



## Award of available Spectrum: 10, 28, 32 and 40GHz Bands

This document sets out Ofcom's decisions for the award of wireless telegraphy licences in these spectrum bands. The Information Memorandum for this award is published separately.

Statement

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## Section 1

# Executive summary

- 1.1 Ofcom's Spectrum Framework Review: Implementation Plan ('SFR: IP')<sup>1</sup>, issued on 13 January 2005, included provisional proposals on the award of wireless telegraphy licences for 10 GHz, 28 GHz, 32 GHz and 40 GHz (the 'spectrum bands'). These bands are the subject of the award process covered by this document.
- 1.2 Following consideration of responses to the proposals in the SFR: IP, on 29 June 2006 Ofcom published a consultation document setting out its detailed proposals for awarding wireless telegraphy licences to use the spectrum bands 10 GHz, 28 GHz and 32 GHz and to defer the award of 40 GHz (the 'June consultation'<sup>2</sup>). Ofcom held a public seminar on the proposals on 28 July. In the light of points raised in responses to its proposals, Ofcom published a discussion document on 11 January 2007 (the 'January discussion document'<sup>3</sup>) that proposed revised packaging of the spectrum available in the 10 GHz band, inclusion of the 40 GHz band in the award and the award of licences by a combinatorial clock auction. It held a public seminar on 30 January 2007 to present these further proposals. Ofcom published a further discussion document on 15 March 2007 (the 'March discussion document'<sup>4</sup>) that set out some options for making the 10 GHz available for use at the Olympic Games and Paralympic Games in 2012. This statement sets out Ofcom's conclusions on the matters raised in the June consultation and in the January and March discussion documents and in responses to the proposals made in them.
- 1.3 Ofcom has decided to amend the proposals set out in the June consultation so that the key elements of the award will be as follows:
  - Ofcom will hold an auction in late 2007 or early 2008 for the award of UK wireless telegraphy licences to use the spectrum bands 10 GHz, 28 GHz, 32 GHz and 40 GHz.
  - The auction will take the form of a combinatorial clock auction.
  - The spectrum lots to be auctioned will be mainly for UK coverage but three lots in 28 GHz will have varying degrees of geographical coverage.
  - The licences will have an indefinite term with a minimum period of fifteen years (during which time Ofcom's powers to revoke will be limited).
  - The licences will be tradable.
  - The licences will be technology and application neutral, except for licences for 10 GHz frequencies, which will be restricted to fixed systems and wireless cameras.
- 1.4 Ofcom is publishing, at the same time as this statement, the following documents that are also relevant to this award process:
  - an information memorandum, which sets out relevant information that interested parties should take into account when considering their possible participation in the award process; and

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<sup>1</sup> <http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/?a=87101>

<sup>2</sup> [www.ofcom.org.uk/consult/condocs/10ghz/](http://www.ofcom.org.uk/consult/condocs/10ghz/)

<sup>3</sup> <http://www.ofcom.org.uk/consult/condocs/10-40GHz/10-40ghz.pdf>

<sup>4</sup> <http://www.ofcom.org.uk/consult/condocs/2012olympics/olympics2012.pdf>

- a notice of Ofcom's proposal to make four statutory instruments in relation to the award process in accordance with section 122 of the Wireless Telegraphy Act 2006. These statutory instruments include the auction regulations, regulations extending spectrum trading to the bands, regulations to allow for publication of the identity and terms of the licences in the bands and an order limiting the number of licences in the bands.
- 1.5 Interested parties are advised to familiarise themselves with the auction regulations, in particular the rules that prevent association and collusion between bidders.
  - 1.6 Ofcom intends to start the award process by the end of 2007 or early 2008.

## Section 2

# Introduction

- 2.1 This statement sets out Ofcom's decisions on various matters relating to the award of wireless telegraphy licences for the use of the spectrum bands 10, 28, 32 and 40 GHz. It sets out various amendments to proposals in the June consultation. These have been made following careful consideration of the responses to that consultation. This statement It also takes into account the feedback received from the January and March discussion documents and from the public seminars held on 28 July 2006 and 30 January 2007.
- 2.2 Further details of Ofcom's plans for the award, including application instructions, are given in documents published alongside this statement, specifically the information memorandum and the proposed auction regulations.
- 2.3 In the case of conflict or ambiguity between this statement, the information memorandum and the proposed auction regulations, precedence shall be given to each of the following in the order set out below:
- first, the provisions of the auction regulations;
  - second, the information memorandum; and
  - third, the provisions of this statement.
- 2.4 Ofcom intends to start the award process by the end of 2007 or early 2008.

## Overview of responses to the June consultation document

- 2.5 Ofcom received 44 responses to the June consultation and has placed the non-confidential responses on its website<sup>5</sup>. The main comments were:
- Some respondents said that it would be more appropriate to offer smaller lots in the 10 GHz band, rather than a single lot, in order to maximise flexibility and overall efficiency of use. There was, however, no consensus about the appropriate size of lots; for example a number of respondents suggested that two lots of 2x50 MHz be made available while another suggested five lots of 2x20 MHz.
  - One respondent suggested that there should be larger lots in the 32 GHz band and if larger lots were not available the respondent would be exposed to aggregation risk.
  - Some respondents said that award of the 40 GHz band should not be deferred.
  - Some respondents suggested licences with local or regional, as well as UK, coverage.
  - Some respondents asked for more information on MOD use of the 10 GHz band.

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<sup>5</sup> The responses may be found at <http://www.ofcom.org.uk/consult/condocs/10ghz/responses/>

- A large number of amateur radio licensees suggested that the proposal to award the available spectrum at 10 GHz did not take account of planned amateur satellite use and contravened internationally agreed spectrum use. Some also suggested that the proposed power levels would interfere with weak satellite signals.
- Some respondents suggested that the proposal for 28 GHz would promote further fragmentation of the band, result in lack of harmonisation at European level and undermine its exploitation for satellite broadband applications.
- One respondent asked for more information on band sharing issues in 28 GHz and 32 GHz.
- One respondent suggested that the packaging of lots and auction design should ensure that aggregation risk to bidders is minimised as far as possible.
- One respondent suggested that bidders should be restricted to three of the 12 available licences being proposed.
- One respondent was concerned about the lack of visibility regarding dispute resolution and auction rules.

2.6 A summary of the responses is included in Annex 1.

### **Overview of responses to the January discussion document**

2.7 Ofcom received 11 responses to the January discussion document and has placed the non-confidential responses on its website<sup>6</sup>. The main comments were:

- Some respondents supported the proposal for a combinatorial clock auction.
- One respondent suggested that the award of 40 GHz had only weak support and was not justified.
- One respondent was concerned about reliance on secondary market and suggested that Ofcom should consider introducing a 'use it or lose it' licence condition or selection criteria to ensure a vibrant industry.
- One respondent suggested that generic lots were not suitable and made the auction more complicated and that Ofcom should publish the auction design advice it had received.
- One respondent questioned the reason for changing the 10 GHz block size and suggested there would be an aggregation risk for those wanting 2x100 MHz.
- One respondent wanted more information on MOD locations at 10 GHz and on the potential for interference from amateur use.
- One respondent suggested 7 MHz lots at 10 GHz and that the block edge mask would restrict point-to-point applications, particularly at 10 GHz.

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<sup>6</sup> <http://www.ofcom.org.uk/consult/condocs/10-40GHz/responses/>

- Some respondents said that satellite operators required access to 28-29.5 GHz and so needed spectrum across all five packages on offer. They suggested that there should be a mechanism for permitting FSS gateway earth stations to use the entire band on a co-primary basis via established SES licensing process, with Administrative Incentive Pricing and co-ordination between FSS and terrestrial operators.

2.8 A summary of the responses is included in annex 1.

### **Overview of responses to the March discussion document**

2.9 Ofcom received five responses to the March discussion document and has placed the non-confidential responses on its website<sup>7</sup>. The responses provided a diversity of views, with no consensus that 10 GHz would be suitable for wireless cameras or that the inclusion of the proposed licence condition would be appropriate. In particular, there was concern that requiring licensees to avoid interference to use of the band for the Games would have a negative impact on the optimal use of the spectrum.

2.10 Ofcom has carefully considered all the points made. Sections 3 - 5 below and Annex 1 sets out its conclusions.

### **Associated Documents**

2.11 Ofcom is publishing alongside this statement the following documents:

- The information memorandum - this sets out relevant information that interested parties should take into account when considering their possible participation in the award process.
- A notice of Ofcom's proposal to make four statutory instruments in relation to the award process in accordance with section 122 of the Wireless Telegraphy Act 2006. These statutory instruments include the auction regulations, regulations extending spectrum trading to the bands, regulations to allow for publication of the identity of licensees and terms of the licences in the band and an order limiting the number of licences in the band. The statutory consultation period for these instruments expires on 17 September 2007.

### **Document structure**

2.12 In addition to the executive summary (Section 1) and this introduction (Section 2), this statement comprises:

- Section 3 – which considers issues relating to the available spectrum and its packaging;
- Section 4 – which considers the auction format and rules;
- Section 5 – which considers the technical and other conditions to be included in the wireless telegraphy licences;
- Section 6 – which sets out the next steps for this award process; and

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<sup>7</sup> <http://www.ofcom.org.uk/consult/condocs/2012olympics/responses/>



- Annex 1 – which summarises the main points made in the responses to the June consultation and January and March discussion documents.

## Section 3

# Available spectrum and its packaging

## 10 GHz

### Spectrum packaging

3.1 Ofcom's proposal in the June consultation was to offer the 2x100 MHz available in the 10 GHz band as a single UK-wide lot. Some responses suggested it would be more appropriate to offer smaller lots in order to maximise flexibility and overall efficiency of use. There was, however, no real consensus about the appropriate size of lots; for example a number of respondents suggested that two lots of 2x50 MHz be made available while another suggested five lots of 2x20 MHz.

