determines the prices for the Auction Stage. In the case there are many sets of prices satisfying these three conditions, we impose a fourth condition that selects a unique set of prices. We express this condition in terms of an algorithm for checking that it is satisfied:

- first calculate the opportunity cost for a particular winning bidder which is defined to be:

a) the amount of the winning bid of that bidder; less

b) the total of all winning bids in the winning combination; plus

c) the greatest possible total of bids subject to: (i) accepting at most one bid from each bidder; (ii) accepting no bids from that winning bidder; and (iii) allocating each lot at most once;

- second, the sum of the squares of the differences between the price for each winner and the opportunity cost for that winner should be minimised amongst all sets of prices satisfying the previous three conditions.

A8.100 This procedure produces a unique price for each winning bidder that is no more than their winning bid and is at least the reserve price for that package.

End of the Auction Stage

A8.101 Once the auctioneer has determined the winning bids and the prices to be paid by winning bidders, the outcome of the Auction Stage will be announced to bidders.

A8.102 The following information will be released to all bidders:

- the identity of the winning bidders;
- the frequency ranges awarded to winning bidders, including any guard blocks that will be awarded to bidders in addition to their winning bid;
- the usage rights that will apply to each lot awarded; and
- the price to be paid for each winning bid.

The Grant Stage

A8.103 In the Grant Stage, winning bidders are granted licences for the frequencies corresponding to the lots in their winning bid plus any guard blocks if applicable. The usage rights for these lots (except guard blocks) are determined according to the usage nomination in their winning bid.

A8.104 Winning bidders will be refunded the amount of their deposit less the price for their winning bid, as determined according to the rules above, less any amount that has been forfeit.

A8.105 Losing bidders, applicants who did not qualify and applicants who withdrew before the last day for withdrawal will be refunded their deposits, unless these have been forfeit.

Other auction rules

Exceptional circumstances

A8.106 Exceptional circumstances are determined by the auctioneer. They could include, for example, widespread technical failure or concern about possible collusion amongst bidders.

A8.107 In the case of exceptional circumstances during the Auction Stage, the auctioneer has the discretion to:

- postpone the deadline for a round in progress;
- postpone the scheduling of further rounds;
- cancel a round that is either underway or for which round results have not yet been released, and re-schedule the round again; or
- void all bids received in the auction, and either cancel the auction or start the auction again.

A8.108 In the event that an individual bidder breaches the activity rules, as defined in the regulations, the bidder will either be fined but permitted to continue in the auction, or be expelled from the auction, depending on the severity of the breach. If a bidder is expelled from the auction, all its bids will become void, but for the avoidance of doubt there will be no retrospective change made to the process of the auction up to that point so far as it affects other bidders.

Unallocated lots

A8.109 It is possible that at the end of the Auction Stage, some lots may be unallocated, either due to deficient demand or because the winner determination produces a set of winning bids whose aggregate demand for lots is less than supply. Any such lots will be designated as ‘unsold lots’. Ofcom will retain any unsold lots for future award as appropriate.

Information policy

A8.110 Information policy determines the information released to bidders and the general public.

A8.111 All bidders will receive the same information (other than details of their own bids which are private up to the conclusion of the auction). Even if a bidder drops its eligibility to zero, it will continue to be able to monitor the progress of the auction (unless it is excluded from the award process, and locked out of the electronic auction system by the auctioneer, for transgressing the rules). The information that will be released in each stage of the auction is described in the relevant section of the rules above.

A8.112 Before the auction, Ofcom will publish on its website the number and identity of the bidders. Upon completion of the Auction Stage, Ofcom will publish on its website the identity of the winning bidders, the frequencies that they have won and their licence fees.

A8.113 After the award process is concluded, Ofcom intends to publish on its website details of all valid primary and supplementary bids.

Breach of activity rules

A8.114 Any breach of the activity rules which would materially affect the outcome of the award process may result in a bidder or applicant forfeiting its deposit and may also result in that bidder or applicant being excluded from the award process. If a bidder has been issued a licence and is later found to have breached the activity rules, the licence may be revoked. The activity rules apply to all bidders and all applicants who have qualified to bid and they continue to apply until the licences have been awarded.

