OFFICE OF COMMUNICATIONS

Recognised Spectrum Access as applied to Radio Astronomy

A statement on proposals for applying RSA to Radio Astronomy

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Contents

Section 1

Summary

1.1 This Statement presents the conclusions following a consultation which proposed applying Recognised Spectrum Access (RSA) to radio astronomy. The public consultation was published on 6 April 2005 and is available electronically on Ofcom's Website http://www.ofcom.org.uk/consult/condocs/astronomy

1.2 This Statement sets out Ofcom's policy decisions in respect of the proposals highlighted within the consultation.

1.3 Ofcom would like to reiterate that this Statement and the preceding consultation relate only to the introduction of RSA for spectrum used by radio astronomy. Work is being undertaken separately in relation to the introduction of RSA for satellite (and other) services and this will be the subject of a separate consultation.

Ofcom's role and RSA

1.4 Ofcom has a duty under the Communications Act 2003 (the "2003 Act") to secure optimal use of the radio spectrum, having regard to a number of factors including the efficient management and use of the spectrum. Section 159 empowers Ofcom to introduce RSA for the purpose of carrying out certain of its functions in relation to the radio spectrum. RSA is a means for OFCOM to take into account, within national spectrum planning, the use of frequencies used for reception of services that do not require to be licensed under the Wireless Telegraphy Act 1949, for example because transmissions are made from outside the UK. Radio astronomy comes within this category because the equipment used receives signals from space but does not transmit.

1.5 Under section 160 of the 2003 Act, a grant of RSA would have the effect of requiring Ofcom in planning and managing the radio spectrum to take account of the use of the spectrum that is the subject of the grant on a comparable basis to a licensed use.

1.6 The consultation sought views on:

- the appropriateness of RSA as a spectrum management tool for the Radio Astronomy Service;
- whether the list of typical RSA parameters was appropriate;
- whether an indefinite duration with minimum 5 year notice period in the event of revocation was suitable;
- the proposed basis for fees;
- whether spectrum trading and liberalisation should be applied;
- whether additional regulatory impacts or policy implications should be considered.

1.7 During the consultation period, the independent audit of spectrum holdings by Professor Martin Cave, which is reviewing the effectiveness of ongoing incentives for public sector users to maximise efficient use of the spectrum, sought views on a number of emerging issues [1]. That document, which referred to spectrum used for

[1] Independent Audit on Spectrum Holdings – 'Emerging issues' July 2005 - http://www.spectrumaudit.org.uk/pdf/Emerging_Issues.pdf

radio astronomy and mentioned Ofcom's proposals to introduce RSA for radio astronomy, sought views on the general question of the role of market mechanisms in meeting public sector requirements for spectrum.

1.8 Professor Cave intends to report later this year. While it would not be appropriate for Ofcom to anticipate the conclusions of the audit or the Government's response, it is relevant to note that the Government, in responding to the review of spectrum management by Professor Cave that was published in 2002, agreed with his recommendation that radio astronomers should face incentives to use spectrum efficiently through a combination of spectrum pricing and trading. This was coupled with a commitment to continue to support world-class radio astronomy in the UK and the expressed intention that spectrum pricing should act as an incentive to spectrum efficiency but should not reduce the resource currently devoted to radio astronomy.

1.9 The funding of radio astronomy is, of course, a matter for the Government, not for Ofcom. In setting fees for RSA, Ofcom will, however, exercise its power in accordance with the relevant provisions set out in the 2003 Act and the Wireless Telegraphy Act 1998. This includes Ofcom having regard in particular to various factors, such as the efficient management and use of the radio spectrum.

1.10 From the radio astronomers' point of view (in shared bands), there is no formal security that Ofcom will not license terrestrial services that may interfere with reception to an extent greater than the radio astronomers would wish. At a time of growing demand and increasing spectrum congestion, RSA would require that Ofcom take into account radio astronomy users when carrying out its spectrum management functions. Radio astronomy is a major user of spectrum using approximately 2% of spectrum below 50 GHz of which two thirds is shared with active services. A list of these frequencies is given in Annex 3.

Responses to the consultation

1.11 Ofcom received 13 responses from the scientific research community within the UK as well as from the satellite and mobile industry. A full list of respondents is given in Annex 2. The responses have been placed on Ofcom's website.

1.12 The responses dealt with 3 main issues, which are addressed separately in Section 4 of this Statement:

1.12.1 the principle of introducing RSA for radio astronomy;

1.12.2 the fee basis for RSA;

1.12.3 spectrum trading and liberalisation

1.13 A summary of the other points raised with Ofcom's comments is tabulated in Annex 1.

Ofcom's conclusions

1.14 Ofcom is grateful to all who responded and has carefully considered the comments.

1.15 Ofcom's conclusions and reasoning are set out in more detail in the following Sections of this Statement. Where appropriate, we have modified some aspects of our proposals to meet the concerns that were expressed by respondents to the consultation. Key points made in this Statement are summarised below.

- Ofcom's policy objective is to secure optimal use of the radio spectrum used for radio astronomy. It believes this is best secured by:
  - making transparent the economic cost of making spectrum available for radio astronomy and so assisting rational and informed decision-making;
  - providing appropriate incentives for radio astronomers to use spectrum efficiently.
- We remain of the view that the introduction of RSA for radio astronomy will help secure optimal use of the radio spectrum and intend to proceed but have modified our proposals to reflect concerns expressed in the responses.
- The parameters proposed in the consultation to be included in the RSA are appropriate.
- Initially, RSA will only address in-band interference issues although Ofcom is aware of the sharing issues which exist for out-of-band emissions. We will adopt a balanced approach to avoid undue constraints on the deployment of other services. It is unnecessary to consult separately on the initial values of those parameters as they will reflect the status quo so no additional restrictions will be imposed on other services.
- An indefinite term with a minimum 5 year notice period is appropriate for RSA for radio astronomy.
- In bands used for radio astronomy and in which alternative use of the spectrum is permitted by the International Radio Regulations, the RSA fees should be set by Administrative Incentive Pricing (AIP) based on the opportunity cost of denying the spectrum to alternative services.
- Were radio astronomers to relinquish their use of any part of the spectrum they currently use, whether on a national or regional basis, Ofcom would consider each request for change of use in accordance with Ofcom's liberalisation policy. Ofcom favours maximum flexibility in how spectrum is used but would check in particular that any change of use was compatible with the UK's international obligations and did not cause an unacceptable increase in interference for neighbouring spectrum users.
- It is desirable in principle for radio astronomy RSA to be tradable to give increased incentive for spectrum efficiency. However, the incentive effect will depend on whether or not the radio astronomy community is allowed to retain the proceeds of trading. Ofcom does not intend to introduce trading for radio astronomy RSA at this time but will revisit this issue in the light of the Government's response to the Cave Audit.

Next steps for radio astronomy RSA

1.16 To introduce RSA for radio astronomy, it will be necessary for Ofcom to make RSA regulations under section 159 of the 2003 Act and also to make fees regulations. We expect to publish a notice to consult on the necessary regulations in due course.

1.17 Please note that you can register at http://www.ofcom.org.uk/static/subscribe/select_list.html to obtain automatic notifications of when Ofcom documents are published.

1.18 The remainder of this Statement is structured as follows:

- Section 2 – provides an overview of the legal and regulatory framework associated with RSA and describes broadly what Ofcom's policy on RSA for radio astronomy is aiming to achieve.
- Section 3 – describes Ofcom's approach to managing the radio spectrum and explains how RSA will promote optimal use of spectrum for radio astronomy.
- Section 4 - summarises the responses to the consultation and sets outs Ofcom's general policy position.
- Annex 1 – provides a summary of the other points raised in the consultation with Ofcom's comments.

Section 2

Background

2.1 This Section provides a brief overview of the main legislative provisions relevant to Ofcom's duties and functions in relation to radio spectrum, although it is not a comprehensive statement of all the legal provisions that are relevant to Ofcom's functions and to RSA. It further briefly explains the nature of radio astronomy and how RSA for radio astronomy fits into the general spectrum framework.

Legal and regulatory framework

2.2 The Communications Act 2003 (the "2003 Act") empowers Ofcom to introduce RSA on a selective basis to manage the radio spectrum more effectively.

2.3 Section 159 of the 2003 Act prescribes the circumstances relevant for a grant of RSA, namely:

> (i) a person is proposing to use or to continue to use a station or apparatus for wireless telegraphy;
>
> (ii) the circumstances of the use are circumstances specified for the purposes of that section in regulations made by Ofcom;
>
> (iii) that use does not require a wireless telegraphy licence but will involve the emission of electro-magnetic energy with a view to the reception of anything at places in the United Kingdom or in the territorial waters adjacent to the United Kingdom; and
>
> (iv) for the purposes of that section it is immaterial whether the emissions are from a place within the United Kingdom or from a place outside the United Kingdom.