3.2 In considering the appropriate size of smaller lots Ofcom has considered the radio systems that might operate in the band. The systems identified, and Ofcom's assumptions on what might be regarded as the smallest practicable block sizes, are as follows:

- Fixed wireless access (FWA) (PtMP)                      2x28 MHz (possibly lower)
- Backhaul (PtMP)    2x56 MHz
- Backhaul (PtP)    2x56 MHz (possibly lower)
- Programme making and special events (PMSE)                      10 MHz (digital) or 20 MHz (analogue)

These assumptions are also dependant upon the technology choice for the system (i.e. modulation order, access method, antenna characteristics etc.).

3.3 There is clearly no single block bandwidth that will cater for these various systems. Ofcom is faced, therefore, with the problem of either choosing a particular block size (or combination of block sizes) that will suit some bidders better than others, or to allow the market to determine how much spectrum is awarded to each bidder using a more sophisticated auction design.

3.4 Considering this latter option, it seems that 10 MHz is the smallest assignment that any potential user is likely to want to acquire and that demand from most likely uses could be met by contiguous aggregations of 2x10 MHz lots. For example, a backhaul provider requiring 2x56 MHz could use six contiguous lots of 2x10 MHz, leaving 2x4 MHz spare which could be used for frequency separation with adjacent users.

3.5 It would seem appropriate, therefore, to offer ten 2x10 MHz lots, provided that an auction can be devised that will allow bidders to acquire contiguous aggregations of lots. Ofcom considers that a suitable auction can be devised and proposes to package the available spectrum in this way. However, as explained in paragraph 5.7 below, in order to reduce co-ordination requirements it also intends to require each bidder to bid for at least two such lots (i.e. a minimum of 2x20MHz).

3.6 Ofcom put forward this revised proposal in the January discussion document. One respondent questioned the reason for changing the 10 GHz block size and suggested there would be an aggregation risk for those wanting 2x100 MHz. Ofcom

notes that the case made in responses to the June consultation justifies offering smaller spectrum lots in the award and that its decision to offer ten 2x10 MHz lots, with a requirement that any bid should be for at least two such lots, provides for flexible and efficient use of the band. The combinatorial clock auction will ensure that bidders wanting a package of lots in the band, including a package of 2x 100 MHz, will not face an aggregation risk.

- 3.7 This revised approach to packaging the spectrum requires consideration of whether the spectrum usage rights set out in the June consultation should be modified for spectrum blocks smaller than 2x100 MHz. This is discussed in paragraph 5.6 below.

### **Amateur radio use of the band**

- 3.8 A large number of amateur radio licensees in responses to the June consultation suggested that the proposal to award the available spectrum at 10 GHz did not take account of planned amateur satellite use and contravened internationally agreed spectrum use. Some also suggested that the proposed power levels would interfere with weak satellite signals. Ofcom believes that its auction of the spectrum 10.125-10.225 paired with 10.475-10.575 GHz is fully compliant with the international regulations which permits national administrations to make their own national decisions. The Amateur and Amateur satellite service is permitted, in the 10.450-10.500 GHz band, the top 25 MHz of which (10.475-10.500 GHz) is within the spectrum for this award. However this use is as a secondary user on a non-interference and non-protected basis. (This secondary use is identified in the UK Frequency Allocation Table 2007<sup>8</sup>.) Ofcom's proposal to auction the band for commercial use is not the first time that a primary use by commercial users has been licensed in this band (see paragraphs 6.18-6.19 of the SFR: IP). Ofcom does not consider that the maximum ERIP level which is permitted under the licence offered in the award will be used by the licensee in the majority of deployments.

### **London 2012 Olympic Games and Paralympic Games**

- 3.9 In the March discussion document Ofcom proposed that a condition might be included in the licences to be awarded that would allow Ofcom to vary the licence terms for the purpose of meeting the UK's international obligations relating to the 2012 Games. Ofcom received five responses and has placed the non-confidential responses on its website. There was a divergence of views on whether the 10 GHz band would be required for the Games and, if so, the best way of protecting use at the Games from interference caused by those obtaining licences in the award. There was also concern that if licensees were required to avoid interference to users at the Games they would be unable to optimise use of the spectrum. One particular suggestion from the Five Host Boroughs was that an East London geographic area (where majority of the Games events take place) be excluded from (at least two) spectrum lots and then made subject of a specific award for the purpose of the Games.
- 3.10 In light of the outcome of this consultation, Ofcom has decided that no condition should be included in the licences for use of the 10GHz band to be awarded under this award process.
- 3.11 Section 5 of the Communications Act provides that the Secretary of State may direct Ofcom in relation to its functions relating to the management of the radio spectrum. The Secretary of State's power extends to issuing directions to Ofcom for the

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<sup>8</sup> <http://www.ofcom.org.uk/radiocomms/isu/ukfat/>

purpose of securing compliance with international obligations of the United Kingdom. The Government has advised Ofcom that the guarantees given to the International Olympic Committee constitute international obligations of the United Kingdom.

- 3.12 It is not possible for the Secretary of State to fetter his discretion about the exercise of his power to issue directions to Ofcom relating to the management of the radio spectrum. However, neither the Government nor Ofcom expect to exercise their powers, without the consent of the licensee, to vary or revoke the licences being awarded under this award process for the purpose of meeting obligations relating to the 2012 Olympic Games.

## 28 GHz

### Satellite use of 28.0-29.5 GHz

- 3.13 In the June consultation Ofcom proposed to auction two UK lots each of 2x112 MHz and three geographically limited lots each of 2x112 MHz (the geographical coverage of each varies – see annex 9 of the June consultation). There was general support for the proposals. However, Avanti Screenmedia and Intellect suggested that it would promote further fragmentation of the band, result in lack of harmonisation at European level and undermine its exploitation for satellite broadband applications. In response to the January discussion document, along with EADS Atrium and SAPREG and ESOA, they pointed out that some satellite operators required access to 28-29.5 GHz and so needed spectrum across all five packages on offer. They suggested that there should be a mechanism for permitting FSS gateway earth stations to use the entire band on a co-primary basis via the established SES licensing process, with AIP pricing and co-ordination between FSS and terrestrial operators. It was also suggested that 28.8365-29.9485 GHz should not be auctioned and be retained for unco-ordinated FSS earth stations for consistency with European spectrum harmonisation in accordance with ECC Decision ECC/DEC/(05)01.
- 3.14 Implementation of ECC Decisions is not mandatory and, in common with many administrations, the UK has not implemented ECC/DEC/(05)01 (see the ERO website <http://www.ero.dk/documentation/docs/implement.asp?docid=2054&wd=N>). Nevertheless, Ofcom's decision on packaging the spectrum for award is consistent with the Decision. Ofcom, therefore, does not consider that its decision will further fragment the band or result in lack of European harmonisation. The licences to be awarded for the 28 GHz spectrum will be technology and service neutral and it will be open to a satellite operator to bid for the spectrum, either on its own or in a consortium with other companies. The licences will also be tradable and total or partial transfers of the spectrum rights will be possible; partial transfers could be for either geographical or spectrum partitions. Therefore, it would be possible after the award for a satellite operator to acquire rights to the spectrum from a licensee or, if it were itself a licensee, to transfer all or some of the rights in its licence to one or more operators. Ofcom considers that the flexibility provided by neutral and tradable licences will allow a satellite operator to use the auction and commercial channels to acquire rights to the spectrum that would allow it to establish earth stations in the band.
- 3.15 Ofcom nevertheless has considered the position of those operators who may already have plans to establish gateway earth stations in the UK for uplinking to a satellite that has a planned launch date. It recognises that where such operators require access to the whole 28 GHz band it may be the case that neither the auction nor the secondary market will provide them with sufficient certainty that they will be able to acquire the spectrum they require. Ofcom has explored options for addressing this

issue in ways that would also meet the requirements of both licensees and bidders in the auction for certainty on how the operation of gateway earth stations would impact on their use of the band. Ofcom has decided to adapt its existing permanent earth station licensing procedures so that applications may be made for access to the 28 GHz band that includes spectrum in that part of the band to be awarded. There is a time limit on applications so that details will be available to potential bidders in advance of the auction; Ofcom has set a closing date of 2 November for permanent earth station applications. It has also restricted applications to locations in rural areas. The permanent earth station licence will include a limit on the emissions that will give a reasonable level of protection to terrestrial users; the power flux density produced by an earth station shall not exceed  $-108.5\text{db}(W/(m^2 \cdot 1\text{MHz}))$  for more than 50% of the time produced at 6m above ground level at a distance of 6 km from the earth station. As soon as practicable after the closing date for applications Ofcom will publish on its spectrum awards website (<http://www.ofcom.org.uk/radiocomms/spectrumawards/>) the locations and other details of permanent earth stations that have been applied for or licensed. This should allow potential bidders and other users of the band to assess the potential impact of the existence of permanent earth stations on any plans they may have for developing their own services in the 28 GHz band.

### Existing Broadband Fixed Wireless Access licensees

- 3.16 THUS, which holds a number of 28 GHz broadband fixed wireless access regional licences, asked for one of the sub-national lots to be changed to offer an exact complement to its existing coverage. Apart from the question whether it would be permissible to discriminate in favour of a particular operator in this way, Ofcom does not consider it practicable to modify one of the sub-national lots to meet THUS's request, because none of those lots has individually the geographic coverage that would complement the coverage of THUS's licences.
- 3.17 Orange suggested that Ofcom should clarify whether the existing 28 GHz licensees would be able to refarm their spectrum to new uses and whether these refarming rules could then be consistently applied across all sectors. Ofcom considers that existing arrangements for the variation of licences would apply to any existing 28 GHz licensee wishing to refarm its spectrum. A licensee may submit a variation request to Ofcom and Ofcom will consider the request in accordance with its statutory duties.