A8.115 Events which may lead to exclusion from the award process and/or to an initial deposit or bid deposit being forfeited include:

- an applicant or bidder has submitted false or misleading information to Ofcom;
- an applicant or bidder or any member of its bidder group is colluding or attempting to collude with any other person to distort the outcome of the award process, or is acting in a way which is likely to distort the outcome of the award process;
- the applicant or bidder or any member of its bidder group, or any person to whom confidential information has been disclosed, is disclosing, attempting to disclose or inciting another person to disclose confidential information to anyone other than to a member of its bidder group, Ofcom, a provider of finance (where the disclosure was for the purpose of raising finance for the bid) or to a person considering whether to join the bidder group of the applicant or bidder;
- the applicant or bidder or any member of its bidder group is obtaining or attempting to obtain confidential information in relation to any other applicant or bidder;
- the applicant or bidder or any member of its bidder group is receiving or attempting to receive services in relation to the award process from any person who has provided or is providing services to Ofcom in relation to the award process (for these purposes the advisers are DotEcon Ltd and Professor Peter Cramton
- any member, director or employee of a member of the applicant's or bidder's bidder group, who is also a director or employee of a member of another bidder group, is taking part in the preparation of both bidder groups for participation in the award process or is receiving confidential information relating to both bidder groups;
- a member of an applicant’s or bidder’s bidder group is or becomes a member of another bidder group; and
- a change is occurring in the membership of an applicant’s or bidder’s bidder group subsequent to the application day except where a person ceases to be a member of the bidder group, a person has been added to the bidder group in accordance with the regulations, or where a person becomes an associate through merger and acquisition activity provided that such activity is not for a purpose related to the award process (and provided that the addition will not

result in a member of one applicant or bidder's bidder group also being a member of another bidder group).

A8.116 Where any changes occur to the membership of an applicant's or bidder's bidder group, that applicant or bidder must notify Ofcom as soon as practicable.

Electronic Auction System

A8.117 The Auction Stage will be conducted using an electronic auction system. Bidders will be able to access the system over the public Internet using a standard web-browser. The minimum requirements in terms of hardware and software will be described in a user manual that will be distributed to Qualified Bidders prior to the auction. However, these requirements will not be onerous – a typical PC running Windows and using Internet Explorer or Firefox or an Apple Mac using Safari or Firefox should usually be sufficient. Java will need to be installed on the bidder's computer to access the electronic auction system (if not already available, this can be downloaded from www.java.com and easily installed).

A8.118 Bidders will need to have a reliable Internet connection (128Kbit/s download speed or better, so a typical ADSL or E1/T1 connection will suffice). We recommend that bidders consider having a backup computer and backup Internet connection.

A8.119 Internet addresses for primary and backup auction servers will be communicated to Bidders prior to the auction. In order to access these servers, Bidders will need to install digital certificates on the computers they intend to use to access the electronic auction system. This is a simple process and instructions will be provided in the user manual. Digital certificates will be distributed to bidders by Ofcom and are specific to each bidder. A password will be required to install the certificates, which will be distributed separately.

A8.120 Bidders will be able to log in to the auction system only from computers on which they have installed the necessary digital certificates. A further login username and password is required to access the electronic auction system, which will communicated to Bidders by Ofcom prior to the auction.

A8.121 Bidders will be identified by the electronic auction system through their digital certificates and their username and login password. Bidders will need to ensure that these are not disclosed to third parties. In the event of any breach of security, bidders should contact Ofcom at the soonest opportunity.

A8.122 The electronic auction system only allows a bidder to be logged in from one computer at any one time. However, should there be a failure of the bidder's computer or network connection, the electronic auction system will automatically log out the bidder, who can then log in from a different computer on which the necessary digital certificates are installed. The bidder will be able to continue using the electronic auction system from the point he or she left off.

A8.123 The electronic auction system allows bidders to enter bids and to observe the progress of the auction. It provides a display of the key aspects of the auction state, such as the number of completed primary bid rounds, whether a round is currently running and a countdown timer for submitting decisions when deadlines are in force. It also displays a clock synchronised with the auction server to aid bidders in submitting bids. However, bidders should note that deadlines apply according to the time that bids are received at the server, not the time that they are sent from the bidder's computer. Therefore, it is prudent for bids to be submitted in good time

prior to the end of rounds to allow for network delays. Bids are not processed by the electronic auction system and results are not released until after the end of the round, so there is no strategic advantage to bidders from delaying submission of their bids.