2.4 When carrying out functions under enactments relating to the management of the radio spectrum, Ofcom must act in accordance with various statutory duties including sections 3, 4 and 154 of the 2003 Act. In particular, section 154 provides that Ofcom must have regard to:

- the extent to which the electro-magnetic spectrum is available for use, or further use, for wireless telegraphy;
- the demand for use of that spectrum for wireless telegraphy;
- the demand that is likely to arise in future for the use of that spectrum for wireless telegraphy; and
- the desirability of promoting (i) the efficient management and use of the part of the electro-magnetic spectrum available for wireless telegraphy; (ii) the economic and other benefits that may arise from the use of wireless telegraphy; (iii) the development of innovative services; and (iv) competition in the provision of electronic communications services.

2.5 The grant of RSA would have the effect of requiring Ofcom under section 160 of the 2003 Act to take account of receiving equipment on a comparable basis to a licensed use. This would require Ofcom to take into account the existence of any grant of RSA that is for the time being in force, along with any restrictions and conditions imposed,

to the same extent as Ofcom would take into account a wireless telegraphy licence with terms, provisions or limitations making equivalent provision.

2.6 In addition to specifying the above-mentioned circumstances of the RSA use in regulations made by Ofcom, Ofcom has powers to make regulations prescribing the procedures in accordance with which an application for a grant of RSA must be determined. Such procedures would include provision for (i) time limits for dealing with applications for a grant of RSA; (ii) requirements which must be met before a grant is made; and (iii) the restrictions and conditions to which a grant may be made subject.

2.7 Under section 159 of (and Schedule 5 to) the 2003 Act, Ofcom also has powers to revoke and modify a grant of RSA.

2.8 Section 162 of the 2003 Act empowers Ofcom to make regulations to provide for the conversion of a grant of RSA into a wireless telegraphy licence and vice versa.

2.9 Section 168 of the 2003 empowers Ofcom to make regulations to provide for rights and obligations under a grant of RSA to be tradable.

2.10 Finally, section 1 of the Wireless Telegraphy Act 1998 (the “1998 Act”) empowers Ofcom to make regulations to prescribe fees payable for the making of a grant of RSA. Under section 2(2) of the 1998 Act, Ofcom may, if it thinks fit in the light (in particular) of the matters to which it is required to have regard under section 154 of the 2003 Act, prescribe fees which would be greater than those that would be necessary for the purposes of recovering costs incurred by Ofcom in connection with its functions under the enactments relating to the management of the radio spectrum. In other words, section 2(2) of the 1998 Act (as amended by the 2003 Act) enables Ofcom to set fees for RSA in excess of its spectrum management costs for the purpose of achieving its above-mentioned spectrum management objectives. This mechanism is known as ‘Administrative Incentive Pricing’ (“AIP”).

2.11 The above-mentioned enabling powers to make regulations are exercisable by statutory instrument. As further explained above, before making such regulations, Ofcom will consult on the detail of any such instrument by publishing a notice of its proposals to make regulations in accordance with section 403 of the 2003 Act.

Ofcom’s spectrum functions

Licensing

2.12 As a general rule, the establishment, installation or use of any station (or apparatus) for wireless telegraphy is prohibited under the Wireless Telegraphy Act 1949 (the ”1949 Act”), unless it has been authorised. Authorisation may be granted in two ways: either by way of the grant of a wireless telegraphy licence or by regulations exempting the establishment, installation or use in question from the requirement to be licensed.

2.13 Licensing is reserved for equipment that Ofcom considers has the potential to cause harmful interference. In granting licences, Ofcom imposes various technical conditions in order to avoid unacceptable interference between neighbouring users, e.g. power limits or guard bands between the frequencies licensed to adjacent users. If a service is unlikely to involve any undue interference with wireless telegraphy, Ofcom is required by section 1AA of the 1949 Act and the EU Authorisation Directive 2002/20/EC to exempt it from licensing.

Grants of RSA

2.14 RSA is essentially a new spectrum management instrument that fills a significant gap in the management of the radio spectrum. Radio astronomy in the UK involves reception by radio telescopes located in the UK of signals from outside the UK. Subject to the making by Ofcom of the necessary regulations under section 159 of the 2003 Act (see paragraph 2.3 above), RSA could therefore be introduced to be applicable to radio astronomers. Ofcom believes that RSA has the potential to promote better use of the radio spectrum currently allocated to radio astronomy.

2.15 Radio astronomy use does not require a wireless telegraphy licence as radio telescopes used for observations receive faint signals from space but are not designed to transmit. As radio telescopes are inherently incapable of transmission, they are, by virtue of the Wireless Telegraphy Apparatus (Receivers) (Exemption) Regulations 1989, exempt from the requirement to be licensed.

2.16 The main features of RSA are as follows:

- Grants of RSA can only be made after Ofcom has made the necessary regulations.
- Ofcom would have a duty to take account of the existence of a grant of RSA in the same way as it would in respect of a licence. For example, Ofcom will plan to limit the levels of licence emissions into spectrum and geographical areas covered by RSA.
- RSA would not be mandatory even in bands in which it has been introduced. It will remain perfectly lawful to operate without RSA, although users without RSA might forego the benefits that RSA confers.
- Ofcom would be able to charge fees for RSA that reflect the economic value of the spectrum to which it relates. As for wireless telegraphy licences, there are statutory safeguards to ensure that fees are no higher than required for certain spectrum management purposes.
- RSA may also be made tradable and convertible into licences.
- Similar provisions would apply to the issue, variation and revocation of RSA as apply to licences.
- RSA would not provide an absolute guarantee of protection from interference but offers a higher degree of certainty than would otherwise be the case.

Section 3

RSA for Radio Astronomy

3.1 This Section describes Ofcom's approach to managing the radio spectrum. It explains how RSA will promote optimal use of spectrum for radio astronomy. Radio astronomy is a major user of spectrum using approximately 2% of the spectrum below 50 GHz of which two-thirds is shared with active services.

3.2 In its consultation document [2] published on 6 April 2005 (referred to in this Statement as the "consultation"), Ofcom identified a number of issues to be considered before RSA could be introduced for particular applications. These were summarised as follows:

- process for initial grant of RSA;
- setting technical and geographical parameters for recognition that provide sufficient quality of spectrum without excessively excluding other services;
- the term of the RSA and security of tenure in case of revocation or variation;
- the basis for setting and the level of fees for RSA that are no higher than necessary to provide sufficient incentives for spectrum efficiency;
- the conditions under which RSA should be tradable and convertible into licences and what, if any, restrictions should be imposed on alternative uses;
- publication of information about individual grants of RSA .

Ofcom's approach to managing spectrum

3.3 Radio spectrum is used for a wide variety of purposes, including broadcasting, mobile telephones, business radio, radar and scientific research, including radio astronomy. The spectrum is a finite resource of considerable economic importance and demand for it is increasing.

3.4 Use of the radio spectrum has to be planned and managed to avoid interference that can destroy its value. This is underpinned by a system of licensing the installation and use of radio equipment under the 1949 Act, as amended by the 2003 Act, as discussed in Section 2. In granting wireless telegraphy licences, Ofcom imposes various technical conditions in order to avoid unacceptable interference between neighbouring users, e.g. power limits or guard bands between the frequencies licensed to adjacent users.

3.5 There are three main approaches to managing spectrum. They are:

- **Command and control**: the regulator decides, often in considerable detail, how spectrum is to be used.
- **Exemption from licensing**: users have unrestricted access to spectrum, normally with restrictions on power levels. This is suitable for services that are unlikely to cause interference and can co-exist in an open environment without defined levels of spectrum quality.
- **Market mechanisms**: auctions, incentive pricing and spectrum trading are applied to provide incentives to maximise economic efficiency. Users have freedom within a

[2] 'Recognised Spectrum Access as applied to Radio Astronomy'

liberalised regulatory framework to decide for themselves how best to use the spectrum.

3.6 Historically, command and control has dominated. However, Ofcom believes that market mechanisms are generally more effective than centralised control in achieving optimal use of the radio spectrum and that traditional spectrum management methods based on regulation are no longer sustainable in the face of growing demand for spectrum and proliferating technologies. Ofcom is reforming spectrum management to make greater use of market mechanisms as described in its Spectrum Framework Review (SFR), which is available on Ofcom's web site http://www.ofcom.org.uk/consult/condocs/sfr/. The SFR's central theme is that the management of the radio spectrum can be carried out most effectively if market forces are harnessed to a significantly greater degree than in the past. We consider this approach will:

- promote efficient use of the radio spectrum by allowing spectrum to be transferred to, and used by, the user who values it most highly;
- promote competition by increasing the availability of spectrum for use by the most valuable service; and
- facilitate economically valuable innovation as new users enter the market to offer new services.

3.7 The new approach is primarily implemented through the development and implementation of three policies:

- spectrum trading;
- spectrum liberalisation (i.e. removal of unnecessary restrictions on how spectrum is used); and
- prompt release of unused spectrum into the market, allowing maximum flexibility as to subsequent use.

3.8 Ofcom believes that the shift to the use of market mechanisms to ensure optimal use of the radio spectrum can and should be applied not only to transmitting equipment but also to receive or receive-only equipment. Receiving systems impose constraints on the use of radio spectrum in much the same way as transmitting systems; hence, if Ofcom were required to take into account receiving systems in the management of spectrum, the appropriate market mechanisms should be available to the relevant operators.