### 32 GHz

- 3.18 In the June consultation Ofcom proposed six UK-wide lots, each of 2x126 MHz. There was general support for the proposal though in its response Orange considered that one lot of 2x252 MHz should be offered to avoid aggregation risk. (Orange also considered that the top one-third of the band should be retained for individually licensed fixed links.) Ofcom does not consider that the size of lots should be increased, as it is likely that the resulting lots would be too large for some bidders and this might discourage them from participating. However, Ofcom accepts that there is a degree of complementarity between lots in this band, and that under the previous auction format, bidders seeking multiple lots may have been exposed to aggregation risks. The proposed switch to a combinatorial clock auction format eliminates any aggregation risks for such bidders. Therefore, bidders seeking single 2x126 MHz lots and bidders seeking aggregations of lots should be equally able to meet their requirements.

## 40 GHz

- 3.19 In the June consultation Ofcom proposed that the award of 40 GHz should be deferred, given the apparent lack of demand. Some respondents agreed with this proposal, but a number of others considered that the band provided opportunities for new uses and to defer its award might prove a deterrent to innovation. In the January discussion document Ofcom proposed to include the band in the award. One respondent suggested that this was not justified as it had only weak support.
- 3.20 One of Ofcom's spectrum management objectives is to allow, wherever possible, spectrum to be managed by the market and where spectrum is not already in use to release it as soon as practicable. In this way the market has the opportunity to find uses for the spectrum. In the consultation Ofcom pointed out that it also had to bear in mind the resource costs of a spectrum award and if demand for the relevant spectrum did not exist incurring these costs would not be justified. The evidence available at the time of publication of the consultation document suggested that the 40 GHz band was unlikely to be used for some time. Ofcom, therefore, proposed to defer its award and to review the position within two years.
- 3.21 The interest shown in the band in responses to the June consultation suggests that the market should be given the opportunity to obtain the spectrum as soon as practicable. Ofcom considers that the most efficient way of doing this would be to include the band in the same award process as 10 GHz, 28 GHz and 32 GHz: there may be scope for substitution between 40 GHz and other bands, 32 GHz in particular, and running one award process should reduce overall costs. Ofcom proposes to split the band into six UK-wide lots of 2x250 MHz, each lot being sufficiently large to allow wideband use. Bidders will be able to aggregate lots into contiguous blocks of 2x500 MHz or more.

## Geographical coverage of licences

- 3.22 The majority of responses to the June consultation supported UK licences in all the available bands but two responses suggested that local or regional licences should also be offered. Ofcom considers that licensing on a localised or regional basis could impede efficient use of the spectrum and increase co-ordination requirements. Moreover, there is not a clear basis for determining suitable geographical divisions.

## Section 4

# Auction Format and Rules

- 4.1 In the June consultation Ofcom discussed the issues for auction design and choices of auction format. The key features of the proposed auction were:
- The auction would be a simple simultaneous multi-round auction (SMRA);
  - The winning bidders would be those who submitted the highest bids for each licence;
  - The winning bidders for each licence would pay the amount bid for the licence, or the minimum bid price if there are no other valid bids;
  - There would be specific rules to prohibit collusion and bidder association;
  - The auction would be fully transparent. Comprehensive information about the number, amount and type of bids on each lot would be released after each round. In addition, bidders would be able to monitor the identity of all other bidders and the bids they make;
  - A minimum bid of £50,000 would be set for each licence;
  - Activity and eligibility rules would help manage the pace of the auction and ensure each bidder participates fully;
  - Bidders would be required to submit an initial deposit of £25,000 for each spectrum lot;
  - Winning bidders would be required to pay 100% of the fee by the date set in the Regulations before the licence would be issued;
  - If licences remained unsold, either through absence of bids or default, Ofcom would reconsider its approach to release of the spectrum, and would choose whatever course of action it considered appropriate at that time.
- 4.2 Responses to this proposal on auction design, apart from those from amateur radio licensees who opposed the award of 10 GHz, were largely in favour, though there were some comments of detail. Orange suggested that auction design (and spectrum packaging) should ensure that aggregation risk to bidders was minimised as far as possible. BBC suggested a pre-bid (or initial first round) phase for any 10 GHz lots. On-Communications suggested that bidders should be restricted to three of the twelve proposed packages. Orange were concerned about lack of visibility regarding dispute resolution and auction rules, which they felt needed to be clarified as part of a future consultation on auction design.
- 4.3 In the light of these comments and the revised proposals for packaging 10 GHz and concerns about the packaging of 32 GHz, Ofcom considered it necessary to review the most appropriate auction design. The simple SMRA, which was proposed in the June consultation, is very effective in addressing substitution risks between lots but it is much weaker at addressing aggregation risks across lots than alternative formats that would allow for combinatorial (package) bidding. Ofcom considered that, with the revised spectrum packaging, the simple SMRA was no longer the most appropriate auction format. In the January discussion document it set out proposals for a

combinatorial clock auction and presented these proposals at a seminar on 30 January<sup>9</sup>.

4.4 Some responses to January discussion document supported the revised auction proposal. However, one respondent suggested that generic lots were not suitable and made the auction more complicated. It also asked Ofcom to publish the auction design advice it had received. On the latter point, the advice Ofcom has received on the auction design is reflected in section 6 and annex 2 of the January discussion document.

4.5 On the question of generic lots and auction complexity, an important consideration has been the efficiency with which the auction addresses substitutability and complementarity between lots. Where lots are substitutes or complements, auction design is important in helping bidders to switch demand between lots and manage aggregation risks across lots, so as to ensure an efficient outcome. In this award bidders are likely to view the available lots, both within and across bands as substitutes and/or complements. In particular:

- PMSE bidders are likely to view lots within the 10 GHz band as substitutes;
- Bidders wishing to deploy backhaul or national fixed wireless applications are likely to view lots in the 10 GHz, 28 GHz and 32 GHz bands as substitutes.
- For wideband use, lots at 32 GHz and 40 GHz may be substitutes.

In addition, in all four bands there may be (in-band) complementarities between lots, as some bidders are likely to want contiguous spectrum endowments in excess of those available in single lots. This is likely to be a particular issue in the 10 GHz band in the light of our revised proposal to package the spectrum as 10 lots of 2x10 MHz and in the 32 GHz band, where one operator has expressed an interest in packages of 2x252 MHz.

4.6 In order to cater for these bidders' requirements the auction needs to allow bidding for packages of lots. A simple SMRA, which entails bidding on discrete lots, does not adequately address the aggregation risk that arises where a bidder requires complementary lots. An SMRA with package bidding may become very complex if bidding on the full range of possible packages is permitted. Even if bidding in the auction were restricted to packages of contiguous lots there would still be a large number of possible package bids that could be made in each round of the auction. Adopting a combinatorial clock auction avoids the complexity of an SMRA with package bidding. This is examined further in paragraphs 4.23-4.26 below.

4.7 One respondent to the January discussion document asked Ofcom to provide worked examples of the combinatorial clock auction, particularly on 'best and final offers' and the calculation of 'base prices'. There were also some detailed questions about the auction format and rules raised at the seminar. The Information Memorandum and Notice being published in parallel with this Statement contains further information on the auction process and the auction regulations set out the rules in detail. Ofcom is planning to hold a number of events that will allow interested parties to familiarise themselves with the auction design and procedures.

4.8 Ofcom is also proposing to award spectrum in the 2.6 GHz band and the 1452-1492 MHz band by means of combinatorial clock auctions. It set out its proposals for the

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<sup>9</sup> For the presentation see [http://www.ofcom.org.uk/radiocomms/spectrumawards/awardspending/award\\_10\\_40/slides300107.pdf](http://www.ofcom.org.uk/radiocomms/spectrumawards/awardspending/award_10_40/slides300107.pdf)



2.6 GHz band in a consultation document published on 11 December 2006<sup>10</sup>. Some responses to the proposals raised general questions about the auction design<sup>11</sup> and Ofcom has taken account of these in its consideration of the auction design for this award. A summary of the responses is included in annex 1. Ofcom published on 25 July 2007 a consultation document<sup>12</sup> on the 1452-1492 MHz band that, among other things, explained how it proposed to adapt the combinatorial clock auction design for the award of that band.

## Comparison of combinatorial clock auction and simple SMRA

4.9 In considering the consequences for auction design of changes to packaging of lots in the 10 GHz band and concerns about aggregation risks, Ofcom has compared how the simple SMRA and combinatorial clock auctions deal with key issues that need to be addressed in auction design:

- Common value uncertainty
- Aggregation risk
- Threshold problem
- Complexity
- Strategic bidding
- Strategic demand reduction
- Weak competition
- Unsold lots

## Common value uncertainty

4.10 Ofcom considers that there is likely to be common value uncertainty in this auction. This is because some bidders are likely to want to use this spectrum to provide similar services to common markets. Under these conditions, bidders may benefit from being able to observe how other bidders' demand changes in response to prices. The efficiency of the auction should be improved if bidders are able to observe the behaviour of other bidders over the course of multiple rounds (subject to concerns about not facilitating collusion), relative to participating in a single round sealed bid process.

4.11 Both the simple SMRA and the combinatorial clock auction are open multi-round processes, so both formats offer benefits in terms of reducing common value uncertainty.