A8.124 Submitting a bid into the electronic auction system involves a two-step checking and confirmation process (regardless of whether these are primary round bids or supplementary bids). Bidders will first need to enter their bid (or bids) and send these for checking by the electronic auction system. The system will check that the bid (or bids) is consistent with the auction rules. If not, the bidder will be given an explanation of the problem and be returned to the relevant screen to allow further editing of the bid (or bids). If the bid (or bids) is consistent with the auction rules, the electronic auction system will return a summary of the bid (or bids), which can then be submitted. Only bids that have been submitted will be considered to be valid bids. If a bidder checks a bid, but then fails to submit it, this will be treated as if no bid was made.

A8.125 Throughout the primary bid rounds, bidders will be able to use the electronic auction system to store and update a list of supplementary bids on a provisional basis. This list of provisional supplementary bids can then be edited, checked and submitted during the supplementary bids round. The facility to check and submit supplementary bids will be disabled until the start of the supplementary bids rounds.

A8.126 The electronic auction system will provide summaries of each bidder's own bids and also a history of round prices and excess demand. Downloadable files of own bids and the auction history will be provided for transferring data to other applications. These will be available in comma separated value (.CSV) and tab delimited (.TXT) formats. Either format can be easily read into programs such as Microsoft Excel.

A8.127 The electronic auction system provides a one-way messaging system that allows Ofcom to send notices to bidders. Ofcom envisages this being the primary means of communicating with bidders about round schedules, deposit increase deadlines and other aspects of the auction process. If bidders need to contact Ofcom, they will need to use telephone and fax numbers supplied to them by Ofcom.

Miscellaneous

A8.128 Ofcom has a general power to exclude an applicant or bidder where it considers the grant of a licence to that applicant or bidder would be prejudicial to the interests of national security or where the applicant or bidder is not a fit and proper person to hold a licence.

A8.129 Ofcom has a general power to alter the date, time, or place of delivery of any documents or the completion of any action in relation to the award process.

A8.130 Ofcom has a general discretion to refund any sums paid to it.

Annex 9

Draft licences

Draft licence in SUR terms for a low density network

DRAFT LICENCE

Please note that the following template licence and schedule represents Ofcom's current thinking and may well change as Ofcom's thinking develops

All figures provided in this licence and schedule are indicative only.

Wireless Telegraphy Acts 2006

Office of Communications (Ofcom)

SPECTRUM ACCESS LICENCE 1452 to 1479.5 MHz Band

Licence no: **[xxxxxx]**

Date: **[date]**

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

[company name]
Company Reg No: [xxxxxxxx]
(the "Licensee")
[address 1]
[address 2]
[address 3]
[postcode]

to establish, install and use radio transmitting and receiving stations and/or radio apparatus as described in the Schedule (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 Variation and Revocation

3. Pursuant to paragraph 8 of Schedule 1 to the Wireless Telegraphy Act 2006 (the "Act"), Ofcom may not revoke this Licence under paragraph 6 of Schedule 1 to the Act except:

(a) at the request of, or with the consent of, the Licensee;

(b) in accordance with paragraph 8 of this Licence;

(c) if there has been a breach of a term 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 30(1) and (3) of the Act [23];

(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 (Licence Award) No. X Regulations 200X]** (the "Regulations");

(f) in accordance with paragraph 8(5) of Schedule 1 to the 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 of the Act 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) this 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 fifteen (15) years from the date of this Licence.

4. Ofcom may only revoke or vary this Licence by notification in writing to the Licensee and in accordance with paragraphs 6 and 7 of Schedule 1 to the Act.

[23] These are regulations on spectrum trading.

Changes

5. This Licence is not transferable. The transfer of rights and obligations arising by virtue of this Licence may however be authorised in accordance with regulations made by Ofcom under powers conferred by section 30(1) and (3) of the Act[24].

6. The Licensee must give prior notice to Ofcom in writing of any proposed change to the Licensee's name and address from that recorded in the Licence.

Fees

7. The licence fee in respect of this Licence is [**£xxxxxx]**, which for the avoidance of doubt is exclusive of any VAT which may ultimately be payable.

8. On or after the expiry of twenty (20) years from the date this Licence was granted, the Licensee shall pay to Ofcom such sum(s) as may be provided for in regulations made by Ofcom under sections 12 and 13(2) of the Act, failing which Ofcom may revoke this Licence.

9. 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 sections 12 and 32(2) of the Act 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 15 of the Act any such amount and any such interest is recoverable by Ofcom.

