Review of spectrum fees

For fixed links and satellite services

Initial Consultation

Publication date: 21 May 2015

Closing Date for Responses: 30 July 2015

About this document

This document is an initial consultation on a review of spectrum fees for all authorisations for fixed links and satellite services. This review will include fixed links licence products, all satellite licence products and authorisations known as Recognised Spectrum Access (RSA) for Receive-only Earth Stations (ROES) regardless of the basis of these fees.

Our starting point for our fees proposals is a report we commissioned from Plum Consulting. This report addresses a range of issues including estimates of opportunity cost for fees based on Administered Incentive Pricing (AIP). We are publishing this report alongside this Consultation. This document does not propose new fees levels, but seeks stakeholders' views on the opinions expressed by Plum in its report.

In particular, in this Consultation we are seeking:

- stakeholders' views on the cost assumptions and the methodology used by Plum to estimate opportunity cost of the spectrum; and
- stakeholders' views on the effectiveness of the fees algorithms in incentivising efficient use of spectrum by these services and in particular a number of specific changes to the algorithms proposed by Plum.

In addition, this document provides a broad indication of the likely direction of travel that fees would take if we were to take Plum's recommendations forward.

Ofcom expects to consult on specific fees proposals for these authorisations sometime next year.

Contents

Section 1

Executive Summary

Purpose of the review

1.1 This document is an initial consultation for a review of spectrum fees for all authorisations for fixed links and satellite services. This review will include all fixed links licence products, all satellite licence products and also authorisations known as Recognised Spectrum Access (RSA) for Receive-only Earth Stations (ROES). Annex 5 provides a full list of authorisations that form part of this review and includes Permanent Earth Stations (PES), Transportable Earth Stations, RSA for ROES and fixed links.

Purpose of this document

1.2 This document focusses on those fees that are charged based on Administered Incentive Pricing (AIP). AIP fees are charged at above cost for spectrum that is in excess demand. This document does not propose new fee levels.

1.3 As the first stage in our review we commissioned an independent report from Plum Consulting (in future in this document referred to as the "Plum report" or "Plum") to review our approach to fees. We asked Plum to provide us with:

- estimates of the opportunity costs for fees based on AIP; and
- a review of the appropriateness of the existing fees algorithms in terms of meeting our objective of incentivising the efficient use of spectrum.

1.4 Plum identifies a number of important ways in which our fees could be improved. This includes some significant changes to the opportunity costs of some bands, as well as the factors that are taken into account in the algorithms that are used to set fees. The full Plum report is published on our website.[1]

1.5 Prior to developing detailed proposals for fee levels, we thought it sensible and prudent to seek feedback on Plum's recommendations and how, in light of Plum's suggestions, we should develop revised fee proposals for fixed links and satellite services.

1.6 Consulting on these more general points now will assist us in developing the firm fee proposals we plan to consult on next year.

Key issues we seek comment on

1.7 In particular, in this document, we are seeking to:

- Validate the cost assumptions used by Plum to estimate the opportunity cost of the spectrum. This includes any evidence stakeholders can provide where they do not agree with those used by Plum;

[1] See link: http://stakeholders.ofcom.org.uk/binaries/consultations/review-spectrum-fees-fixed-links-satellite/annexes/plum_report.pdf

- Gather stakeholder views on the effectiveness of the fixed link and satellite services fees algorithms in incentivising efficient use of spectrum;
- Understand stakeholders' views on the practicality, value and relative importance of including a geographic factor for both fixed links and satellite services use as suggested by Plum in its report;
- Understand stakeholders' views on the value and relative importance of Plum's suggestions in relation to the fixed link algorithm including:
    - the benefits and practicality of including a factor to take account of high performance antennas;
    - whether there would be any benefit in us considering a factor to take account of Automatic Transmit Power Control; and
    - the benefits of considering a change to the existing bandwidth factor, so that it better reflects the relative proportion of spectrum used by a licensee in the band.
- Understand stakeholders' views on Plum's suggestion for the algorithms for satellite services on:
    - that a comparison of the area impacted/denied by fixed links and other authorisations would be a better way to ensure equivalence between fees for these services.

Likely direction of fees

1.8 As previously stated, Plum's recommendations will be the starting point for our fees proposals and we will use stakeholder input to this Consultation to build on these.

1.9 However, we agree with Plum that for the band 3.6-3.8 GHz, mobile is likely to be a higher value alternative use for the spectrum. As such, we are likely to propose significantly increased fees for this band, which reflect the high value of the spectrum to mobile use.

1.10 For the other bands, if we follow Plum's recommendations then based on the recognisible trends in demand on own-use opportunity cost of the spectrum:

- Below 20 GHz, where mobile is not deemed a feasible alternative use, we expect to propose marginally higher fees;

- Above 30 GHz, we expect to propose lower fees – perhaps as low as the cost-based floor. However, we would need to be careful of creating perverse incentives given the substitutability between spectrum bands close in frequency.