Application of Ofcom's overall policy framework to radio astronomy

The radio astronomy service

3.9 Radio astronomy consists of the observation of radio signals and the background radio 'noise' for research into the properties of stars, the nature of galaxies and the age of the universe. Radio astronomy is financed in the UK by Government grants to the Particle Physics and Astronomy Research Council ("PPARC").

3.10 Frequencies of observation are largely, if not completely, governed by the physical characteristics of the extra-terrestrial transmissions and fundamental physical constants. So radio astronomers, unlike many other radio users, have little choice about the frequencies they use, although they have some choice over where to locate radio telescopes and some scope to shield them from unwanted signals. A significant range of frequencies is allocated to radio astronomy and are detailed in

Annex D of UK Frequency Allocation Table (the "UK FAT"), some pursuant to international agreements. The International Telecommunication Union ("ITU") has allocated some 2% of the spectrum below 50 GHz to radio astronomy. About one-third is harmonised globally for passive use and is shared with other passive applications, such as remote sensing and earth observation. The remaining two-thirds is shared with active services including terrestrial fixed and mobile services. These services can interfere with radio astronomy and the degree of protection afforded to specific radio astronomy sites could significantly constrain deployment of other services.

Current arrangement

3.11 The current coordination arrangements for radio astronomy are contained in Annex D of the UK FAT. This contains a set of frequencies bands derived from the ITU Radio Regulations ("RRs") which indicates the category of service (exclusive, primary or secondary) afforded to each frequency band allocated to radio astronomy when coordinating against other users of the spectrum (both at national and international level). In practice, these levels of protection (referred to within Annex D of the UK FAT) equate to coordination and exclusion zones of varying size around the astronomy sites using the bands. Protection category A can result in an exclusive national allocation, with no other spectrum user having transmission rights within the band which could interfere with radio astronomy use. Protection categories B and C equate to regional and local coordination/exclusion zones which vary in size according to the frequency band and the intensity of use by commercial services sharing the band. Typically, though protection category B may require the radio astronomer to limit significantly deployment of any service within a 50-100km radius of an astronomy site[3].

3.12 Amendments to Annex D of the UK FAT are usually made after each World Radio Conference and consulted on between Ofcom and the Radio Astronomy and Space Science Frequency Committee ("RASSFC") prior to updating Annex D.

3.13 The use of certain spectrum for radio astronomy in accordance with Annex D of the UK FAT as described above rests on an informal understanding with the radio astronomy community, represented by the PPARC, under which PPARC pays Ofcom an amount corresponding to the costs incurred by Ofcom in managing the spectrum used for radio astronomy. This arrangement has a number of drawbacks as discussed in various documents, including the Cave Review, the Government's response to the Review, the consultation on emerging issues by the Cave Audit and the consultation preceding this Statement e.g. http://www.ofcom.org.uk/consult/condocs/astronomy

Managing spectrum for radio astronomy

3.14 Ofcom have identified below certain drawbacks relating to radio astronomy as a passive receive-only service that cannot cause interference to other uses and that is not subject to wireless telegraphy licensing in the UK.

- From the radio astronomers' point of view (in shared bands), there is no formal security that Ofcom will not license terrestrial services that may interfere with reception to an extent greater than the radio astronomers would wish. Ofcom would endeavour to avoid this but has a statutory duty to manage spectrum in the interests of all who may wish to use it. At a time of growing demand and increasing

[3] Section 14.4 - Review of radio Spectrum Management by Professor Martin Cave for DTI and HM Treasury – March 2002

spectrum congestion, RSA would require that Ofcom take into account radio astronomy users when carrying out its spectrum management function. Ofcom proposes that RSA would be subject to similar provisions as licences on security of tenure.

- From the point of view of effective management of the valuable spectrum resource, Ofcom has no basis for giving receive-only users incentives to use spectrum more efficiently or to transfer it to others who have a higher value use. Spectrum management tools of incentive pricing, auctions and trading cannot be applied in respect of a non-statutory registration scheme.
- The opportunity cost of denying spectrum to other services is not transparent to decision-makers, which may lead to sub-optimal decisions and misallocation of spectrum resource.

3.15 As discussed below, the introduction of RSA will remedy these drawbacks by providing a mechanism for radio astronomy to be charged a fee that reflects the value of the spectrum and for radio astronomy spectrum to be traded.

How RSA will promote optimal use of spectrum for radio astronomy

3.16 Ofcom's objective in introducing RSA for radio astronomy is to contribute to securing optimal use of the radio spectrum in accordance with its statutory duties and within the framework of its general spectrum policies.

3.17 Although radio astronomy does not involve transmission, it involves detecting faint signals from space and observations are very susceptible to interference from terrestrial sources. It therefore requires other radio services in and near the frequency bands used for observations to be excluded from a sizable area around radio telescopes.

3.18 This means that radio astronomy is effectively occupying large and potentially valuable blocks of spectrum to the exclusion of other users, which imposes a cost on the economy that is likely to increase as commercial demands on spectrum grow. The Cave Review recommended that UK radio astronomy should be subject to AIP and trading in bands in which the UK has scope under international regulations to deploy other radio services; and that radio astronomers should be compensated where they allow other services to deploy within their defined spectrum access[4]. This would make the opportunity cost of radio astronomy, in terms of denying spectrum access to other services, transparent and guide rational decisions on how much of the available spectrum should be devoted to radio astronomy. It would also provide incentives for radio astronomers to share spectrum with other users. The Government, in its response, accepted that recommendation.

3.19 The application of spectrum pricing and trading to radio astronomy would secure optimal use of the spectrum by extending to radio astronomers the incentives to use spectrum efficiently that apply to other spectrum users.

Key areas of RSA policy for radio astronomy

3.20 This Section has set out the background to and rationale for Ofcom's intention to introduce RSA for radio astronomy. In Section 4, Ofcom responds to specific points raised in the consultation and sets out, so far as possible at this stage, its overall plan and expected timing for introducing RSA for radio astronomy.

[4] Review of radio Spectrum Management by Professor martin Cave for DTI and HM Treasury – March 2002.

Section 4

Responses and conclusions

Introduction

4.1 This Section summarises the responses to the consultation and presents Ofcom's conclusions.

4.2 The responses may be found on Ofcom's website at: http://www.ofcom.org.uk/consult/condocs/astronomy/responses/

The proposals in the consultation

4.3 The consultation sought views on proposals on the appropriateness of RSA as applied to radio astronomy and providing appropriate incentives for radio astronomers to consider the choices of whether or not to relinquish spectrum. The proposals were aimed at enhancing the efficient and effective management of the radio spectrum allocated to radio astronomy, in accordance with Ofcom's statutory duties.

4.4 Against that background, Ofcom proposed and sought views on the following.

- The appropriateness of RSA as a spectrum management tool for radio astronomy which would formalise the present arrangement and place radio astronomy use of spectrum on a more secure basis.
- Whether the list of proposed RSA parameters for radio astronomy were suitable and if others needed to be recorded.
- Whether an indefinite term with a minimum 5 year notice period date was applicable to RSA for radio astronomy, appreciating the importance of long-term stability for radio astronomy in view of the long-term nature of research.
- The proposed basis for fees for radio astronomy RSA suggesting that like those for licences, fees should be based on the value of the alternative use of the spectrum (i.e. opportunity cost).
- The proposal that spectrum trading and liberalisation should be considered for radio astronomy RSA, noting the incentives for making radio astronomy RSA tradable and convertible.
- Other regulatory impacts or policy considerations not mentioned by the consultation that were pertinent to RSA for radio astronomy.

The consultation included an impact assessment ("IA") as defined by section 7 of the 2003 Act.

Impact assessment

4.5 The analysis presented in this Section represents an impact assessment (IA). It explains how Ofcom has decided to modify its proposals in the light of responses to the consultation in order to mitigate further the risks identified in the IA included with the consultation document.

4.6 The consultation raised a number of general policy issues relating to the introduction of RSA for radio astronomy and invited comments. This Section sets out Ofcom's general position on issues in light of the responses to the consultation. A more detailed summary in tabular form is set out in Annex 1. The particular issues discussed in this Section are:

- the principle of introducing RSA for radio astronomy;
- the fee basis for radio astronomy RSA;
- The application of spectrum trading and liberalisation to spectrum used for radio astronomy.

4.7 The proposals discussed in the consultation analysed the options, the benefits, costs, risks and mitigating measures which are summarised below.