10. 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 sections 12 and 13(2) of the Act will be made, except at the absolute discretion of Ofcom (in accordance with regulation XX of the Regulations.

Radio Equipment Use

11. The Licensee must ensure that the Radio Equipment is 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.

[24] See Ofcom's website for the latest position on spectrum trading and the types of trade which are permitted.

12. 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

13. 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

14. A person authorised by Ofcom may require any of the radio stations or radio apparatus that comprise the Radio Equipment 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 breach of a term of the 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.

15. Ofcom may require any of the radio stations or radio apparatus that comprise 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

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

Interpretation

17. 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 8 of the Act; and

(b) the expressions "undue interference", “station for wireless telegraphy” and “apparatus for wireless telegraphy” shall be construed in accordance with section 115 of the Act.

18. The schedules to this Licence form part of this Licence together with any subsequent schedules which Ofcom may issue as a variation to this Licence at a later date.

19. The Interpretation Act 1978 shall apply to this Licence as it applies to an Act of Parliament.

Issued by Ofcom

Signed by

For the Office of Communications

DRAFT SCHEDULE

Please note that the following template licence and schedule represents Ofcom's current thinking and may well change as Ofcom's thinking develops

All figures provided in this licence and schedules are indicative only.

SCHEDULE 1 TO LICENCE NUMBER: [xxxxxx]

Schedule Date: **[date]**

Licence Category: **Spectrum Access Licence 1452 to 1479.5 MHz Band**

1. Description of Radio Equipment Licensed

In this Licence, the Radio Equipment means any radio transmitting and receiving stations and/or any radio apparatus.

2. Interface Requirements for the Radio Equipment use

Use of the radio equipment shall be in accordance with the following Interface Requirement:

IR [xxxx] [25]for "Spectrum Access in the band 1452 – 1492 MHz band"

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

(a) During the period that this Licence remains in force and for six (6) months thereafter, unless consent has otherwise been given by Ofcom, 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 one hundred (100) metres resolution);

c) antenna height (above ground level) and type, bearing east of true north; and

[25] Available from the Ofcom website at http://www.ofcom.org.uk

d) radio frequencies used by the Radio Equipment; and

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

(iii) the operational details of base station sites listed in schedule 2 paragraph 4 required to establish compliance in any particular area;

and the Licensee must produce these records if requested by a person authorised by Ofcom, within a period of [xx] days.

(b) The Licensee shall inform Ofcom of the address of the premises at which this Licence and the information detailed at sub-paragraph 3(a) above shall be kept.

(c) The Licensee must submit to Ofcom copies of the records detailed in sub-paragraph 3(a) above at such intervals as Ofcom shall notify to the Licensee.

(d) The Licensee must also submit to Ofcom in such manner and at such times, all information relating to the establishment, installation or use of the Radio Equipment, whether stored in hard copy or electronic form, as reasonably requested for the purposes of verifying compliance with this Licence or for statistical purposes.

(e) The Licensee must ensure that the Radio Equipment is established and installed only for terrestrial use.

4. Site Clearance Requirements

(a) Except where specified in sub-paragraph 4(b), the Licensee must obtain from Ofcom a valid site clearance certificate prior to establishing, installing or using the Radio Equipment:

(b) Sub-paragraph 4(a) does not apply to:

(i) base transceiver stations incorporating transmitters radiating not more than 17 dBW ERP; and

(ii) aerial systems, which do not extend beyond thirty metres above ground level, or do not increase the height of an existing (site cleared) structure by five meters or more.

5. Cross-border coordination

The Licensee must ensure that the Radio Equipment is operated in compliance with such cross-border coordination and sharing procedures as may be notified to the Licensee by Ofcom.

6. Permitted Frequency Bands

Subject to the Out-of-Block Emissions permitted under paragraph 9, the Radio Equipment must only transmit and/or receive on the following frequency bands (the “Permitted Frequency Bands”):

(i) 1465.8 MHz - 1467.512 MHz

7. Maximum permissible EIRP

No limit.

8. Maximum permissible transmitter density

The number of transmitters in any 50km x 50km square centred on the intersection of any 1km OS grid lines within the licensed area must not exceed 80.

9. Maximum permissible aggregate PFD

The maximum aggregate PFD in the Permitted Frequency Band(s) specified in paragraph 6(i) shall be not more than -48 dBW/m^2/MHz at a height of 1.5 metres above ground level for 95% of locations within a test area as defined in paragraph 12. The maximum aggregate PFD is due to transmissions by equipment located in the above test area and which is licensed to operate in the Permitted Frequency Band(s) as specified in paragraph 6(i).