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<sup>10</sup> <http://www.ofcom.org.uk/consult/condocs/2ghzawards/>

<sup>11</sup> <http://www.ofcom.org.uk/consult/condocs/2ghzawards/responses/>

<sup>12</sup> [http://www.ofcom.org.uk/consult/condocs/1452\\_1492/1452\\_1492.pdf](http://www.ofcom.org.uk/consult/condocs/1452_1492/1452_1492.pdf)

## Aggregation risk

- 4.12 Aggregation risks are a significant concern in this award. For some bidders, the value that they place on acquiring bundles of lots will be higher than the sum of the values of the individual lots, owing to synergies between lots. Moreover, some bidders are likely to have minimum requirements for spectrum within bands which can only be met by acquiring multiple lots within the same band, most likely on a contiguous basis. Under any auction format where bidding takes place on individual lots such bidders will be exposed to aggregation risks.
- 4.13 Aggregation risks are generally considered undesirable as they discourage bidders from bidding their true value for available spectrum. In the worst case bidders may not even participate in the auction owing to the risk that they might win only a subset of the lots they require which would be insufficient to provide services. This may undermine the efficiency of the auction outcome, as bidders with lower value for the available spectrum may instead be successful in the auction.

### Aggregation risk: simple SMRA

- 4.14 The simple SMRA is not effective at addressing aggregation risks. Bidders have some flexibility to monitor the likelihood of their winning particular bundles of lots over multiple rounds. However, this flexibility diminishes towards the end of the auction, as it can be difficult for bidders to reduce the number of lots on which they are bidding and to exit the auction without winning any lots at all.
- 4.15 Aggregation risks can be diminished by packaging spectrum into larger bundles that reflect the requirements of bidders. In the June consultation, using the proposed packaging and a simple SMRA format, Ofcom judged that the aggregation risks bidders would be exposed to were sufficiently modest that they would be unlikely to compromise the efficiency of the award outcome. However, the consultation responses produced new information about bidder requirements and prompted Ofcom to change the spectrum packaging. Taken together, these suggest that aggregation risks for some bidders may be substantial:
- i) At least one respondent to the consultation expressed interest in purchasing two complementary lots in the same frequency band under the previous packaging approach.
  - ii) The division of the 10 GHz band into ten lots of 2x10 MHz will mean that many bidders for this spectrum will likely have demand for multiple contiguous lots.
- 4.16 Ofcom considers that a simple SMRA may not adequately alleviate these aggregation risks. Therefore, there is a strong case for allowing bidders to submit bids for packages of lots, rather than only bidding separately on individual lots. However, integrating package bidding into a standard SMRA format is problematic, as it places onerous requirements on bidders to determine bids for a number of mutually exclusive bid options in each round and requires the auctioneer to run complex pricing algorithms each round to determine individual lot prices.

### Aggregation risk: combinatorial clock auction

- 4.17 The combinatorial clock auction proposed here brings together the simplicity of a clock auction with the superior efficiency properties of a combinatorial SMRA when some bidders consider lots to be complements. As with a combinatorial SMRA, the use of package bidding eliminates aggregation risks. However, onerous requirements

on bidders to make extensive bids in each round are diminished and the approach to determining clock prices for lots over multiple rounds is straightforward.

- 4.18 All package bids are mutually exclusive. It is not possible for a bidder to win only part of a package on which it bids; bids stand or fall in their entirety. Therefore, bidders can fully express the value of synergies between lots and are never exposed to being stranded with lots that they do not want.

### Threshold problem

- 4.19 One downside of package bidding is that facilitating aggregation for larger bidders may introduce a 'threshold problem'. This occurs where small bidders (wanting few lots) find it difficult to concert their bidding in a way capable of displacing larger bidders (wanting to aggregate many lots), even though the small bidders' collective valuation may be higher.
- 4.20 In any auction with package bidding, such as the combinatorial clock auction, the question arises whether individual small bidders will have sufficient incentives to raise bids to levels where they collectively displace aggregating bidders. There may be a free-rider problem in that if one or more small bidders raise their bids this may benefit all small bidders by displacing the package bidder. This means that a small bidder will have an incentive not to raise its bid even though it may have a higher value on the lots it wants to win. This could result in inefficiency if the combined value of small bidders exceeds that of the package bidder. However, this problem needs to be balanced against the potentially severe aggregation risks that may be faced by the large bidder.
- 4.21 Ofcom considers that the benefits from mitigating aggregation risks created by using a combinatorial clock format for this award significantly outweigh any costs related to increased threshold risks.

### Complexity

- 4.22 Other things being equal, simpler auctions are preferable from both the perspective of bidders and Ofcom. For bidders, the more straightforward and transparent the auction is, the more likely they are to develop an efficient bidding strategy, and the less likely they are to make mistakes. Simpler auctions may also reduce participation costs for bidders and administrative costs for Ofcom.
- 4.23 One of the main attractions of the simple SMRA is that it is relatively straightforward to implement and easy for bidders to understand. However, in auctions where there are many lots an SMRA with package bidding may become very complex if bidding on the full range of possible packages is permitted. Even if bidding in the auction were restricted to packages of contiguous lots there would still be a large number of possible package bids that could be made in each round of the auction.
- 4.24 Adopting a combinatorial clock auction avoids the complexity of an SMRA with package bidding. First, by using generic lots the number of possible packages that can be bid on in the clock stage is significantly reduced. Second, bidders are only required to make one bid each round for their most preferred package of lots, and they may bid for other packages in the supplementary bids round. Third, prices are set round-by-round using a simple and transparent process.
- 4.25 The combinatorial clock auction is also strategically simple for bidders. In a simple SMRA bidders must condition their bids to manage aggregation risks and this can

lead them to bid less than their true value and/or avoid bidding on lots where the risk of being stranded without complementary lots is greatest. Furthermore, as only the highest bids on specific lots are ultimately binding there may be strong incentives for strategic bidding (see below). By contrast, there are strong incentives for straightforward bidding with the combinatorial clock format, as any bid submitted in any round could potentially become a winning bid.

### Strategic bidding

- 4.26 Depending on the structure of supply and demand for lots, SMRAs may be vulnerable to strategic behaviour which can distort the auction outcome and reduce efficiency. Examples of strategic behaviour which have affected previous spectrum awards that used an SMRA format include:
- i) Code bidding / signalling – using bid amounts to signal bidding intentions to other bidders for the purposes of tacit collusion;
  - ii) Price manipulation – deliberately bidding up the price of specific lots with the aim of disadvantaging competitors with less flexible bid strategies;
  - iii) Punishment – encouraging other bidders to withdraw demand for specific lots by threatening to drive up the price of other lots that they also want;
  - iv) Parking – bidding on lots which the bidder ultimately does not want, so as to retain eligibility to switch demand to other lots. Bidders may do this for two reasons: to keep the prices on desired lots from increasing too quickly and to maintain the flexibility to punish competitors.
- 4.27 The simple SMRA, especially if augmented with rules that permit bid withdrawals or switching so as to mitigate aggregation risks, may be particularly vulnerable to strategic bidding.
- 4.28 The combinatorial clock format should be less vulnerable to strategic manipulation than the simple SMRA. As all bids are potentially binding the strategic incentive to bid on unwanted lots during intermediate rounds of the auction is largely eliminated.

### Strategic demand reduction

- 4.29 SMRAs are potentially vulnerable to strategic demand reduction. Specifically, bidders may be tempted to reduce their demand in the auction with the objective of achieving a lower price per lot than would be possible if they bid strictly on the basis of their valuation. This may reduce the efficiency of the auction outcome.
- 4.30 Strategic demand reduction is most likely to be a problem in auctions where there are a few bidders seeking many lots and demand is not greatly in excess of supply. Such a scenario appears possible for this award. It is relevant to both the simple SMRA and combinatorial clock auction formats. However, clock auctions may be more vulnerable to strategic demand reduction, as with uniform pricing of lots there is a more direct relationship between reducing demand and the price paid.
- 4.31 Nevertheless, Ofcom does not consider the risks associated with strategic demand reduction to be sufficient to suggest not using a combinatorial clock auction. Incentives for strategic demand reduction are largest for those wanting most lots, so this may work to reduce concentration in downstream markets for goods and services. Clearly this is only relevant where winners are likely to compete in the same economic markets but this appears possible for these bands. Although strategic demand reduction may be poor for efficiency in the narrow sense of allocation within

the auction relative to the valuations of bidders, it may be good for efficiency in the wider sense of reducing any incentives to concentrate lots to gain downstream market power. Where bidders are downstream competitors the overall impact of strategic demand reduction on consumer welfare is ambiguous.

- 4.32 It is also difficult for bidders to predict what the effect of reducing demand will be on the price paid, as this may not necessarily be determined solely by the outcome of the clock auction but rather by optimising over all bids received in the course of the auction in the supplementary bids stage.
- 4.33 In the event that the award is competitive, this will anyway tend to reduce the incentive for strategic demand reduction, as winners are unlikely to receive a large proportion of the available lots. Even if the award is not particularly competitive there may be opportunity to reduce incentives for strategic demand reduction by ending the clock stage early and allowing for a greater role for supplementary bids (see discussion of weak competition below).

### Weak competition

- 4.34 SMRA formats may be vulnerable to weak competition, either as a result of bidder asymmetries (which discourage perceived weaker bidders from participating) or 'demand fixing' where bidders co-ordinate prior to the auction in an attempt to eliminate excess demand and thus achieve low prices. Bidder asymmetries are not obviously a concern for this auction: there is no particular reason to expect that there will be some bidders who are anticipated to be systematically stronger and more likely to win than others. However, there is uncertainty over the level of demand.
- 4.35 Both the simple SMRA and combinatorial clock auctions are potentially vulnerable to demand fixing. In both cases, measures to restrict transparency – such as hiding the number or names of applicants – may help to prevent coordination. Alternatively, the combinatorial clock auction could be terminated early (i.e. before demand is reduced to less than equal supply) and concluded with a combinatorial sealed bid round with relaxed activity rules. Ofcom has included rules in the draft auction regulations to address the potential for demand fixing. In the primary bid (clock) stage of the auction it will release at the end of each round only aggregate information on bids in each band, without identifying bids by particular bidders. Also, Ofcom will be able to terminate this stage early and proceed to the supplementary bid stage.

