

Award of available spectrum: 10 GHz, 28 GHz, 32 GHz and 40 GHz

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

Consultation

Publication date: 29 June 2006

Closing Date for Responses: 7 September 2006

109

Contents

Section		Page
1	Executive summary	3
2	Introduction	8
3	Ofcom's duties and functions	17
4	Ofcom's objectives and approach to the award	21
5	Spectrum packaging	26
6	Auction design	31
7	Regulatory conditions	40
8	Next steps and timetable	50
Annex		Page
1	Responding to this consultation	52
2	Ofcom's consultation principles	54
3	Consultation response cover sheet	55
4	Consultation questions	57
5	Draft licence template	58
6	Transmission rights	72
7	Impact assessment	88
8	Summary of SFR: IP responses	95
9	28 GHz licences geographical coverage	106

9 28 GHz licences geographical coverage10 Glossary

Section 1

Executive summary

- 1.1 As part of Ofcom's plans to implement its strategy of ensuring optimal use of the radio spectrum it has developed a programme of awards of wireless telegraphy licences that is designed to put unused or under-used spectrum into the market. One such award is of wireless telegraphy licences for the spectrum bands 10 GHz, 28 GHz and 32 GHz. These bands are not currently licensed for use, except for some regional broadband fixed wireless access licences in the 28 GHz band. Part of the 32 GHz band has been open for fixed links assignments since 2003 but there are no current assignments in it and there is a moratorium on applications pending the outcome of this consultation. There is also some use of the available 10 GHz band by the Ministry of Defence.
- 1.2 This consultation sets out in detail Ofcom's proposals for the award of wireless telegraphy licences to use these bands, in the light of responses it received to the Spectrum Framework Review: Implementation Plan consultation document published in January 2005. It also explains Ofcom's proposal for deferring the award of licences in the 40 GHz band.

An overview of the key proposals

- 1.3 Ofcom proposes, subject to the outcome of the current consultation, to hold an auction in 2007 for the award of UK wireless telegraphy licences to use the spectrum bands 10 GHz, 28 GHz and 32 GHz.
- 1.4 The key elements of the proposed spectrum packaging and licensees' rights and obligations for the spectrum to be auctioned are as follows:
 - Twelve licences will be offered. Most will have UK coverage one in the 10 GHz band, two in 28 GHz, and six in 32 GHz. In addition, three 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.
- 1.5 The key elements of the proposed award process are as follows:
 - All licences will be awarded through a single auction.
 - The auction will take the form of a simultaneous multiple round auction.
 - The winning bidders will be those which submit the highest bids for each licence.
 - A minimum bid price of £50,000 will be set for each licence.

Next steps

1.6 This consultation closes on 7 September 2006. Ofcom plans to hold a seminar on its proposals for interested parties in late July.

- 1.7 After considering the responses to this consultation, Ofcom expects to publish the following key documents in 2007.
 - a short statement on this consultation;
 - an Information Memorandum, describing in detail the relevant information for the award, such as the award procedure and rules, prospective licence conditions and other information likely to affect use of the bands;
 - draft regulations setting out the auction rules; and
 - draft regulations to allow spectrum trading for this licence.
- 1.8 Ofcom will consider any comments it receives on the draft auction regulations before finalising them. The regulations will then be made to allow Ofcom to hold the auction. Before the auction is held Ofcom expects to hold a further "question and answer" session, in particular on the rules for the auction.

Detailed summary of Ofcom's proposals

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

Spectrum Packaging	Ofcom's proposals		
Number of licences	There will be 12 licences awarded for use within the United Kingdom (this excludes the Isle of Man and the Channel Isles): one at 10 GHz, five at 28 GHz and six at 32 GHz.		
Wireless Telegraphy rights and obligations	Ofcom proposals		
Licence conditions	The licences will be technology neutral. The licence conditions will be the minimum necessary to:		
	 ensure compliance with international requirements; and 		
	 ensure effective use of the licensed frequencies by controlling interference between different licensed services. 		
	The technical conditions will comprise a constraint on use defined by reference to spectrum masks. They are set out in section 7 of this document.		
Licence term	The licences will have an indefinite duration, with a minimum term of 15 years during which Ofcom's powers to revoke will be limited. Ofcom will have the power to revoke for spectrum management reasons on not less than 5 years' notice after the minimum period, which could lead to the licence being terminated the day after the expiry of the 15 year minimum period or any time thereafter.		
Licence fees	The auction will determine the fee payable for the licences. After the expiry of the minimum period, if the licensees continue to hold the licences, there may be additional charges in line with Ofcom's policy on spectrum pricing at that time.		
Spectrum trading	The licences will be tradable. All types of trade (partial or total; and concurrent or outright) will be permitted.		

Table 1 – Summary of Ofcom's proposals

and Rules	
Auction format	The auction will be a simultaneous multiple round auction (SMRA).
Determining the successful bidders	The winning bidders will be those that submit the highest bids for each licence.
Pricing rule	The winning bidder for each licence will pay the amount bid for the licence, or the minimum bid price if there are no other valid bids.
Transparency	The auction will be fully transparent. Comprehensive information about the number, amount and type of bids on each lot will be released after each round. In addition, bidders will able to monitor the identity of all other bidders and the bids they make.
Prohibitions on bidder association and collusion	There will be specific rules to prohibit collusion and bidder association.
Minimum bid price	A minimum bid price of £50,000 will be set for each licence.
Activity and eligibility rules	Activity rules will help manage the pace of the auction and ensure each bidder participates fully. For each round the auctioneer will set the level of activity required of bidders. Each applicant will be required to declare the number of spectrum lots that it wishes to bid for. This will determine its initial quota, as a bidder, of eligibility points. One eligibility point will allow a bid to be made on one spectrum lot. During the course of the auction a bidder's eligibility points will be affected by the application of the activity rules.
Deposits	Ofcom will set an initial deposit of £25,000 for each spectrum lot. A mechanism will be introduced to ensure that bidders increase their deposits in a way that reflects their aggregate bid levels at set points during the auction.
Payment terms	Winning bidders will be required to pay 100% of the fee by the date set in the Regulations before the licence is issued.
Unsold licences	If licences remain unsold, either through absence of bids or default, Ofcom will reconsider its approach to release of the spectrum, and will choose whatever course of action it considers appropriate at that time.

Award Mechanism | Ofcom's proposals

Questions:

1). Do stakeholders agree with the proposals for the award of licences in the 10 GHz, 28 GHz and 32 GHz bands in 2007?

2). Do stakeholders agree with the proposal to include in the award of the 32 GHz band that portion of the band that has been open since 2003 for point-to-point applications?

3). Do stakeholders agree with the proposals to defer the release of the 40 GHz band and review the position in two years' time?

4). Do stakeholders have any other comments on the contents of this document?

Section 2

Introduction

2.1 This document consults on Ofcom's plans for awarding wireless telegraphy licences for use in the spectrum bands 10.125-10.225 GHz paired with 10.475-10.575 GHz ('the 10 GHz band'), 27.8285-28.4445 GHz paired with 28.8365-29.4525 GHz ('the 28 GHz band') and 31.815-33.383 GHz ('the 32 GHz band'). It also covers Ofcom's proposal to defer the award of licences in 40.5-43.5 GHz ('the 40 GHz band').

Ofcom's approach to spectrum management

- 2.2 The proposals outlined in this consultation build upon those in the Spectrum Framework Review: Implementation Plan ("SFR:IP")¹. They are designed to implement Ofcom's general approach to spectrum management which has been set out in a number of documents published by Ofcom, including:
 - the Spectrum Framework Review consultation document published in November 2004 ("SFR") and Statement published in June 2005 ("SFR Statement")²;
 - the Spectrum Trading consultation document published in November 2003 ("Trading Consultation Document") and Statement published in August 2004 ("Trading Statement")³;
 - the Spectrum Liberalisation consultation document published in September 2004 ("Liberalisation Consultation Document") and Statement published in January 2005 ("Liberalisation Statement")⁴;
 - the approach is also summarised in section 3 of the SFR:IP.

Ofcom's programme of spectrum awards

- 2.3 The proposals outlined in this consultation form part of a wider programme of awards which was proposed in the SFR:IP. Ofcom's general approach to this programme was outlined in the Interim Statement on the SFR:IP published on 28 July 2005⁵. Ofcom expects to publish more detailed documents with specific plans for each award as the programme advances, and corresponding statements. The first such consultation document, published alongside the Interim Statement, covered proposals for the award of 1781.7-1785 MHz paired with 1876.7-1880 MHz⁶. It was then followed by proposals for the bands 412-414 MHz paired with 422-424 MHz⁷, published on 13 October 2005, proposals for the award of 1785-1805 MHz in Northern Ireland⁸, published on 15 December 2005, proposals for the award of 1452-1492 MHz, published on 31 March 2006⁹, the proposals for the award of 872-876 MHz paired with 917-921 MHz, published on 11 April 2006¹⁰, and the proposals for
- ¹ <u>http://www.ofcom.org.uk/consult/condocs/sfrip/</u>

² <u>http://www.ofcom.org.uk/consult/condocs/sfr</u>

³ http://www.ofcom.org.uk/consult/condocs/spec_trad/

⁴ http://www.ofcom.org.uk/consult/condocs/liberalisation

⁵ http://www.ofcom.org.uk/consult/condocs/sfrip/statement/

⁶ http://www.ofcom.org.uk/consult/condocs/1781

⁷ http://www.ofcom.org.uk/consult/condocs/spectrum_award

http://www.ofcom.org.uk/consult/condocs/availspec/

⁹ http://www.ofcom.org.uk/consult/condocs/1452-1492/

¹⁰ http://www.ofcom.org.uk/consult/condocs/872-876/

the award of 55-68 MHz, published on 26 April 2006¹¹. The present document is the seventh in the programme.

2.4 The Ofcom website includes a dedicated section for the spectrum awards programme which sets out relevant information and includes links to key documents for the programme and individual awards. Ofcom intends to use the section as the main point for provision of information on spectrum awards. Its address is http://www.ofcom.org.uk/radiocomms/spectrumawards/.

Proposals in SFR:IP

2.5 The SFR:IP contained initial proposals on the award of each of the 10 GHz, 28 GHz, 32 GHz and 40 GHz bands. There were 24 responses that commented on one or more of the bands. Comments mainly concerned potential uses for the bands and packaging of the spectrum, and there were also some comments on auction design. A detailed summary of responses with Ofcom's conclusions is included, in tabular form, in Annex 8. Non-confidential responses have been placed on Ofcom's website at http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/responses/.

Description of the available spectrum bands

International regulatory position

- 2.6 The subdivision of the radio spectrum into specific frequency bands and the allocation of those bands to various radio services is a process that occurs globally in the ITU, at the European level in CEPT and the EU, and nationally, through regulatory decisions made by Ofcom. The fundamental reason for international co-ordination of radio use has, historically, been the risk of harmful interference between use in one jurisdiction and use in another, given that radio emissions do not stop at national borders.
- 2.7 The ITU Radio Regulations (ITU-RR) define those uses for specific spectrum bands that will have international recognition under the Radio Regulations. The allocation of frequencies in the world is divided into three Regions; Region 1, 2 and 3. The United Kingdom falls within Region 1. Within each frequency band, radio communications services are allocated on the basis of 'primary' and 'secondary' service, either on a worldwide or Regional basis. Allocation of secondary services shall not cause harmful interference to allocations of assigned primary services. (Article 5 of the ITU RR).
- 2.8 Further information on International allocations in the bands for award is contained in Annex 6. Information on UK allocations is set out below. UK allocations are set out in the UK Frequency Allocation Table (<u>http://www.ofcom.org.uk/radiocomms/isu/ukfat/</u>). They may change from time to time.

10 GHz band

- 2.9 The spectrum available for award comprises two blocks of 100 MHz, namely 10.125-10.225 GHz paired with 10.475-10.575 GHz. This is shown as package 1 in figure 1 below.
- 2.10 The band 9.5-10.5 GHz is managed by MOD and an agreement with MOD allows civil use within it. MOD use includes an airborne common data link that transmits to

¹¹ <u>http://www.ofcom.org.uk/consult/condocs/rrs_5568/</u>

ground stations. These transmissions are in the lower block available for award (10.125-10.225 MHz). It is expected that this use will have no more than an occasional and localised impact on civil use (see Annex 6). Ofcom is exploring with MOD the arrangements that would apply to shared use of the band. Ofcom intends to provide further information on this before the award.

2.11 MOD have secondary status in the band 10.5-10.6 GHz and its use is coordinated with Ofcom. In the future, details of MOD proposed use will be forwarded to the licensee for consideration. MOD use of this band in recent years has been infrequent and has been for temporary assignments only.



Figure 1 Band Plan 10 GHz (Frequencies in GHz)

- 2.12 There are two civil uses in the 9.5-10.5 GHz band that overlap or abut the spectrum for award, namely amateur radio and short range devices.
- 2.13 The Amateur and Amateur satellite service is permitted, as a secondary user on a non-interference and non-protected basis, in the 10.450-10.500 GHz band, the top 25 MHz of which (10.475-10.500 GHz) falls within the spectrum available for award. It is earmarked for satellite downlinks (space to Earth direction) but there are currently no satellites operating in the band. (See Annex 6 for further details.)
- 2.14 The short range devices in the band are low-power flow and level detection systems, which are devices used mainly for measuring the contents of containers at industrial sites such as refineries. Currently these level gauges are subject to licensing but Ofcom is considering an ECC proposal to exempt these devices from licensing.

28 GHz band

- 2.15 The spectrum available for award is 27.8285-28.4445 GHz and 28.8365-29.4525 GHz. Part of this spectrum is available throughout the UK it is shown as packages 1 and 2 in figure 2 below. The rest is available in more limited parts of the UK it is shown as BFWA 1, 2 and 3 in figure 2.
- 2.16 The spectrum that is available on a geographically limited basis is part of the spectrum that the Radiocommunications Agency (RA) made available by auction in

November 2000 in regional packages. The three spectrum packages were offered then in each of 11 English regions and in Scotland, Wales and Northern Ireland. Of the 42 licences offered 15 were awarded. Details of the regions and licence holders are shown in Annex 9. (A description of each of the regions is given in The Wireless Telegraphy (Broadband Fixed Wireless Access Licences) Regulations 2000 – see http://www.opsi.gov.uk/si/si2000/20002039.htm.) The geographical coverage now available for each spectrum package is shown in figure A9.2 in Annex 9.



Figure 2 Band Plan 28 GHz (Frequencies in GHz)

- 2.17 It is worth noting briefly the status of this band in the international spectrum framework. The 27.5 GHz to 29.5 GHz band is allocated on a co-primary basis to the fixed service (FS), fixed satellite service (FSS) and the mobile service (MS). Satellite earth stations may operate in the band and in adjacent spectrum and in setting licence conditions Ofcom has taken account of the need to protect satellite use.
- 2.18 The spectrum that RA auctioned in 2000 was made available on the basis of a the spectrum blocks detailed in ECC Decision ERC/DEC(00)09. It was in two frequency blocks of 392 MHz: 28.0525 GHz-28.4445 GHz paired with 29.0605 GHz-29.4525 GHz.
- 2.19 Since the auction in 2000 CEPT has undertaken further work in relation to the 28 GHz band that has led to Electronics Communications Committee Decision ECC/DEC/(05)01¹². This Decision identified additional spectrum for terrestrial services as well as for uncoordinated, freely deployed satellite earth stations. This additional spectrum identified in the Decision includes the packages 1 and 2 in figure 2, which form part of the spectrum available for award. The UK has not committed to implementing this Decision, though Ofcom's proposals are in the main consistent with it.

32 GHz band

2.20 The spectrum available for award is 31.815-33.383 GHz. In February 2003 the band was planned for the introduction of fixed services in a phased manner, with the first step being opening part of it for point-to-point applications. This was the upper third of the two sub-bands (32.319-32.571 GHz paired with 33.131-33.383 GHz). The remaining two-thirds were held back for future possibilities and the SFR: IP proposed to award one or more UK licences in this spectrum.

¹² <u>http://www.ero.dk/documentation/docs/doc98/official/pdf/ECCDEC0501.PDF</u>

2.21 In the three years since the upper third has been available for individual point-topoint applications there has been very limited interest and there are no live assignments in the band. Ofcom proposes to close this part of the band for individual fixed link assignments and to offer the whole band for award. Proposals for the packaging of the band are contained in section 5 below.

Spectrum for release as per SFR-IP 31800 32319 32571 Offcom Administered Spectrum for release as per SFR-IP Offcom Administered Point to point links 32571 3313 33383

Figure 3 Band Plan 32 GHz (Frequencies in MHz)

2.22 In the ITU Radio Regulations this band is allocated on a primary basis to the fixed service and radionavigation service. Parts of the band are also allocated on a primary basis to space services and inter-satellite services. This is also the case in the European Common Allocation Table. There are guard bands at each end of the band, to protect adjacent users – closed circuit television (CCTV) below 31.8 GHz and radiolocation above 33.4 GHz.

40 GHz band

2.23 The spectrum available for award is 40.5-43.5 GHz. The ERC in June 1999 designated this band for multimedia wireless systems (MWS), which it defined as terrestrial multipoint systems that provide fixed wireless access (FWA) to the end user for multimedia services (ECC/DEC(99)15)¹³. The UK has incorporated MWS into the national Frequency Allocation Table, which references this Decision. However, there has been no use of the band for this purpose in the UK, neither, so far as Ofcom is aware, has there been significant use in the rest of Europe or elsewhere.



Figure 4 Band Plan 40 GHz

¹³ <u>http://www.ero.dk/documentation/docs/doc98/official/Word/DEC9915E.DOC</u>

- 2.24 The ITU Radio Regulations allocate, in Region 1, 40.5-42.5 GHz on a co-primary basis to broadcasting, broadcasting-satellite, fixed and fixed satellite services, and 42.5-43.5 GHz on a co-primary basis to fixed, fixed satellite, mobile and radio astronomy services. Ofcom is aware of five satellite filings in the band.
- 2.25 The band 42.5-43.5 GHz is currently used in the UK by the radio astronomy service. There are no terrestrial services in the band at present, though future use on a shared basis would be feasible. Ofcom consulted on the proposals for Recognised Spectrum Access (RSA) for the Radio Astronomy Service in April 2005 and issued a statement in October 2005, in which it said that it expected, in due course, to publish a notice to consult on the necessary regulations for the introduction of RSA.

Potential uses of the spectrum bands and demand assessment

- 2.26 Ofcom commissioned the consultants Quotient and Indepen ('the consultants') to assess the potential demand for the four bands 10 GHz, 28 GHz, 32 GHz and 40 GHz and to provide guidance on the appropriate award process.¹⁴ They identified a number of potential applications, which fall broadly into three categories:
 - mobile and fixed network operators who might use spectrum to backhaul their own networks, primarily with the aim of reducing costs. The interest here is in paired spectrum.
 - FWA network operators who might deploy broadband access networks in addition to providing backhaul, both for themselves and for other network operators. The interest here is primarily in paired spectrum.
 - Broadcasters who might use spectrum in the 10GHz band for video links and wireless cameras. The interest here is in unpaired spectrum.
- 2.27 Some pertinent details on various potential applications include:
 - FWA there is commercially available point-to-multipoint equipment in the 10 GHz, 28 GHz and 32 GHz bands. It requires paired spectrum, but TDD equipment is being developed at 28 GHz. As identified above, the 40 GHz band has been identified by the ERC for MWS but there has been virtually no commercial deployment of such systems, though research is being undertaken.
 - Fixed links point-to-point links are used to provide backhaul for mobile and FWA networks and from WiFi hotspots. There is increased interest in point-to-multipoint technology for this application, particularly in densely populated areas. The 10 GHz, 28 GHz and 32 GHz bands are all suitable for fixed links. The large bandwidth available at 40 GHz makes the band potentially suitable for high capacity links, providing throughputs of up to 1 Gbit per second. Equipment has yet to be developed for the band but equipment is available for bands above 60 GHz.
 - Video links some use is currently made by programme making and special events (PMSE) users in the 10 GHz and 12 GHz bands. Research is under way to improve performance in these bands which cannot currently match performance at 2 GHz. These links are one way and so do not need paired spectrum. CCTV also operates in the 2.4 GHz licence exempt band and in the 31 GHz licensed band. Both the 10 GHz and 32 GHz bands could be used for this service.

¹⁴ Indepen and Quotient were commissioned to assess the potential business opportunities for spectrum within the 10, 28, 32 and 40GHz bands. They collected information from 82 potentially interested parties across a range of industries as part of the exercise.