10. Maximum permissible Out-of -Block aggregate PFD

The maximum aggregate PFD outside the Permitted Frequency Band(s) specified in paragraph 6(i) shall be not more than:

Offset from relevant block edge	Maximum aggregate PFD
	At a receive antenna height of 1.5 m above ground level (dBW/m^2/MHz)
-4.0 to -1.0 MHz (lower band edge)	-128
-1.0 to -0.8 MHz (lower band edge)	-128
-0.8 to -0.6 MHz (lower band edge)	-121
-0.6 to -0.4 MHz (lower band edge)	-112
-0.4 to -0.2 MHz (lower band edge)	-103
-0.2 to 0.0 MHz (lower band edge)	-88
0.0 to 0.2 MHz (upper band edge)	-88
0.2 to 0.4 MHz (upper band edge)	-103
0.4 to 0.6 MHz (upper band edge)	-112
0.6 to 0.8 MHz (upper band edge)	-121
0.8 to 1.0 MHz (upper band edge)	-128
1.0 to 4.0 MHz (upper band edge)	-128

at a height of 1.5 metres above ground level for 95% of locations within a test area as defined in paragraph 12. The maximum aggregate PFD is due to transmissions by equipment located in the above test area and which is licensed to operate in the Permitted Frequency Band(s) as specified in paragraph 6(i).

11. Compliance with PFD conditions

For the purpose of establishing compliance with the PFD conditions set out in paragraphs 9 and 10 a methodology based on radio-frequency propagation modelling shall be used. This methodology is set out in schedule 2 to this licence.

12. Definition of a test area

The test area is defined as a square area including at least ten transmitters and centred on the intersection of any 1km Ordnance Survey (OS) grid lines. The appropriate test area[26] at a particular location is the smallest of the following areas, 1 km^2, 4 km^2, 25 km^2, 100 km^2, 400 km^2, 2500 km^2 or 10000 km^2, which includes at least ten transmitters.

13. Interpretation

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-wave dipole.

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

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

(e) “Out-of-Block Emissions” means radio frequency emissions generated by the Radio Equipment and radiated into the frequency bands adjacent (in terms of frequency) to the Licensee’s Permitted Frequency Bands.

(f) “Base station” means a radio transmitter with or without a receiver installed to provide a communications service, typically used in mobile or broadcasting radio systems.

(g) “PFD” means power-flux density and is a measure power received per unit area per unit frequency. For the purposes of this licence it is expressed in the following units dBm/m^2/MHz.

[26] This sample licence assumes that a test area of 10000 km^2 will include at least ten transmitters and does not account for special cases where this is not true. However, actual licences will have appropriate text to define the test area in these special cases.

(h) “aggregate PFD” means the combined PFD cause by all transmitters authorised by this licence

DRAFT SCHEDULE

Please note that the following template licence and schedule represents Ofcom's current thinking and may well change as Ofcom's thinking develops

All figures provided in this licence and schedules are indicative only.

SCHEDULE 2 TO LICENCE NUMBER: [xxxxxx]

Schedule Date: **[date]**

Licence Category: **Spectrum Access Licence 1452 to 1479.5 MHz Band**

1. Radio-frequency propagation model

For the purpose of radio-frequency propagation modelling ITU-R Recommendation P.1546-3 shall be used.

2. Terrain data

[OS 50m terrain data] shall be used.

3. Clutter data

[XYZ clutter data] shall be used.

4. Calculation methodology

To verify compliance, PFD values will be calculated using any suitable radio-frequency software planning tool implementing the radio-frequency propagation model and terrain and clutter data sets described in paragraphs 1, 2 and 3.

At each of the [XX] test points[27] distributed uniformly across the test area defined in Schedule 1 paragraph 12, an average PFD value will be calculated at the height specified in Schedule 1 Paragraph 9, and Schedule 1 Paragraph 10.

The operational details of all transmitting stations within the area for which compliance is to be established will be entered into the radio-frequency software planning tool. These details will include as a minimum:

[27] Test points that are located over a water feature (e.g. lake, sea or river) are ignored and PFD levels are not calculated at these points. However, there should at least be ten transmitters (or ten receivers for uplink channels) within the effectively smaller test area. If this is not the case, then a larger test area is used to meet this requirement.