### Unsold lots

- 4.36 Unsold lots are only a concern if they occur because bidders have been unable or unwilling to express the full value of their demand for different packages of lots, owing to spectrum packaging or auction design. If unsold lots occur purely as a result of lack of market demand this is an unavoidable outcome and does not affect the efficiency of the award.
- 4.37 A simple clock auction would not be a good mechanism for awarding this spectrum as there would be a significant risk of unsold lots, despite there being potential demand for them. Trying to apply a uniform price for all lots of a given category may lead to unsold lots if demand drops below supply at the end of the clock auction. This may result in an inefficient allocation. For example, there might be individual bidders willing to buy the unsold lots at less than the final clock price. More generally, it might be possible to package unsold lots with additional lots and allocate these packages to bidders with a greater willingness to pay for the package than the opportunity cost to other bidders.

- 4.38 The combinatorial clock format can eliminate the problem of inefficiently unsold lots through the supplementary bids stage. This stage allows bidders to express their preferences for many different packages. The supplementary bids are considered to see if there might be a more efficient allocation of the available spectrum that allocates more lots than were bid for in the final round of the clock stage.

### **Conclusions on the comparison of combinatorial clock auction and simple SMRA**

- 4.39 The combinatorial clock auction brings together the simplicity of a clock auction with the superior efficiency properties of a combinatorial SMRA when some bidders consider lots to be complements. With this format much of the benefit of a combinatorial SMRA can be achieved without onerous requirements on bidders to make extensive bids, or the need to run complex pricing algorithms each round. Taking this into account and the points arising from the comparison of the two auction designs Ofcom has decided that a combinatorial clock auction should be used for this award. In the draft regulations it has introduced rules that restrict transparency and allow the early termination of the clock stage, both of which address the questions of strategic demand reduction and weak competition discussed above.

### **Spectrum cap**

- 4.40 One response to the consultation - from On-Communications Ltd - raised concerns about competition and suggested capping bidders.
- 4.41 In the June consultation document Ofcom said that it did not believe that there were significant competition concerns in relation to the award. This reflected the advice of its market consultants, who did not see a need for imposing a spectrum cap on any or all of the bands. Ofcom recognises that in light of the identified demand there is a low probability that all the available spectrum would be won by one party. However, if there were a number of licensees in the spectrum bands this could benefit other spectrum users and consumers through the availability of a wider choice of service providers. Ofcom therefore considers that it would be prudent to impose a spectrum cap for each participant in the award, but that the cap should not be set so low that it would prevent bidders from acquiring sufficient spectrum to support the efficient provision of services. Ofcom has looked at two possible approaches: (i) limiting the number of lots obtainable in each of the bands or (ii) limiting the total number of lots obtainable.
- 4.42 On (i) Ofcom recognises that there is interest in using 10 MHz for FWA and backhaul and that both uses are likely to require the whole band. Setting a cap on the number of lots obtainable in the band would work against this. It is also possible that satellite earth station operators who wish to gain access to the whole 28-29.5 GHz band might seek to obtain access through the auction to that part being awarded. To do so they would need to be able to bid for all five 28 GHz lots. Ofcom would not want to impose a limitation that would prevent them doing this. Ofcom has therefore concentrated on option (ii). A limitation on the total number of lots that could be bid for would prevent a single bidder obtaining all the spectrum, without necessarily limiting what a bidder could obtain in a particular band. The mechanism for doing this would be a limit on the number of eligibility points for each bidder.
- 4.43 The total number of eligibility points for all 27 spectrum lots being awarded in the seven national and 28 GHz sub-national bands is 82. There are significant differences in the characteristics of different bands, in terms of propagation, available

bandwidth and, in relation to the 28 GHz band, geographic coverage and so Ofcom considers that bidders should be able to bid for a package of bands. An appropriate cap would be one that allowed a bidder to obtain spectrum in each of the bands (including all of 10 GHz) while preventing a bidder from obtaining all of the national spectrum in both 28 GHz and 32 GHz, which are the two bands which, for some applications, are the closest substitutes for each other.

- 4.44 In order to obtain all of the national lots in the two bands a bidder would need 48 eligibility points. A cap therefore needs to be lower than this figure. Ofcom considers that a cap of 42 eligibility points would be appropriate. A cap of 42 would allow a bidder to obtain a substantial amount of spectrum in any or each of the spectrum bands. Ofcom considers that this would provide sufficient spectrum to support the requirements of the operators that have shown an interest in using this spectrum.

## Section 5

# Wireless telegraphy licence conditions and other spectrum rights and obligations

5.1 In section 7 and annex 6 of the June consultation, Ofcom set out its proposals for the transmission rights and regulatory conditions that would be contained in licences for the spectrum bands.

### Technical conditions

5.2 The main technical conditions were as follows:

- The spectrum mask proposed for 10 GHz, 28 GHz and 32 GHz was defined by the points listed in the table below, with linear interpolation between them.

Frequency Offset from edge of block	Maximum permitted EIRP level
in block other than that defined below	55 dBW (in any measured bandwidth)
-14 MHz of block edge	30 dBW/MHz
Block edge when arrived at from in-block	11 dBW/MHz
Block edge when moving out-of-block	-39 dBW/MHz
+14 MHz of block edge	-52 dBW/MHz
Where; - = in-block + = out-of-block linear interpolation between points	

\* with slightly amended rights for the use of satellite uplinks in the 28 GHz band

5.3 In the January discussion document Ofcom reviewed the above mask in view of the revised proposal to include the 40 GHz spectrum in the auction. Ofcom concluded that the above spectrum mask would be appropriate for 40 GHz.

### 10 GHz blocks

5.4 The spectrum mask proposed in the June consultation defined the permitted in-block and out-of-block emission limits for a licensee holding all the available 2x100 MHz in the 10 GHz band. Since Ofcom's revised proposal was to package the available 10 GHz spectrum as ten lots of 2x10 MHz, the January discussion document therefore considered what additional boundary conditions should apply between blocks in this band.

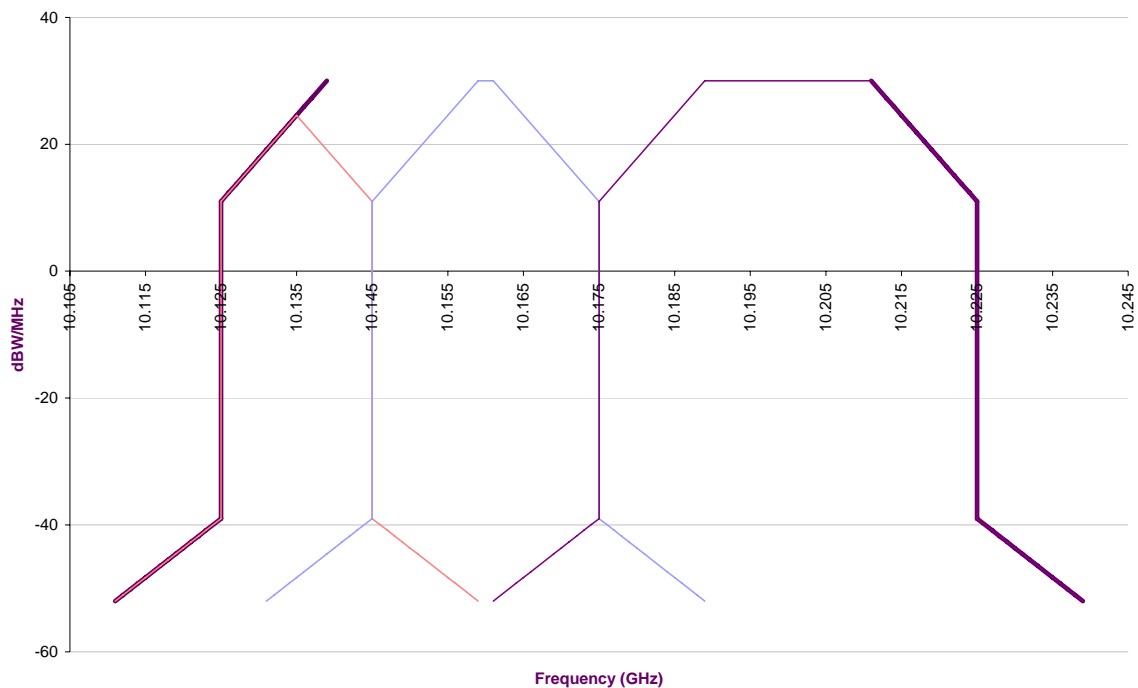
5.5 The January discussion document explained that the 2x10 MHz lots proposed for the band are designed to allow aggregation into what bidders may consider desirable paired blocks, for example, 2x30 MHz, 2x50 MHz, 2x60 MHz or 2x100 MHz. Where blocks of 2x20 MHz or more are obtained in the auction the previously proposed mask remained appropriate, though for a block of 2x20 MHz permitted in-band eirp



would be no more than 24.6 dBW/MHz, and even only then at the very centre of the block.