Option/issue	**Benefits**	**Costs/risks**	**Mitigation**
Introduce RSA for radio astronomy	Enhanced security for radio astronomy	Increased fees reduce funding for radio astronomy and impact UK achievements in field	Radio astronomers can decide whether or not to take advantage of RSA. Funding for radio astronomy sufficient to offset the impact of RSA fee.
Technical parameters of RSA	Recognition will provide enhanced assurance as Ofcom will have a statutory duty to take radio astronomy into account in spectrum planning	If parameters are too demanding, other services will be unduly constrained. If they are too relaxed, radio astronomy will be affected by harmful interference	Appropriate choice of technical parameters based on international standards. Trading will provide a mechanism to adjust boundaries with commercial services

Option/issue	Benefits	Costs/risks	Mitigation
Level of fees	Incentives for spectrum efficiency. Transparency aids decision-making	Financial impact on radio astronomy and reduction in funds for research	Funding arrangements by Government take spectrum fees into account. Fees no higher than necessary and based on spectrum management considerations. Possible phasing of fee changes. Any reductions of fees from more efficient use will be retained for science.
Trading and conversion of RSA	Incentives for optimal spectrum use. Promotes innovation and competition.	Reduced opportunities for radio astronomy if spectrum is converted to use of transmitting equipment.	Decision to trade spectrum is voluntary. Radio astronomers can decide whether or not to retain spectrum and terms on which to make it available for other use. Radio astronomers can acquire spectrum through the market if needed. Scientific funding might benefit from financial proceeds of trading.

4.8 In addition to the above issues, the consultation sought views on whether any regulatory impacts or policy considerations not otherwise mentioned would be pertinent to RSA for radio astronomy. Responses to this question are covered in more detail in Annex 1.

4.9 Against the IA highlighted above, the following sections addresses the main principles drawn from the responses received.

Principle of introducing RSA for radio astronomy

4.10 In the consultation, Ofcom proposed that introducing RSA for radio astronomy would formalise the present arrangement and place radio astronomers' use of spectrum on a more secure basis. Spectrum access and quality would be achieved through a statutory duty requiring Ofcom to take account of radio astronomy within specified technical parameters when planning spectrum and licensing other services. It would also enable spectrum pricing and trading policies to be applied to spectrum used by radio astronomy. Ofcom believes that it is important, as a general rule, to give all spectrum users incentives to use spectrum efficiently.

4.11 In formulating the proposals in the consultation, Ofcom took account of preliminary discussions with PPARC on behalf of the radio astronomy community in the UK, and also the recommendations of the Cave report on spectrum management and the Government's response, as described in the previous Section.

4.12 Radio astronomy is not a commercial service. Nonetheless, it is important and desirable that non-commercial services should face incentives to use spectrum efficiently.

4.13 Ofcom's duty to take account of the interests of all who may wish to use spectrum would include the interests of non-commercial services such as radio astronomy. Ofcom appreciates the importance and desirability of having thriving and successful world-class radio astronomy centres of excellence in the UK. However, in Ofcom's view, its statutory remit to secure optimal use of the spectrum is in general best achieved through giving all users, including radio astronomy, appropriate incentives to use spectrum efficiently. This implies the application of appropriate pricing and opportunities to trade spectrum within a liberalised regulatory regime. In the light of this, Ofcom posed the following question in the consultation:

> *Question 1: Do you agree that the RSA is an appropriate spectrum management tool for radio astronomy?*
>
> *If not, what alternative mechanism would you propose?*

4.14 A total of 13 responses were received from the scientific research community, and satellite and mobile industries within the UK expressing views on our proposals on RSA for radio astronomy.

4.15 Some respondents agreed that the granting of an RSA was a reasonable and appropriate tool for recognising and managing the interests of spectrum users who did not transmit within the UK. It was noted how appropriate the use of RSA would be in respect of radio astronomy which required protection from radio emissions into the bands that they studied but did not require corresponding rights to transmit. Furthermore, it was pointed out that a standard radio licence would not be appropriate tool for managing radio astronomer's use of the radio spectrum as radio astronomers only require freedom from interference at specified geographic locations for which the right to transmit is not required.

4.16 From the 13 responses received, 9 respondents suggested that it would be inappropriate to consider RSA as protection was already afforded through Annex D

of the UK FAT. That Annex D sets out four levels of protection afforded to each frequency band allocated to radio astronomy which can vary from full protection for a primary or exclusive allocation to no protection afforded to a radio astronomy service in a specific band.

4.17 As mentioned in previous Section 3, Annex D of the UK FAT is a set of frequencies bands which are derived from the RRs. Currently, Annex D is used to provide supplementary information on the coordination agreements, types of measurements and levels of protection afforded to each radio astronomy frequency band within the UK.

4.18 Under the current arrangements, the UK administration has actively taken practicable measures to protect the radio astronomy service when planning assignments. However, this arrangement does not confer any formal security on radio astronomers. The introduction and grant of RSA would impose a statutory duty on Ofcom to recognise the use of spectrum by radio astronomy and provide a degree of security that present arrangements do not accord.

4.19 Some respondents suggested that secondary allocations to radio astronomy in the bands 1718.8 – 1722.2 MHz and 2670 – 2690 MHz needed to be changed or removed as secondary allocations could not claim protection from primary services. Particular concerns were expressed concerning the possible impact of a radio astronomy RSA on mobile services operating in the band 1718.8 – 1722.2 MHz.

4.20 Ofcom is aware of the issues surrounding the treatment of secondary and primary allocations and the impact this would have on other users of the same spectrum. The treatment of the particular radio astronomy allocations as currently identified in Annex D of the UK FAT will depend on the relative category of services concerned, taking particular note of the situation in neighbouring countries and what the RSA applicant decides to include in their request for a grant of an RSA for which Ofcom will consider. Ofcom intends to apply a balanced approach to avoid causing undue constraints on new and existing services through coordination with those services potentially affected by any decision made by Ofcom in the treatment of allocations under grants of RSA. The initial technical parameters selected for RSA will reflect the status quo so no additional restrictions will be imposed on other services by the grant of RSA.

4.21 Several respondents advised against making changes to domestic regulations in light of the interference issues being discussed for radio astronomy at ITU-R in the context of resolutions 739 and 740. Resolution 739 (WRC-03) refers to the compatibility between the radio astronomy service and the active space services in certain adjacent and nearby frequency bands. Resolution 740 refers to the future compatibility analyses between the radio astronomy service and active space services in certain adjacent and nearby frequency bands.

4.22 Ofcom is aware of the current studies (resolution.740 resolves 1) [5] taking place within the ITU-R on the compatibility between the radio astronomy and active space services in certain adjacent and nearby frequency bands. Work has begun on this issue under WRC-07 agenda item 1.21 within ITU-R task group 1/9 and the CPG project team PT2 within CEPT. Ofcom notes that the unwanted emission threshold levels for geostationary and non-geostationary space stations as referred to within resolution 739 (Annex 1) and 740 actually refer to out-of-band emissions which this consultation does not address. Ofcom is aware of the sharing issues which exist for out-of-band emissions and the stringent protection levels referred to under ITU-R

[5] http://www.itu.int/ITU-R/study-groups/rsg8/rwp8a/seminars/new-tech/Documents/740.doc

recommendation 769-2. However, RSA will initially only cover in-band sharing and interference scenarios. It should be noted that the protection of radio astronomy service from out-of-band emission from other services is currently being considered in the ITU-R task group 1/9 (TG 1/9) and the findings of the study will be considered at World Radio Conference 2007 under agenda item 1.21. Ofcom is actively participating in the work of TG 1/9 and will consider the findings of the task group when is finalised and published.

4.23 Respondents noted that satellite and radio astronomy services have co-existed in bands such as 3.1 – 10.7 GHz without causing interference. This has been the case whereby Ofcom has provided interference protection (noted under Annex D of the UK FAT) when handling any potential risks of interference by consulting with stakeholders in the market to resolve and where appropriate minimise risk.

4.24 To illustrate this point, respondents referred to the example case of the consultation on mobile 24 GHz short range radars ("SRR") which was published on 21 April 2005. Ofcom notes that this consultation was a result of an eSafety initiative to improve road safety in Europe for which the European Commission adopted a Decision (2005/50/EC) on the harmonisation of the 24 GHz range radio spectrum band (21.65 to 26.65 GHz) for the time-limited use by automotive short range radar equipment ("SRR equipment") in the Community. All member states were required to make the band available through transposing the Decision into domestic legislation. In the UK, this has been achieved by making regulations in the form of a statutory instrument which permitted the use of SRR equipment without the need to hold a wireless telegraphy licence under the 1949 Act.

4.25 Furthermore, the decision to implement the use of 24 GHz SRRs in the UK was a result of an EC decision that required member states to make regulatory provisions for the use of SRR devices.

What alternative mechanism would you propose?

4.26 Respondents suggested continuing the status quo for which fees for radio astronomy which reflected the actual spectrum management costs (i.e. purely administrative arrangement with no trading or AIP) as they felt that the existing arrangement was adequate and did not require changing.

4.27 Ofcom notes that currently, under Annex D of the UK FAT, no regulatory mechanism is available to support the proposed alternative approach. The drawbacks associated with continuing the status quo are discussed in Section 3.

4.28 Concerns were highlighted about the ambiguity surrounding how RSA, wireless telegraphy licences and exemption regulations would relate to each other. This statement explains in Section 2 how RSA, wireless telegraphy licences and exemptions are related.

4.29 Several responses indicated some confusion over whether an RSA is actually a wireless telegraphy licence. To clarify the differences between an RSA and a licence the following description is provided for the purpose of this Statement.