(a) the location of each transmitting antenna to an accuracy of 1 metre;

(b) the height above ground level of each transmitting antenna to an accuracy of 1 metre;

(c) the azimuth of each transmitting antenna on each site;

(d) the horizontal and vertical profile of each transmitting antenna on each site (without taking into account any down-tilt);

(e) the down-tilt (physical and electrical) of each transmitting antenna;

(f) the maximum operational EIRP per MHz within the permitted frequency bands given in schedule 1 paragraph 6; and

(g) the out-of-block emission profile in EIRP per MHz (to a maximum of 4 MHz either side of the permitted frequency bands given in schedule 1 paragraph 6 of each transmitting antenna.

Compliance to the licence terms is established if the PFD values predicted by the radio-frequency software planning tool are no greater those given in Schedule 1 Paragraphs 9 and 10 for the specified proportion of locations within the areas for which compliance is to be established (the size of these areas must be consistent with the areas specified in schedule 1 paragraphs 9 and 10.

Draft licence in SUR terms for a high density network

DRAFT LICENCE

Please note that the following template licence and schedule represents Ofcom's current thinking and may well change as Ofcom's thinking develops

All figures provided in this licence and schedule are indicative only.

Wireless Telegraphy Acts 2006

Office of Communications (Ofcom)

SPECTRUM ACCESS LICENCE 1452 to 1479.5 MHz Band

Licence no: **[xxxxxx]**

Date: **[date]**

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

[company name]
Company Reg No: [xxxxxxxx]
(the "Licensee")
[address 1]
[address 2]
[address 3]
[postcode]

to establish, install and use radio transmitting and receiving stations and/or radio apparatus as described in the Schedule (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 Variation and Revocation

3. Pursuant to paragraph 8 of Schedule 1 to the Wireless Telegraphy Act 2006 (the "Act"), Ofcom may not revoke this Licence under paragraph 6 of Schedule 1 to the Act except:

(a) at the request of, or with the consent of, the Licensee;

(b) in accordance with paragraph 8 of this Licence;

(c) if there has been a breach of a term 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 30(1) and (3) of the Act [28];

(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 (Licence Award) No. X Regulations 200X]** (the "Regulations");

(f) in accordance with paragraph 8(5) of Schedule 1 to the 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 of the Act 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) this 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 fifteen (15) years from the date of this Licence.

4. Ofcom may only revoke or vary this Licence by notification in writing to the Licensee and in accordance with paragraphs 6 and 7 of Schedule 1 to the Act.

[28] These are regulations on spectrum trading.

Changes

5. This Licence is not transferable. The transfer of rights and obligations arising by virtue of this Licence may however be authorised in accordance with regulations made by Ofcom under powers conferred by section 30(1) and (3) of the Act[29].

6. The Licensee must give prior notice to Ofcom in writing of any proposed change to the Licensee's name and address from that recorded in the Licence.

Fees

7. The licence fee in respect of this Licence is [**£xxxxxx]**, which for the avoidance of doubt is exclusive of any VAT which may ultimately be payable.

8. On or after the expiry of twenty (20) years from the date this Licence was granted, the Licensee shall pay to Ofcom such sum(s) as may be provided for in regulations made by Ofcom under sections 12 and 13(2) of the Act, failing which Ofcom may revoke this Licence.

9. 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 sections 12 and 32(2) of the Act 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 15 of the Act any such amount and any such interest is recoverable by Ofcom.

10. 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 sections 12 and 13(2) of the Act will be made, except at the absolute discretion of Ofcom (in accordance with regulation XX of the Regulations.

Radio Equipment Use

11. The Licensee must ensure that the Radio Equipment is 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.

[29] See Ofcom's website for the latest position on spectrum trading and the types of trade which are permitted.

12. 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

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

(b) 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

14. A person authorised by Ofcom may require any of the radio stations or radio apparatus that comprise the Radio Equipment 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 breach of a term of the Licence has occurred; and/or

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

15. Ofcom may require any of the radio stations or radio apparatus that comprise 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

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

Interpretation

17. 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 8 of the Act; and

(b) the expressions "undue interference", “station for wireless telegraphy” and “apparatus for wireless telegraphy” shall be construed in accordance with section 115 of the Act.

18. The schedules to this Licence form part of this Licence together with any subsequent schedules which Ofcom may issue as a variation to this Licence at a later date.