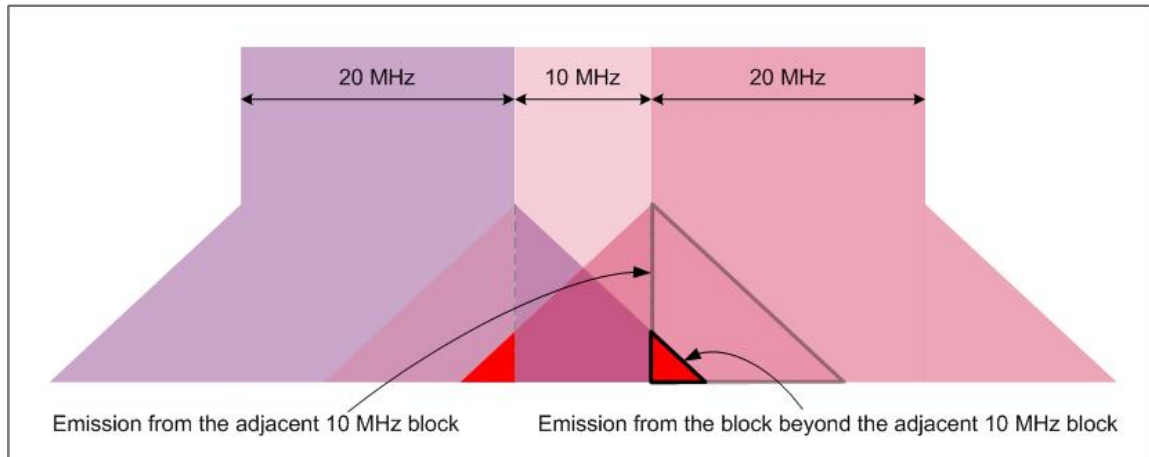
- 5.6 Figure X illustrated how the spectrum mask would apply to blocks of various sizes, i.e. 20 MHz, 30 MHz and 50 MHz or 100 MHz. For blocks of 20 MHz the eirp will be constrained by the mask across the entire block, with the maximum permitted eirp being 24.6 dBW/MHz at the centre of the block, falling to 11 dBW/MHz at the block edges.

**Figure X**



- 5.7 The effect of applying the mask to blocks adjacent to a 10 MHz block was illustrated in figure Y. There is an overlap in emissions from each such block not only into the 10 MHz block but also into the block beyond. This applies on both sides of the 10 MHz block, so that each adjacent block might receive out-of-block emissions both from its neighbouring 10 MHz block and from the block beyond that. This could necessitate co-ordination with two operators rather than just one. In order to avoid this possibility Ofcom proposed to set 2x20 MHz as the minimum amount of spectrum for which bids will be accepted.

Figure Y



Note: the size of the adjacent blocks does not affect the situation. 20 MHz blocks are shown to give a sense of scale.

### Radio amateur use in 10 GHz

- 5.8 A large number of responses were received to the June consultation from radio amateurs and their clubs and associations which expressed concern that the proposed power levels for the award spectrum would have a serious impact upon weak amateur satellite signals. The Amateur and Amateur satellite service is permitted, in the 10.450-10.500 GHz band, the top 25 MHz of which (10.475-10.500 GHz) is within the spectrum for this award and is limited to the Amateur Satellite Service only. However, Amateur use is as a secondary user on a non-interference and non-protected basis. Ofcom does not believe that the maximum EIRP level which is permitted under the licence offered in the award will be used by the licensee in the majority of deployments. Additionally, the directional properties of the antennas used in deployments will further reduce occurrence of potential interference.
- 5.9 BT asked for more information on the risk of interference from radio amateurs in the 10 GHz band. As stated in 5.8, the spectrum between 10.475-10.500 GHz is permitted to be used by the Amateur Satellite Service on a secondary basis. In the UK, of the Radio Amateurs currently licensed, it is likely that only a percentage of them will make use of the 10.475-10.500 GHz band. This is further qualified by the information publicly available, which seems to indicate that the Amateur community currently make use of this band in the Space to earth direction. Ofcom is not proposing to change the UK Amateur allocation status in the 10.475-10.500 GHz band. The secondary status of the Amateur use means that it is the responsibility of the Amateur Radio licensee to ensure that they do not cause interference to other primary users (the licensee under this award). Any breach of those conditions would put them outside the terms of their licence and this could result in enforcement action being taken.

### Block edge mask

- 5.10 One response to the January discussion document commented on the proposed block edge mask that will be applied to all bands under the award. The response noted that whilst the proposed mask appeared to be valid for some deployments it may limit some systems under certain circumstances. In conclusion the response noted that following the award, operators should be able to discuss a relaxation of the mask where the operators will have better knowledge of the systems that they will

deploy. Ofcom has modified the technical licence conditions so that where narrow beamwidth antennas are used out of block emissions may be increased by 20 dB. In addition, where spectrally adjacent operators agree between themselves they should have the opportunity to liberalise their spectrum rights to better suit their individual requirements. Ofcom published a consultation document in 2005 which gave details on how licensees would be able to action liberalisation requests<sup>13</sup>. Therefore Ofcom does not see the need to alter the spectrum mask as originally proposed.

### **Co-ordination in 28 GHz and 32 GHz**

- 5.11 One response asked for more information on co-frequency and adjacent band issues in the 28 GHz and 32 GHz band. Ofcom considers that it has provided sufficient information in the Information Memorandum to enable prospective licensees to make their own compatibility assessment using their own deployment strategies. Also, operators should manage the co-ordination environment where they consider that there is a need for management of duplex arrangements in the frequency blocks.

### **Regulatory conditions**

- 5.12 A confidential respondent suggested that the minimum licence term of 15 years may need to be extended. Ofcom considers that the proposed minimum licence term of 15 years is appropriate. To determine the length of the minimum term, Ofcom considered the relevant period that provides a reasonable chance for the businesses that might be most likely to operate in the bands to make a return on their investment.

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<sup>13</sup> <http://www.ofcom.org.uk/consult/condocs/liberalisation/>

## Section 6

# Next steps

- 6.1 Ofcom intends to hold this award as soon as possible. The key next step in the award process is for Ofcom to make the statutory instrument which sets out the auction rules. A draft of these regulations is one of the documents published alongside this statement; it is subject to a statutory consultation period of at least one month. After the closing date for responses to this statutory consultation, Ofcom will consider responses and assess whether it should amend the proposed regulations. It will then make the regulations and they will come into force on the date specified in them, which is likely to be about one month after the date they are made.
- 6.2 The timing cannot be finalised before the statutory consultations have closed and Ofcom has considered responses. Subject to this, Ofcom expects the auction regulations to be in force by a date that would allow the auction process to start in late 2007 or early 2008. An indicative timeline for the process from the application date is set out in Section 4 of the Information Memorandum. This may be updated nearer the time.

## Further events

- 6.3 Ofcom is planning to hold a number of events that will allow interested parties to familiarise themselves with the auction design and procedures. These will include a seminar, to be held before the Regulations are made, to explain the auction rules and to demonstrate the Electronic Auction System. Ofcom will also hold test auctions for applicants who qualify as bidders in the auction.

## Annex 1

# Summary of responses to the June 2006 consultation and January and March 2007 discussion documents

A1.1 Ofcom received 44 responses to the June consultation. The table below sets out a summary of the responses and Ofcom's view of the main points raised.

Issue raised	Comments	Ofcom's response
<b>10 GHz</b>		
Spectrum packaging	<p>The BBC and Intellect suggested that the spectrum be packaged in smaller lots such as two lots of 2x50 MHz. The BBC also suggested five lots of 2x20 MHz or multiple lots of varying sizes.</p> <p>Orange suggested two separate unpaired 100 MHz lots.</p> <p>The Radio Society of Great Britain nominally preferred that the spectrum be offered in smaller lots (e.g. 50 MHz blocks).</p>	<p>After careful consideration of the responses Ofcom proposes to offer the spectrum as ten 2x10 MHz lots with the requirement that each bidder must bid for a least two such lots (i.e. 2x20 MHz (see section 3 paragraphs 3.1 to 3.6 of this Statement)).</p>
Radio Amateurs' concerns	<p>A large number of responses received from radio amateurs and their clubs/associations expressed concern that the proposed power levels would have a serious adverse effect on weak satellite signals.</p>	<p>The Amateur and Amateur satellite service is permitted, in the 10.450-10.500 GHz band, the top 25 MHz of which (10.475-10.500 GHz) is within the spectrum for this award. However, this use is as a secondary user on a non-interference and non-protected basis. (This secondary use is identified in the UK Frequency Allocation Table 2007.) Ofcom's proposal to auction the band for commercial use is the not the first time that a primary use by commercial users has been licensed in this band. Ofcom does not consider that the maximum ERIP level which is permitted under the licence offered in the award will be used by the licensee in the majority of deployments.</p>
	<p>A large number of the responses received from radio amateurs and their clubs/associations expressed concern that the proposals contravene the</p>	<p>Ofcom believes that its auction of the spectrum 10.125-10.225 paired with 10.475-10.575 GHz is fully compliant with the international regulations, which permit national administrations to make their own decisions.</p>

	international regulatory position regarding frequency allocations.	
MOD use	BT, MLL Telecom, On-Communications and a confidential respondent felt that further information needed to be available about the MOD's current and future use of the 10 GHz band in order to evaluate potential interference.	Ofcom has provided information on MOD current and future use of this band in the information memorandum (to the extent that security considerations allow).
Status	Intellect asked for clarification of whether the new proposed 10 GHz licensee(s) would have equal primary status with MOD or be secondary users.	The band 9.5-10.5 GHz is managed by the MOD and an agreement with the MOD allows civil use within it. The arrangements that apply to the shared use of the band are detailed with the information memorandum
Interference from radio amateurs	BT asked for more information on the risk of interference from radio amateurs in the 10 GHz band.	Ofcom has provided information on amateur use of this band in the information memorandum.
Interference to satellite dishes	Mr A Watt questioned whether there was a potential for interference into BSkyB satellite dishes.	Ofcom does not believe that there will be significant interference potential from the users of this band to domestic satellite reception.
Radar level gauges	A confidential response suggested that the future regulatory status of low power radar level gauges in the 10 GHz band needs to be defined.	Ofcom has provided information on low power radar gauges in the information memorandum.
<b>28 GHz</b>		
Spectrum packaging	<p>THUS suggested that it would be helpful if one of the three partial UK packages could be an exact 'fit' around the regions it already holds.</p> <p>BAA asked that spectrum be awarded in local packages wherever possible.</p>	<p>Ofcom does not consider it practical to modify one of the geographically limited lots to meet THUS's request. Additionally, to favour one particular operator in such a way might give rise to the question of discrimination.</p> <p>Ofcom's consultants found a limited interest in regional licences and a greater preference shown for UK wide licences. (Paragraphs 5.17-5.23 of the June consultation refer).</p>
Earth station uplink licensing	Avanti Screenmedia and Intellect felt that the Ofcom proposals would promote further fragmentation of the 28 GHz band. Intellect asked for clarification of the status of and arrangements for earth station uplink licensing re Ofcom's proposals.	The proposals with regard to the 28 GHz band are consistent with Decision ECC/DEC(05)01 and those wishing to use the available spectrum for satellite operations may participate in the award. Nevertheless, Ofcom has decided to adapt its existing permanent earth station licensing procedures so that applications may be made for access to the 28 GHz band that includes spectrum in that part of the band to be awarded. However, there will be a time limit on applications so that details will be available to potential bidders in advance of the auction;