- A wireless telegraphy licence is an authorisation to transmit that carries an implicit recognition of reception of the transmitted signal on that frequency. Many terrestrial communications links are two-way, either simplex (i.e. on the same frequency) or duplex (i.e. using different frequencies for each direction). This recognition is then used in the planning of any new radio services, e.g. by ensuring sufficient

separation in frequency, location or time to avoid harmful interference that unacceptably degrades reception.

- A wireless telegraphy licence is mandatory (permission to do that which would be illegal without it) unless use of specific equipment is exempted from individual licensing. RSA is not mandatory.
- RSA provides the holder of the grant the opportunity to identify frequency bands and geographic areas within which we recognise and endeavour to ensure that agreed levels of interference are not exceeded. This recognition will be used in the planning and coordination of any new services operating in the same frequency band.

4.30 Within the general remarks received on the appropriateness of RSA for radio astronomy, respondents made reference to the proportion of spectrum allocated to radio astronomy. Ofcom is aware that 2% of spectrum under 50 GHz is allocated to radio astronomy of which two-thirds is shared with active services, deployment of which could be constrained by specific radio astronomy sites.

Ofcom's decision

4.31 In light of the IA summarised above, Ofcom has considered the two scenarios referred to in the consultation, namely the introduction of RSA for radio astronomy, on the one hand, and continuation of the status quo without RSA, on the other hand. Ofcom considers that the availability of an RSA for radio astronomy offers a better degree of security than is presently available under the current UK FAT Annex D arrangements and will help secure optimal use of the spectrum.

Fee basis for RSA

4.32 The decision how to set fees for RSA is independent of the decision on whether to introduce RSA. It would be possible to introduce RSA and to charge fees calculated to recover that part of Ofcom's costs attributable to managing spectrum used for radio astronomy. However, in the consultation, Ofcom proposed that, in the specific case of radio astronomy, fees for RSA should be set above the level necessary to recover its costs, that is to say on an AIP basis. This was in order to provide incentives to use the spectrum more efficiently. Ofcom proposed that radio astronomy RSA fees should be based on the value of the alternative use of the spectrum (i.e. opportunity cost). The fee algorithm would take account of (a) bandwidth (b) co-ordination area and (c) impact factor (i.e. the constraint on deployment of other services). This is in line with the approach recommended by the review of spectrum pricing carried out by Indepen, Aegis Systems and Warwick Business School in February 2004[6].

4.33 The fees for exclusive frequency bands would, for the present, be zero rated. This is because under international agreement, no alternative use of spectrum can be applied and there is therefore zero opportunity cost.

4.34 Radio astronomy operators currently use frequency bands at fixed locations, thus constraining the use by other services in certain geographic areas. These frequency bands are listed in Annex D of the UK FAT.

4.35 The listed frequency bands can, if no longer required for radio astronomy, be converted to other use. This would result in a reduction in the fee paid for radio

[6] http://www.ofcom.org.uk/research/industry_market_research/m_i_index/spectrum_research/independent_review/?a=87101

astronomy. The Government has indicated in its response to the Cave review that any cost savings made by the radio astronomy service for spectrum fees will be available to invest in developing radio astronomy[7].

4.36 As stated in the consultation, the continued limitation of interference in large and potentially valuable blocks of spectrum for radio astronomy imposes a cost on the economy, which is likely to increase as commercial demands on spectrum grow. The Cave review recommended that UK radio astronomy should be subject to AIP in bands in which the UK has scope under international regulations to deploy other radio services; and that radio astronomers should be compensated where they allow other services to deploy within their defined spectrum access. This would make the opportunity cost of radio astronomy, in terms of denying spectrum access to other services, transparent and guide rational decisions on how much of the available spectrum should be devoted to radio astronomy. It would also provide incentives for radio astronomers to share spectrum with other users.

4.37 AIP has been progressively rolled out since 1998 to the majority of licence classes and public sector use. AIP is an important mechanism for fulfilling Ofcom's general duty to promote the efficient use of spectrum where there is excess demand. The underlying principle is that AIP fees are set to equal the estimated marginal value of spectrum based on its opportunity cost. Those users to whom spectrum is worth less than the AIP fee will give it up, ultimately leading to the transfer of spectrum to those who value it the most[8].

4.38 As stated in the consultation, the fees for RSA will be no greater than necessary for spectrum management purposes. On the basis of fees, Ofcom posed the following question in the consultation:

Question 4: Do you agree with the proposed basis for fees for radio astronomy RSA?

If you disagree, please give your reasons and suggest alternatives.

4.39 A number of respondents noted the lack of detail on the 'impact factor' and felt it was difficult to comment meaningfully.

4.40 As stated in the consultation document, the impact factor refers to for example the constraints on deployment of other services. One practical example of this in relation to radio astronomy would be the constraints imposed on fixed wireless services when deploying stations near to radio astronomy sites. With this in mind, Ofcom will take the appropriate measures to define actual constraints imposed on other services by radio astronomy. One respondent suggested that the RSA fee paid by radio astronomers' should be proportionate to the degree of displacement required of existing services.

4.41 Questions were raised by respondents on whether opportunity cost would be based on actual or theoretical demand of alternative uses.

4.42 Objections were received on the grounds that the proposed fee basis did not reflect protection of the radio astronomy service but rather the opportunity cost when

[7] The Government Response to the Review of Radio Spectrum Management – October 2002; section 11.5

[8] Emerging Issues - A consultation document July 2005 - http://www.spectrumaudit.org.uk/Consultation.htm

compared to the commercial value of the spectrum. However, if transparency is required then a more appropriate basis would be to zero rate the value of radio astronomy and base the RSA fee on the actual cost related to spectrum administration.

4.43 The radio astronomy community commented that AIP was not an appropriate basis for pricing use of spectrum for radio astronomy as it takes no account of the financial resources of the different services sharing frequency bands.

4.44 Others, however, agreed with Ofcom that fees for RSA should reflect the opportunity cost of allocating the spectrum to radio astronomy and denying it to alternative applications.

4.45 In considering the question of fees, we have taken into account that radio astronomy is not a commercial service and accept that it requires some form of support from Ofcom or the Government. However, we do not believe that it would be conducive to securing optimal use of the radio spectrum to grant it privileged access to spectrum. If a particular public policy goal imposes an economic cost through its use of spectrum, it is generally better to secure this by financing it from general taxation as this is less distortionary than granting access to spectrum on preferential terms.

4.46 Radio astronomy is currently financed by Government through its grants for scientific research and Ofcom would expect this to continue. In its response to the Cave Review, the Government reaffirmed its commitment to supporting world-class radio astronomy, agreed that radio astronomy should be subject to spectrum pricing in order to provide an incentive for spectrum efficiency and stated that it was not its intention that the introduction of this should reduce the resource currently devoted to radio astronomy. Ofcom believes that the best way of securing optimal use of the spectrum while supporting radio astronomy in the UK is for incentive pricing and trading to be extended to radio astronomy through the medium of RSA while the Government continues to provide the level of financial support that it considers appropriate. Radio astronomy should pay for spectrum as it does for its other inputs. The level of financial support for scientific research in general, and radio astronomy in particular, is a matter for the Government, not for Ofcom.

4.47 Currently, the fees paid to Ofcom for radio astronomy support reflect the costs associated with management of radio spectrum used for radio astronomy. They do not reflect the opportunity cost related to the spectrum. When AIP based fees are introduced, the current charging mechanism will be replaced with a more transparent charging mechanism.

4.48 Below is a summary of some of the comments received which questioned whether AIP should be applied to radio astronomy RSA:

- Spectrum fees are paid by the Government (through grants to radio astronomy) to the Government (that is, the Consolidated Fund) so a decrease or increase in fees has no net effect. Ofcom does not agree with this comment. Ofcom understands that Government funding for science (including radio astronomy) is constrained and that scientific bodies have incentives to maximise the output they derive from their given funding. The level of fees will make transparent the opportunity cost of allocating spectrum to radio astronomy and aid rational decision-making. Moreover, there could be an incentive effect if radio astronomy is allowed to retain the benefit of any reduction in fees resulting from relinquishing or sharing spectrum with commercial users.

- Access to finances and the impact of potentially high fees are very different for a Government financed scientific organisation compared to a privately funded commercial entities. Ofcom does not believe that this makes any difference to the principle of applying market mechanisms. The public sector has paid for spectrum access on a comparable basis as the private sector since the introduction of spectrum pricing in 1998 and this policy has secured wide acceptance.
- Radio astronomy is not a commercial service and hence radio astronomy and an alternative commercial user would value the spectrum on entirely different bases. Moreover, Radio astronomy requires access to very specific frequencies due to scientific needs, whereas commercial applications have more generalised spectrum requirements. Ofcom does not believe that there points affect the principle of charging for spectrum. There are various measures radio astronomers can take to reduce the opportunity cost of their use of spectrum, from relocation to better shielding of sites to greater sharing with commercial users.

4.49 Responses from the radio astronomy community noted that, although additional funding would be provided in the short term by OST, there was no guarantee that it would continue, highlighting a risk that in the medium to long term PPARC may experience a reduction in funds available to research projects.