19. The Interpretation Act 1978 shall apply to this Licence as it applies to an Act of Parliament.

Issued by Ofcom

Signed by

For the Office of Communications

DRAFT SCHEDULE

Please note that the following template licence and schedule represents Ofcom's current thinking and may well change as Ofcom's thinking develops

All figures provided in this licence and schedules are indicative only.

SCHEDULE 1 TO LICENCE NUMBER: [xxxxxx]

Schedule Date: **[date]**

Licence Category: **Spectrum Access Licence 1452 to 1479.5 MHz Band**

1. Description of Radio Equipment Licensed

In this Licence, the Radio Equipment means any radio transmitting and receiving stations and/or any radio apparatus.

2. Interface Requirements for the Radio Equipment use

Use of the radio equipment shall be in accordance with the following Interface Requirement:

IR [xxxx] [30]for "Spectrum Access in the band 1452 – 1492 MHz band"

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

(a) During the period that this Licence remains in force and for six (6) months thereafter, unless consent has otherwise been given by Ofcom, 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 one hundred (100) metres resolution);

c) antenna height (above ground level) and type, bearing east of true north; and

[30] Available from the Ofcom website at http://www.ofcom.org.uk

d) radio frequencies used by the Radio Equipment; and

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

(v) the operational details of base station sites listed in schedule 2 paragraph 4 required to establish compliance in any particular area;

and the Licensee must produce these records if requested by a person authorised by Ofcom, within a period of [xx] days.

(b) The Licensee shall inform Ofcom of the address of the premises at which this Licence and the information detailed at sub-paragraph 3(a) above shall be kept.

(c) The Licensee must submit to Ofcom copies of the records detailed in sub-paragraph 3(a) above at such intervals as Ofcom shall notify to the Licensee.

(d) The Licensee must also submit to Ofcom in such manner and at such times, all information relating to the establishment, installation or use of the Radio Equipment, whether stored in hard copy or electronic form, as reasonably requested for the purposes of verifying compliance with this Licence or for statistical purposes.

(e) The Licensee must ensure that the Radio Equipment is established and installed only for terrestrial use.

4. Site Clearance Requirements

(c) Except where specified in sub-paragraph 4(b), the Licensee must obtain from Ofcom a valid site clearance certificate prior to establishing, installing or using the Radio Equipment:

(d) Sub-paragraph 4(a) does not apply to:

(i) base transceiver stations incorporating transmitters radiating not more than 17 dBW ERP; and

(ii) aerial systems, which do not extend beyond thirty metres above ground level, or do not increase the height of an existing (site cleared) structure by five meters or more.

5. Cross-border coordination

The Licensee must ensure that the Radio Equipment is operated in compliance with such cross-border coordination and sharing procedures as may be notified to the Licensee by Ofcom.

6. Permitted Frequency Bands

Subject to the Out-of-Block Emissions permitted under paragraph 9, the Radio Equipment must only transmit and/or receive on the following frequency bands (the “Permitted Frequency Bands”):

(i) 1465.8 MHz - 1467.512 MHz

7. Maximum permissible EIRP

The maximum mean EIRP of any transmitter deployed in the Permitted Frequency Band(s) specified in paragraph 6(i) shall not exceed 6kW within a single 1.7MHz channel.

8. Maximum permissible transmitter density

No limit.

9. Maximum permissible aggregate PFD

The maximum aggregate PFD in the Permitted Frequency Band(s) specified in paragraph 6(i) shall be not more than -48 dBW/m^2/MHz at a height of 1.5 metres above ground level for 95% of locations within a test area as defined in paragraph 12. The maximum aggregate PFD is due to transmissions by equipment located in the above test area and which is licensed to operate in the Permitted Frequency Band(s) as specified in paragraph 6(i).

10. Maximum permissible Out-of -Block aggregate PFD

The maximum aggregate PFD outside the Permitted Frequency Band(s) specified in paragraph 6(i) shall be not more than:

Offset from relevant block edge	Maximum aggregate PFD
	At a receive antenna height of 1.5 m above ground level (dBW/m^2/MHz)
-4.0 to -1.0 MHz (lower band edge)	-128
-1.0 to -0.8 MHz (lower band edge)	-128
-0.8 to -0.6 MHz (lower band edge)	-121
-0.6 to -0.4 MHz (lower band edge)	-112
-0.4 to -0.2 MHz (lower band edge)	-103
-0.2 to 0.0 MHz (lower band edge)	-88
0.0 to 0.2 MHz (upper band edge)	-88
0.2 to 0.4 MHz (upper band edge)	-103
0.4 to 0.6 MHz (upper band edge)	-112
0.6 to 0.8 MHz (upper band edge)	-121
0.8 to 1.0 MHz (upper band edge)	-128
1.0 to 4.0 MHz (upper band edge)	-128

at a height of 1.5 metres above ground level for 95% of locations within a test area as defined in paragraph 12. The maximum aggregate PFD is due to transmissions by equipment located in the above test area and which is licensed to operate in the Permitted Frequency Band(s) as specified in paragraph 6(i).