		Ofcom has set a closing date of 2 November 2007 for permanent earth station applications.
Harmonisation	SAP REG suggested that Ofcom retain 28.8365 – 28.9485 GHz for uncoordinated FSS use. If it is awarded for FS use this will result in a lack of harmonisation at European level.	Ofcom proposes to auction this spectrum on a technology and service neutral basis. Ofcom does not believe that, in practice, harmonisation is driven by regulatory decisions alone and the market is therefore being given the opportunity to make the decision as to which technology and service the spectrum can be most successfully used for.
Existing 28 GHz licences	Orange felt that Ofcom should clarify whether the existing 28 GHz licensees would be able to refarm their spectrum to new uses and whether these refarming rules could then be consistently applied across all sectors.	A licensee of an existing 28 GHz BFWA licence wishing to vary its licence (either technical or non-technical terms) may submit a variation request to Ofcom and Ofcom will consider the request in accordance with its statutory duties.
Co-frequency and adjacent band sharing issues	A confidential response suggested that Ofcom should provide more information on potential co-frequency and band sharing issues.	Ofcom believes that it has provided sufficient information in the information memorandum to enable prospective licensees to make their own compatibility assessment, taking account of their own deployment strategies.
Co-ordination	T-Mobile had concerns regarding co-ordination processes.	Ofcom believes that industry should manage the co-ordination environment where it considers that there is a need for duplex arrangements of frequency blocks.
Potential demand for spectrum	THUS were uncertain whether there will be any significant commercial demand for 28 GHz spectrum.	Ofcom's consultants found that there was commercial interest in the release of spectrum in the 28 GHz band. (Paragraphs 5.17-5.23 of the June consultation refer)
<b>32 GHz</b>		
Spectrum packaging	Orange suggested: One licence of 2x252 MHz (service and technology neutral). Two licences of 2x126 MHz (service and technology neutral). Two licences of 2x252 MHz (individual point to point links).	Ofcom does not consider that the size of lots should be increased, as it is likely that the resulting lots would be too large for some bidders and this might discourage them from participating. However, Ofcom accepts that there is a degree of complementarity between lots in this band and that under the previous auction format bidders seeking multiple lots might have been exposed to aggregation risks. The proposed switch to a combinatorial clock auction format eliminates any aggregation risks for such bidders. Therefore, bidders seeking single 2x126 MHz lots and bidders seeking aggregations of lots should be equally able to meet their requirements.
Point to point links	Orange felt that 32.319-32.571 GHz paired with 33.131-33.383 GHz should be retained for individual	Ofcom considers that sufficient alternative spectrum is available to meet current and future requirements for point-to-point links.

	<p>licensed point to point links.</p> <p>T-Mobile suggested that one or two 126 MHz blocks be retained for point to point links.</p>	
Potential demand for spectrum	THUS were uncertain whether there will be any significant commercial demand for 32 GHz spectrum.	It is Ofcom understanding that there is a commercial interest in the release of spectrum in the 32 GHz band which was confirmed by Ofcom's consultants.
Co-frequency and adjacent band sharing issues	A confidential response suggested that Ofcom should provide more information on potential co-frequency and band sharing issues.	Ofcom believes that it has provided sufficient information in the information memorandum to enable prospective licensees to make their own compatibility assessment using their own deployment strategies.
<b>40 GHz</b>		
Release of band	<p>BAA felt that the release of the band should not be deferred and it should be awarded under Light Licensing conditions.</p> <p>BT felt that that 40 GHz should be awarded as part of the 10/28/32 GHz process. If this was not possible they suggested making the spectrum available on an administratively priced basis.</p> <p>Intellect suggested that to defer release may deter innovation.</p> <p>On-Communications felt that demand may require the proposed two year deferral period to be accelerated.</p> <p>The Radio Society of Great Britain suggested that long term, easy access could be organised for Amateur and T &amp; D users.</p> <p>A confidential respondent felt that to release spectrum onto the market without evidence of demand could lead to inefficient use of spectrum and fragmentation of bands.</p>	<p>In response to the June consultation a number of respondents expressed an interest in acquiring spectrum in the 40 GHz band. One of Ofcom's spectrum management objectives is to allow, wherever possible, spectrum to be managed by the market and where spectrum is not already in use to release it as soon as practicable. Ofcom therefore considers that the spectrum in the 40 GHz band should be released and the most efficient way of doing this would be to include the band in the same award process as 10 GHz, 28 GHz and 32 GHz.</p>
<b>General</b>		
Auction design	On-Communications suggested that bidders be	Ofcom is setting a limit on the number of lots for which any one bidder may bid. The



	<p>restricted to three of the twelve proposed packages.</p> <p>Orange asked that auction lots and design ensured that aggregation risk to bidders is minimised as far as possible.</p> <p>The BBC suggested a pre-bid (or initial first round) phase for any 10 GHz lots.</p> <p>Orange were concerned about lack of visibility of regarding auction rules and dispute resolution, which needed to be clarified as part of a future consultation on auction design.</p> <p>A confidential respondent felt that Ofcom's auction design should take account of any 'toe hold' issues.</p>	<p>mechanism for doing this is a limit on the number of eligibility points for each bidder.</p> <p>The simultaneous multi-round combinatorial clock auction. is more efficient at reducing aggregation risks than the previously proposed simultaneous multiple round auction design. (see the January discussion document).</p> <p>The revised packaging of 10 GHz and revised auction design will allow bidders to determine the appropriate packages for which they wish to bid.</p> <p>Ofcom published a further public consultation in the form of a Discussion Document on auction design on 11 January 2007. Ofcom have also published auction rules within the draft version of 'The Wireless Telegraphy (Licence Award) (No.2) Regulations 2007'. These draft regulations are incorporated in the public consultation document 'Notice of Ofcom's proposal to make regulations in connection with the award of 10 GHz, 28 GHz, 32 GHz and 40 GHz', which was published on 7 August 2007.</p> <p>A view on whether a potential bidder had a 'toe hold' would require an assessment and/or definition of the relevant downstream market. Ofcom believes that the technology and service neutral character of this auction makes it difficult to determine how the spectrum bands to be auctioned would be used, and therefore to define a relevant market. Ofcom's view is that there is no adequate justification in excluding or penalising any particular bidders from the auction.</p>
Packaging	MLL Telecom asked that both national and regional licences be offered.	Ofcom's consultants found a limited interest in regional licences and a greater preference shown for UK wide licences (paragraphs 5.17-5.23 of the June consultation refer).
Licence term	A confidential response suggested that the minimum licence term of 15 years may need to be extended.	Ofcom considers that the proposed minimum licence term of 15 years is appropriate. To determine the length of the minimum term, Ofcom considered the relevant period that provides a reasonable chance for the businesses that might be most likely to operate in the bands to make a return on their investment (paragraphs 7.17-7.19 of the June consultation refer).
Competition	A confidential respondent felt that the analysis of the competition issues was not	Ofcom believes that the impact assessment it carried out satisfies the requirement of considering objectively the costs, benefits

	comprehensive.	and risks of the options involved.
Spectrum usage rights	<p>THUS suggested that it may be better to delay the auction until most of the uncertainties over spectrum usage rights have been resolved.</p> <p>A confidential respondent had concerns regarding the application of spectrum usage rights when the neighbouring body is a public body such as the MOD. They also felt that there may be a timing issue in connection with the award re the negotiation of these rights between public and civil bodies.</p> <p>A confidential respondent was concerned that spectrum usage rights might be defined in a vague manner which might consequently limit UWB operation.</p> <p>BT suggested that licence holders should be permitted to select bandwidths appropriate to cater for traffic and modulation.</p>	<p>Since receiving this response Ofcom have published a document on spectrum usage rights <u>Next steps for SURs</u> which is available at: <a href="http://www.ofcom.org.uk/consult/condocs/sur/next_steps2/">http://www.ofcom.org.uk/consult/condocs/sur/next_steps2/</a></p> <p>Ofcom has detailed the transmission rights for the spectrum bands in the information memorandum (which is published at the same time as this statement) and consider that these have been clearly defined.</p> <p>On 5 June 2007 Ofcom published a consultation document on its proposal to make UWB licence exemption regulations <a href="http://www.ofcom.org.uk/consult/condocs/uwb_exemption/">http://www.ofcom.org.uk/consult/condocs/uwb_exemption/</a>. The consultation closed on 6 July.</p> <p>Ofcom considers that it has packaged the award spectrum in a way which will offer bidders flexibility to select bandwidth for the provision of any subsequent services which they may wish offer.</p>

A1.2 Ofcom received 11 responses to the January discussion document. The table below sets out a summary of the responses and Ofcom's view of the main points raised.