4.50 Ofcom has since discussed this concern further with PPARC and the DTI. The Government made a statement in its response to the Cave Review that it did not intend that the introduction of AIP for radio astronomy should lead to any reduction in the level of resources available to radio astronomy. There is no indication that the Government's position has changed and, on that basis, the introduction of AIP would not impact negatively on radio astronomy. The initial effect of the increase in fees will be mitigated by the fact that fees for RSA will replace, not add to, the existing cost-based charge paid by PPARC. Any future increases in RSA fees will be subject to full consultation and Ofcom would be prepared to consider phasing if necessary to avoid disrupting PPARC's existing spending plans.

4.51 As noted in the Cave Review [9], the continued protection from interference of large and valuable blocks of spectrum for the purposes of UK-based radio astronomy imposes a cost on the rest of the UK economy, and one which is likely to increase as commercial demands on spectrum rise. At present, the cost is invisible to science policy makers and spectrum managers and so cannot readily influence decisions about where and how basic scientific research is best carried out.

Alternatives to the proposed fee basis for radio astronomy RSA

4.52 Respondents suggested that if it were possible to extend the concept of AIP to the existing fee basis for radio astronomy then RSA would not be necessary.

4.53 The spectrum management tool RSA is the only instrument by which the charging mechanism AIP can be applied to receive only services within the UK under the 1998 Act, as discussed in Section 2.

Ofcom's decision

4.54 In conclusion, Ofcom concluded that, in bands used for radio astronomy and in which alternative use of the spectrum is permitted by the RRs, the RSA charging mechanism should be based on the application of AIP based on the opportunity cost of denying the spectrum to alternative services.

[9] Section 14.6 - Review of radio Spectrum Management by Professor Martin Cave for DTI and HM Treasury – March 2002

Spectrum trading and liberalisation

4.55 Spectrum trading is the transfer of rights and associated obligations to use spectrum. This allows holders of wireless telegraphy licences issued under the 1949 Act to transfer some or all of the rights and associated obligations that they enjoy as a result of those licences to third parties. This enables spectrum to migrate to users that will use it most efficiently, thus benefiting the economy. It may, for example, enable spectrum users to amalgamate new spectrum with existing spectrum to expand the range or level of services they offer. Ofcom believes that spectrum trading will help to optimise the use of the finite spectrum resource for the benefit of UK consumers and citizens[10].

4.56 Spectrum liberalisation is the reduction or removal of restrictions on the use that can be made of spectrum. Traditionally, wireless telegraphy licences have specified, often in considerable detail, the use to which spectrum can be put and the means by which that spectrum can be exploited – including for example details of the service that can be offered and the technology that can be deployed. Spectrum liberalisation involves the reduction or removal of these restrictions[11].

4.57 As mentioned in the consultation and also in Section 2 of this Statement, the 2003 Act empowers Ofcom to make regulations to make RSA tradable and to provide for the use of spectrum that is subject to RSA to be converted to a use requiring a licence.

4.58 An example of how this might work in practice would be a situation where an RSA holder did not wish to use the facility for several months a year. In this event, they may wish to make this time available to other services for the duration of the downtime. This could be done either by simply trading the RSA or by converting the RSA into a licence to use the spectrum during the downtime to provide an alternative service. In the consultation, Ofcom proposed that the RSA holder would be able to trade that right. Also, Ofcom proposed that the conversion step would be necessary to allow the transaction to go ahead as RSA does not authorise the use of spectrum to make radio transmissions. In the consultation, Ofcom also stated that it would equally be open to RSA holders to acquire spectrum licences to extend their RSA.

4.59 As stated in the consultation, Ofcom believes that it would be advantageous to make radio astronomy RSA tradable and also convertible. This would provide both a mechanism and an added incentive to make the best possible use of the spectrum. However, conversion would not be allowed in radio astronomy bands in which international agreements prohibit any radio transmission.

4.60 Ofcom therefore proposed to introduce regulations that allow radio astronomy RSA to be traded and converted into licences and vice versa. Ofcom stated that it was likely that RSA for radio astronomy would be divided into frequency bands, by location and by time. This would make holdings as flexible as possible and facilitate trading and change of use.

4.61 Ofcom appreciates that the radio astronomy community will continue to make research its main priority. Nonetheless, there could be worthwhile benefits to be gained from facilitating flexibility in the use of radio astronomy bands. It would be for the RSA-holder in the first instance to decide whether to trade, the amount of the frequency band and the time slot to offer and which alternative uses to accommodate. Trading and change of use would require Ofcom's consent. On the

[10] http://www.ofcom.org.uk/consult/condocs/spec_trad/statement/sts.pdf
[11] http://www.ofcom.org.uk/consult/condocs/liberalisation/liberalisation/spec_liberalisation.pdf

basis of spectrum trading and liberalisation, Ofcom posed the following question in the consultation:

Question 5: Do you think that spectrum trading and liberalisation should be applied to radio astronomy RSA?

4.62 Responses raised a number of concerns about the appropriateness of spectrum trading and liberalisation for radio astronomy RSA. These are summarised below with Ofcom's comments.

4.62.1 Respondents have reservations about how appropriate spectrum trading and liberalisation would be to bands in which radio astronomy was a primary service. It was stressed that great care should be taken in the change of use to avoid causing harmful interference to other holders of RSA. Ofcom agrees that it would be necessary to give careful consideration to change of use from radio astronomy to active services.

4.62.2 The introduction of trading and liberalisation would not result in any clearly defined rights or benefits for owners of RSA grants, whether radio astronomy or other services. Ofcom remains of the view that trading and liberalisation will, in principle, be beneficial. However, we agree that the full benefits will not be realised unless the radio astronomy community is allowed to retain the proceeds. This issue is expected to be clarified in the Government's response to the Cave Audit.

4.62.3 It was believed that the spectrum trading market would be slow to develop and there would be no sense in having a secondary market at this time, especially as responses from the radio astronomy community indicated that they would be reluctant to engage in trading. Furthermore, respondents noted that under the current arrangements with the Office of Science and Technology, radio astronomy could not trade spectrum and therefore would not benefit even if trading was an option. Ofcom notes that it would be for the holder of RSA to decide whether or not to trade.

4.62.4 It would be inappropriate to apply conversion to RSA for which a grant of an RSA can be converted into a licence used to provide services that would normally require the award of spectrum licences in an open, transparent and non-discriminatory manner. This would apply to radio astronomy and other services affected by future RSA decisions.

4.62.5 Respondents suggested that trading of radio astronomy RSA is not appropriate due to the fact that radio astronomy bands are constrained by nature, e.g. cosmic sources, and hence it is not possible for emission frequencies to be changed. Ofcom does not believe that this affects the principle of trading. There are various measures radio astronomers can take to reduce the opportunity cost of their use of spectrum, from relocation to better shielding of sites to greater sharing with commercial users.

4.62.6 Respondents questioned the appropriateness of radio astronomers trading RSA in order to achieve cost savings and whether money provided by the Government to pay radio astronomy spectrum fees should be spent on other projects if spectrum is no longer required. They felt that Government funding was intended to support specific purposes and should not be transferred. The question of how proceeds from spectrum trading should be accounted for in

public expenditure terms and whether radio astronomy should benefit from the proceeds is a matter for the Government, not Ofcom. The question of incentives to public sector users of spectrum, including radio astronomy, to use spectrum more efficiently is currently under review by the Cave Audit.

Ofcom's decision

4.63 Ofcom has carefully considered the responses. We remain firmly of the view that trading and liberalisation will, in principle, be beneficial in relation to spectrum used for radio astronomy as for other spectrum. However, in view of the fact that there has been relatively little spectrum trading to date where it has been introduced, the expressed reluctance of the radio astronomy community to participate in trading at this time and the lack of clarity about whether radio astronomy would keep the proceeds of trading, Ofcom does not intend to make RSA tradable or convertible at this time. Ofcom's longer term aim remains to make radio astronomy RSA tradable and to liberalise its use as far as possible consistent with international obligations and avoidance of unacceptable increases in interference. We intend to revisit this issue in due course in the light of the Government's response to the Cave Audit.

Ofcom Conclusions

4.64 Ofcom is grateful to all who responded and has carefully considered the comments.

4.65 Ofcom's conclusions and reasoning are set out in more detail in the remainder of this Section and in Annex 1 to this Statement. Where appropriate, we have modified some aspects of our proposals to meet the concerns that were expressed by respondents to the consultation. Key points made in this Statement are summarised below.