- Satellite earth stations some of the bands are suitable for this application in the earth to space direction. However, use would depend on the availability of satellite capacity and may require international agreement and co-ordination.
- 2.28 The consultants found that, overall, potential demand exceeded the total available spectrum across the bands, although interest was moderate and was not evenly spread across the bands. They found that there was most interest for spectrum in the 10 GHz band, with parties expressing interest in spectrum for use in backhaul, FWA or PMSE applications. Most were interested only in paired spectrum, although it is likely that PMSE users would be interested in unpaired blocks of spectrum. Potential bidders wishing to obtain spectrum for FWA applications and for mobile and FWA backhaul networks also expressed interest in the 28 GHz band. There appeared to be stronger demand for paired spectrum available nationwide than for regional and/or unpaired spectrum. The consultants' market analysis found that there was less interest in acquiring spectrum in the 32 GHz band than in the 10 GHz or 28 GHz bands. Generally there was a preference for paired blocks of 100 MHz and 112 MHz.
- 2.29 The consultants found that for FWA and backhaul applications the 10 GHz, 28 GHz and 32 GHz bands were substitutes, though 10 GHz was considered likely to be more valuable than 28 GHz or 32 GHz, which were likely to be closer substitutes for each other. In addition, some potential bidders wanted spectrum in more than one band.
- 2.30 The consultants also examined the potential for band management activities in these frequency bands. The Independent Audit of Spectrum Holdings produced by Professor Martin Cave¹⁵ saw the 32 GHz band as a candidate for a band manager approach as a way of addressing the potential restrictions that fixed links licensing imposes on the ability of the market to deliver spectrum to the highest value use. It recommended that Ofcom should give the 32 GHz award high priority if its market study revealed significant demand. The consultants spoke to a number of organisations about taking on a band management role. Almost all were interested in taking on spectrum management and related functions but saw the purchase of spectrum as a risk where future demand was uncertain. Despite this cautious reaction Ofcom considers that in awarding all frequency bands it should ensure that a framework exists to allow band management activity to occur if this is economically attractive.
- 2.31 Ofcom has already set out in some detail one model that might be followed for establishing band management, using the framework of spectrum trading. This discussion was included in the consultation document on the award of 412-414 MHz/422-424 MHz referred to above in paragraph 2.3. Ofcom is proposing that all the licences awarded in the 10 GHz, 28 GHz and 32 GHz bands should be tradable.

Why consider the 10 GHz, 28 GHz and 32 GHz bands together?

- 2.32 In relation to each of these three available bands the consultants identified a number of potential demands:
 - At 10 GHz there were three potential demands: for backhaul by mobile and FWA operators, for provision of FWA services and for video links from broadcasters.
 - At 28 GHz there was a demand for backhaul from mobile and FWA operators and for provision of FWA services.
 - At 32 GHz there was a demand for backhaul from mobile and FWA operators.

¹⁵ <u>http://www.spectrumaudit.org.uk/</u>

- 2.33 The three bands, therefore, might all be used for point-to-point and/or point-tomultipoint applications. Equipment for the bands is available from numerous vendors, though the choice is more limited for 32 GHz than for the other bands. There is some variation in infrastructure costs and link length, with 10 GHz likely to be somewhat more favourable than the other two bands, particularly where line of sight was more easily obtained, i.e. in less built up areas. Notwithstanding these differences it is likely that all three bands are to some extent economic substitutes for each other, at least as far as both backhaul and FWA uses are concerned, with the 28 GHz and 32 GHz bands being close substitutes. This means that those wishing to obtain spectrum for such uses might be prepared to obtain spectrum in any of the bands, or perhaps in a combination of bands,
- 2.34 This points clearly to the need to examine the award of the bands in a concerted way, and to consider ways in which bidders can consider acquiring spectrum in any or all of the bands at the same time.

Consideration of the 40 GHz band

- 2.35 The consultants found no evidence of demand to acquire spectrum in the 40 GHz band at this time, nor any evidence of commercially available equipment. This suggests that if the band were released in the near future there is unlikely to be any demand for licences.
- 2.36 Ofcom has therefore considered whether to proceed with the release of the band. One of Ofcom's spectrum management objectives is to allow, wherever possible, spectrum to be managed by the market and wherever spectrum is not already in use in the market Ofcom aims to release it as soon as reasonably practicable. If the band were released to the market, consistent with this strategy, the market would have an opportunity to find new uses for it, and, subject to the terms of the award, the maximum flexibility to make use of the spectrum. The identity of the use and user could change over time, through the secondary market. These considerations point towards releasing the band to the market if at all possible.
- 2.37 However, Ofcom also has to bear in mind the resource costs of a spectrum award process, including the opportunity cost of its own staff time. If demand for the spectrum does not exist incurring these costs is not justified.
- 2.38 Of com has considered the other options for the band, apart from holding an auction.

Licence exemption: this could stimulate innovation and the development of new services but there is no indication of demand for licence exempt use of the band, either in the UK or across Europe. Also, opening the band on this basis would make it difficult to reverse the position where it later transpired that the band could support high value services that required licensed spectrum.

License on a first come first served basis: this could be under a full licensing or light licensing regime, with spectrum awarded on demand and co-ordination of use either by Ofcom or by users themselves. Licensing on this basis may not put the spectrum into the hands of those most likely to use it efficiently, and it may result in fragmentation of the spectrum. Ofcom believes that an appropriate award process should be established when it becomes clear that there is demand for the spectrum.

Award temporary trial licences: Ofcom has considered the desirability of awarding pioneer licences to encourage experimental use of the spectrum, providing licensees with the possibility of permanent licences where they had identified viable uses.

There are a number of difficulties with this approach, in particular the likelihood that the grant of permanent licences could not be made on an objective and nondiscriminatory basis. Moreover, Ofcom offers non-operational development licences that enable activities such as the trialling of services and the testing and development of equipment. It believes that such licences offer a suitable option for those wishing to explore the potential of the 40 GHz band.

- 2.39 The available evidence suggests that the band is unlikely to be used for some time, whether on a licensed or licence exempt basis. In the light of the considerations summarised above, Ofcom proposes to defer release of the band. If there are companies that wish to explore the band's potential in advance of its release they may do so under Ofcom's non-operational development licensing regime.
- 2.40 Ofcom proposes to review the position within two years, in the light of market and technology developments. In the meantime, if any interested party wished to bring forward proposals for the use of spectrum in the band Ofcom would be happy to reconsider the position.

Section 3

Ofcom's duties and functions

3.1 This section provides a brief overview of the main UK and European legislative provisions relevant to wireless telegraphy licensing and to the proposed award process. It does not provide a comprehensive statement of all legal provisions which may be relevant to Ofcom's functions and to the award of a wireless telegraphy licence for the use of the spectrum bands.

Ofcom's general duties

- 3.2 Under section 3(1) of the Communications Act 2003 it is the principal duty of Ofcom in carrying out its functions:
 - (a) to further the interests of citizens in relation to communications matters; and
 - (b) to further the interests of consumers in relevant markets, where appropriate by promoting competition.

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

- (a) the optimal use for wireless telegraphy of the electromagnetic spectrum;
- (b) the availability throughout the UK of a wide range of services;
- the availability throughout the UK of a wide range of TV and radio services which (taken as a whole) are both of high quality and calculated to appeal to a variety of tastes and interests;
- (d) the maintenance of a sufficient plurality of providers of different television and radio services;
- (e) the application in the case of all television and radio services of standards that provide adequate protection to members of the public from the inclusion of offensive and harmful material, unfair treatment in programmes and unwarranted infringement of privacy;

and to have regard to certain matters which include:

- principles of better regulation (section 3(3));
- the desirability of promoting competition (section 3(4));
- the desirability of encouraging investment and innovation (section 3(4)(d));
- the desirability of encouraging availability and use of broadband services throughout the UK (section 3(4)(e));

- the different needs and interests of persons in different parts of the UK (section 3(4)).
- 3.3 As the management of the UK radio spectrum is governed by the European Communications Directives, which aim to harmonise the regulation of electronic communications networks and services throughout the European Union, section 4 of the Communications Act 2003 requires Ofcom when carrying out its spectrum functions to act in accordance with the "six community requirements" set out in that section when managing the wireless spectrum in the UK. Of relevance are the following:
 - (a) The requirement to promote competition (section 4(3));
 - (b) The requirement to secure that Ofcom's activities contribute to the development of the European internal market (section 4(4));
 - (c) The requirement to promote the interests of all persons who are citizens of the European Union (section 4(5));
 - (d) The requirement to act in a technology neutral way (section 4(6));
 - (e) The requirement to encourage to such extent as appropriate the provision of network access and service interoperability (section 4(7)); and
 - (f) The requirement to encourage such compliance with international standards as is necessary for (a) facilitating service interoperability; and (b) securing freedom of choice for the customers of communications providers (sections 4(9) and (10)).

Ofcom's duties when carrying out spectrum functions

- 3.4 In carrying out its spectrum functions it is the duty of Ofcom (under section 154 of the Communications Act 2003) to have regard in particular to:
 - (a) the extent to which the spectrum is available for use or further use, for wireless telegraphy;
 - (b) the demand for use of that spectrum for wireless telegraphy; and
 - (c) the demand that is likely to arise in future for the use of that spectrum for wireless telegraphy.

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

- the efficient management and use of the spectrum for wireless telegraphy;
- (b) the economic and other benefits that may arise from the use of wireless telegraphy;

- (c) the development of innovative services; and
- (d) competition in the provision of electronic communications services.
- 3.5 Where it appears to Ofcom that any of its duties in section 154 conflict with one or more of its general duties under sections 3 to 6 of the 2003 Act, priority must be given to its duties under those sections.

Granting wireless telegraphy licences

- 3.6 Ofcom's legal power to grant wireless telegraphy licences is set out in the Wireless Telegraphy Act of 1949. Section 1(1) of that Act makes it an offence for any person to establish or use any station for wireless telegraphy or to install or use any apparatus for wireless telegraphy except under and in accordance with a licence granted by Ofcom under that section (a wireless telegraphy licence).
- 3.7 Section 1(2) of that Act gives Ofcom the power to grant wireless telegraphy licences subject to such terms as Ofcom thinks fit.
- 3.8 However, Ofcom's broad discretion in relation to the terms that can be imposed in a wireless telegraphy licence is subject to the rule that Ofcom must impose only those terms that it is satisfied are objectively justifiable in relation to the networks and services to which they relate, not unduly discriminatory, and proportionate and transparent as to what they are intended to achieve (section 1D(9)).

Providing for an auction of wireless telegraphy licences

- 3.9 Under Article 5(2) of the Directive on the authorisation of electronic communications networks and services 2002/20/EC (the "Authorisation Directive"), when granting rights of use of radio frequencies (wireless telegraphy licences in the UK context), Member States must do so through open, transparent and non-discriminatory procedures.
- 3.10 Under Article 7(2) of the Authorisation Directive where the number of rights of use of radio frequencies needs to be limited, Member States' selection criteria must be objective, transparent, non-discriminatory and proportionate. (Section 164 of the Communications Act 2003 requires Ofcom to make an order setting out the criteria).
- 3.11 Within that context, Ofcom has power under section 3 of the Wireless Telegraphy Act 1998 (having regard to the desirability of promoting the optimal use of the electromagnetic spectrum) to make regulations providing that applications for the grant of wireless telegraphy licences must be made in accordance with a procedure which involves the applicants making bids for licences (for example an auction).
- 3.12 Ofcom has broad powers in section 3(3) to make provision in regulations for the form of the licences and the auction bidding procedure.

Charging fees for wireless telegraphy licences

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

of the matters to which they are to have regard under section 154 of the Communications Act 2003.

- 3.14 The fees for most wireless telegraphy licences are set out in such regulations (including those fees which are set by Ofcom in order to incentivise the use of the spectrum). The current regulations are the Wireless Telegraphy (Licence Charges) Regulations 2005 (SI 2005/1378).
- 3.15 Under Article 13 of the Authorisation Directive, any fees imposed for rights of use of radio frequencies shall reflect the need to ensure the optimal use of the resources. Such fees must be objectively justifiable, transparent, non-discriminatory and proportionate in relation to their intended purpose (and take into account the objectives set out in Article 8 (Policy objectives and regulatory principles) of Directive 2002/21/EC¹⁶ (the "Framework Directive")).
- 3.16 In the following sections of this consultation, Ofcom sets out its analysis of its proposals against its statutory duties and the general requirements applicable to licensing processes and licence conditions.

¹⁶ The Directive of the European Parliament and the Council on a common regulatory framework for electronic communications networks and services (2002/21/EC)

Section 4

Ofcom's objectives and approach to the award

4.1 This section sets out Ofcom's objectives for the award of the 10 GHz, 28 GHz and 32 GHz bands ('the spectrum bands') and its consideration of some key issues relating to the award: whether to authorise use on a licence exempt or licensed basis; the mechanism for awarding licences; offering licences on a technology and service neutral basis; timing of the award; and, competition issues. The proposal to defer the award of the 40 GHz band is discussed above in section 2.

Objectives for the award

- 4.2 The main objective of this award of wireless telegraphy licences is to promote the optimal use of the electro-magnetic spectrum, including the spectrum bands. In preparing the proposals designed to secure that objective, Ofcom has had regard, in particular, to the availability of and demand for spectrum and to the desirability of promoting:
 - the efficient management and use of the spectrum;
 - the economic and other benefits that may arise from use of the spectrum;
 - the development of innovative services; and
 - competition in the provision of electronic communications services.
- 4.3 The SFR identifies the use of auctions as the most appropriate means to distribute spectrum that is not currently assigned where demand for the spectrum is likely to exceed supply. It also sets out the view that spectrum should be auctioned in a technology and usage neutral way. We have followed this approach in framing the proposals for the award of this band.

Choice of assignment mechanism

Licence exemption

- 4.4 As noted in the SFR:IP and elsewhere, Ofcom has a duty (in section 1AA of the Wireless Telegraphy Act 1949) to make regulations exempting particular equipment if it is satisfied that its use for wireless telegraphy is not likely to involve undue interference. Ofcom has considered whether use of equipment in the spectrum bands would be suitable for licence exemption.
- 4.5 The market assessment has revealed a range of potential uses of the bands, including FWA, backhaul for both FWA and mobile operations, and video links and wireless cameras for PMSE. These uses require power levels that would create large zones of potential interference around transmitters and/or require a guaranteed level of service only feasible within an interference-free environment. Deployment on a licence exempt basis would be likely to result in unacceptable interference. Ofcom therefore considers that a licence exempt approach would be unlikely to lead to optimal use of the spectrum bands.

Award through an auction

- 4.6 Ofcom has considered what is likely to be the most efficient mechanism for awarding licences for the spectrum bands. Ofcom has set out, in the SFR:IP and in the SFR Statement, its general view that an auction mechanism is likely to be its preferred tool for assigning licences for unused spectrum, where demand could exceed supply. An auction is likely to be the most open, transparent and non-discriminatory way of releasing spectrum, using clear and simple criteria to identify eventual licensees among a number of candidates. Having considered the particular circumstances of these spectrum bands, taking into account that potential demand is likely to exceed the total available spectrum across the bands, Ofcom has concluded that an auction mechanism should be used.
- 4.7 Auctions are used to award licences to those bidders prepared to pay most for them. They are, therefore, likely to lead to the spectrum rights being assigned to users that value them most highly. These will generally be those likely to use the spectrum most efficiently. By contrast, in Ofcom's view, other assignment mechanisms are unlikely to be as efficient in promoting optimal use of the spectrum. Alternative assignment mechanisms include first come first served processes, where licences are assigned to applicants in the order of their application, and comparative selection processes, where licences are assigned to the applicants that, in the regulator's judgement, best satisfy the selection criteria that it has set. A first come first served process would not be appropriate in this case, where demand for spectrum could exceed supply - the first applicants may not be those who would make the optimal use of the spectrum. A comparative selection process involves defining selection criteria and assessing candidates' submissions and so carries the risk of subjective judgements being made and of the spectrum not being awarded to the bidder best able to use it to maximum economic advantage.
- 4.8 Ofcom's considers that this reasoning is relevant to these spectrum bands as it is to many other spectrum bands. Moreover, as discussed above, the three bands could all be used for similar applications and could be substitutes for each other. Bidders might be prepared to obtain spectrum in any of the bands, or perhaps in a combination of them. An auction would be the most effective mechanism for allowing bidders to meet their requirements, by giving them the ability to switch between bands or to obtain a package of licences in a simultaneous process. These aspects of the award process are discussed more fully in section 6.
- 4.9 Ofcom has considered the possibility of low demand for licences in the spectrum bands and the risk of incurring costs in the preparations for an award that might prove unnecessary. Ofcom believes that, bearing in mind that the award is one in a programme of awards and that preparations have already been made for other awards, the additional costs of preparing for this award are likely to be modest. Alternative award mechanisms would themselves incur costs, without providing the advantages of an auction.
- 4.10 Ofcom's proposal to use an auction as the method for assignment, and Ofcom's other proposals relating to the details of the auction design, are derived from the objectives for the award, and in particular the aim of securing optimal use of the spectrum. It is not Ofcom's objective to raise revenue by means of spectrum auctions and, given Ofcom's statutory duties, this is not a consideration that Ofcom has taken into account.

Technology and service neutrality

- 4.11 As set out elsewhere (see in particular the SFR, SFR:IP and Liberalisation Statement), and consistent with its statutory duties, Ofcom's preferred approach is to remove restrictions in existing wireless telegraphy licences that are no longer proportionate or objectively justified, enabling users to make better use of the spectrum and to introduce a wider range of services and technologies. Equally, when granting new wireless telegraphy licences Ofcom believes that, since technologies can change and develop over time, any restrictions on the permitted use of the spectrum must be kept to the minimum necessary and must be clearly justifiable and proportionate. Ofcom does not wish to constrain future use of spectrum by prescribing the permitted use in licences where it is not necessary for spectrum management reasons.
- 4.12 Ofcom considers that this approach is also supported by the fact that the Framework Directive requires that national regulatory authorities take the utmost account of the desirability of making regulations technologically neutral. As a consequence, Ofcom is required in section 4 of the Communications Act 2003 to meet a number of duties relating to "community requirements". One of these is a requirement to act in a technology neutral way.
- 4.13 Consistent with this general approach, Ofcom intends to release unused bands to the market with only those technology and usage restrictions that are the minimum necessary for the efficient management of the radio spectrum and the avoidance of interference, and for compliance with Ofcom's statutory duties and international obligations.
- 4.14 Ofcom's technical analysis (see Annex 6), indicates that it is not necessary to place any technology or usage restrictions on the spectrum bands other than power level and out-of-block emissions. In making this spectrum available in a technology neutral way, licensees will have the freedom to deploy a particular technology if they wish, but will not be required to do so. Ofcom considers that this is a proportionate and objectively justifiable approach, which provides the most appropriate means of meeting Ofcom's objectives for the award and its duties under UK and European law. It is not unduly discriminatory as it avoids differential treatment of technologies or persons and is transparent in what it seeks to achieve.

Timing of the award

4.15 Ofcom aims to release spectrum, where it is not already in use, as soon as reasonably practicable. It indicated in the SFR:IP Interim Statement that, following a consultation on detailed proposals for the award of the spectrum bands, it would possibly hold the award in 2006-07. No response suggested that this was unacceptable. The market assessment showed some keenness for the award of 28 GHz regional licences on a short time scale but there was generally a relaxed view on the timescale. Ofcom considers that it should be practicable to hold the award in 2007 but will consider the appropriate timing in the light of responses to this consultation.

Competition issues

4.16 Competition issues may arise if there are no close substitutes to the spectrum bands being awarded in order to serve relevant downstream market(s). In the absence of close substitutes, the purchase of all available spectrum could have the effect of excluding potential competitors from supplying the downstream market(s) in question. As a result there could be a significant impact on competition in the downstream market(s) for services that require the spectrum as an input since no alternative input would be available. In effect a bidder could achieve a monopoly position through the acquisition of the spectrum.

- 4.17 The more (and closer) substitutes that exist, however, the less the potential impact on the downstream market(s), since potential competitors could use these substitutes with little impact on their costs or service quality.
- 4.18 Ofcom has considered the extent to which substitutes exist for the spectrum bands being considered for auction. This has been done by assessing the potential for using alternative inputs to produce the applications expected to be supplied using spectrum in the spectrum bands.
- 4.19 It is also worth considering whether any competition problems would be caused if a successful bidder already held a position of strength in any markets such that it might have anti-competitive motives for acquiring the spectrum. If this were to be the case it might be appropriate to award the spectrum in a way that is more likely to facilitate entry and/or to promote competition more generally.

Programme-making and special events

- 4.20 Broadcasters and programme makers are potential users of the 10 GHz band for PMSE applications such as video links and wireless cameras.
- 4.21 A number of spectrum bands, other than the 10 GHz band, could be used for supplying PMSE services. It is possible that spectrum for PMSE will become more scarce (relative to demand) over the next 10 years, assuming no further spectrum is made available, as some of the bands are expected to be reclaimed for other uses. In principle, if there were a shortage a single broadcaster could purchase all the available 10 GHz spectrum, thereby denying it to potential competitors.
- 4.22 However, Ofcom does not expect there to be significant competition concerns. This is for several reasons. First, other spectrum continues to be available for wireless cameras (the most likely PMSE application at 10 GHz), so even if one party acquired all the spectrum for award at 10 GHz, spectrum that is an acceptable substitute is available. Second, Ofcom's programme of releasing spectrum on a technology and application neutral basis includes other bands that could also be used for wireless cameras (e.g. 1452-1492 MHz, 2010-2025 MHz, 2290-2302 MHz and 2500-2690 MHz). Third, work under way by Ofcom could further increase the supply of spectrum for civil use (including PMSE)¹⁷. In addition changes to the availability and relative cost of satellite links over time may mean that these could provide an effective substitute for terrestrial links. Moreover, Ofcom has no reason to believe that any broadcaster is currently in a position of market power, such that there may be anticompetitive motives for acquiring the spectrum.

Fixed applications

4.23 For point-to-point and point-to-multipoint based services the three bands proposed for auction are broadly substitutable, although Ofcom's consultants have suggested that there is likely to be more interest in the 10 GHz band than in the 28 GHz or 32 GHz bands. In addition spectrum in the 23 GHz, 26 GHz and 38 GHz bands can be

¹⁷ For example, the Independent Audit of Spectrum Holdings produced by Professor Martin Cave recommended the sharing of MOD bands, some of which may be useful for PMSE. In addition other spectrum or shared spectrum may become available for PMSE.

used for point-to-point applications, although this would be a weaker substitute than the other bands since it would not support point-to-multipoint applications.