11. Compliance with PFD conditions

For the purpose of establishing compliance with the PFD conditions set out in paragraphs 9 and 10 a methodology based on radio-frequency propagation modelling shall be used. This methodology is set out in schedule 2 to this licence.

12. Definition of a test area

The test area is defined as a square area including at least ten transmitters and centred on the intersection of any 1km Ordnance Survey (OS) grid lines. The appropriate test area[31] at a particular location is the smallest of the following areas, 1 km^2, 4 km^2, 25 km^2, 100 km^2, 400 km^2, 2500 km^2 or 10000 km^2, which includes at least ten transmitters.

13. Interpretation

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-wave dipole.

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

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

(e) “Out-of-Block Emissions” means radio frequency emissions generated by the Radio Equipment and radiated into the frequency bands adjacent (in terms of frequency) to the Licensee’s Permitted Frequency Bands.

(f) “Base station” means a radio transmitter with or without a receiver installed to provide a communications service, typically used in mobile or broadcasting radio systems.

(g) “PFD” means power-flux density and is a measure power received per unit area per unit frequency. For the purposes of this licence it is expressed in the following units dBm/m^2/MHz.

[31] This sample licence assumes that a test area of 10000 km^2 will include at least ten transmitters and does not account for special cases where this is not true. However, actual licences will have appropriate text to define the test area in these special cases.

(h) “aggregate PFD” means the combined PFD cause by all transmitters authorised by this licence

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All figures provided in this licence and schedules are indicative only.

SCHEDULE 2 TO LICENCE NUMBER: [xxxxxx]

Schedule Date: **[date]**

Licence Category: **Spectrum Access Licence 1452 to 1479.5 MHz Band**

1. Radio-frequency propagation model

For the purpose of radio-frequency propagation modelling ITU-R Recommendation P.1546-3 shall be used.

2. Terrain data

[OS 50m terrain data] shall be used.

3. Clutter data

[XYZ clutter data] shall be used.

4. Calculation methodology

To verify compliance, PFD values will be calculated using any suitable radio-frequency software planning tool implementing the radio-frequency propagation model and terrain and clutter data sets described in paragraphs 1, 2 and 3.

At each of the [XX] test points[32] distributed uniformly across the test area defined in Schedule 1 paragraph 12, an average PFD value will be calculated at the height specified in Schedule 1 Paragraph 9, and Schedule 1 Paragraph 10.

The operational details of all transmitting stations within the area for which compliance is to be established will be entered into the radio-frequency software planning tool. These details will include as a minimum:

[32] Test points that are located over a water feature (e.g. lake, sea or river) are ignored and PFD levels are not calculated at these points. However, there should at least be ten transmitters (or ten receivers for uplink channels) within the effectively smaller test area. If this is not the case, then a larger test area is used to meet this requirement.

(h) the location of each transmitting antenna to an accuracy of 1 metre;

(i) the height above ground level of each transmitting antenna to an accuracy of 1 metre;

(j) the azimuth of each transmitting antenna on each site;

(k) the horizontal and vertical profile of each transmitting antenna on each site (without taking into account any down-tilt);

(l) the down-tilt (physical and electrical) of each transmitting antenna;

(m) the maximum operational EIRP per MHz within the permitted frequency bands given in schedule 1 paragraph 6; and

(n) the out-of-block emission profile in EIRP per MHz (to a maximum of 4 MHz either side of the permitted frequency bands given in schedule 1 paragraph 6 of each transmitting antenna.

Compliance to the licence terms is established if the PFD values predicted by the radio-frequency software planning tool are no greater those given in Schedule 1 Paragraphs 9 and 10 for the specified proportion of locations within the areas for which compliance is to be established (the size of these areas must be consistent with the areas specified in schedule 1 paragraphs 9 and 10.