- Ofcom's policy objective is to secure optimal use of the radio spectrum used for radio astronomy. It believes this is best secured by:
  - making transparent the economic cost of making spectrum available for radio astronomy and so assisting rational and informed decision-making;
  - providing appropriate incentives for radio astronomers to use spectrum efficiently.
- We remain of the view that the introduction of RSA for radio astronomy will help secure optimal use of the radio spectrum and intend to proceed with our proposals modified as described in this statement.
- The parameters proposed in the consultation to be included in the grants of RSA remain appropriate.
- Initially, RSA will only address in-band interference issues although Ofcom is aware of the sharing issues which exist for out-of-band emissions. We will adopt a balanced approach to avoid undue constraints on the deployment of other services. It is unnecessary to consult separately on the initial values of those parameters as they will reflect the status quo so no additional restrictions will be imposed on other services.
- An indefinite term with a minimum 5 year notice period, remains appropriate for RSA for radio astronomy.
- In bands used for radio astronomy and in which alternative use of the spectrum is permitted by the RRs, the RSA charging mechanism should be based on the

application of AIP based on the opportunity cost of denying the spectrum to alternative services.

- Were radio astronomers to relinquish their use of any part of the spectrum they currently use, whether on a national or regional basis, Ofcom would consider each request for change of use in accordance with Ofcom's liberalisation policy. Ofcom favours maximum flexibility in how spectrum is used but would check in particular that any change of use was compatible with the UK's international obligations and did not cause an unacceptable increase in interference for neighbouring spectrum users.
- It is desirable, in principle, for radio astronomy RSA to be tradable and convertible to give increased incentives for spectrum efficiency. However, the incentive effect will depend on whether or not the radio astronomy community is allowed to retain the proceeds of trading. Ofcom does not intend to introduce trading for radio astronomy RSA at this time and will revisit this issue in the light of the Government's response to the Cave Audit.

Next steps for radio astronomy RSA

4.66 To introduce RSA for radio astronomy, it would be necessary for Ofcom to make RSA regulations under section 159 of the 2003 Act and also to make fees regulations. We expect to publish a notice to consult on the necessary regulations, which will contain more detail of the policy decisions set out in this Statement, in due course.

Annex 1

Summary of responses

A1.1 This Annex sets out a summary of responses made to the consultation in relation to questions 2, 3 and 6 not discussed elsewhere in this statement.

Technical and geographical parameters

A1.2 Given the sensitivity of radio astronomy receivers, it is necessary to ensure considerable geographical separation between radio astronomy and transmitting equipment operating within the same frequency bands. The problem is especially acute in the case of mobile services, for which planning is made more difficult as the location of the terminals is unconstrained and cannot be known with certainty.

A1.3 The geographic area and bandwidth incorporated in an RSA are entirely dependent on the parameters listed in the consultation. The magnitude of these parameters will be established through the RSA application process and the specific requirements of the applicant. These will vary from site to site and also by frequency depending on the level of interest and the nature of observations. In setting these parameters, it is necessary to balance the interests of radio astronomers in not suffering levels of interference that would prevent accurate observations and of users in the same frequency bands in not being subject to excessive constraints.

A1.4 In the consultation, a list of proposed parameters was presented for use in the development of RSA for radio astronomy.

- Frequency Band
- Category of Co-ordination
- ITU-R Recommendations and footnotes (Detrimental Interference and Compatibility)
- Type of observation measurement - Spectral line or Continuum
- Single Dish or MERLIN or very long baseline interferometry (VLBI)
- Number of Radio astronomy Service Sites and NGRs
- Typical Interference/Noise performance criteria
- Status of frequency allocation
- Coordination Distance (radius)
- Time sharing agreement

A1.5 On the basis of the listed parameters above, Ofcom posed the following question in the consultation:

Question 2: Do you agree with the list of proposed RSA parameters for radio astronomy? Should other parameters be recorded in RSA?

A1.6 The table below sets out the comments, where they differed from Ofcom's view, made by respondents in relation to this question and Ofcom's response.

Issue raised	Comments	Ofcom's response
Disturb the balance of rights	ESOA raised concerns on how RSA would disturb the balance of rights by other users in the same frequency bands which highlighted the issue as to how it would be possible to identify the correct holder of an RSA and prevent others from benefiting from it in the same location.	We note that it is unlikely that in band users of the same spectrum would incur constraints from other users of the current in band spectrum who decide on taking out an RSA. As previously mentioned, Ofcom will undertake where necessary practical steps to coordinate with other users of the same spectrum. We intend to address this further along with developing the rights and obligations of an RSA holder in the forthcoming regulations on RSA. Any decisions made on the rights and obligations assigned to an RSA holder will be in accordance with international obligations and binding community measures. However, it should be pointed out that to date Ofcom is unaware of any other receive only services which would benefit from an RSA within the radio astronomy frequency bands.
Defer setting protection levels until work is concluded in the ITU-R	Concerns were raised by the Global V-SAT Forum that the protection levels under ITU-R Rec 769-2 if applied to radio astronomy in the context of RSA which would bring about conservative protection levels without consideration of the impact on other services.	Ofcom fully understands that the protection requirement of radio astronomy as given in the ITU-R recommendation 769-2 is stringent and believes that it is important that a balanced approach should be taken when considering the needs of users of the same spectrum.

Issue raised	Comments	Ofcom's response
Technical and geographical parameters not specific to RSA	Inmarsat noted that the parameters listed within the consultation were not specific to RSA as they were used for interference assessment and coordination under the current regime for radio astronomy	The parameters proposed in Section 4 of the consultation identified typical examples of parameters which might be applied to radio astronomy RSA and are by no means definitive. They were derived from discussions with radio astronomers.
Separate consultation on RSA parameter values	Inmarsat asked for a separate consultation on the proposed parameter values in order to be open and fair before implementing RSA.	It is unnecessary to consult separately on the initial values of those parameters as they will reflect the status quo so no additional restrictions will be imposed on other services. However, the specific characteristics of the radio astronomy sites to be protected will be notified by the radio astronomy site operator depending on the nature and sensitivity of observations. Ofcom will then need to determine the feasibility of granting the full extent of the request and set the fees accordingly.

Issue raised	Comments	Ofcom's response
Differences afforded to radio astronomy relating to in and out-of-band emissions	Vodafone advised Ofcom to be mindful of Article 4.6 of the RRs which relates to protection requirements for radio astronomy which differ between in-band and out-of-band interference. They suggested the grant of an RSA for radio astronomy should not confer rights in respect of spurious emissions from stations in other Radiocommunication Services. If enforced, this would effectively provide radio astronomers with a right of veto over all potential change of use in any band.	Article 4.6 of the RRs deal with protection afforded to radio astronomy service from services operating in other bands. The RSA will only cover in-band sharing and interference scenarios. It should be noted that the protection of radio astronomy service from out-of-band emission from other services is currently considered in the ITU-R task group 1/9 (TG 1/9) and the findings of the study will be considered at World Radio Conference 2007 under agenda item 1.21. Ofcom is actively participating in the work of TG 1/9 and will consider the findings of the task group when is finalised and published.
Competing with commercial users of the spectrum	The British Astronomical Association pointed out that radio astronomers could not compete with commercial users of spectrum as fewer radio observatories existed in comparison to commercial operators of transmitting equipment in the UK. This would imply an imbalance for which Ofcom should not favour towards the interests of those people generating the most funds.	Ofcom notes that whether services directly compete in downstream markets is irrelevant for whether they compete for spectrum use. Radio astronomy is not a commercial service. However, it does compete for spectrum use. Ofcom's general policy is to provide incentives to optimise the use of spectrum, which RSA as a spectrum management tool would accomplish through mechanisms such as spectrum trading and liberalisation. However, this option is being deferred for radio astronomy as mentioned in Section 4.

Ofcom's decision

A1.7 In light of the responses received, Ofcom concludes that the parameters proposed in the consultation are appropriate to include in the RSA for radio astronomy.

Term of RSA and security of tenure

A1.8 In the consultation, Ofcom proposed that RSA should be granted for an indefinite term with a 5-year period of notice. This would place RSA on a comparable footing to existing spectrum licences to which spectrum trading has been extended and give sufficient stability for the radio astronomy community.

A1.9 On this basis, the consultation asked for views on the following question:

Question 3: Is a rolling 5 year term, without fixed termination date, appropriate for RSA for radio astronomy?

A1.10 The table below sets out the comments, where they differed from Ofcom's view, made by respondents in relation to this question and Ofcom's response.

Issue raised	Comments	Ofcom's response
5 years is too short	Concerns were raised by the British Astronomical Association that the period identified was too short in comparison to the European Space Agency whose long term scientific research can extend to e.g. 25 years.	The 5 years refers to the notice period, not the licence term. The latter is open-ended.

A1.11 Of the 3 responses received on this issue, 1 respondent agreed that 5 years was acceptable by noting the importance of stability and providing certainty over a period of time.

A1.12 One of the responses asked about the circumstances in which Ofcom might revoke or vary RSA. As for licences, Ofcom would not expect to revoke or vary RSA very often. The following lists some scenarios in which this might happen. Further details of Ofcom's policy on revocation and variation can be found under Ofcom's current Licensing Policy Manual:
http://www.ofcom.org.uk/radiocomms/ifi/licensing_policy_manual_2/

- With the consent of the RSA holder.
- For non-payment or late payment of the relevant RSA fee.
- If there has been a breach of any of the terms of the RSA.
- If the grantee of an RSA has not complied with any requirement of any relevant trading regulations (if applicable).