- 4.24 It is also worth noting that wired applications, such as leased lines or self-provided fibre, may provide cost effective substitutes for wireless applications. However this may raise the possibility of other competition concerns. The leased line market review (http://www.ofcom.org.uk/consult/condocs/llmr/llmr_review/llmr_1-11.pdf) did not find that wireless applications were effective substitutes for leased line applications but it is worth considering the competition concerns that could arise if the spectrum could be used to provide an effective substitute to wired applications. For example, since BT is considered to have significant market power in the terminating segment and trunk segment wholesale leased line markets, it could potentially be motivated to acquire the spectrum so as to reduce the competitive threat to its market power in wholesale leased lines from fixed links using this spectrum.
- 4.25 However, given the availability of substitute spectrum for the likely downstream uses it is not clear that such a strategy could be feasible and, in addition, competition law or specific regulatory remedies are available to address such issues if they arise. Therefore, Ofcom does not believe that there is any significant competition concern in relation to the proposed auction of the spectrum bands.

Section 5

Spectrum packaging

- 5.1 This section outlines Ofcom's proposals and rationale for the packaging of rights and obligations to be granted under the wireless telegraphy licences for the spectrum bands.
- 5.2 Ofcom's principles for spectrum management, as set out in the SFR and SFR:IP, suggest that in general decisions as to how spectrum is used should be determined by market mechanisms, rather than being the responsibility of the regulator. However, to make spectrum available to the market Ofcom must package the spectrum in some way. This should be done in a way that facilitates efficient use.
- 5.3 In order to achieve this Ofcom needs to understand the potential uses of the spectrum. The proposals outlined in this section draw on the market assessment undertaken for Ofcom by its consultants see paragraphs 2.26ff above. Ofcom considers that the proposals are consistent with the objectives identified for the award and its statutory duties.
- 5.4 Ofcom aims to package spectrum in such a way as to enable potential users to obtain spectrum that is compatible with their commercial needs. To this end packaging options need to reflect likely demand for the spectrum and the most likely technologies to be deployed in each of the spectrum bands. Depending on the downstream application for the spectrum, requirements of potential users may vary; they may, for example, have different requirements in terms of bandwidth and/or geographic coverage of spectrum.
- 5.5 Ofcom has considered different packaging options for each of the spectrum bands, focussing on geographic coverage and the appropriate number of licences to be awarded in each. Options include: offering licences on a paired or unpaired basis; a regional or a UK basis; and the appropriate spectrum assignment within each band. Although demand for spectrum is uncertain, as are the type of technologies or services that will be deployed in each band, the consultants surveyed a number of potential bidders for their preferences about spectrum usage. The packaging options reflect the findings of their survey.
- 5.6 The way spectrum is packaged will have an impact on auction design. For example, to the extent that licences are independent, auction design will generally be simplified; complexities are introduced where demand for one licence is affected by the price of another. There are a number of other issues to be considered in terms of how packaging affects auction design. For example, ideally spectrum packages should not be so small that bidders are required to acquire more than one package in order to satisfy their minimum requirements. This would force bidders to face the risk of winning an inadequate amount of spectrum through the auction process and cause them to incur costs after the auction (i.e. purchasing additional spectrum from successful bidders) or be left with spectrum which they could not use. Similarly it would be preferable if spectrum packages were not so large that bidders acquired spectrum which was surplus to their requirements. This could have the effect of denying other potential bidders the opportunity to use the surplus spectrum.
- 5.7 These considerations may affect participation in the auction. Ofcom's aim is to package the spectrum in a way that maximises the chance of attracting serious bidders. It is desirable not to deter potential bidders by inappropriate spectrum

packaging. This is important since the most efficient auction outcome is likely to be achieved where there is a degree of competition for the packages.

5.8 Therefore Ofcom has considered how the available spectrum can be packaged taking into account both demand from potential bidders and the implications for auction design and a successful auction. The packaging options Ofcom has considered for each band are outlined below, along with an assessment of the advantages and disadvantages of each option. The auction design is discussed in Section 6.

10 GHz spectrum packaging options

5.9 There is a total of 2x100 MHz of spectrum available in the 10 GHz band. Ofcom is proposing to offer this as a single UK lot. In arriving at this proposal Ofcom considered two options: offering two separate 100 MHz lots or a single paired 100 MHz lot. The relative advantages and disadvantages of both options are considered below.

Option A: two separate 100 MHz lots

- 5.10 Option A has been considered because of the interest shown in the spectrum by the PMSE community. Since PMSE links operate in one direction the interests of any potential bidder planning PMSE use could be met by acquiring unpaired spectrum (such as a single lot of 100 MHz). However, bidders wishing to acquire spectrum for FWA and backhaul applications will require paired spectrum (such as 2x100 MHz).
- 5.11 The benefit of offering two separate 100 MHz lots at 10 GHz is that in principle it might provide a better way of addressing both the needs of potential bidders interested in acquiring spectrum for PMSE and the needs of those interested in acquiring spectrum for FWA and backhaul applications. There might be a related benefit in terms of increased competition for the lots.
- 5.12 However, there would also be a significant disadvantage to this option for bidders interested in FWA and backhaul applications. This is that they would face the risk of acquiring only one of the two 100 MHz lots on offer, which would not give them sufficient spectrum for their requirements. In other words, these bidders would be exposed to aggregation risk. The auction might be designed to address this risk by accommodating package bidding, but this, in turn, can create problems for single lot bidders competing against a package bidder for the same lot. This aspect of auction design is discussed below in paragraphs 6.19-6.20.

Option B: a single paired (2x100 MHz) lot

- 5.13 The alternative package considered is that of a single paired (2x100 MHz) lot. This would reduce the aggregation risk for potential bidders interested in FWA and backhaul applications, which on the evidence of Ofcom's market assessment are among the more likely uses for the spectrum.
- 5.14 Under this option, there is a greater probability that individual bidders interested in PMSE applications might need to acquire more spectrum than they required. However, PMSE bidders would have the opportunity to adjust their behaviour in order to manage this risk. In particular different PMSE bidders could work together before the auction to reduce this risk. They could for example form a consortium to bid for the spectrum with a view to either sharing access to it or dividing it after the auction. With the application of spectrum trading, a wide range of options would be

open to the winning bidders for future disposition of the spectrum, including separating the single licence into two licences each of 100MHz (or other splits by frequency or geography).

- 5.15 The consultants found that the interest shown in spectrum for PMSE application reflected the views of a consortium of broadcasters, indicating that such coordination should be possible between interested parties.
- 5.16 Ofcom views this option as preferable as it would meet the predominant source of demand for paired spectrum without eliminating the possibility of those wanting unpaired spectrum meeting their own requirements, by for example forming a bidding consortium.

28 GHz spectrum packaging options

5.17 As explained above, the spectrum available for auction in this band consists of two UK paired spectrum lots of 2x112 MHz, as well as a number of regional licences which were not sold in a previous auction. Since the consultants found that there was considerably more interest in UK licences than regional licences and for paired than unpaired spectrum Ofcom has considered the relative merits of options which reflect this demand.

UK licences

- 5.18 The spectrum available for auction on a UK basis in this band consists of two UK blocks, each of 2x112 MHz. However, it would be possible to offer one of the blocks as two unpaired lots. This would give two options to consider:
 - Option 1: three UK lots, consisting of a paired lot of 2x112 MHz and two unpaired lots each of 112 MHz;
 - Option 2: two UK lots, consisting of two paired lots each of 2x112 MHz.
- 5.19 Since the consultants found that there was limited interest in unpaired spectrum for this band Option 2 would be preferable, particularly since numerous parties expressed interest in paired spectrum in this band. The disadvantage of this is that if a potential bidder did want to acquire an unpaired lot it would be forced to acquire spectrum which was surplus to its requirements. However, the limited interest in unpaired lots suggests that this should not be a major consideration. Option 1 could create an excess supply of unpaired lots but add to potential excess demand for paired lots.

Regional licences

- 5.20 There are 27 existing regional licences available within three separate spectrum packages of 2x112 MHz. The consultants found limited interest in these licences, with greater preference shown for UK-wide licences. As a result Ofcom has considered ways in which the lots could be packaged to encourage more interest. This gives rise to three possible options for packaging the spectrum:
 - Option 1: 27 regional paired lots of 2x112 MHz;
 - Option 2: two geographically limited paired lots of 2x112 MHz and one regional lot of 2x112 MHz;

- Option 3: three geographically limited paired lots of 2x112 MHz.
- 5.21 Options 2 and 3 have been devised such that the regional blocks have been aggregated to form two or three sub-UK licences. This is expected to be of more interest to potential bidders than 27 regional lots, since they would be able to acquire licences covering more useful geographic areas than under Option 1. Figure A9.2 in Annex 9 illustrates the coverage of each potential geographically limited lot.
- 5.22 In addition the aggregation of regional lots is likely to simplify the auction design. If regional lots were offered for auction the design would have to cater for the likelihood of complementarity between lots for prospective bidders wishing to obtain UK or near-UK coverage. Otherwise, the problem for such bidders would be that they then faced aggregation risk.
- 5.23 The disadvantage of aggregating the regional lots is that anyone wishing to focus on a particular region would be forced to obtain a licence with a wider geographical coverage. Option 2 is designed to overcome this problem. However, Ofcom believes that the risk of this occurring is small since few organisations expressed interest in the regional licences to the consultants. Ofcom therefore favours option 3.

32 GHz spectrum packaging options

- 5.24 As noted in paragraph 2.21, Ofcom is proposing to merge the upper portion of this band, currently available for fixed link assignments, with the rest of the band. Taking account the central guard band of 56 MHz, this would enable Ofcom to package 2x756 MHz into appropriate UK lots. Three options have been considered for packaging:
 - Option 1: a single UK paired lot of 2x756 MHz;
 - Option 2: a single UK paired lot of 2x252 MHz and four UK paired lots of 2x126 MHz;
 - Option 3: six UK paired lots of 2x126 MHz.
- 5.25 Ofcom believes that Option 1 is not a viable option given that the package available is likely to be significantly larger than any potential bidder requires for their applications and would likely result in some unsatisfied demand i.e. would be economically inefficient.
- 5.26 Options 2 and 3 have been considered as viable in terms of attracting interest from potential bidders. However, Option 3 is considered more appropriate for a number of reasons. First, by offering similarly sized packages of spectrum to those available in the other bands bidders are more likely to view the packages as substitutable. This is likely to benefit the auction outcome if there is excess demand for some bands/packages since potential bidders will have other options available to them.
- 5.27 Option 2 has the benefit of satisfying demand for larger licences. One potential bidder expressed interest in this to the consultants. Although a bidder could acquire more than one 2x126 MHz lot to satisfy its requirements it could face an aggregation risk in the auction: by bidding on separate lots it would face a risk of not acquiring as much spectrum as it needed. However, Ofcom believes that interest has been shown in larger packages mainly to cover the possibility of future business growth and with it growth in spectrum requirements, rather than because of complementarity (e.g. two contiguous lots being more valuable than the combined value of each on its own).

- 5.28 In addition, by offering a number of smaller lots, Ofcom avoids the situation where bidders are forced to acquire larger blocks of spectrum than they require for their applications. Consequently, Ofcom believes that Option 3 is the most appropriate option.
- 5.29 A further option would be to divide the band into, say, 15 unpaired 100 MHz lots. This would potentially allow greater flexibility in use of the band, allowing bidders to obtain assignments for both paired and unpaired use. But a more complex auction design might be needed to address the aggregation risks faced by bidders wanting to pair lots. Given that demand appears to be predominantly for paired spectrum the extra complexity introduced would not be justified.

Summary of proposed licence packages

5.30 The table below summarises the proposed spectrum packages. The advantages and disadvantages of each package are summarised in the impact assessment at Annex 7.

Band	Spectrum packages
10 GHz	One UK licence of 2x100 MHz
28 GHz	Two UK licences each of 2x112 MHz
	Three 'geographically limited' licences each of 2x112 MHz, each with varying geographical coverage (see Annex 9 for maps illustrating this)
32 GHz	Six UK licences each of 2x126 MHz
TOTAL	12 licences

Section 6

Auction design

- 6.1 In general, assuming that there are no major market failures, the amount that someone is willing to pay for spectrum is a good indicator of who will use the resource most efficiently. An auction is a good mechanism for determining this. Section 4 outlined Ofcom's view that auctions are likely to be the most open, transparent and non-discriminatory method for releasing unused spectrum and as such are likely to be the preferred method for assigning licences for unused spectrum, compared with beauty contests or the award of spectrum on a first come first served basis.
- 6.2 This section considers the options for auction design available to Ofcom. Ofcom must decide on the format of the auction as well as designing the rules for running the auction and selection of the winners. Issues considered include whether:
 - Bidders should be able to bid for all licence packages at the same time (simultaneous bidding) or for one package after another (sequential bidding);
 - There should be an open auction, where bidders can see each others' bids, or a sealed bid auction, where each bid is concealed;
 - The auction should be based on a single round or multiple round format;
 - There are generic or specific lots;
 - Bidders should only be able to bid for discrete lots or different combinations of lots (known as combinatorial or package bidding).
- 6.3 In addition auctions need to be practical from the perspective of both Ofcom and bidders. Consequently the evaluation of different formats also considers the relative complexity of the possible auction designs.
- 6.4 The choice of auction rules is also considered in this section. These generally depend on the auction format and cover issues such as:
 - Selection of the winning bidder for example how winners will be chosen if there
 is a tie;
 - How much the winning bidders have to pay;
 - The size of the deposit required;
 - The minimum bid price.

Issues for auction design

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

- There may be asymmetries between potential bidders in the auction, as a result of differences in their current market position and the information available to them about the market opportunity offered by the spectrum, or because of differential access to finance (possibly as a result of capital market inefficiency). This may encourage perceptions that some bidders (e.g. incumbent operators) are 'strong' and others (e.g. prospective entrants) are 'weak', even if in some cases, a 'weak' bidder might have the strongest business case. Where asymmetries are significant, weak bidders may be reluctant to invest time and effort in entering the auction, with the consequence that the auction may be less competitive and effective than it might have been. Auction theory and practice has demonstrated that open, multi-round auctions tend to discourage entry by 'weak bidders', who fear that they will be overbid until they lose. By contrast, the use of sealed bids and/or restrictions on transparency can help to ease the impact of asymmetries, as 'weak' bidders perceive themselves to have a better chance of winning. This may encourage competition within the auction.
- Some auction designs may be vulnerable to strategic behaviour by bidders attempting to influence the auction outcome in their favour. For example, (especially in open multiple round auctions) it may sometimes be possible for strong bidders to collude, tacitly or otherwise, to fix the number of licences or influence the price that they pay.
- A further potential problem that requires consideration when designing the format of an auction is the situation where bidders have a high degree of common value uncertainty on licences, such that they are potentially exposed to the problem of 'the winner's curse'. This arises because those bidders who over-estimate the value of licences in a common value setting are likely to win. Rational bidders should respond to this problem by reducing their bids relative to their best estimates of value. Nevertheless, the common value uncertainty faced by bidders can result in problems, either because differences in the assessment of common value may swamp small differences in the true value across bidders or else because winner's curse affects weak bidders more than strong bidders, exacerbating their disadvantages. Using open, multi-round auctions and high transparency can reduce common value uncertainty, as bidders can learn from the bidding behaviour of competitors.

Choices for auction format

Simultaneous or sequential award of spectrum lots

- 6.6 If the spectrum is awarded as multiple lots (see section 5 on packaging proposal) these can be sold either simultaneously (all at the same time) or sequentially (one after the other). An important consideration in deciding which is preferable in any given case is the complementarity and substitutability of the spectrum lots.
- 6.7 The demand assessment suggested no lots would be perceived as complementary by bidders if Ofcom's preferred packaging options are adopted. As a result aggregation risk (i.e. the risk that a bidder will win one lot but not other complementary lots) should be largely avoided.
- 6.8 For most categories of bidders (with the exception of PMSE operators which have been identified as being primarily interested in unpaired spectrum lots in the 10 GHz band), UK-wide paired lots of 2x100 MHz or similar across the spectrum bands would potentially be substitutable. This appears to be the case for bidders wishing to acquire spectrum for FWA and backhaul applications. The effect of this is that

bidders' demands between lots will be affected by the relative prices of individual lots. The substitutability of lots across bands introduces the risk that a bidder may win one lot (or group of lots) when, at prevailing prices for a substitute lot(s), it would have preferred to win this other lot (or group of lots) and would have the highest valuation for that lot.

- 6.9 Sequential auctions create severe difficulties for bidders where lots are either substitutes or complements. In a sequential auction bidders must bid for one lot without knowing what the price of other substitutable or complementary lots will be. By contrast, a simultaneous approach can allow bidders to manage both substitution risk and, to some extent, aggregation risk (associated with complementary lots).
- 6.10 Given the substitutability of the lots in question, Ofcom has a preference for the simultaneous award of all lots across all bands.

Single round (sealed bid) or multiple rounds (ascending bids)

- 6.11 Both single round sealed bid and multiple round ascending bid auction formats are commonly used for assigning radio spectrum. Sealed bids may be favoured for their simplicity and, where there are significant bidder asymmetries and related concerns about the level of competition in the auction and relevant downstream markets, because they can encourage participation. However, in some circumstances, multiple round auctions can produce more efficient outcomes than sealed bid auctions as bidders can learn from observing the behaviour of competitors over the course of the auction. Ofcom proposes, for a number of reasons, to award the available spectrum across these bands through a multiple round process.
- 6.12 Where common value uncertainty exists, the outcome of the auction will be enhanced if bidders are able to observe the behaviour of their rivals over the course of multiple rounds. Since there may be bidders targeting very similar downstream markets, e.g. FWA operators, it is possible that they will have a high degree of common value. However, whether there will be a high degree of uncertainty about this common value and how it compares to private value considerations is not clear. On balance, however, Ofcom considers that there is likely to be some common value uncertainty and that bidders may benefit from being able to observe how their rivals' demand shifts in response to prices.
- 6.13 As discussed above, most bidders for the available spectrum are likely to face substitution risks. By allowing bidders to shift between lots and adjust their demand in response to changes in relative prices, these risks can be minimised.
- 6.14 Although multiple round auctions might be more complex to participate in than sealed bid contests, Ofcom believes the benefits of participation simplicity are not so great that this could justify using a significantly less efficient auction format. In addition Ofcom will ensure that bidders are well informed about the auction design and its procedures prior to the award, among other things through bidder seminars.
- 6.15 It is also relevant to consider that while participation in a multiple round auction may be complex for bidders a single round sealed bid auction can also introduce strategic complexity for bidders. This is particularly so where it is difficult for bidders to calculate the value of the spectrum that is available. As noted above, in a sealed bid auction, there is no opportunity for bidders to learn through the auction process. This means that in a sealed bid auction, bidders will potentially have to invest more time and resource to calculate their willingness to pay for the available spectrum and will

not benefit from the information about value otherwise revealed in an open ascending auction.

Generic or specific spectrum lots

- 6.16 Ofcom is proposing that the lots available for award should be sold on a specific basis, i.e. where bidders bid for lots defined by specific frequencies. In contrast, with generic lots bidders simply specify the number of lots that they want; the actual frequencies that they are awarded are allocated in a follow-up process.
- 6.17 The main advantage of the generic approach lies in the simplicity of the process for bidders they have to identify only the number of lots they want at a particular price. However, in such a generic approach bidders cannot express a preference between lots, which may not be appropriate where there are significant differences in value between lots.
- 6.18 Although some lots across all three bands could be considered substitutes by some bidders. Ofcom does not believe that offering generic lots would be acceptable to all bidders. The spectrum will appeal to different types of bidders with different applications in mind and using different technologies and equipment (some of which may be better suited to some bands than others) and so some bidders will have strong preferences about the spectrum they wish to acquire. Furthermore, bidders may not be comfortable bidding for generic lots without knowing which specific frequencies they will be assigned. Using specific lots adds to the complexity of the auction process but Ofcom believes that this is justified in order to satisfy bidder requirements to express preferences between different lots.

Package (combinatorial) bidding

- 6.19 In an auction with package bidding, bidders submit mutually exclusive bids for combinations of lots, rather than making multiple bids on individual lots. Package bidding can improve the efficiency of auctions in the specific circumstance when lots are complementary because it reduces aggregation risks for bidders. This should encourage participation by bidders with different patterns of complementarities, resulting in more efficient outcomes.
- Ofcom has considered whether package bidding would be appropriate for this award. 6.20 The need for such an approach is limited as 10 GHz is the only band where complementarity might be a feature, and that would only occur if the band were offered as unpaired lots, e.g. two each of 100 MHz. (This is on the assumption that the regional licences in the 28 GHz band are aggregated into sub-UK licences.) Moreover, package bidding is not without its problems. In particular, while addressing the aggregation risk, it introduces a threshold risk¹⁸ for bidders wishing to obtain only one of a pair of lots. The risk may be overcome by such single lot bidders acting in concert, with the aim of out-bidding those bidding for both lots. As discussed in paragraphs 5.14-5.16 above. Of com considers that single lot bidders might take such an approach in co-ordinating their bids for the proposed 2x100 MHz lot at 10 GHz. This would be Ofcom's preferred way for single lot bidders to achieve their objectives since it could be adopted within a simultaneous multiple round auction (SMRA) and avoid complicating the auction design where the issue to be addressed affects only one of the three bands to be awarded.