Issue raised	Comments	Ofcom's response
10 GHz spectrum packaging	<p>A confidential respondent questioned why the 10 GHz block size was changed. There would be an aggregation risk for those wanting 2x100 MHz.</p> <p>SIAE Microelectronics suggested 7 MHz blocks.</p>	<p>There is clearly no block bandwidth that will cater for all radio systems that might operate in the 10 GHz band. Ofcom notes that the case made in responses to the June consultation justifies offering smaller lots in the award and that its decision to offer 2x10 MHz lots, with a requirement any bid should be for at least two such lots, provides for flexible and efficient use of the band. The combinatorial clock auction will ensure that bidders wanting a package of lots in the band, including a package of 2x100 MHz, will not face an aggregation risk.</p>

Auction design	<p>Wrege Associates commended Ofcom's efforts to improve on the SMRA. They were concerned about the practicability of topping up deposits in the clock stage.</p> <p>BT supported the new auction design. But asked for worked examples of 'best and final offers' and 'base prices'.</p> <p>MLL thought the auction design to be as good as any.</p> <p>A confidential respondent queried the benefits of a more complex auction design. It considered generic lots were not suitable and made the auction more complicated. Ofcom should publish the auction advice it had received.</p>	<p>The rules on topping up deposits in the primary bid rounds of the auction are designed to ensure that bidders have sufficient time to make the necessary arrangements with their bankers.</p> <p>The information memorandum contains an illustration of submitting 'best and final offers' (now called 'supplementary bids'). Ofcom will provide further illustrations during events it is planning to explain the auction design and bidding process.</p> <p>The complexity of the auction and generic lots are discussed in section 4 of this statement.</p> <p>The auction advice Ofcom has received is reflected in section 4 of this statement and in section 4 of the information memorandum.</p>
Technical conditions	SIAE Microelectronics suggested the block edge mask would restrict p-t-p applications and suggested alternatives.	Ofcom has modified the technical licence conditions so that where narrow beamwidth antennas are used out of block emissions may be increased by 20 dB.
MOD use in 10 GHz	BT asked for more information on MOD locations.	Ofcom has provided information on MOD current and future use of this band in the information memorandum (to the extent that security considerations allow).
Interference from radio amateurs in 10 GHz	BT asked for more information on the risk of interference from radio amateurs in the 10 GHz band.	Ofcom has provided information on amateur use of this band in the information memorandum.
Earth station uplink licensing in 28 GHz	Avanti Screenmedia, EADS Astrium, SAPREG & ESOA and Intellect suggested that there should be a mechanism for permitting FSS	<p>The proposals with regard to the 28 GHz band are consistent with Decision ECC/DEC(05)01 and those wishing to use the available spectrum for satellite operations may participate in the award.</p> <p>Ofcom has considered the position of those operators who may already have plans to establish gateway earth stations in the UK for uplinking to a satellite that has a planned</p>

	<p>gateway earth stations to use the entire band on a co-primary basis via established SES licensing process, with AIP pricing and co-ordination between FSS and terrestrial operators. It was also suggested that 28.8365-29.9485 GHz should not be auctioned and be retained for uncoordinated FSS earth stations for consistency with European spectrum harmonisation in accordance with ECC Decision ECC/DEC/(05)01.</p>	<p>launch date. It has decided to adapt its existing permanent earth station licensing procedures so that applications may be made for access to the 28 GHz band that includes spectrum in that part of the band to be awarded. There will be a time limit on applications so that details will be available to potential bidders in advance of the auction; Ofcom will set a closing date in mid-November for gateway earth station applications. (See paragraph 3.12 of this statement.)</p>
Harmonisation	<p>SAP REG suggested that Ofcom retain 28.8365 – 28.9485 GHz for uncoordinated FSS use. If it is awarded for FS use this will result in a lack of harmonisation at European level.</p>	<p>Ofcom proposes to auction this spectrum on a technology and service neutral basis. Ofcom does not believe that, in practice, harmonisation is driven by regulatory decisions alone and the market is therefore being given the opportunity to make the decision as to which technology and service the spectrum can be most successfully used for.</p>
Award of 40 GHz	<p>A confidential respondent thought that support for awarding the 40 GHz band was weak and not justified.</p>	<p>One of Ofcom's spectrum management objectives is to allow, wherever possible, spectrum to be managed by the market and where spectrum is not already in use to release it as soon as practicable. In this way the market has the opportunity to find uses for the spectrum. The interest shown in the band in responses to the June consultation suggests that the market should be given the opportunity to obtain the spectrum as soon as practicable. Ofcom considers that the most efficient way of doing this would be to include the band in the same award process as 10 GHz, 28 GHz, and 32 GHz.</p>
Secondary market	<p>MLL were concerned about Ofcom's reliance on the secondary market. Ofcom should consider 'use it or lose it' licence conditions and selection criteria.</p>	<p>As described in paragraph 3.34 of the SFR: IP Interim Statement (<a href="http://www.ofcom.org.uk/consult/condocs/sfrip/statement/">http://www.ofcom.org.uk/consult/condocs/sfrip/statement/</a>), Ofcom does not believe that such licence conditions are likely to meet the objective of ensuring that this spectrum is used effectively.</p>

A1.3 Ofcom received 5 responses to the March discussion document. The table below sets out a summary of the responses and Ofcom's view of the main points raised.

Issue raised	Comments	Ofcom's response
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Requirement for use of 10 GHz at the 2012 Games	Comments ranged from the Five Host Boroughs was most essential for fixed and semi-mobile applications to the BBC saying that it was unlikely that 10 GHz spectrum will be required as equipment will not be available	In light of responses, and in recognition that other higher-frequency bands may well be suitable for video links and wireless cameras, Ofcom does not expect that the 10 GHz band will be required for the Games.
Impact on optimal spectrum use of requiring licensees to avoid interference to users at the Games	One response suggested that the proposal would reduce the value of the spectrum and place major constraints on backhaul and FWA use.	Ofcom has noted this comment.
How to ensure access to 10 GHz for the Games	The Five Host Boroughs and RSGB agreed with Ofcom's suggestion for successful bidders to avoid interference to temporary use at the Games.	Ofcom does not consider that it should take steps to ensure access to 10 GHz at the Games.
Licence condition to avoid interference to users at the Games	There was some agreement with Ofcom's proposed licence condition. The Five Host Boroughs suggested that that at least two 2x10 MHz lots be assigned (on a geographical basis) for the purposes of the Olympic Games.	Ofcom will not include in the licences to be awarded a condition relating to the Games.

A1.4 The table below sets out a summary of the responses on auction design to the 2.6 GHz consultation and Ofcom's view of the main points raised. Ofcom's views relate solely to the award that is covered in this document; it has not finalised decisions on the 2.6 GHz award.

<b>Issue raised</b>	<b>Comments</b>	<b>Ofcom's response</b>
Complex auction design	A number of responses made the general point that the auction design was complex and would discourage entry, particularly by smaller companies.	The combinatorial clock auction is strategically simple for bidders. There are strong incentives for straightforward bidding with the combinatorial clock format, as any bid submitted in any round could potentially become a winning bid.
Testing the design	Orange were concerned that the auction design was experimental. H3G said the design ought to be tested	Ofcom is undertaking an intensive programme of testing the auction design and bidding process. It is also engaging external consultants to test the software, in particular its application of the winner determination and pricing rules.  Ofcom will run a programme of workshops and mock auctions over the period up to the auction start so that potential applicants and bidders can familiarise themselves with the auction design and process.
Pricing rules	Wrege Associates was very supportive but commented	A second price rule will apply in the assignment stage. The pricing rules are set

	<p>that the assignment stage should also be second price and that the algorithms for the BAFO (supplementary bid) and assignment stages should be published.</p> <p>The assignment stage should be second price(Orange)</p> <p>Rule on winning prices unclear (Vodafone).</p> <p>Pricing rule in BAFO (supplementary bid) stage unclear – will encourage strategic bidding (H3G).</p>	<p>out in detail in the draft auction regulations.</p>
Transparency	<p>Two respondents (including Arqiva and one confidential) commented on the need for more transparency.</p>	<p>Ofcom considers that the information it will publish will be sufficient for bidders to pursue efficient bidding strategies.</p>
Threshold problem	<p>A confidential respondent commented that the design favoured larger bidders – there was a threshold problem.</p>	<p>Ofcom considers that the benefits from mitigating aggregation risks created by using a combinatorial clock format for this award significantly outweigh any costs related to increased threshold risks.</p>
Bid increments	<p>No information on increments – whether fixed for the auction (Orange).</p> <p>Link round-to-round price increases to supply/demand differences (Vodafone).</p>	<p>The amount by which prices per lot increase from round to round for those bands 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.</p>
Submission of supplementary bids	<p>Onerous for BAFOs (supplementary bids) to be submitted after each round – should occur at end of clock stage (Vodafone)</p> <p>Purpose of BAFO (supplementary bid) stage unclear (H3G).</p>	<p>Supplementary bids will be submitted in the supplementary bid round only.</p>
Design of assignment stage	<p>Assignment stage poorly designed – an SMRA or multi-round clock auction would be better (H3G).</p>	<p>The purpose of the assignment stage is limited to determining how the available frequencies in each band are distributed amongst the winning bidders from the principal stage and Ofcom does not consider that an SMRA is required for this purpose in the circumstances of this award.</p>