Ofcom's decision

A1.13 In light of the responses received, Ofcom concludes that the proposed indefinite term with a 5 year notice period is appropriate for RSA for radio astronomy.

Other regulatory impacts or policy considerations not covered

Question 6: Are there any regulatory impacts or policy considerations not otherwise mentioned in this consultation that are pertinent to RSA for radio astronomy?

A1.14 Questions were raised as to whether Ofcom would take account of radio astronomy if radio astronomers decided not to take out an RSA, claiming that Ofcom had a duty of care to radio astronomy. As explained in sections 2 and 3, RSA will provide radio astronomy with enhanced certainty.

A1.15 Concerns were raised as to how Ofcom would deal with a situation where more than one passive service operated in the same band as in the example 23.6 – 24 GHz.

A1.16 Due to high susceptibility to interference, passive services normally operate in the exclusive bands where all emissions are prohibited. Within the band 23.6 – 24 GHz three types of passive services operate for example radio astronomy; earth exploration satellites and space research. Since passive services do not involve any transmission of radio waves it should be noted that they can co-exist in the same band. However, it should be noted that this arrangement does not apply to all radio astronomy bands as there are other radio astronomy bands which are shared with other active services.

A1.17 Respondents questioned how radio astronomy could compete if the primary drive for radio astronomy is not a competitive one. They noted that research only competes with research for access through bidding for time for which research in radio astronomy community has policy dictated at international level. However, radio astronomy does compete with commercial services in shared bands. The point that it does not compete commercially is in Ofcom's view not relevant in the principle of RSA.

A1.18 Respondents referred to ultra wide band ("UWB") and questioned how spectrum would be handled as this had not been covered within the consultation as a possible regulatory/policy implication when applying RSA to radio astronomy.

A1.19 Recent consultations on UWB did not consider passive bands in relation to UWB, as UWB focused on 3.1 – 10.6 GHz and most of core radio astronomy bands were outside these bands[12]. However, Ofcom has commissioned a separate study to assess the impact of UWB on radio astronomy for which the results will be due out later this year.

A1.20 Questions were raised as to why Ofcom had ignored the advice submitted by the Trade and Industry Select Committee which examined radio spectrum management policy during the passing of the 2003 Act, who in their report concluded that if RSA is introduced, it should be charged for on a cost-recovery basis.

A1.21 In its response to the Select Committee's report, the Government agreed that cost recovery was a reasonable approach where evidence suggests that there is no spectrum management need for fees to be higher. However, it was noted that setting

[12] http://www.ofcom.org.uk/consult/condocs/uwb/uwb2/uwb.pdf

fees above cost recovery would be beneficial in promoting spectrum efficiency where there is congestion and providing a level playing field between users of the spectrum[13].

A1.22 Ofcom's proposals are consistent with the Governments response to the Committee. The justification for AIP radio astronomy RSA is set out elsewhere in this statement i.e. in Section 4.

A1.23 Questions were received as to how Ofcom would manage the amateur radio astronomer. The current version of Annex D of the UK FAT only recognises the protection requirements of 6 RAS sites and does not contain any recognition of measurements conducted by amateur radio astronomers. Ofcom believes that the introduction of RSA to radio astronomy will offer the opportunity for other users of the service to be recognised. Furthermore, the two frequency bands referred to (151 MHz and 2695 MHz) by the Radio Astronomy group of the British Astronomical Association (BAA RAG) identifies passive bands which are protected under the RRs for which Ofcom has no intention to introduce AIP based fees. Regarding the question on protection of 30 kHz, it should be noted that there is no allocation to radio astronomy in this band under the UK FAT or Radio Regulation table.

A1.24 Ofcom appreciates the work undertaken by amateur radio astronomy community and will continue to consult with them alongside other stakeholders on such matters relating to the developments of RSA. It should also be noted that Ofcom consults with all interested parties on the protection of radio astronomy through UK study group 7 and the Radio Astronomy and Space Science Frequency Committee.

Miscellaneous issues

A1.25 Summarised below is a number of general issues which were raised alongside the six questions proposed in the consultation.

[13] Radio Spectrum Management: Government reply to the third report of session 2002-03 from the Trade and Industry Committee – 14 March 2003

Issue raised	Comments	Ofcom's response
Define 'spectral and economic efficiency'	Intellect asked for more detail on the definition of 'spectral and economic efficiency' as this would provide a better understanding of Section 159(1) of the 2003 Act.	As stated in the consultation, market mechanisms such as auctions, incentive pricing and spectrum trading are applied to provide incentives to promote optimal use of spectrum. Ofcom has explained its statutory duties relating to spectrum management in Section 2 of this statement and its general approach in various documents such as the Spectrum Framework Review.
Confirmation that internationally agreed regulations will continue.	Inmarsat raised concerns over the use of the phrase 'for the present' which was referred to in the consultation under Section 4.6 which stated: 'The fees for exclusive frequency bands would, for the present, be zero rated. This is because under international agreement, no alternative use of spectrum can be applied and there is therefore zero opportunity cost'.	Ofcom fully supports the internationally agreed regulations but also recognises it may be necessary to review regulations and decisions from time to time to take into account of the growing demand for spectrum for new services. Ofcom will in all cases act in accordance with the UK's international obligations.

Annex 2

List of respondents to the consultation

BT

European Satellite Operators Association (ESOA)

Global V-SAT Forum (GVF)

INMARSAT

Intellect

Jodrell Bank Observatory

O2

PPARC

Radio Astronomy group of the British Astronomical Association (BAA RAG)

Satellite Action Plan Regulatory Group (SAP REG)

Satellite Industry Association

T-Mobile

Vodafone

Annex 3

List of radio astronomy frequencies below 50 GHz

MHz	
13.36	13.41
25.55	25.67
37.75	38.25
80.5	82.5
150.05	152
326.5	328.5
406.1	410
606	614
962	970
1350	1380
1380	1400
1400	1427
1610.6	1613.8
1660	1660.5
1660.5	1668
1668	1670
1718.8	1722.2
2290	2300
2655	2670
2670	2690
2690	2700
4600	4950
4825	4835
4950	4990
4990	5000
6650	6675.2
8400	8500

GHz.	
10.6	10.68
10.68	10.7
14.47	14.5
15.35	15.4
22	22.21
22.21	22.27
22.21	22.5
22.81	22.86
23.07	23.12
23.6	24
31.3	31.5
31.5	31.8
42.5	43.5
48.94	49.04

Annex 4

Glossary

AIP

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

Allocation

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

Assignment

Authorisation given by a licensing authority for a radio station to use a specific radio frequency or channel under specified conditions.

Band

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

Cave Review

Review of Radio Spectrum Management, by Professor Martin Cave, published March 2002.

Coordination

This term refers to the process under which a new user seeks the agreement of existing users to share access to a particular range of frequencies while avoiding harmful interference.

EU

European Union: Collective of European Member States.

FSS

Fixed Satellite Services: A satellite system, where the ground or earth station is fixed during transmission and/or reception.

GHz

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

Impact Factor

A measure of the constraints on deployment on transmitting equipment as a result of avoiding interference to radio astronomy sites.

Interference

The effect of unwanted signals upon the reception of a wanted signal in a radio system, resulting in degradation of performance, misinterpretation or loss of information compared with that which would have been received in the absence of the unwanted signal.

ITU

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

ITU Resolution

A piece of text giving instructions on the organisation, methods or programmes of the Radiocommunication Assembly or on a ITU Study Group’s work.

kHz

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

Liberalisation

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

MHz

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

Mobile Satellite (MSS)

A service between mobile earth stations and one or more space stations.

Ofcom

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

PPARC

The Particle Physics and Astronomy Research Council. The research council responsible for funding Radio astronomy in the UK.

Primary

This is a term used to indicate that a frequency allocation for a particular service has priority over other services in the same band. It is quite frequent to have several services that are 'co primary' (e.g. fixed and mobile) where both services have equal priority. See paragraphs 5.23 to 5.33 of the ITU Radio Regulations.

RA

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

Radio astronomy

The scientific endeavour of observing deep space by means of receiving Radio Frequency signals emitted by celestial bodies.

Radio Spectrum

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

IA

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

RSA

Recognised Spectrum Access: A method of recognising the use of radio spectrum by an operator which is not covered by a Wireless Telegraphy Act Licence or a Licence Exemption.

Secondary

This term is defined in paragraphs 5.28 to 5.31 of the ITU Radio Regulations. Stations of a secondary service shall not cause harmful interference to primary services or claim protection from harmful interference from primary services. See 'Primary'.

Spectrum trading

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

Terrestrial

Terrestrial radio service: any radio service other than a space service or radio astronomy.

Ultra Wide Band

Technology developed to transfer large amounts of data wirelessly over short distances, typically less than ten metres.

Undue Interference

Interference with any wireless telegraphy that is harmful, as provided by section 183 Communications Act 2003. This includes interference that creates dangers or risks of dangers to the functioning of any radiocommunications service designed for the purposes of navigation or safety services, or if the interference degrades, obstructs or repeatedly interrupts authorised broadcasting or other wireless telegraphy.

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)