¹⁸ Threshold risk refers to the problem of free-riding among single lot bidders. Some of the single lot bidders may restrain their bidding in the hope that others will bid high enough for their joint bids to beat those bidding for the paired lot.

Conclusions on auction format

6.21 The key factors influencing Ofcom's assessment of the various auction formats are summarised in the following table

Format	Advantages	Disadvantages
Simultaneous award of lots	Allows bidders to manage substitution risks	
Sequential award of lots		Limited knowledge for bidders of the price to be paid for substitute lots
Single round	Allows simple sealed bid process	Does not enable bidders to gain information on lot values from others bidders' behaviour
Multiple round	Allows bidders to observe behaviour of rivals and refine their own valuations	More complex to run than single round auction
Generic lots	Simplifies the auction	Requires follow-up action to assign specific spectrum packages
Specific lots	Suitable where there are material differences between lots	More complex for the auction process than generic lots
Package bidding	Reduces aggregation risks for bidders where lots are complementary	May complicate auction design and introduces threshold risk

6.22 Ofcom has concluded that using a SMRA process would be the most appropriate approach for the award of these bands, rather than sequential or single round formats. Moreover, it would be appropriate to use specific rather than generic lots. Ofcom does not believe that it is appropriate to introduce package bidding to the auction design.

Auction rules

6.23 The following describes how the auction will be run, on the basis that it will be a SMRA. Full details of the rules for the action will be included in Regulations that Ofcom will separately consult on and make before the auction.

Participation rules

- 6.24 Of com does not intend to restrict who may bid in the auction beyond requiring that each bidder be capable of meeting the terms of the licence to be issued and be a fit and proper person to hold a licence.
- 6.25 Ofcom is not proposing to place any restrictions on the number or identity of lots that an eligible bidder can bid for, other than as determined by their initial deposits.
Bidder association and rules prohibiting collusion

6.26 Rules to prohibit collusion and bidder association will be important given that this is a multiple round auction, and penalties will need to be an adequate deterrent to such behaviour.

Minimum bid price

- 6.27 Minimum bid prices are a useful mechanism for deterring frivolous bidders, as long as they are not set so high as to deter any serious entrants. As a result Ofcom intends to set a minimum bid price above zero for each individual lot. The minimum bid prices would also determine the initial prices for lots in the auction. For this award, the main considerations for setting minimum bid prices above zero are:
 - to ensure that the auction only attracts serious bidders; and
 - to speed up the auction process, if possible, by avoiding having many auction rounds at prices per lot where there is substantial excess demand for all lots.
- 6.28 The aim of attracting only serious bidders points to setting a minimum bid price at a low but non-trivial level. For small spectrum lots in other auctions Ofcom has proposed a minimum bid price of £50,000 per lot. This auction will use a multiple round rather than sealed bid process. Thus, instead of a single round in which all prices are determined, prices may rise only gradually on a round-by-round basis. Therefore, there may be a case for setting a minimum bid price above £50,000 per lot if Ofcom could be reasonably confident of attracting demand for all lots at much higher prices. However, this should be offset against the risk that a high minimum bid price will deter potential bidders and that Ofcom may face the need to repeat the auctions with a lower minimum bid price. As a result Ofcom believes that £50,000 is an appropriate non-trivial minimum bid price for each lot that will be available.

Activity rules and bidder eligibility

- 6.29 The eligibility points that a bidder holds determines the maximum number of lots that it may bid for in the auction. Ofcom is proposing that each lot in the auction will be covered by a single eligibility point. It would be possible for Ofcom to vary the eligibility points between licences where, for example, the spectrum quantity or quality varied significantly between them. Ofcom is proposing that similar (although not identical) lots are offered for each licence and so it seems appropriate to assign one eligibility point per licence.
- 6.30 Applicants will be required to state how many licences they wish to bid for (though not which ones) and this will determine their eligibility points at the start of the auction.
- 6.31 Activity rules are designed to ensure each bidder participates fully in the auction. To this end Ofcom wishes to ensure that a bidder cannot refrain from bidding until a late stage in the auction, having watched bidding activity in the early rounds. Such bidder behaviour would enable it to assess others' actions without revealing its own strategy. This is counter to a key function of the SMRA, which is the sharing of information between bidders, and all must engage fully to allow this.
- 6.32 A bidder is active in a round if it either holds the highest bid on one of the licences *or* if it makes an acceptable bid on one of the licences *or* if it exercises a waiver. In order to ensure full participation each bidder will have to meet the activity levels set

by the auctioneer, or else lose eligibility points. Ofcom may decide to set an activity requirement of 100% throughout the auction. Alternatively, it may decide to use activity requirements that become progressively more onerous as prices come closer to final prices. This is the approach used in many previous SMRAs, which set activity requirements in stages.

- 6.33 The advantage of using stages is that it allows more fluid switching between licences, as bidders do not necessarily need to bid on all of the licences that they might ultimately need until late in the auction when prices are more informative.
- 6.34 With this approach, Ofcom would set an activity requirement between 0% and 100%. for each stage of the auction. If we call this requirement X, bidders would need to exhibit activity of at least X% of their eligibility in order to maintain their current level of eligibility. The value of X is typically increased in steps as activity in the auction falls, e.g. a typical SMRA might have three stages, with X= 60%, 75% and 100%.
- 6.35 To illustrate how the activity rule would work in general, suppose that eligibility at the start of a round was E. A bidder would need to have activity of at least X*E. (Rounding is required if X*E is not an integer) If the level of activity (A) is less than the activity requirement (AR), eligibility in the next round is reduced in proportion to the shortfall, i.e. eligibility becomes E*A/AR (again rounding to an integer may be required).

Deposit and payment rules

- 6.36 Deposits are upfront payments that will be forfeited if a bidder breaks specific auction rules or a winning bidder defaults on its payment. They help to deter frivolous bidders and to reduce any strategic incentives for default. Ofcom must include the level of both initial deposits and bid deposits as part of the auction rules. The initial deposit could be either a flat rate or linked to the number of licences an applicant wishes to bid for. Ofcom considers that the latter approach would be appropriate. This ensures that the gains from default (to potential defaulters) are diminished and links deposits to bidder demands.
- 6.37 Ofcom therefore proposes setting an initial level of deposit proportionate to the number of lots on which an applicant declares it wishes to bid. For example if the initial deposit was set at £25,000 per lot, then a bidder wishing to start the auction with eligibility to bid for five available lots would need to submit a deposit of £125,000.
- 6.38 Setting bid deposits is less straightforward. Given the possibility that bids in the auction could rise to many times the minimum bid prices, it is apparent that the initial deposits could during the course of the auction become too small a proportion of bids to act as an adequate deterrent to default. Therefore, Ofcom proposes to introduce a mechanism to ensure that bidders increase their deposits in a way that reflects their aggregate bid levels at set points during the auction.
- 6.39 A problem with this proposal is that it can be difficult to administer. The auctioneer needs confirmation that a bidder has sufficient deposit to cover its exposure to payment in any round; bidders will have to arrange timely deposits and the auctioneer will need to receive timely updates from its bank. One way of minimising the problem is to set the points at which deposits increase in such a way that they are not reached too frequently. But the auctioneer must also ensure that these points are not so widely spaced that the deterrent to default and to bidders deliberately

breaching the auction rules is undermined. This calls for fine judgement in setting the points at an appropriate level.

6.40 Ofcom propose that winning bidders will be required to pay 100% of the fee for their licence by a specified time, and the licences will only be issued after payment has been received. Further, if a bidder defaults on payment for the licence it will forfeit its deposit and will remain liable for the outstanding balance, and of course it will not be granted a licence.

Bid withdrawal

6.41 Bid withdrawal is a means of reducing aggregation and substitution risks by allowing current high bidders to withdraw their bids. Where there are aggregation risks, such that a bidder risks being stranded on a lot for which it has little value when not combined with another complementary lot, there may be an argument to allow bid withdrawal. In addition bidders may face substitution risk, where they are the highest bidder for a licence for which there is a lower priced substitute. Although, as there is no evidence of complementarity between licences (given the packaging proposed), aggregation risks are not thought to be relevant for this award, bidders may face some substitution risk. However Ofcom believes that the risk faced by bidders is not sufficiently large to warrant the complexity to auction rules which would be introduced by allowing bid withdrawal.

Managing the pace of the auction

- 6.42 Rules concerning bid increments, the timing of rounds, waivers and recess days will affect the pace and management of the auction process. Ofcom intends to deploy rules that can give itself as auctioneer flexibility in managing the pace of the auction such that it can proceed as quickly as possible, without jeopardising efficiency.
- 6.43 Bid increments are set by the auctioneer to control the pace of the auction. Large bid increments can be used to accelerate the pace of the auction, but they should not be so large that they lead to an inefficient assignment at the margins. Ofcom's provisional proposal is to retain flexibility to set increments between 5% and 100%. This should allow the auctioneer to address the possibility that the minimum bid price has been set low relative to valuation for the licences. By retaining the flexibility to alter bid increments up or down in different rounds, subject to providing bidders with at least one round notice of any change, the auctioneer should be able to effectively steer the pace of the auction and react to the level of activity.
- 6.44 Round lengths need only be as long as is necessary to allow bidders to input, check and submit their bids. As with bid increments, Ofcom proposes giving the auctioneer full flexibility to determine the length of a round. Early in the auction, when bidders are getting used to the system and may have many new bids to submit each round, round lengths of, say, 30 minutes or more may be required. However, later in the auction, when there may be very few new bids or price changes in each round, shorter rounds of about 15 minutes or less may be feasible.
- 6.45 Intervals between rounds are important in managing the pace of the auction. The auctioneer will have the flexibility to set the timetable for rounds on a day-by-day basis. As activity in the auction slows, it may be possible to decrease the interval between rounds and so increase the number of rounds per day. However, in setting the timetable, the auctioneer would take into account the need to provide bidders with some predictability as to the pace of the auction, so that they can plan ahead for likely price increases and resulting changes in deposit requirements. For example,

where bidders are required to increase their deposit and so require time to arrange deposit transfers, longer gaps between rounds may be required.

- 6.46 Waivers allow a bidder to submit bids below its activity requirement without sacrificing eligibility in the next round. Waivers enable bidders to stand back from the auction and assess their position without being concerned about also submitting a bid during that round. Ofcom's provisional proposal is that bidders should be granted three waivers each at the beginning of the auction. Waivers could be deployed deliberately by bidders or would be deployed automatically in the event that a bidder, for whatever reason, failed to submit any bids in a round. This should protect against the risk of bidders being unable to submit bids on time due to circumstances beyond their control.
- 6.47 In addition Ofcom would retain discretionary powers to temporarily suspend the auction, or call recess days, abandon a round and restart the auction from the end of the previous round, or declare a 'last and final round'. These powers are primarily needed to guard against exceptional technical problems.

Transparency

6.48 Ofcom proposes that 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 also be able to monitor the identity of all other bidders and the bids they made. Bidders would also receive information about each bidder's initial eligibility and changes in eligibility on a round by-round basis.

Penalties

6.49 A bidder's deposit may be forfeit in full or in part if it breaches any of the auction rules, which cover such things as the submission of false or misleading information and collusive behaviour. A bidder may also be excluded from the auction. The Regulations may contain provision for minor penalties to discourage bidders from committing misdemeanours that disrupt the auction but would not distort its outcome. As deposits are to be made in cash, any monetary penalties incurred will be deducted from a bidder's deposit before it is either refunded or set off against payment of a winning bidder's licence fee.

Electronic bidding

6.50 Ofcom envisages that the auction will be run electronically allowing remote bidding, e.g. via the internet or a private network, using a secure system. Bespoke software will be designed to provide a bidder interface and to process bids.

Unsold licence

6.51 If any licences remain unsold after the auction - either through an absence of bids or default - Ofcom will reconsider its approach to release of the spectrum, and will choose whatever course of action it considers appropriate at that time.

Section 7

Regulatory conditions

7.1 This section sets out the proposed technical and regulatory conditions specific to the wireless telegraphy licences that Ofcom proposes to award for use of the spectrum bands. The underlying principle has been to keep restrictions on the use of the bands to the minimum necessary for efficient use of the spectrum and the avoidance of undue interference. This is consistent with Ofcom's preferred approach for technology and service neutrality, enabling users to make better use of the spectrum and to introduce a wide range of services and technologies. Responses to the SFR:IP relevant to licence conditions are addressed at Annex 8. A draft licence including the proposed licence conditions including further details on the transmission rights can be found in Annex 5.

Summary of technical licence conditions

- 7.2 Ofcom expects future use of the spectrum bands to be predominantly terrestrial fixed systems, though satellite earth stations may be used in 28 GHz. However, as except for the 10 GHz band there is little or no current use in the spectrum bands Ofcom has set the technical licence conditions without reference to specific technologies. Since there is no one technology that defines expected use in the bands there are a wide range of variables, including bandwidth, antenna patterns and modulation schemes. This means that the block edge mask to be applied to each band must be a compromise taking into account various considerations.
- 7.3 The spectrum mask used for all three bands derives from the spectrum mask shown in ECC Report 32¹⁹, which addresses point-to-multipoint (p-t-mp) co-existence (one of the potential uses in these bands). The mask proposed is where the guard band is included in the spectrum between adjacent spectrum blocks. However, the eirp limits in that mask appear to be too low for point-to-point (p-t-p) services that require long link lengths. Therefore, the eirp limit for the spectrum block has been limited only by the ITU limit for those bands noted in Article 21 Sections I and II of the Radio Regulations, while retaining the roll off as the emissions reach the edge of the block. The interface requirements for the spectrum bands refer to the limits in ETSI EN 301 390. This document quotes the spurious emissions and receiver immunity limits for equipment types that are likely to be used in the spectrum bands. The rationale behind this is that it is reasonable to expect the out-of-block emissions to be at a level shown within this document, where the combination of output power and antenna gain gives a value below that specified for the spectrum mask. Otherwise systems that employed low gain antennas might be permitted to exceed the antenna port spurious levels within EN 302 390, which would not be appropriate.
- 7.4 The licences originally awarded in the 10 GHz band (which have now been cancelled) restricted both the channelisation and bandwidths of the systems that might be used. Ofcom has used the core elements of the block edge mask referenced in ECC Report 32 in setting the proposed transmission rights for the band.
- 7.5 In setting the proposed transmission rights for 28 GHz Ofcom has considered the possibility of satellite earth stations operating both in the band and in adjacent spectrum. Because of the potential for the terrestrial use to cause interference into

¹⁹ <u>http://www.ero.dk/documentation/docs/doc98/official/pdf/ECCREP032.PDF</u>

satellite station receivers, and in order to protect satellite systems, the Radio Regulations note limits on the terrestrial use in terms of maximum power emitted and emissions directed towards the geostationary arc. Ofcom has taken account of these limits in setting the licence conditions for the band. It has recognised that in addition to terrestrial use the licensee may wish to work to a satellite. In that case the eirp may be increased above the limit for terrestrial use, as that terrestrial limit may be inadequate to access satellites. The technical content of spectrum Decision, ECC/DEC(05)01²⁰, produced by CEPT in March 2005, forms the basis of some of the qualified technical requirements in the band.

- 7.6 For reasons similar to those applying to the 10 and 28 GHz bands, the spectrum mask Ofcom proposes for the 32 GHz band has been derived from that used in ECC Report 32.
- 7.7 A more detailed discussion of the technical considerations that apply to the spectrum bands is contained in Annex 6.

10 GHz band

7.8 The spectrum rights proposed for the 10 GHz band are:

Necessary Bandwidth²¹ of emissions to be within the bands below

Spectrum Access 10 GHz (1) 10.125 to 10.225 10.475 to 10.575 GHz 2 x100 MHz	Spectrum Access 10 GHz (1) 10 125 to 10 225 10 475 to 10 575 GHz 2 x1
---	---

The spectrum mask for operation is represented as;

Offset from edge of block	Maximum permitted level
in block up to and including -14 MHz	55 dBW (in any measured bandwidth
from -14 MHz up to and including 0 MHz	$30 - (^{19}/_{14} \text{ x} \Delta_{F1}) \text{ dBW/MHz Note 1}$
from 0 MHz up to and including +14 MHz	-39 – (13 / ₁₄ x Δ_{F2}) dBW/MHz Note 2
+14 MHz of block edge	-52 dBW/MHz

Note 1: Δ_{F1} is the frequency offset between -14 MHz to 0 MHz of the block edge.

Note 2: Δ_{F2} is the frequency offset between 0 MHz to +14 MHz of the block edge.

Where;

0 MHz = edge of block - = in block of block edge

+ = out of block of block edge

²⁰ <u>http://www.ero.dk/documentation/docs/doc98/official/pdf/ECCDEC0501.PDF</u>

²¹ Necessary bandwidth is that as described within ITU-R SM.328-10

28 GHz band

7.9 The spectrum rights proposed for the 28 GHz band are:

Necessary Bandwidth of emissions to be within the blocks below

Spectrum Access Geographically limited Package 1	28.0525 to 28.1645	29.0605 to 29.1725	GHz	2 x112 MHz
Spectrum Access Geographically limited Package 2	28.1925 to 28.3045	29.2005 to 29.3125	GHz	2 x 112 MHz
Spectrum Access Geographically limited Package 3	28.3325 to 28.4445	29.3405 to 29.4525	GHz	2 x 112 MHz
Spectrum Access 28 GHz (1)	27.8285 to 27.9405	28.8365 to 28.9485	GHz	2 x112 MHz
Spectrum Access 28 GHz (2)	27.9405 to 28.0525	28.9485 to 29.0605	GHz	2 x 112 MHz

For terrestrial use spectrum mask is represented as;

Offset from edge of block	Maximum permitted level
in block up to and including -14 MHz	55 dBW (in any measured bandwidth)
from -14 MHz up to and including 0 MHz	30 – (¹⁹ / ₁₄ x Δ_{F1}) dBW/MHz Note 1
from 0 MHz up to and including +14 MHz	-39 – (13 / ₁₄ x Δ_{F2}) dBW/MHz Note 2
+14 MHz of block edge	-52 dBW/MHz

Note 1: Δ_{F1} is the frequency offset between -14 MHz to 0 MHz of the block edge.

Note 2: Δ_{F2} is the frequency offset between 0 MHz to +14 MHz of the block edge.

Where;

0 MHz = edge of block

- = in block of block edge

+ = out of block of block edge

- 7.10 In the packages identified above it is will also be possible to provide satellite services, for such use for those systems the following parameters will apply::
 - the elevation angle of the main beam of the transmitting earth station shall be higher than 10° above the horizontal and the maximum EIRP limit in the tables in section 7.2 does not apply;

(ii) the off axis eirp density shall be limited to -35 dBW/MHz; (off axis refers to angles greater than 7° from the axis of the main beam of transmission).

(iii) satellite earth stations shall not have their transmitted occupied band edges closer than 10 MHz from the edge of the frequency blocks noted in Section 7.9 except where that block edge abuts spectrum available for satellite earth stations (27.8285 GHz, 28.4445 GHz, 28.8365 GHz and 29.4525 GHz).

Existing regional 28 GHz BFWA licences – technical licence terms

7.11 It may be noted that the spectrum rights in the regional BFWA 28 GHz licences awarded in 2000 (see paragraph 2.16 above) are not defined in terms of a block edge mask: guard bands separate the frequency assignments for each licence and licensees are required to comply with the co-ordination guidelines published by Ofcom²². Ofcom is proposing to amend these guidelines to accommodate use by satellite earth stations in the Geographically limited packages as outlined in Section 5 and Annex 9.

32 GHz band

7.12 The spectrum rights proposed for the 32 GHz band are:

Necessary Bandwidth²³ of emissions to be within the bands below

Spectrum Access 32 GHz (1)	31.815 to 31.941	32.627 to 32.753	GHz	2 x 126 MHz
Spectrum Access 32 GHz (2)	31.941 to 32.067	32.753 to 32.879	GHz	2 x 126 MHz
Spectrum Access 32 GHz (3)	32.067 to 32.193	32.879 to 33.005	GHz	2 x 126 MHz
Spectrum Access 32 GHz (4)	32.193 to 32.319	33.005 to 33.131	GHz	2 x 126 MHz
Spectrum Access 32 GHz (5)	32.319 to 32.445	33.131 to 33.257	GHz	2 x 126 MHz
Spectrum Access 32 GHz (6)	32.445 to 32.571	33.257 to 33.383	GHz	2 x 126 MHz

The spectrum mask is represented as;

Offset from edge of block	Maximum permitted level
in block up to and including -14 MHz	55 dBW (in any measured bandwidth)
from -14 MHz up to and including 0 MHz	$30 - ({}^{19}\!/_{14} x \Delta_{F1}) dBW/MHz$ Note 1
from 0 MHz up to and including +14 MHz	-39 – (13 / ₁₄ x Δ_{F2}) dBW/MHz Note 2
+14 MHz of block edge	-52 dBW/MHz

Note 1: Δ_{F1} is the frequency offset between -14 MHz to 0 MHz of the block edge.

Note 2: Δ_{F2} is the frequency offset between 0 MHz to +14 MHz of the block edge.

Where;

0 MHz = edge of block

- = in block of block edge

+ = out of block of block edge

7.13 The spectrum mask is not qualified on the basis of any technology or service as there is current use within the spectrum bands identified. The rationale for this approach is given in Annex 6.

²² http://www.ofcom.org.uk/radiocomms/ifi/tech/co_docs/28ghzcodoc.pdf

²³ Necessary bandwidth is that as described within ITU-R SM.328-10

Non-technical licence conditions

- 7.14 It was proposed in the SFR:IP that new licences to be awarded by auction should generally have an indefinite term with a minimum period. During the minimum period the grounds for revocation by Ofcom would not include a general right to revoke for spectrum management reasons. After the end of the minimum term, the grounds for revocation by Ofcom would include such a right, subject to a minimum notice period of five years. Ofcom also proposed that notice of revocation for spectrum management reasons could be given so that the licence ended the day after the expiry of the minimum term.
- 7.15 The aim of these proposals was to provide licensees with a minimum period during which they would have high security of tenure, and grounds for revocation would be limited to a narrowly defined set of conditions. The period of the minimum term should be linked to a reasonable view of the period required to earn a return on the investment anticipated for efficient use(s) of the spectrum. The aim of proposing an indefinite duration was to give the licensee the opportunity to continue operating its business beyond the minimum term. However, during this period Ofcom would be able to recover the spectrum by serving a notice of revocation in a similar manner to many other spectrum licences, if this step was justified on spectrum management grounds.
- 7.16 Consistent with the Interim Statement on the SFR:IP, Ofcom proposes to take the following approach to the award of the spectrum bands:
 - The licences will have an indefinite duration.
 - The licences will have a minimum term of 15 years.
 - The licences may be revoked before the expiry of the minimum term on the limited grounds set out below in paragraph 7.20.
 - The licences may be revoked from any point after the expiry of the minimum term on the grounds set out in paragraph 7.21. They may be revoked for spectrum management reasons subject to Ofcom giving five years notice. Notice of revocation may be issued during the minimum term, for revocation to take effect after expiry of the minimum term.

Minimum term + 1 day: earliest possible entry into effect of a revocation on spectrum management grounds (subject to a minimum notice period of five years).



Figure 1: Graphical illustration of the licence term

Tenure during the minimum term

- 7.17 The proposed minimum term is designed to provide licensees with a high security of tenure for investment planning purposes. During that period, Ofcom will not be able to revoke licences for spectrum management reasons and will only be able to do so in the particular circumstances described in paragraph 7.20.
- 7.18 To determine the length of the minimum term, Ofcom has 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. This is based on assessments of-
 - initial fixed costs and operating costs to exploiting the spectrum;
 - the time needed to roll out an operational service;
 - projected rates of uptake of services and associated revenues.
- 7.19 Based on a consideration of the potential business cases for deploying various technologies in these bands, Ofcom considers that a minimum term of 15 years would be appropriate.
- 7.20 During this minimum term the licence may only be revoked for the following reasons:
 - with the consent of the licensee;
 - for non-payment or late payment of the relevant licence fee;
 - if there has been a breach of any of the terms of the licence;
 - if the licensee has not complied with any requirement of any relevant trading regulations;

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

After the minimum term

- 7.21 When the minimum term has expired, the licence will remain in force and continue to be held by the licensee. Two additional conditions will then also apply:
 - one providing an additional power for Ofcom to revoke the licence on spectrum management grounds as described above; and
 - one allowing Ofcom to apply annual licence fees.
- 7.22 Whether an annual licence fee is applied after the expiry of the period of the minimum term will depend on Ofcom's general approach to fees for the use of spectrum at that time and how that general approach relates to these licences. Such fees could be set at a level to recover a share of the costs of regulation; it may alternatively be based on Administrative Incentive Pricing (AIP). This provision will allow for the potential application of AIP to the licensed use of the spectrum after the end of the minimum term if this is appropriate in the context of Ofcom's statutory duties. AIP presently plays an important role in incentivising efficient spectrum management, and Ofcom has stated that it expects to continue applying AIP after introducing spectrum trading in order to promote efficient use of the spectrum.
- 7.23 Ofcom does not consider that it is necessary or appropriate to specify now the level of the annual licence fees, if any, that may be applied to the bands after the end of the minimum term. Ofcom would expect to bring forward proposals on this matter to a timescale that gave licensees reasonable notice of any relevant fees before they became payable.
- 7.24 Ofcom believes that it is necessary to include these additional licence conditions in relation to the licence period after the minimum term because of the need for the regulator to be able to intervene if required to promote efficient use of the spectrum. Ofcom has a high degree of confidence that the auction, including the payment of the auction fee, will secure efficient use of the spectrum during the minimum term. However, it is less clear that this objective will be met after the minimum term, or indeed for the entire indefinite duration of the licence. The longer the period over which the regulator is required to look forward, the greater the uncertainty that exists. At present, the ability to revoke licences on spectrum management grounds, and the ability to charge fees (including to promote optimal use of the spectrum) are important mechanisms in the regulator's toolkit. Ofcom considers that it is proportionate and objectively justifiable to include provisions allowing the regulator to take these steps after the end of the minimum term of these licences. Ofcom also

considers that the inclusion of these provisions is transparent as to what it seeks to achieve and does not unduly discriminate against any person.

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

Spectrum trading

- 7.26 Ofcom has started the implementation of spectrum trading for selected licence classes in 2004, through the Wireless Telegraphy (Spectrum Trading) Regulations 2004²⁴. The changes, described in the Spectrum Trading Statement, published in August 2004, introduced the possibility for licensees in specific classes to carry out:
 - outright total transfers, i.e. transfers of all of the rights and obligations arising under a licence to a third party.
 - concurrent total transfers, i.e. transfers (of all of the rights and obligations arising under a licence) to a third party which result in a concurrent holding of those rights and obligations by the transferor and the transferee(s);
 - outright partial transfers, i.e. outright transfers of some of the rights and obligations arising under a licence to a third party; and
 - concurrent partial transfers, i.e. transfers of some of the rights and obligations arising under a licence to a third party which results in a concurrent holding of those partial rights and obligations by the transferor and the transferee(s).
- 7.27 The exhibit below gives some illustrative examples of the types of transfers that are possible.



7.28 In the case of these bands, Ofcom proposes to amend the Wireless Telegraphy (Spectrum Trading) Regulations to allow all of these types of transfer.

Liberalised use of the band and spectrum quality benchmarks

- 7.29 In January 2005, Ofcom published a statement on spectrum liberalisation, describing changes in the way licensees of particular licence classes can use the spectrum. These changes, programmed for the year 2005, are being implemented in stages to
- ²⁴ Statutory Instrument 2004 No. 3154

facilitate the optimal use of the spectrum. The full statement and associated documents can be found at: <u>http://www.ofcom.org.uk/consult/condocs/liberalisation/</u> and <u>http://www.ofcom.org.uk/radiocomms/ifi/trading/libguide/</u>.

- 7.30 The spectrum liberalisation process described in the statement includes changes to three licensing sectors in 2005 Business Radio, FWA and Fixed Links and the use of two mechanisms for liberalisation of spectrum use through individual licence variation, following a request by a licensee, or through a generic licence change applied by Ofcom. The licences proposed for award in the bands will bear conditions similar in principle, in terms of technology neutrality and possible change of use, to those that Ofcom would aim to introduce through a generic change to existing licences in a given class or sector. As a result, Ofcom proposes to pursue the approach of liberalising spectrum use in this band allowing spectrum trading and reconfiguration.
- 7.31 In the SFR:IP, Ofcom indicated its plan to award the bands without restrictions as to service provision or technology other than the power limit. The spectrum masks specified to that effect, described in Annex 6, allow licensees in the bands to transmit while minimising the risk of causing interference to adjacent licensed users. Licensees will be free to deploy the technologies of their choice and change their use of the spectrum or these technologies within the relevant spectrum mask, without requiring Ofcom's approval.
- 7.32 In order to give prospective licensees some guidance as to the likelihood of interference from adjacent band users, Annex 6 describes the relevant technical characteristics (i.e. maximum permissible power and permissible out-of-block emissions) of the adjacent spectrum users. This information can be construed as defining the elements of a Spectrum Quality Benchmark (SQB) as described in the Liberalisation Statement. In other spectrum bands where trading and liberalisation have been implemented, SQBs are used to define the standard of spectrum quality that licensees can expect to experience. SQBs are used in assessing requests for licence variations and investigating and resolving interference complaints.
- 7.33 Any change by a licensee in the band that would depart from its respective licence conditions (e.g. power level and out-of-block emission mask) will be subject to prior approval by Ofcom. The same will apply to any change by licensees in adjacent bands that would depart from the conditions in those licences. Ofcom will consider any requests for change on their merits at the time.

Existing regional 28 GHz BFWA licences

7.34 The regional licences that were awarded in 2000 (see paragraph 2.16 above) have a duration of 15 years from issue, expiring on 31 December 2015. These licences are now tradable and in one case, a trade has already taken place; this was the transfer to THUS plc of four licences from Your Communications Ltd (see http://146.101.202.225/public-tnr/tradeDetails.do). A licensee wishing to vary its licence - either the technical or non-technical terms - may submit a variation request to Ofcom and Ofcom will consider the request on its merits, in the light of Ofcom's statutory duties.

Summary of licence terms applicable to the bands

7.35 The main non-technical conditions proposed to be included in the draft licences to be awarded for the bands are:

- Licence term minimum term of 15 years, with an indefinite term thereafter, subject to revocation on 5 years' notice (potentially subject to AIP);
- Tradability the licences will be tradable;
- Liberalisation the licences will contain the minimum necessary technical conditions and will not specify either equipment or services.
- 7.36 The licence fee for the minimum term will be determined by the auction.
- 7.37 The licences will permit use within the United Kingdom of Great Britain and Northern Ireland. The geographically limited licences will have the geographical coverage illustrated in Annex 9. The licences will not permit use in the Channel Islands and the Isle of Man.
- 7.38 Ofcom believes that all of the proposed conditions meet the statutory requirements, set out in section 3, in particular the requirements only to impose terms that are objectively justified, non-discriminatory, proportionate and transparent.
- 7.39 In setting these terms, Ofcom has taken into account the available technical and economic evidence on the likely use of the band and believes that these terms represent the minimum necessary to ensure efficient use of the radio spectrum and therefore they are objectively justified. The term preserves Ofcom's discretion on notice to revoke the licence for spectrum management reasons, after the minimum term, if it becomes necessary to do so. The proposed provisions on licence fees are objectively justified because they will either be determined by the bidders themselves in the auction (see section 6 for auction details) or if, as indicated above, following the expiry of the minimum term other licence fees are payable, these will be justified to ensure continued efficient use of the band or to recover a share of the regulatory costs.
- 7.40 Ofcom also believes that these licence conditions are proportionate since they are, in Ofcom's view based on the evidence available, the minimum set of restrictions which are required to promote efficient use of the band and the other objectives relevant to this award process. The proposed licence terms are also transparent in that they are clear as to the purpose in each case and they are set out in the draft licence which is included in Annex 5.
- 7.41 Ofcom has also considered carefully whether the proposed licence terms will discriminate unduly against any other person, including existing licensees in other spectrum. Ofcom has concluded that the proposals do not involve undue discrimination.

Section 8

Next steps and timetable

Analysis of responses

8.1 Ofcom will analyse all responses it receives by the closing date for this consultation of 7 September 2006 and, in finalising the award process, consider them against its statutory duties.

Publication of a draft information memorandum and draft auction regulations

- 8.2 Ofcom will publish an Information Memorandum for the award. This will be designed to give bidders as much information as necessary for them to decide whether to enter the auction and how they would prepare for participation. It may be modified or complemented by the publication of updates and answers to specific questions.
- 8.3 Regulations will provide the legal basis for the auction and contain detailed and comprehensive rules and procedures for its running. The regulations are made by means of a statutory instrument. They must be published in draft with a minimum of 28 days allowed for comments. When all comments have been considered and necessary amendments made the regulations are made in final form; they come into force approximately one month after being made.
- 8.4 According to Ofcom's provisional timetable, both the Information Memorandum and the draft regulations should be published, at the same time, in 2007. The final version of the regulations would subsequently be made to allow the auction to take place in 2007.

Other regulations and documents for publication

- 8.5 As part of the preparations for this award and before prospective bidders are invited to consider participating in the award process, Ofcom will publish new regulatory documents and amend existing regulations to incorporate the conclusions of this consultation where appropriate.
- 8.6 This will include:
 - amending the spectrum trading regulations (Statutory Instrument 2004 No. 3154) before the award process to cover the 10 GHz, 28 GHz and 32 GHz bands;
 - publishing an interface requirements for the bands before the award process to reflect the technical conditions to be adopted for the licences;
 - amending the order limiting the number of licences for certain categories (Statutory Instruments 2003 No. 1902) at the next relevant regular update;
 - amending the UK Frequency Allocation Table at the next relevant regular update and UK Frequency Allocation Plan after the award to include the new assignments for the bands.

Events and communications on the award

- 8.7 Of com intends to give a presentation in late July to stakeholders interested in this award to publicise and explain the details.
- 8.8 There are likely to be further events to assist potential bidders in understanding the auction rules before the auction takes place.

Annex 1

Responding to this consultation

How to respond

Ofcom invites written views and comments on the issues raised in this document, to be made by **5pm on 7 September 2006**

Ofcom strongly prefers to receive responses as e-mail attachments, in Microsoft Word format, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), among other things to indicate whether or not there are confidentiality issues. The cover sheet can be downloaded from the 'Consultations' section of our website.

Please can you send your response to <u>Joe.sonke@ofcom.org.uk</u>.

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

Joe Sonke 3rd Floor Riverside House 2A Southwark Bridge Road London SE1 9HA Tel: 020 7783 4345 Fax: 020 7783 4303

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

It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views, and how Ofcom's proposals would impact on you.

Further information

If you have any want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Joe Sonke on 020 7783 4345.

Confidentiality

Ofcom thinks 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, <u>www.ofcom.org.uk</u>, ideally on receipt (when respondents confirm on their response cover sheer that this is acceptable).

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.

Ofcom reserves its power to disclose any information it receives where this is required to carry out its legal requirements. Ofcom will exercise due regard to the confidentiality of information supplied.

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

Next steps

Following the end of the consultation period, Ofcom intends to publish a statement in 2007.

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

Ofcom's consultation processes

Ofcom is keen to make responding to consultations easy, and has published some consultation principles (see Annex 2) which it seeks to follow, including on the length of consultations.

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 <u>consult@ofcom.org.uk</u>. We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, whose views are less likely to be obtained in a formal consultation.

If you would like to discuss these issues, or Ofcom's consultation processes more generally, you can alternatively contact Vicki Nash, Director for Scotland, who is Ofcom's Consultation Champion:

Vicki Nash Ofcom Riverside House 2A Southwark Bridge Road London SE1 9HA Tel: 0141 229 7401 Fax: 0141 229 7433 E-mail: <u>vicki.nash@ofcom.org.uk</u>

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.
- 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 organisations interested in the outcome of our decisions. This individual (who we call the consultation champion) will also be the main person to contact with views on the way we run our consultations.
- 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, <u>www.ofcom.org.uk</u>, 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 cover sheet for responses (see below) and would be very grateful if you could send one with your response. This will speed up our processing of responses, and help to maintain confidentiality by allowing you to state very clearly what you don't want to be published. We will keep your completed cover sheets confidential.
- 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 cover sheet 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 in the form of a Microsoft Word attachment to an email. Our website therefore includes an electronic copy of this cover sheet, which you can download from the 'Consultations' section of our website.
- 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 cover sheet only so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS		
Consultation title:		
To (Ofcom contact):		
Name of respondent:		
Representing (self or organisation/s):		
Address (if not received by email):		
CONFIDENTIALITY		
What do you want Ofcom to keep confidential?		
Nothing Name/contact details/job title		
Whole response Organisation		
Part of the response If there is no separate annex, which parts?		
If you want part of your response, your name or your organisation to be confidential, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?		
DECLARATION		
I confirm that the correspondence supplied with this cover sheet is a formal consultation response. It can be published in full on Ofcom's website, unless otherwise specified on this cover sheet, and I authorise Ofcom to make use of the information in this response to meet its legal requirements. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.		
Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here.		
Name Signed (if hard copy)		

Annex 4

Consultation questions

1). Do stakeholders agree with the proposals for the award of licences in the 10 GHz, 28 GHz and 32 GHz bands in 2007?

2). Do stakeholders agree with the proposal to include in the award of the 32 GHz band that portion of the band that has been open since 2003 for point-to-point applications?

3). Do stakeholders agree with the proposal to defer the release of the 40 GHz band and review the position in two years' time?

4). Do stakeholders have any other comments on the contents of this document?

Annex 5

Draft licence template

A5.1 Please note that the following template licence represents Ofcom's current thinking and may well change as Ofcom's thinking develops and after consideration of responses to this consultation.

Wireless Telegraphy Acts 1949 and 1998

Office of Communications (Ofcom)

LICENCE FOR THE USE OF THE SPECTRUM BANDS [10GHz, 28GHz and 32GHz]

Note: The Permitted Frequency Bands in a particular licence will be determined by the outcome of the auction.

Licence no.

[Insert Licence Number]

Date: [Insert Date]

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

[Insert Licensee's Name and Company Registration Number]

("the Licensee")

[Insert Registered Company Address]

Xxxxxxxxxx

Xxxxxxxxxx

Xxxxxxxxxx

Xxxxxx

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 section 4 of the Wireless Telegraphy Act 1998, Ofcom may not revoke or vary this Licence under section 1(4) of the Wireless Telegraphy Act 1949 except:

- (a) at the request of, or with the consent of, the Licensee;
- (b) in accordance with paragraph 8 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 168(1) and (3) of the Communications Act 2003²⁵;
- (e) if, in relation to the Licensee, any of the events listed in regulation [xx] of the Wireless Telegraphy (Licence Award) (No. X) Regulations 200X occurred prior to the grant of this Licence where the occurrence of the event materially affected the outcome of the award process under those Regulations;
- (f) in accordance with section 4(5) of the Wireless Telegraphy Act 1998;
- (g) if it appears to Ofcom to be necessary or expedient [to revoke or vary the Licence] for the purposes of complying with a direction by the Secretary of State given to Ofcom under section 5 or section 156 of the Communications Act 2003; or
- (h) for reasons related to the management of the radio spectrum, provided that in such case:
 - i 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. Of com may only revoke or vary this Licence by notification in writing to the Licensee and in accordance with section 1E of the Wireless Telegraphy Act 1949.

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 168(1) and (3) of the Communications Act 2003²⁶.

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 [*insert licence fee*], which for the avoidance of doubt is exclusive of any VAT which may ultimately be payable.

8. On or after the expiry of fifteen 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 1 and 2(2) of the Wireless Telegraphy Act 1998, 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 1 and 2(2) of the Wireless Telegraphy Act 1998 from the date such amount falls due until the ²⁵ These are regulations on spectrum trading.

²⁶ See Ofcom's website for the latest position on spectrum trading and the types of trade which are permitted.

date of payment, calculated with reference to the Bank of England base rate from time to time. In accordance with section 4A of the Wireless Telegraphy Act 1998 any such amount and any such interest is recoverable by Ofcom.

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 1 and 2(2) of the Wireless Telegraphy Act 1998 will be made, except at the absolute discretion of Ofcom (in accordance with regulation xx of the Wireless Telegraphy (Licence Award) (No. x) Regulations 200X).

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.

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 1 of the Wireless Telegraphy Act 1949; and
 - (b) the expressions "undue interference", "station for wireless telegraphy" and "apparatus for wireless telegraphy" shall be construed in accordance with section 19 of the Wireless Telegraphy Act 1949.

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

SCHEDULE 1 TO LICENCE NUMBER: [Insert Licence Number]

Schedule Date: [Insert Date]

Licence Category: Licence for the use of the spectrum bands Licence for the use of the spectrum bands 10 GHz, 28 GHz and 32 GHz

Annex i for Spectrum Access 10 GHz Annex ii for Spectrum Access 28 GHz Annex iii for Spectrum Access 32 GHz

Note: The Permitted Frequency Bands in a particular licence will be determined by the outcome of the auction.

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

Annex i for Spectrum Access 10 GHz Annex ii for Spectrum Access 28 GHz Annex iii for Spectrum Access 32 GHz

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

- (a) During the period that this Licence remains in force and for 6 months thereafter, 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 100 metres resolution);

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

- d) radio frequencies used by the Radio Equipment;
- ii a statement of the number of subscribing customers;

and the Licensee must produce these records if requested by a person authorised by Ofcom.

- (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 subparagraph 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) Annex i for Spectrum Access 10 GHz Annex ii for Spectrum Access 28 GHz Annex iii for Spectrum Access 32 GHz

4. Site Clearance Requirements

Annex i for Spectrum Access 10 GHz Annex ii for Spectrum Access 28 GHz Annex iii for Spectrum Access 32 GHz

5. Coordination

Annex i for Spectrum Access 10 GHz Annex ii for Spectrum Access 28 GHz Annex iii for Spectrum Access 32 GHz

6. 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.

7. Permitted Frequency Bands

Annex i for Spectrum Access 10 GHz Annex ii for Spectrum Access 28 GHz Annex iii for Spectrum Access 32 GHz

8. Maximum permissible EIRP

Annex i for Spectrum Access 10 GHz Annex ii for Spectrum Access 28 GHz Annex iii for Spectrum Access 32 GHz

9. Permissible Out-of -Block Emissions

Annex i for Spectrum Access 10 GHz Annex ii for Spectrum Access 28 GHz Annex iii for Spectrum Access 32 GHz

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.

Annex i: Spectrum Access 10 GHz

2. Interface Requirements for the Radio Equipment

The Radio Equipment shall comply with the following Interface Requirement:

IR2047 "Spectrum Access 10.125 to 10.225 paired with 10.475 to 10.575 GHz"

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

(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 17dBW ERP; and/or

ii aerial systems, which do not extend beyond thirty (30) metres above ground level, or which do not increase the height of an existing building by more than five (5) metres (whichever is the higher).

5. Coordination

(a) The Licensee must operate the Radio Equipment in accordance with any coordination procedure notified by Ofcom.

(b) Without prejudice to the Site Clearance required by paragraph 4, the Licensee must obtain permission from Ofcom prior to establishing, installing and/or using the Radio Equipment at any geographic location covered by this Licence.

(c) Of com shall grant such permission where it is satisfied that:

the Licensee has put in place procedures to protect any other military assignments within the Licensee's Permitted Frequency Bands notified from time-to-time to Ofcom by the Ministry of Defence.

Notification to the NFAP: All assignment details should be communicated to Ofcom, for the purposes of national and international recording. The details of assignments should be communicated, in the format stated in paragraph 7(b), at date intervals of; no later than 3 months after, but not more than one year prior to, the commencement of transmissions.

7. Permitted Frequency Blocks

- (a) 10.125 to 10.225 GHz
- (b) 10.475 to 10.575 GHz

8. Maximum permissible (mean) eirp

The maximum eirp power in the Permitted Frequency Blocks is;

55 dBW (in any measured bandwidth)

9. Permissible Out-of -Block Emissions

For Out-of-Block Emissions (i.e. emissions outside the Permitted Frequency Block(s) specified in paragraph 7(a,b) at either the upper or lower edge), the maximum mean EIRP shall not exceed the following:

Offset from edge of block	Maximum permitted level
in block up to and including -14 MHz	55 dBW (in any measured bandwidth)
from -14 MHz up to and including 0 MHz	30.0 – (¹⁹ / ₁₄ x ∆ _{F1}) dBW/MHz Note 1
from 0 MHz up to and including +14 MHz	-39.0 – (¹³ / ₁₄ x ∆ _{F2}) dBW/MHz Note 2
+14 MHz of block edge	-52.0 dBW/MHz

Note 1: Δ_{F1} is the frequency offset between -14 MHz to 0 MHz of the block edge limits in 7 (a) & (b) above.

Note 2: Δ_{F2} is the frequency offset between 0 MHz to +14 MHz of the block edge limits in 7 (a) & (b) above.

Where;

0 MHz = edge of block - = in block of block edge + = out of block of block edge

Annex ii: Spectrum Access 28 GHz

2. Interface Requirements for the Radio Equipment

The Radio Equipment shall comply with the following Interface Requirement:

IR2048 "Spectrum Access 27.8285 to 28.4445 GHz paired with 28.8365 to 29.4525 GHz"

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

(e) The Licensee must ensure that the Radio Equipment is established and installed only for terrestrial or satellite (Earth to space) 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 terrestrial stations where:

i transceiver stations incorporating transmitters radiating not more than 17dBW ERP; and/or

ii aerial systems, which do not extend beyond thirty (30) metres above ground level, or which do not increase the height of an existing building by more than five (5) metres (whichever is the higher).

(c) Sub-paragraph 4(a) does not apply to satellite earth stations where;

satellite earth stations incorporating transmitters radiating not more than 50dBW ERP.

5. Coordination

(a) The Licensee must operate the Radio Equipment in accordance with any coordination procedure notified by Ofcom.

Notification to the NFAP: All assignment details should be communicated to Ofcom, for the purposes of national and international recording. The details of assignments should be communicated, in the format stated in paragraph 7(b), at date intervals of; no later than 3 months after, but not more than one year prior to, the commencement of transmissions.

7. Permitted Frequency Blocks

Subject to the Out-of-Block Emissions permitted under paragraph 9, the Radio Equipment must only transmit on the following frequency bands (the "Permitted Frequency Blocks"):

(a) [27.8285 to 27.9405 GHz][27.9405 to 28.0525 GHz][28.0525 to 28.1645 GHz][28.1925 to 28.3045 GHz][28.3325 to 28.4445 GHz]

(b) [28.8365 to 28.9485 GHz][28.9485 to 29.0605 GHz][29.0605 to 29.1725 GHz][29.2005 to 29.3125 GHz][29.3405 to 29.4525 GHz]

(c) satellite earth stations shall not have their transmitted occupied band edges closer than 10 MHz from the edge of the frequency blocks noted in Section 7 (a)(b) except where

that block edge abuts spectrum available for satellite earth stations (27.8285 GHz, 28.4445 GHz, 28.8365 GHz and 29.4525 GHz).

Note: The Permitted Frequency Blocks in a particular licence will be determined by the outcome of the auction.

8. Maximum permissible (mean) eirp

The maximum eirp power in the Permitted Frequency Blocks is:

- (a) for terrestrial systems:
 - (i) 55 dBW in any measured bandwidth;
- (b) for satellite systems:

(iii) the permissible EIRP shall be set by the satellite operator and site clearance requirements;

9. Permissible Out-of -Block Emissions

For Out-of-Block Emissions (i.e. emissions outside the Permitted Frequency Band(s) specified in paragraph 7(a,b) at either the upper or lower edge), the maximum mean EIRP shall not exceed the following:

For terrestrial use;

Offset from edge of block	Maximum permitted level
in block up to and including -14 MHz	55 dBW (in any measured bandwidth)
from -14 MHz up to and including 0 MHz	30.0 – (¹⁹ / ₁₄ x ∆ _{F1}) dBW/MHz Note 1
from 0 MHz up to and including +14 MHz	-39.0 – (¹³ / ₁₄ x Δ _{F2}) dBW/MHz Note 2
+14 MHz of block edge	-52.0 dBW/MHz

Note 1: Δ_{F1} is the frequency offset between -14 MHz to 0 MHz of the block edge limits in 7 (a) & (b) above.

Note 2: Δ_{F2} is the frequency offset between 0 MHz to +14 MHz of the block edge limits in 7 (a) & (b) above.

Where;

0 MHz = edge of block - = in block of block edge + = out of block of block edge

for satellite systems;

(i) the elevation angle of the main beam of the transmission shall be higher than 10° above the horizontal.

(ii) the off axis eirp density shall be limited to -35 dBW/MHz; (off axis refers to angles greater than 7° from the axis of the main beam of transmission)

(iii) from -10MHz of block edge, up to and including block edge and any point beyond block edge, the emission shall be attenuated by; $43 + 10 \log_{10}(P)$] dB, (where *P* is the mean power in watts supplied to the antenna transmission line) or 60 dBc, whichever is less stringent

Annex iii: Spectrum Access 32 GHz

2. Interface Requirements for the Radio Equipment

The Radio Equipment shall comply with the following Interface Requirement:

IR2049 "Spectrum Access 32 GHz"

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

(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 17dBW ERP; and/or

ii aerial systems, which do not extend beyond thirty (30) metres above ground level, or which do not increase the height of an existing building by more than five (5) metres (whichever is the higher).

5. Coordination

(a) The Licensee must operate the Radio Equipment in accordance with any coordination procedure notified by Ofcom.

Notification to the NFAP: All assignment details should be communicated to Ofcom, for the purposes of national and international recording. The details of assignments should be communicated, in the format stated in paragraph 7(b), at date intervals of; no later than 3 months after, but not more than one year prior to, the commencement of transmissions.

7. Permitted Frequency Blocks

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

(a) [31.815 to 31.941 GHz] [31.941 to 32.067 GHz] [32.067 to 32.193 GHz] [32.193 to 32.319 GHz] [32.319 to 32.445 GHz] [32.445 to 32.571 GHz]

(b) [32.627 to 32.753 GHz] [32.753 to 32.879 GHz] [32.879 to 33.005 GHz] [33.005 to 33.131 GHz] [33.131 to 33.257 GHz] [33.257 to 33.383 GHz]

Note: The Permitted Frequency Bands in a particular licence will be determined by the outcome of the auction.

8. Maximum permissible (mean) eirp

The maximum eirp power in the Permitted Frequency Blocks is;

55 dBW in any measured bandwidth.

9. Permissible Out-of -Block Emissions

For Out-of-Block Emissions (i.e. emissions outside the Permitted Frequency Band(s) specified in paragraph 7(a,b) at either the upper or lower edge), the maximum mean EIRP shall not exceed the following:

Offset from edge of block	Maximum permitted level
in block up to and including -14 MHz	55 dBW (in any measured bandwidth)
from -14 MHz up to and including 0 MHz	30.0 – (¹⁹ / ₁₄ x ∆ _{F1}) dBW Note 1
from 0 MHz up to and including +14 MHz	-39.0 – (¹³ / ₁₄ x ∆ _{F2}) dBW Note 2
+14 MHz of block edge	-52.0 dBW/MHz

Note 1: Δ_{F1} is the frequency offset between -14 MHz to 0 MHz of the block edge limits in 7 (a) & (b) above.

Note 2: Δ_{F2} is the frequency offset between 0 MHz to +14 MHz of the block edge limits in 7 (a) & (b) above.

Where;

0 MHz = edge of block - = in block of block edge

+ = out of block of block edge
Annex 6

Transmission rights

Foreword

- A6.1 Ofcom's intention is to award spectrum with technology and usage restrictions that are the minimum necessary for the efficient management of the radio spectrum and the avoidance of undue interference, and that comply with Ofcom's statutory duties and international obligations. As recognised in the Spectrum Framework Review, even under a technology and usage neutral approach there is a requirement to specify the technical characteristics of the licences available in an auction. It is important that likely uses of the spectrum are taken into account in specifying any technical parameters to the usage rights. (This can be done without requiring that the uses considered are those that must be made of the spectrum.)
- A6.2 In developing transmission rights for the bands covered by this document, Ofcom's intention is to set in-band and out-of-band power limits that should be sufficient to prevent undue interference into adjacent band uses.
- A6.3 Except for 10 GHz there is little or no current use in the bands to be awarded or in the bands immediately adjacent to them. This means that any limits have to be set without reference to specific technologies that may be in use. The main factors that Ofcom has taken into account in considering the rights to be established are:
 - at a minimum, the necessary bandwidth²⁷ of any individual emission must be placed within the spectrum limits awarded;
 - guard band consideration should be internalised within the awarded spectrum block;
 - out of block emissions should be attenuated accordingly (i.e. they are not considered adjacent channel).
- A6.4 These measures offer a reasonable balance between flexibility of use within the spectrum ranges awarded to the operator, efficiency and minimal constraints; all of which are key principles of Ofcom's spectrum management approach.
- A6.5 Ofcom expects the most likely use of the bands to be terrestrial fixed systems, though satellite earth stations may be used in 28 GHz. Where fixed systems are deployed the two likely systems in the bands to be awarded will be point-to-point (p-t-p) or point-to-multipoint (p-t-mp). These two systems involve markedly different considerations because one of the most influential factor in the spectrum co-existence environment is the passive element, i.e. the antenna. Between p-t-p and p-t-mp implementations antenna gains can vary across a range of 25dB and the area/zone for consideration is almost exclusively dictated by the gain, location and direction of the antenna; this is something not controlled by the regulator under a geographical area/spectrum block authorisations regime. This can result in different interference environments for p-t-p and p-t-mp.
- A6.6 It is unlikely that the bands will be used for mobile services. The main reason for this is that bands above 6 GHz are not suited to mobile services due to the relatively higher attenuation in these spectrum bands when compared to sub-5 GHz bands (i.e. losses

²⁷ Necessary bandwidth is that as described within ITU-R Recommendation SM.328-10

through physical objects, vegetation, rain etc.). Typically, highly directional antennas with high gain antennas are used to overcome these effects, which traditionally require stationary implementation. There may, of course, be future technical developments that make mobile use feasible but, for the time being, Ofcom does not anticipate this. Operators who are interested in mobile spectrum are likely to target at least sub-10 GHz spectrum (if not lower).

- A6.7 There is no one technology that defines expected use in the bands. This means that there are a wide range of variables:
 - bandwidths could vary from 3.5 to112 MHz (spectrum block permitting);
 - duplex methods might be either TDD or FDD;
 - access technologies may include for example TDMA, FDMA, W-CDMA or OFDM/A;
 - modulation order levels of QPSK through to 64/128QAM; and
 - antenna gain variation of 25 dB.

This level of variables means that any block edge mask will be a compromise between these considerations.

A6.8 The spectrum mask used for all three bands to be awarded derives from the spectrum mask shown in ECC Report 32²⁸ where the guard band is included in the spectrum between adjacent spectrum blocks. However, the eirp limits discussed within the mask appears to be insufficient for p-t-p services that require long link lengths. Therefore, the eirp limit within the spectrum block has been limited only by the ITU limit for those bands noted in Article 21 Sections I and II of the Radio Regulations but it retains the roll off as the emissions reach the edge of the spectrum block to be awarded. Included with the interface requirements for the bands, reference is made to the limits in ETSI EN 301 390. This document quotes the spurious emissions and receiver immunity limits for equipment types that are likely to be used in the bands. The rationale behind this is that it is reasonable to expect the out of block emissions to be at a level shown within this document where the combination of output power and antenna gain gives a value that is below that which is specified for the spectrum mask. Not qualifying this figure may permit systems that employ low gain antennas to exceed the antenna port spurious levels within EN 302 390, which would be inappropriate.

International regulatory position

- A6.9 The subdivision of the radio spectrum into specific frequency bands and the allocation of those bands to various radio services is a process that occurs globally in the ITU, at the European level in CEPT and the EU, and nationally, through regulatory decisions made by Ofcom. The fundamental reason for international co-ordination of radio use has, historically, been the risk of harmful interference between use in one jurisdiction and use in another, given that radio emissions do not stop at national borders.
- A6.10 The existence of an international framework has a number of advantages for users round the world, but also imposes some constraints on national freedom of action. The nature of those constraints varies significantly depending on the particular international body and international agreement that is relevant.

²⁸ <u>http://www.ero.dk/documentation/docs/doc98/official/pdf/ECCREP032.PDF</u>

A6.11 The ITU Radio Regulations (ITU-RR) define those uses for specific spectrum bands that will have international recognition under the Radio Regulations. The allocation of frequencies in the world is divided into three Regions; Region 1, 2 and 3. The United Kingdom falls within Region 1. Within each frequency band, radio communications services are allocated on the basis of 'primary' and 'secondary' service, either on a worldwide or Regional basis. Allocation of secondary services shall not cause harmful interference to allocations of assigned primary services. (Article 5 of the ITU RR). The ITU-RR allocations are discuss below.

10 GHz band

- A6.12 In Region 1, the ITU-RR allocations for the band 10.125 to 10.225 paired with 10.475 to 10.575 GHz are:
 - to the fixed and mobile services on a primary basis in the bands 10.125 to 10.225 GHz and 10.500 to 10.575 GHz;
 - to the radiolocation service on a primary basis in the bands10.125 to 10.225 and 10.475 to 10.500 GHz and on a secondary basis in the bands 10.500 to 10.575 GHz;
 - to the amateur service on a secondary basis in the bands 10.125 to 10.225 and 10.475 to 10.500 GHz and to the amateur satellite service on a secondary basis in the band 10.475 to 10.500 GHz.

Noting that not all international allocations are implemented nationally.

28 GHz band

- A6.13 In Region 1, the ITU-RR allocations for the band 27.5 to 29.5 GHz are:
 - to the fixed, fixed satellite (Earth to space) and mobile services on a primary basis in the bands 27.5 to 29.5 GHz;
 - to the earth exploration satellite service on a secondary basis in the band 28.5 to 29.5 GHz;

Noting that not all international allocations are implemented nationally.

A6.14 The allocation of the band to FS and FSS was detailed in Electronic Communications Committee Decision (ECC/DEC/(05)01). This Decision identified additional spectrum for terrestrial services as well as for uncoordinated, freely deployed satellite earth stations. This additional spectrum includes the packages 1 and 2 in figure 2 above which form part of the spectrum available for award. The UK has not committed to implementing this Decision.

32 GHz band

A6.15 In Region 1, the ITU-RR allocations for the band 31.8 to 33.4 GHz are:

- to the fixed and radionavigation services on a primary basis in the band 31.8 to 33.4 GHz;
- to the space research service on a primary basis in the band 31.8 to 32.3 GHz;
- to the inter-satellite service on a primary basis in the band 32.0 to 33.0 GHz.

Noting that not all international allocations are implemented nationally

10 GHz technical considerations

- A6.16 As documented in the SFR:IP, the licences that had originally been issued to operators in the 10 GHz band have been cancelled. Those licences were awarded with the following technical parameters;
 - RF Carrier spacing using a modified channel raster based on that detailed in CEPT/ERC/ Recommendation 12-05²⁹;
 - Emission designation = 7M0G7WWF;
 - Maximum permissible eirp for base stations = 25 dBW;
 - Maximum permissible eirp for repeater station = 33 dBW.
- A6.17 Clearly these parameters restrict both the channelisations and the bandwidth of systems. In establishing the transmission rights in the 10 GHz band the core elements of the block edge mask referenced in ECC Report 32 were used, although the majority of the in-band power is limited only by the ITU Limits noted within Article 21 Section II of the Radio Regulations, i.e. +55 dBW in any measurement bandwidth.

In band interference issues

MOD

A6.18 MOD has primary status in the lower block of spectrum (10.125 – 10.225 GHz). MOD has an ongoing and expanding need for a system referred to as a Common Data Link (CDL), which currently makes use of an airborne platform working to ground stations. The airborne system will be used by MOD as required, with varying ground station locations and varying flight paths. The system has three modes. Modes 1 and 2 are limited to the spectrum between the two blocks to be awarded and in this environment it is only their out-of-block emissions that will be present in the lower spectrum block. Use of Mode 3 is within the lower block (see figure 1 in Section 2.11).

²⁹ <u>http://www.ero.dk/documentation/docs/doc98/official/pdf/REC1205E.PDF</u>



- A6.19 Figure A6.1 above shows that the transmissions from the aeronautical platform are targeted towards the CDL ground station at all times. These transmissions overlap, in spectrum terms, the majority of the lower spectrum block (10.125-10.225 GHz). The return path from the CDL ground station is not within, or adjacent to, the spectrum to be awarded.
- A6.20 Studies have shown that the targeted emission from the CDL aircraft under Mode 3 will have some impact on use of the lower block. This depends on the flight path of the aircraft in respect to the ground station and on the gain and direction of the receiving system's antenna.
- A6.21 Using the parameters supplied by MOD, figure A6.2 below shows the worst case onground power flux density level from a single aircraft at differing arrival angles.



- A6.22 This calculated flux density level is for the main beam of the aircraft emission as the aircraft flies directly over an associated CDL ground station and it is measured at the CDL ground station location (i.e. airborne antenna points towards the CDL ground station at all times).
- A6.23 Two technical simulation studies have been undertaken to look at the potential impact. In the first one an airborne platform was flown directly over the CDL ground station and a 10 GHz station was placed at various set distances from the CDL ground station (100m, 1km, 10km 100km). A number of different antennas were attached to the 10 GHz station and the full parameters are shown below for both the 10 GHz station Table 1 and Table 2 and the airborne platform Table 3.

Table A6.1

Terrestrial Station	
Reference Frequency	10.35 GHz
Bandwidth Used	14 MHz
Receiver Sensitivity Level to yield a BER of better than 10 ⁻⁶	-101dBm (default figure from table 7 of EN 302 326-2
Link Budget Requirement	Not Known

Table A6.2

Antennas Modelled			
Туре	Gain	Beamwidth	Elevation
ETSI EN302 326-3 (SS2)	+14dBi	108°	-1°
ETSI EN302 326-3 (DN3A)	+26dBi	18°	+1°
Manufacturer A (study two only)	+46.8dBi	1.1°	0°
Manufacturer B (study two only)	+35.5dBi	2.8°	0°
The terrestrial station had all four of the above antennas attached. Each antenna was pointed at 0°, 90°, 180° and 270° with respect to north with the indicated elevation figures for each antenna.			

Table A6.3

MOD Airborne use		
Altitude	6km	
Flight Path (study one)	Directly overhead of CDL ground station	
Flight Path (study two)	Variable, but within 200 nautical miles of CDL ground station	
Flight dynamics	Level	
TX Bandwidth Limits (occupied bandwidth)	480 MHz	
Eirp	33 dBW	
Antenna Polarisation	RHCP (Right Hand Circular Polarisation)	
Antenna Beamwidth	10°	
Notes: MOD airborne Antenna always points to its appropriate terrestrial ground station (CDL) (i.e. not at the terrestrial station unless co-located). The CDL ground station transmissions (uplink) are not within the bands of interest within this award.		

Propagation model for	ITU-R PN:452-10
interference path between MOD	(time/locations percentages, random, at each
use and terrestrial station	iteration)
Bandwidth correction was considered between the MOD transmitter and the Terrestrial RX.	

- A6.24 These parameters showed that where co-located the maximum corrected received value is some 60 dB above the -101dBm referenced value. At distances of 100m up to 10km between the CDL ground station and the 10 GHz station, the maximum received level by the terrestrial station drops to a level approximately 50 dB above the Receiver Sensitivity Level (RSL) value shown. At 100km the received level is approximately 5dB above the -101dBm figure. It is clear from the results that this is the worst case environment, as the plane not only directly flies overhead (for co-located and 100m) but also the main beam of the airborne platform is on bore sight of the antenna of the terrestrial station. It should also be noted that these results make no allowance for link budgets that may be employed. For these reasons these results are not considered to be representative.
- A6.25 In the second simulation a Monte Carlo statistical analysis was undertaken. In this model the same parameters shown in the tables 1, 2 and 3 above were used, in addition to the antennas shown as "Manufacturer A" and "Manufacturer B". The simulation gives a statistical result of the number of breeches (i.e. ≥ -100dBm) of the RSL figure shown in table A6.4. From a fixed central point the airborne platform was randomly moved up to 200 nautical miles (ground distance) from its associated CDL ground station. At each iteration the terrestrial station was also moved, randomly, up to 200 nautical miles from the MOD ground station. The MOD ground station did not move through the whole analysis. 60,000 iterations were undertaken. Taking a figure of ≥ -100dBm as an interference breach the following percentages were recorded:

Table A6.4

Antenna Considered	Percentage breeches (i.e. ≥ - 100dBm)
ETSI EN302 326-3 (ETSI Antenna Code SS2)	16.5%
ETSI EN302 326-3 (ETSI Antenna Code DN3A)	24.0%
Manufacturer A	2.1%
Manufacturer B	6.8%

A6.26 It should be noted that this is for a single platform that is airborne and operational. Obviously if at anytime during the modelling the MoD system was not operational the percentage figures would be lowered.

Low power radar level gauges

A6.27 These systems are currently licensed on a no fee basis and are UWB-like in their operation. As shown, in the band plan (figure 1 in section 2 of this document) their use overlaps the lower block entirely and the upper block by 25 MHz. Two eirp levels are mentioned in the current licences in the band: 0.5mW (or -29.5dBm/MHz) and 1.6mW (or -30.7dBm/MHz).

A6.28 These systems are used in liquid storage tanks (i.e. metallic or concrete) and are on sites such as refineries and sewage works. Their impact is likely to be very limited because of the large attenuation of the tanks on the signal eirp and their location mainly on private sites. There are approximately 127 deployments in the UK. These level gauges are currently subject to licensing but Ofcom is considering an ECC proposal to exempt some of these devices from licensing.

Amateur radio service

- A6.29 Within the band plan shown in figure 1 of section 2 the Amateur Radio Satellite Service overlaps 25 MHz of the upper civil spectrum block (10.475-10.5 GHz). Use by radio amateurs is on a secondary and non-interference, non-protected basis. As the allocation is not qualified, direction of use could be permitted from Earth to space and from space to Earth.
- A6.30 Publicly available information on the Amateur Satellite use shows that this band is earmarked as a space to earth band³⁰. It also appears that currently there are no Amateur Satellites operating in this band. No information on the parameters for this Amateur Satellite use is available and therefore their impact has been considered as minimal and highly unlikely. Amateur Satellite systems can be developed and launched by other administrations/countries and these systems may have coverage over the UK. In these cases, the UK would be not be in a position to question their authority as the operation would be within the international allocations.
- A6.31 As use is on a secondary basis a future spectrum access licensee will not be obliged to protect the national Amateur use. Use by the Amateur Service on a national basis would only be permitted where the Amateur licensee could be confident of not causing interference to the spectrum access licensee.

Adjacent band interference issues

MOD

- A6.32 As noted in the band plan, operation of the CDL system in Modes 1 and 2 will be adjacent to the civil use on the upper side of the lower spectrum block. In this situation a number of out-of-block emissions that could affect the future licensee have been discussed with MOD.
- A6.33 ITU Limits This requires attenuation of the signal where it falls outside the Mode 1 and 2 block shown in the band plan by;

43 + 10Log₁₀(P) dB or 70dBc, whichever is the less stringent³¹

where P is the output power applied to the transmission line - dBc refers to a level relative to the main carrier.

³⁰ <u>http://www.amsat.org/amsat-new/satellites/</u>. NB Ofcom is not responsible for the content of external websites.

³¹ This figure refers to transmitters installed after 1st January 2003, for equipment installed before that date, refer to ITU-R Radio Regulation Appendix 3 Section 1 Table 1.

Amateur radio service

A6.34 In those blocks shown as available to the Amateur Radio Service (terrestrial use) and the Amateur Satellite Service (that part out of band) use by the future licensee would be expected to meet the ITU figures for out-of-band emissions of

Attenuation of = $43 + 10 \text{Log}_{10}(P)$ dB or -70dBc, which ever is the less stringent

where P is the output power applied to the transmission line - dBc refers to a level relative to the main carrier.

28 GHz technical considerations

- A6.35 These rights are shown at paragraph 7.9. As mentioned in the foreword to this annex, the lack of current use in the band and the fact that there are no current use metrics available means a variety of spectrum masks could be justified, on the basis of a qualified technology. The generic limits shown for the block edge mask are also derived from the mask documented in ECC Report 32 (Section 3.1.3). In addition the spurious limits within ETSI EN 301 390, noted within the informative section of the Interface Requirement for the bands shown, are applied for the reasons given in the Foreword to this Annex.
- A6.36 Because of the potential for the terrestrial use to cause interference into satellite station receivers, and in order to protect satellite systems, the Radio Regulations note limits on the terrestrial use in terms of maximum power emitted and emissions directed towards the geostationary arc. These upper maximum power limits are taken into account in paragraph 7.9. It is recognised that in addition to terrestrial use the licensee may wish to work to a satellite. In that case the eirp may be increased above the limit for terrestrial use, as that terrestrial limit may be inadequate to access satellites. Ofcom is aware of the technical content of a spectrum Decision, ECC/DEC(05)01³², produced by CEPT in March 2005. This forms the basis of some of the qualified technical requirements within the 28 GHz band.
- A6.37 ECC/DEC(05)01, states that 'uncoordinated FSS Earth stations shall not have their occupied band edges closer than 10 MHz from the edges of the noted frequency bands...'. Ofcom believes that there is no need to set limits within the spectrum block as operators will be better placed to understand the actual use made within their blocks, as well as the adjacent spectrum environment, and to manage their use through operator negotiation. As a default satellite, (uplink) transmissions will not be permitted in the 10 MHz at the edge of the awarded spectrum block (as licence schedule 1 paragraph 7(c) see Annex 5). This is because, initially, operators will be unaware of the actual use in adjacent spectrum blocks (i.e. it might be satellite or terrestrial).
- A6.38 A minimum earth station elevation requirement of more than 10° above the horizontal has been set, which is the same limit noted within ECC/DEC(05)01 to protect spectrum blocks where terrestrial and satellite use is adjacent. ECC/DEC(05)01 also quotes a limiting off-axis eirp for earth station use, which has been incorporated within the satellite access rights shown in paragraph 7.9. Again operators will be in a better position to discuss the adjacent spectrum block issues and changes can be actioned through operator negotiation and a liberalisation request via Ofcom (see paragraph 7.29ff).

³² http://www.ero.dk/documentation/docs/doc98/official/pdf/ECCDEC0501.PDF

A6.39 Under this award process, where spectrum derived from the remaining BFWA Regional 28 GHz licences (as geographically limited licences) is to be awarded with flexible rights, there may be a need for geographical border coordination of satellite earth station systems with geographically adjacent terrestrial users. As the boresight of the satellite earth station transmission could breach the border pfd figure - but at a point way above that which is considered for terrestrial systems - it is proposed that the 28 GHz co-ordination guidelines document be amended to address the use 33 . Therefore, rather than considering the boresight of transmissions of the earth station for calculation of the pfd trigger level (as that point may be far higher than what would ever be considered for terrestrial use) operators should only consider a point up to, and no more than, 30 metres above ground on the same earth station azimuth for the boresight transmission. However, where the antenna radiation pattern (e.g. off axis emission) would result in a higher pfd at the geographical boundary than the 30 m above ground boresight azimuth figure that figure should be considered. Where the earth station boresight crosses the boundary at less than 30 m above ground the boresight pfd figure should be considered, but again where the radiation pattern of the antenna results in a higher pfd figure then that should be considered. For example:

Figure A6.3



³³ <u>http://www.ofcom.org.uk/radiocomms/ifi/tech/co_docs/28ghzcodoc.pdf</u>



A6.40 Figures A6.3 and A6.4 above show the consideration of satellite earth stations in the 28 GHz geographically limited spectrum packages (see paragraph 5.20ff), where there are shared national geographical borders. These considerations only apply to satellite earth stations. Terrestrial stations should continue to use the established considerations in the Ofcom co-ordination guidelines document.

32 GHz technical considerations

In band

A6.41 The band has no current use, though one part of the band was originally to be made available for individually licensed p-t-p links. Ofcom will award the band on a technology and service neutral basis. For reasons similar to those applying to the 10 and 28 GHz bands, any block edge mask could be justified, where qualified against known or implied technologies taken in conjunction with deployment-dependent metrics (i.e. eirp, gain, location and direction of individual antennas). That cannot be done for bands where operators make those deployment centric decisions and so the spectrum mask has also been derived from that used in ECC Report 32 (as discussed for the 10 and 28 GHz bands). Other parameters, as described in the foreword to this annex, will play a much larger role in the radio environment than the small propagation difference between the three bands.

Adjacent band

- A6.42 Spectrum to the low frequency side of Package 1 (31.815-31.941 GHz) abuts a band administered by Ofcom. This band 31.0-31.3 GHz paired with 31.5-31.8 GHz is used for analogue Closed Circuit Television (CCTV) systems in accordance with Ofcom's Technical Frequency Assignment Criteria document, OfW 31 (available from the Ofcom website). These assignments are for predominately p-t-p fixed links and are based on 28 MHz channels on a UK specific raster (detailed in OfW 31). ETSI currently publish a technical standard EN 300 632 Fixed radio link equipment for the transmission of analogue video signals operating in the frequency bands 24.25 GHz to 29.50 GHz and 31.0 GHz to 31.8 GHz. The maximum indicative eirp in this band is +30 dBW (15.5 dBW/MHz).
- A6.43 At present there is no documented use in the bands 33.4-34.2 GHz other than the generic allocation to radiolocation in the current UK Frequency Allocation Table. This band is managed by MOD and further information may become available over time.

International Coordination for 10, 28 and 32 GHz

A6.44 At present there is no Memorandum of Understanding (MOU) between the UK and other countries where international coordination would be deemed appropriate for the three frequency bands. For the time being, operators in these bands should apply the following³⁴;

Terrestrial Services in the 10, 28 and 32 GHz Bands:

Limit: spectrum flux density (PFD) not exceeding -115 dBW/(MHzxm²) at the geographical border of another country (where a sea path exists between UK and the other country, the low tide coastline should be used).

Calculation: based on the ITU-R P.452-12 based on the free space propagation and an atmospheric attenuation³⁵ of 0.015 dB / km for 10 GHz, 0.12 dB / km for 28 GHz and 0.1 dB / km for 32 GHz.

Satellite Services in the 28 GHz band only

A6.45 Where satellite earth stations are used in the 28 GHz band operators will need to assess whether international coordination is required. The trigger for coordination with another administration, in the absence of an MOU, is via the technical processes of ITU-R Radio Regulation Appendix 7. This process results in a coordination contour that illustrates the administration with which international coordination is required. As the coordination contour is specific to each deployment it is not possible to give a definitive indication and operators would need to calculate these contours taking into account their specific operations. However, a number of examples are given, which give an indication as to whether coordination would be expected for the parameters given. For example:

³⁴ Derived from examples in ECC Report 76

http://www.ero.dk/documentation/docs/doc98/official/pdf/ECCREP076.PDF.

³⁵ Taken from ITU-R Recommendation P.676, Annex 2 Figure 5.



The above diagram shows the coordination contour (mode 1 and mode 2) for a satellite earth station as per ITU-R Appendix 7.

The satellite and earth station details are;

Satellite	
Name	NSS KA21
Longitude, Position	20.0 West

5.933 degrees West
54.616 degrees North
29-25Log(FI)
-33 dBW/Hz
51K2G7W
197.1°
26.3°
27.925 GHz

This illustration shows that for the parameters shown, international coordination is required with Ireland.



The earth station details are taken from the published typical earth station parameters supplied with the ITU

The above diagram shows the coordination contour (mode 1 and mode 2) for a satellite earth station as per ITU-R Appendix 7.

The satellite and earth station details are;

Satellite	
Name	EUTELSAT KA 7E
Longitude, Position	7.0 East

Earth Station	
Position Longitude	1.86 degrees West
Position Latitude	52.485 degrees North
Antenna Radiation Pattern	29-25Log(FI)
Power Spectral Density	-43.2 dBW/Hz
Emission Code	1M40G7W
Azimuth	168.9°
Elevation	29.4°
Frequency	28.700 GHz

This illustration shows that for the parameters shown, international coordination is not required.

NOTE: The coordination contours shown in figures A6.5 and A6.6 are purely for illustrative purposes only and in no way should be taken as a default when assessing whether international coordination for a satellite earth station is required. The parameters shown in figures A6.5 and A6.6 are taken from the typical earth station parameters as supplied under the ITU satellite network filing for the associated satellite network named. Where any of the

associated station details are altered from that shown, the coordination contour would no longer be valid. Operators would need to calculate their own contour for the earth station parameters they would use.

.

Annex 7

Impact assessment

- A7.1 This annex sets out an Impact Assessment (IA) as defined by section 7 of the Communications Act 2003.
- A7.2 Consistent with Ofcom's guidelines on the use of impact assessments (see <u>http://www.ofcom.org.uk/consult/policy_making/guidelines.pdf</u>), this IA:
 - Defines the issue being considered and identifies the citizen/ consumer interest;
 - Defines the policy objective
 - Identifies and assesses the options and identifies the impacts on stakeholders; and
 - Assesses the impact on competition.

The issue being considered and the citizen/consumer interest

- A7.3 This consultation document is considering the award of spectrum in the 10GHz, 28GHz, 32GHz and 40GHz bands. It considers the available spectrum in each band, as well as the different options for packaging the spectrum and the design of the awards process.
- A7.4 The spectrum could potentially be used to provide a number of services, including FWA, point-to-multipoint cellular and FWA network backhaul applications, PMSE applications and CCTV networks. These would be expected to deliver benefits for citizens/ consumers. As set out by Ofcom previously in its spectrum framework plan documents, Ofcom's view is that where possible, citizen/consumer interests in relation to the allocation of spectrum are best served through spectrum trading and liberalisation.

The policy objective

A7.5 Ofcom has a principal duty to further the interests of citizens in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate, by promoting competition. Further, in securing this principal duty Ofcom is required to secure the optimal use of wireless telegraphy of the electromagnetic spectrum. Therefore, the objective of the policy is to award the available spectrum in such a way as to maximum the likelihood that it will secure optimal use of the spectrum and to minimise any competition concerns that may arise.

Identification and assessment of options and the impacts on stakeholders

Licence exemption

A7.6 Ofcom could allocate this spectrum on a licence exempt basis or with licences. The options are considered in the table below.

Option	Advantages	Disadvantages
Licensed spectrum	Reduced risk of interference means that different operators will have the confidence to invest in deploying services in this spectrum.	Higher costs of allocating and administering the spectrum.
Licence exempt spectrum	This could stimulate innovative use of the spectrum and the development of new services.	There is no indication of demand for licence- exempt use either in the UK or across Europe. There may be interference issues associated with licence exemption. This is likely to depress the value that can be generated from use of the spectrum. Moreover opening the bands on this basis would make it difficult to reverse the position if it later transpired that the band could support high value services that required licensed spectrum.

A7.7 Given the risks of inefficiency from a licence exempt approach Ofcom is proposing to licence this spectrum.

Choice of assignment mechanism

A7.8 Ofcom could allocate this spectrum in a variety of ways that can be grouped in three ways, auction, "first come, first served" and comparative selection. Comparative selection was ruled out during the SFR:IP consultation process. The first two options are considered below.

Option	Advantages	Disadvantages
Auction	Clear and simple criteria for identifying winning bids.	Transaction and participation costs may be incurred by bidders.
	Open, transparent, and non- discriminatory.	
	Most likely to lead to an efficient outcome.	
First come first served	Appropriate method where supply exceeds demand.	In this case the market assessment suggests that there will be excess demand for the 10GHz, 28GHz and 32GHz bands. As a result licensing on this basis may not put the spectrum into the hands of those most likely to use it efficiently, and it may result in fragmentation of the spectrum.

A7.9 Ofcom's general view is that an auction mechanism is the preferred tool for assigning licences to unused spectrum where it is clear that there is excess demand for the

spectrum. Having considered the particular circumstances of the 10GHz, 28GHz and 32GHz bands Ofcom proposes use an auction mechanism to award the spectrum.

Technology and service neutrality

This spectrum could be awarded on either a technology and service neutral basis or it could be mandated for a particular technology or service. These options are considered in the table below.

Technology and service neutral approach	The demand assessment suggests that a range of users with different technologies and services may wish to use this spectrum. Under this approach the market determines the optimum use of the spectrum. The potential efficiency of the auction is maximised by allowing bidders the option of using the technology and service that they prefer. Consistent with the framework Directive. This approach does not impose constraints on future use.	Bidders face uncertainty over the nature of adjacent users (although risks can be mitigated by defining appropriate spectrum usage rights).
Mandate a specific service or technology	Bidders have certainty over nature of adjacent spectrum users. In certain circumstances this could assist in facilitating international harmonisation of equipment (though this can also be achieved by less intrusive means).	Requires Ofcom to choose one or more technologies or services. Could result in a sub optimal choice of technology or services. Could exclude technologies or services that may provide greater benefits than the chosen technologies or services. Future use is constrained to specific technologies or services, which could well be less efficient than under a neutral approach.

A7.10 In order to maximise efficiency and to enable the market to choose the most efficient outcome, Ofcom proposes to use a technology and service neutral approach.

Competition issues

A7.11 Ofcom has also considered whether the auction of the spectrum could negatively impact on competition in downstream markets if control of all or a significant proportion of the spectrum were to be gained by a limited number of bidders. It is also worth considering whether any competition problems would be caused if a successful bidder already held a position of strength in any markets such that it may have anti-competitive motives for acquiring the spectrum. If this were to be the case it may be appropriate to package the spectrum in such a way as to promote multiple entry and/or place restrictions on the amount of spectrum that any single bidder can acquire.

- A7.12 However as noted in section 4, Ofcom does not believe the risk of competition concerns arising from the proposed auction is significant, given the substitutes available for the spectrum and the possibility of further substitutable spectrum being released. In addition, Ofcom has not identified potential bidders who might have anti-competitive motives for acquiring the spectrum in order to foreclose particular downstream markets.
- A7.13 If a single bidder were to acquire all available spectrum for a particular use this could have potential to cause competition concerns, through the possibility that such a bidder could utilise its position to create a barrier to entry by excluding competitors access to a key input. However, given the availability of substitute spectrum for likely downstream uses such a strategy is unlikely to be feasible and, in any case, competition law or specific regulatory remedies are available to address such issues if they arise. As such, where it is not clear that specific competition concerns arise, it is not necessary to address these through spectrum policy.

Packaging options

A7.14 Ofcom has considered the packaging options for the 10GHz, 28GHz and 32GHz bands, focussing on geographic coverage and the appropriate number of licences to be awarded in each band. Options include: offering licences on a paired or unpaired basis; a regional or a UK basis; and, the appropriate spectrum assignment within each band. These are considered in more detail in Section 5 but the table below gives an overview of the packaging options for each band and summarises their respective advantages and disadvantages.

Band & option	Advantages	Disadvantages
10 GHz		
Option A: two separate 100 MHz lots	Lots small enough to address needs of potential bidders. May be more competition for lots than under Option B.	Introduces complementarity for some bidders and hence aggregation risk. Complementarity of lots complicates auction design.
Option B: one 2 x 100 MHz lot	Eliminates complementarity issue, thereby reducing aggregation risk to some bidders and substantially simplifying auction design.	Bidders requiring a single unpaired lot may have to co- ordinate their bidding with other parties or face acquiring more spectrum than they require.
28 GHz		
UK option A: three UK lots, comprising one paired (2x112 MHz) and two unpaired licences (each of 112 MHz)	Flexibility of spectrum offering retained.	Little interest has been expressed in unpaired licences. Aggregation risk if bidder wishes to acquire two unpaired lots – which most potential bidders seem to want.
UK option B: two UK lots (each of 2x112 MHz)	More likely to reflect demand. Simplifies auction design.	If a bidder did want unpaired spectrum it would have to co- ordinate with another bidder also wanting unpaired spectrum

		or might have to acquire more than it required.
Regional option A: 27 regional paired lots of 2x112 MHz		Bidders exposed to aggregation risk if they wish to acquire several regional lots. Accommodating the desire to aggregate potentially complementary regional lots by bidders may complicate auction design
Regional option B: two geographically limited paired lots of 2x112 MHz and one regional lot of 2x112 MHz	Retains flexibility by supplying regional spectrum. Aggregation of regional lots pre- auction simplifies auction design.	Very limited interest shown in regional lots
Regional option C: three geographically limited paired lots of 2x112 MHz	Aggregation of regional lots pre- auction simplifies auction design.	Does not cater for interest (albeit limited) shown in regional lots
32 GHz		
Option A: one UK paired lot of 2x756 MHz	Simplifies auction design.	Significantly larger than any potential bidder has expressed interest in.
Option B: one UK paired lot of 2x252 MHz and four UK paired lots of 2x126 MHz	May satisfy demand for larger licences.	The larger lots may be too large compared with any interest expressed to date, such demand for more than one lot as may exist does not seem likely to result in complementarity, and more than one 2 x 126MHz lot can be bid for in the auction.
Option C: six UK paired lots of 2x126 MHz	Matches prospective bidders' demand. Similarly sized packages to	
	other bands increases substitutability across bands.	
I in a gradient and a start	Maximiana flavikility of	
Unpaired alternative	spectrum offerings	Likely to lead to aggregation risk (for those seeking paired spectrum) and hence complicates auction design.

A7.15 Having considered the relative merits of the various options in terms of the likely strength of demand for the different packages (in each of the bands), the consequences for auction design and the likely impact on downstream competition, Ofcom proposes auction of the following spectrum packages:

Band	Spectrum packages
10 GHz	One UK licence of 2x100 MHz
28 GHz	Two UK licences each of 2x112 MHz
	Three 'geographically limited' licences each of 2x112 MHz, each with varying geographical coverage (see Annex 9 for maps illustrating this)
32 GHz	Six UK licences each of 2x126 MHz
TOTAL	12 licences

Auction design options for the different packages

A7.16 There are a number of different auction formats available, which may be suitable for the award of multiple lots of spectrum frequencies. Ofcom's assessment of the advantages and disadvantages of key auction design features are set out in the table below:

Auction format	Advantages	Disadvantages
Sequential award of lots		A sequential sale is problematic since bidders will not know the price to be paid for substitute lots.
Multiple round (ascending bids)	In the absence of competition concerns, considered to produce more efficient outcomes as bidders can learn and refine their own valuations from observing behaviour of competitors over the course of the auction. Allowing bidders to respond to relative prices reduces substitution risks.	Award process more complex than a single round award, but not so great as to justify using a significantly less efficient auction format. (Bidder strategies may, however, be simpler with a simple ascending multiple round auction.)
Single round (sealed bids)	Simpler to administer. May encourage participation when there are bidder asymmetries	Does not enable bidders to gain information on lot values from other bidders' behaviour.
Generic lots	Simplifies the auction	Requires follow-up action to assign specific spectrum packages.
Specific lots	Allows bidders to express a preference between lots, which is appropriate where there are material differences between lots.	More complex than award with generic lots.
Use of package (combinatorial) bidding	Key benefit is where there are strong complementarities amongst lots. However, given the packaging proposed, this is not relevant for this auction.	Makes the auction more complex, especially if all possible combinations are allowed.

A7.17 Ofcom has concluded that using a simultaneous, multiple round process is the most appropriate approach for the award of these bands, rather than sequential or single round formats. Ofcom does not believe there would be any benefits to introducing combinatorial bidding to the auction design, given the lots proposed.

Annex 8

Summary of SFR: IP responses

- A8.1 This annex sets out a summary of the responses made to the Spectrum Framework Review: Implementation Plan, which are relevant to the 10 GHz, 28 GHz, 32 GHz and 40 GHz bands.
- A8.2 The full text of the responses can be found on the consultation section of the Ofcom website at http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/responses/. Nineteen respondents provided comments on the 10 GHz proposals, seventeen respondents provided comments on the 28 GHz proposals, fifteen respondents provided comments on the 32 GHz proposals and thirteen respondents provided comments on the 40 GHz proposals. Two respondents requested confidentiality. Their views have been taken into account, but their responses have not been published on the Ofcom website.

Issue raised	Comments	Ofcom response
10 GHz		
Amateur use	AMSAT UK/BATC and the Microwave Group advised that amateurs have terrestrial allocations at 1010.125 and 10.225-10.475 GHz which are used for Amateur Television and other uses. The Amateur Satellite service has an allocation extending over 10.450-10.500 GHz.	Ofcom notes that the Amateur Satellite service has a secondary allocation from 10.450-10.500 GHz that overlaps the band for award and secondary terrestrial allocations adjacent to it.
Monopoly licensee in the band	The BBC were concerned about the possibility of a single licensee having a monopoly in the band.	Ofcom considers that fact that alternative spectrum is available for video links and wireless cameras should cater for the requirements of operators who do not obtain spectrum in this band.
Co-ordination	O ₂ agreed with the proposal, subject to co-ordination with MOD. MOD did not feel that it was a practical proposition to require the licensee to co- ordinate its use with MOD.	Ofcom is exploring with MOD the arrangements that would apply to shared use of the band.
Spectrum packaging	T-Mobile questioned whether a single licence was appropriate and suggested that 2x50 MHz may be adequate if used for applications such as FWA.	Ofcom's market analysis suggests that 2x100 MHz is more likely to be required for such applications.

	The Welsh Assembly felt that regional licences should be offered for England, NI, Wales and Scotland.	Ofcom believe that there is no clear basis for geographic division of the spectrum and the creation of arbitrary boundaries could impede efficient use and increase interference co-ordination costs. Where there are no strong grounds for limiting the geographic scope of licences on grounds of optimal spectrum use, Ofcom considers that licences should be for the whole of the UK. Division of a UK licence into smaller geographic units could be achieved subsequent to an award through the secondary trading market.
Restrictions on mobile use in new spectrum licences	H3G commented that the mix of technologies that technology neutrality allowed, in particular allowing fixed and mobile in the same band, risked inefficient use of spectrum. It has also commented that restrictions on mobile use should be included in new licences to avoid distorting investment incentives by existing 3G licensees.	Ofcom's intention has been to set technology and usage restrictions that are the minimum necessary for efficient spectrum management. It considers it unlikely that the spectrum bands will be used for mobile services. However, in any event Ofcom considers that restrictions forbidding the use of these bands for mobile services are unnecessary as adequate protection against harmful interference are included in the draft licence. Regulation should not prevent the possibility that these licensees might be able to offer some element of mobility while complying with these conditions (including the obligation not to cause harmful interference). Ofcom does not consider the investment incentives of

		3G licensees are likely to be distorted by increasing the availability of spectrum (including through this award) given that the principle effect of increasing spectrum supply should be to increase the efficiency with which resources are used and create additional opportunities for competition and innovation.
Harmonisation	Stratex felt that in bands of 3.6 GHz and above, there should be greater harmonisation through fora such as the ITU and CEPT/ERC. H3G also believed that the benefits of harmonisation should be considered.	Ofcom recognises the importance of taking into account the plans in the rest of Europe for particular bands. Indeed for some particular awards, for example 2010- 2025 MHz and 2500-2690 MHz, its proposals in the SFR:IP were made expressly subject to particular outcomes at an EU level. In relation to the issue of harmonisation more generally, as Ofcom has set out in the SFR its long-term objective is that harmonisation is predominantly performed in the market with minimal regulatory intervention and is non-binding. However, Ofcom recognises that this will not be achieved immediately and it will continue to participate in international harmonisation activities but it will seek to ensure that regulation is clearly justified and that the benefits exceed the costs. Ofcom does not consider that conferring exclusive access to a particular technology or application is likely to be justified.
28 GHz		

Amateur use	GH Engineering believed that 28 GHz frequencies were unsuitable for the commercial use of FWA and felt that the band should be made available to the amateur service on a non- interference basis The Microwave Group asked that access be provided in this band for innovative amateur use.	Ofcom's market analysis suggests that potential operators in the band do see it as attractive for FWA and other fixed uses. Ofcom considers that the current Amateur spectrum allocations are sufficient to meet users' needs.
Licence term	O ₂ suggested that licences should be offered on a rolling term and existing licences be converted to a rolling term.	An existing licensee wishing to vary the term of its licence may submit a variation request to Ofcom and Ofcom will consider the request on its merits. (Ofcom considers that the phrase 'rolling term' is unhelpful and uses the term 'indefinite duration'. The import is the same. See paragraph 7.14ff)
Auction design	The Welsh Assembly suggested that the 28 GHz and 32 GHz frequencies both be auctioned on a single UK wide basis with a lower combined reserve price than they would have if auctioned separately.	Ofcom agrees with the suggestion of UK national licensing. Our primary objective in an auction is to promote the optimal use of the spectrum. Ofcom considers that the main function of the minimum bid price is to deter frivolous bidders and it should be set at the minimum level necessary to do this without deterring genuine bidders.
Satellite use Restrictions on	The European Satellite Operators Association/Global VSAT Forum were of the view that Ofcom's implementation plan was aimed at reallocating radio spectrum to wireless terrestrial technologies and Ofcom may not have taken account of expected market developments in, for example, ubiquitous and uncoordinated HD FSS potentials H3G commented the mix of	Ofcom proposes to auction the spectrum on a technology and service neutral basis. The market therefore has the opportunity to make the decision as to what technology and service the spectrum can be most successfully used for. Alternative spectrum for HDFSS is available. Ofcom's intention has

mobile use in new spectrum licences	technologies that technology neutrality allowed, in particular allowing fixed and mobile in the same band, risked inefficient use of spectrum. It has also commented that restrictions on mobile use should be included in new licences to avoid distorting investment incentives by existing 3G licensees.	been to set technology and usage restrictions that are the minimum necessary for efficient spectrum management. It considers it unlikely that the spectrum bands will be used for mobile services. However, in any event Ofcom considers that restrictions forbidding the use of these bands for mobile services are unnecessary as adequate protection against harmful interference are included in the draft licence. Regulation should not prevent the possibility that these licensees might be able to offer some element of mobility while complying with these conditions (including the obligation not to cause harmful interference). Ofcom does not consider the investment incentives of 3G licensees are likely to be distorted by increasing the availability of spectrum (including through this award) given that the principle effect of increasing spectrum supply should be to increase the efficiency with which resources are used and create additional opportunities for competition and innovation.
Harmonisation	Stratex felt that in bands of 3.6 GHz and above, there should be greater harmonisation through fora such as the ITU and CEPT/ERC. H3G also believed that the benefits of harmonisation should be considered.	Ofcom recognises the importance of taking into account the plans in the rest of Europe for particular bands. Indeed for some particular awards, for example 2010- 2025 MHz and 2500-2690 MHz, its proposals in the SFR:IP were made expressly subject to particular outcomes at an EU level. In relation to the

		issue of harmonisation more generally, as Ofcom has set out in the SFR its long-term objective is that harmonisation is predominantly performed in the market with minimal regulatory intervention and is non-binding. However, Ofcom recognises that this will not be achieved immediately and it will continue to participate in international harmonisation activities but it will seek to ensure that regulation is clearly justified and that the benefits exceed the costs. Ofcom does not consider that conferring exclusive access to a particular technology or application is likely to be justified.
32 GHz		
Spectrum packaging	BT and Intellect each suggested that 2 UK licences be offered. Orange felt that there should be one licence of 2x500 MHz licence.	Ofcom propose to offer six UK licences each comprising 2x120 MHz which we believe will offer the greatest flexibility for prospective users.
	Pipex suggested that the number of licences to be awarded should be evaluated at a time closer to the auction. T-Mobile felt that there was sufficient spectrum to support a number of users. They also suggested that it may be appropriate to retain sufficient spectrum to support individual link assignments or other unforeseen circumstances where operators may require a licence on a per link or per site basis.	Spectrum is available in other bands to accommodate requirements for individual (centrally managed link by link) fixed links assignments. Ofcom is proposing a different spectrum management approach for the 32 GHz band. This will not preclude the use of the spectrum for fixed link systems.
Auction design	The Welsh Assembly suggested that the 28 GHz and 32 GHz frequencies be auctioned on a	Ofcom agrees with the suggestion of UK national licensing. Our primary

	single UK wide basis with a lower combined reserve price than they would have if auctioned separately. T-Mobile felt that Ofcom should consider a combinatorial auction where bidders can select whether to bid for smaller lots or a package of lots.	objective in an auction is to promote the optimal use of the spectrum. Ofcom considers that the main function of the minimum bid price is to deter frivolous bidders and it should be set at the minimum level necessary to do this without deterring genuine bidders. Ofcom's proposed auction design will allow bidding for lots in all three bands. It does not consider that a combinatorial auction is required in this case.
Amateur use	The Microwave Group asked that access be provided in this band for innovative amateur use.	Ofcom considers that the current Amateur spectrum allocations are sufficient to support innovative use.
Restrictions on mobile use in new spectrum licences	H3G commented that the mix of technologies that technology neutrality allowed, in particular allowing fixed and mobile in the same band, risked inefficient use of spectrum. It has also commented that restrictions on mobile use should be included in new licences to avoid distorting investment incentives by existing 3G licensees.	Ofcom's intention has been to set technology and usage restrictions that are the minimum necessary for efficient spectrum management. It considers it unlikely that the spectrum bands will be used for mobile services. However, in any event Ofcom considers that restrictions forbidding the use of these bands for mobile services are unnecessary as adequate protection against harmful interference are included in the draft licence. Regulation should not prevent the possibility that these licensees might be able to offer some element of mobility while complying with these conditions (including the obligation not to cause harmful interference). Ofcom does not consider the investment incentives of

		3G licensees are likely to be distorted by increasing the availability of spectrum (including through this award) given that the principle effect of increasing spectrum supply should be to increase the efficiency with which resources are used and create additional opportunities for competition and innovation.
Harmonisation	Stratex felt that in bands of 3.6 GHz and above, there should be greater harmonisation through fora such as the ITU and CEPT/ERC. H3G also believed that the benefits of harmonisation should be considered.	Ofcom recognises the importance of taking into account the plans in the rest of Europe for particular bands. Indeed for some particular awards, for example 2010- 2025 MHz and 2500-2690 MHz, its proposals in the SFR:IP were made expressly subject to particular outcomes at an EU level. In relation to the issue of harmonisation more generally, as Ofcom has set out in the SFR its long-term objective is that harmonisation is predominantly performed in the market with minimal regulatory intervention and is non-binding. However, Ofcom recognises that this will not be achieved immediately and it will continue to participate in international harmonisation activities but it will seek to ensure that regulation is clearly justified and that the benefits exceed the costs. Ofcom does not consider that conferring exclusive access to a particular technology or application is likely to be justified. Ofcom have consulted
CAA	O ₂ telt that Ofcom should consult with the CAA before awarding one or more UK licences on a service and	Otcom have consulted CAA.

	technology neutral basis.	
Adjacent fixed link spectrum	Orange supported Ofcom's proposal to award one or more UK licences on a service and technology neutral basis providing that there was no reduction in emission limits imposed on 32 GHz fixed link spectrum which is immediately adjacent.	Ofcom proposes to include the adjacent fixed link spectrum in the award.
	· · · · · ·	
40 GHz		
Spectrum packaging	Kingston Communications felt that 2x250 MHz would be a good opportunity for pioneer licences Orange felt that 2x500 MHz should be reserved for Multimedia Wireless Services (MWS) or fixed links. T-Mobile felt that the priority usage should be for fixed links, with 2x250 MHz initially reserved for fixed point-to-point links for licensing on a per link basis. Innovative services should only be considered if these do not affect the priority usage. T-Mobile suggested that consideration should be given for sub-division for more than one licensee.	Ofcom's market analysis found a lack of demand for use of the 40 GHz band, which is discussed at paragraphs 2.8 to 2.13, and it proposes to defer release of the band. If there are companies that wish to explore the band's potential in advance of its release, they may do so under Ofcom's non- operational development licensing regime.
Timing	Intellect and the Wales Broadband Stakeholder Group felt that the suggested timescale was inappropriate and would divert Ofcom resources. Orange suggested a 'wait and see' approach.	
Point-to-point use	Kingston Communications felt that questioning use of the band for point-to-point links pre- judges the market requirement.	+
European Commission	The Communications Management Assoc advised that management of the 40 GHz band was subject to a formal	

	complaint to the European Commission which would impact	
Restrictions on mobile use in new spectrum	H3G commented that the mix of technologies that technology neutrality allowed, in particular allowing fixed and mobile in the same band, risked inefficient use of spectrum. It has also commented that restrictions on mobile use should be included in new licences to avoid distorting investment incentives by existing 3G licensees.	Ofcom proposes to defer release of this band given the lack of demand and of commercially available equipment. When the band is released Ofcom considers it unlikely that it will be used for mobile services and that restrictions on mobile use will be unnecessary. However, in any event Ofcom considers that restrictions forbidding the use of these bands for mobile services are unnecessary as adequate protection against harmful interference are included in the draft licence. Regulation should not prevent the possibility that these licensees might be able to offer some element of mobility while complying with these conditions (including the obligation not to cause harmful interference). Ofcom does not consider the investment incentives of 3G licensees are likely to be distorted by increasing the availability of spectrum (including through this award) given that the principle effect of increasing spectrum supply should be to increase the efficiency with which resources are used and create additional opportunities for competition and ipnovation
Harmonisation	Stratex felt that in bands of 3.6 GHz and above, there should be greater harmonisation through fora such as the ITU and CEPT/ERC. H3G also believed that the benefits of harmonisation should be	Ofcom recognises the importance of taking into account the plans in the rest of Europe for particular bands. Indeed for some particular awards, for example 2010-

considered.	2025 MHz and 2500-2690
	MHz, its proposals in the
	SFR:IP were made
	expressly subject to
	particular outcomes at an
	EU level. In relation to the
	issue of harmonisation
	more generally, as Ofcom
	has set out in the SFR its
	long-term objective is that
	harmonisation is
	predominantly performed
	in the market with minimal
	regulatory intervention and
	is non-binding. However,
	Ofcom recognises that this
	will not be achieved
	immediately and it will
	continue to participate in
	international
	harmonisation activities
	but it will seek to ensure
	that regulation is clearly
	justified and that the
	benefits exceed the costs.
	Ofcom does not consider
	that conferring exclusive
	access to a particular
	technology or application
	is likely to be justified.

Annex 9

28 GHz licences geographical coverage

Figure A9.1: Licence regions in the 2000 auction (coloured regions are those in which BFWA licences were awarded following the auction)



Region	Licence 1	Licence 2	Licence 3
- J -	(28.0525 - 28.1645GHz paired	(28.1925 - 28.3045GHz paired	(28.3325 - 28.4445GHz paired
	with 29.0605 - 29.1725GHz)	with 29.2005 - 29.3125GHz)	with 29.3405 - 29.4525GHz)
Α	Energis Local Access Ltd	Broadnet UK Ltd	Faultbasic Ltd
В	Your Communications Ltd	Energis Local Access Ltd	Faultbasic Ltd
С	Energis Local Access Ltd	Your Communications Ltd	Faultbasic Ltd
D	Unsold	Unsold	Unsold
E	Unsold	Unsold	Unsold
F	Unsold	Unsold	Unsold
G	Unsold	Unsold	Unsold
Н	Unsold	Unsold	Unsold
	Energis Local Access Ltd	Your Communications Ltd	Unsold
J	Unsold	Your Communications Ltd	Unsold
К	Unsold	Unsold	Unsold
L	Unsold	Energis Local Access Ltd	Unsold
Μ	Unsold	Unsold	Unsold
Ν	Energis Local Access Ltd	Chorus Communication Ltd	Unsold

Table A9.1: Companies to whom licences were awarded in December 2000

Figure A9.2: 28 GHz geographically limited licences
Licence 1
 Licence 2
 Licence 3

 Note: white areas are those to be covered in geographically limited licences. (Red areas are regions currently licensed.)



Annex 10

Glossary

2G

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

3G

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

AIP

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

Band

A defined range of frequencies that may be allocated for a particular radio service, or shared between radio services.

CDMA

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

CDMA-1x

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

CEPT

Conference of European Postal and Telecommunications administrations, comprising over 40 European administrations.

Communications Act

Communications Act 2003, which came into force in 2003.

Co-ordination

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

dBW

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

ECC

Electronic Communications Committee: a committee that reports to CEPT.

EIRP

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

ERC

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

ERP

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

ETSI

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

GHz

Gigahertz: a unit of frequency equal to 1000 million (1×10^9) Hz or cycles per second.

ITU

International Telecommunications Union; an international organisation within the United Nations System where governments and the private sector coordinate, discuss and agree the logistics of global telecom networks and services.

kHz

Kilohertz: a unit of frequency, equal to $1000 (1 \times 10^3)$ Hz or cycles per second.

Liberalisation

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

Licence class

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

Licence exempt

Allowing anyone to use the spectrum for any application under certain specified restrictions, but typically with maximum power levels. The current regulations are the Wireless Telegraphy (Exemption) Regulations 2003 (SI 2003 No. 74), available at:

http://www.legislation.hmso.gov.uk/si/si20 03/20030074.htm

MHz

Megahertz: a unit of frequency equal to $1,000,000 (1 \times 10^6)$ Hz or cycles per second.

MOD

Ministry of Defence.

Ofcom

Office of Communications. Ofcom took over the RA's responsibility for spectrum management in the UK in December 2003.

Out-of-block emissions

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

Partial transfer

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

PAMR

Public Access Mobile Radio

PMR

Private Mobile Radio

RA

The Radiocommunications Agency: a former executive agency of the Department of Trade and Industry, which was responsible for the management of most non-military spectrum in the UK and for representing the UK in relevant international bodies. The RA's functions transferred to Ofcom in December 2003.

SMO

Spectrum Management Organisation

Spectrum Framework Review (SFR)

Ofcom consultation published in November 2004 and resulting statement published in June 2005 by Ofcom on how spectrum will be managed in the future.

Spectrum Framework Review: Implementation Plan (SFR:IP)

Ofcom consultation published in January 2005 by Ofcom on the release of spectrum in 2005 – 08, and on extending spectrum liberalisation and trading to mobile services.

Spectrum mask

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

Spectrum trading

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

Trading Regulations

The Statutory Regulations that facilitate spectrum trading.

Undue interference

Interference in relation to any wireless telegraphy which is undue and also harmful (as described in section 19(5) and (5A) of the Wireless Telegraphy Act 1949). In summary this includes interference that creates dangers or risks of dangers to the functioning of any radiocommunications service designed for the purposes of navigation or safety services, or if the interference degrades, obstructs or repeatedly interrupts authorised broadcasting or other wireless telegraphy.

Wireless telegraphy

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

Wireless telegraphy licences

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

WT Acts

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