Related current consultations

1.11 We note the following consultations that are relevant to this initial consultation on fixed links and satellite fees:

- Spectrum above 6 GHz for future mobile communications;[2]

[2] See link: http://stakeholders.ofcom.org.uk/binaries/consultations/above-6ghz/summary/spectrum_above_6_GHz_CFI.pdf. See update here: http://stakeholders.ofcom.org.uk/consultations/above-6ghz/update-apr15/

- Satellite and space science strategic review that we plan to publish in Q1 FY 2015/16; and
- Mobile data strategy below 6GHz.[3]

Next Steps

1.12 We plan to consult on specific fees proposals for these authorisations sometime next year.

[3] See link: http://stakeholders.ofcom.org.uk/consultations/mobile-data-strategy/

Section 2

Background and purpose

The purpose of this document

2.1 This Initial Consultation requests information from stakeholders that we will use to help inform a review of spectrum fees we are carrying out for all licence products for fixed links and satellite services.

2.2 The products we intend to review are primarily used for fixed links, permanent earth stations (PES) and transportable earth stations (TES) and are available across a wide range of frequency bands. They also include authorisations known as "Recognised Spectrum Access" (RSA) that are available to receive-only earth stations. In addition, there are a small number of "light" licence products that are charged on the basis of our costs. When we make fees proposals we will also consider these cost based fees and how our wider framework for cost based fees[4] should be applied to this sector. Annex 5 provides a full list of the authorisations that will be covered by this fee review.

2.3 Most of these licence products are charged based on Administered Incentive Pricing (AIP). AIP fees are based on the opportunity cost of spectrum use for spectrum where there is excess demand. These AIP fees are the focus of this Consultation.

2.4 As the first stage in our review we commissioned an independent report from Plum Consulting (in this document referred to as the "Plum report" or "Plum"). We asked Plum to provide us with:

- estimates of the opportunity costs of entire bands, as well as for a "typical" deployment of the service being considered in the band (e.g. a typical fixed link); and

- a review of appropriateness of the existing fees algorithms in terms of meeting our objective of incentivising the efficient use of spectrum.

2.5 Plum identifies a number of important ways in which our fees could be improved. They consider that there have been some significant changes to the value of some bands and have suggested some changes to the algorithms that are used to set fees. The full Plum report is published on our website.[5]

2.6 Prior to developing detailed proposals on AIP, we thought it prudent to seek feedback on Plum's recommendations and how, in light of Plum's suggestions, we should develop revised fee proposals for fixed links and satellite services.

2.7 Consulting on these more general points now will assist us in developing firm fee proposals next year.

2.8 In this document we also provide a broad indication of the likely direction of travel we expect fees to take if we were to accept Plum's recommendations (see Section 5). In particular, we emphasise our agreement with Plum that mobile use will be, or is

[4] See link: http://stakeholders.ofcom.org.uk/consultations/cbfframework/
[5] See link: http://stakeholders.ofcom.org.uk/binaries/consultations/review-spectrum-fees-fixed-links-satellite/annexes/plum_report.pdf

already, a realistic alternative use in a small number of bands. We are keen to receive views on this opinion. If it holds, it is likely to result in proposals for fees that are substantially higher than current levels in these bands, as the value of these bands is likely to have increased, or probably will increase as a result.

Why we are initiating this review of fees now

2.9 In December 2010, Ofcom published its Strategic Review of Spectrum Pricing – SRSP*: The revised Framework for Spectrum Pricing* statement (SRSP).[6] This provides our policy framework for how we develop administered incentive pricing (AIP) [7] fee proposals, as well as how and when we decide to undertake pricing reviews.

2.10 When concluding the SRSP we said that, subject to resource availability and consideration of our overall priorities for spectrum management, we intended to carry out a review of the fees for fixed links and satellite services for PES and for TES in all of the bands they are licensed. Our reasons for this were:

- the fees for the respective services had not been substantially reviewed since 2004/5. Since then, both market and technology changes had taken place, potentially making an impact on the value of spectrum; and
- some bands, which were historically only usable for fixed links and PES/TES services, had become increasingly capable of supporting mobile broadband services, a factor which was not reflected in the pricing structure for fixed links and PES/TES services.

2.11 Our prioritisation of resources for 2014/15 enabled us to plan to initiate a review of fixed links, as we stated our Annual Plan.[8]

2.12 Although we do not plan to consult on specific fee proposals until next year, there are a number of policy and implementation issues that we may need to address in order to implement new fees. This is particularly true if we need to revise our algorithms and/or introduce additional parameters such as geographic pricing. Therefore, we would like to understand stakeholder views on these points as soon as possible, so we can address these issues in good time.

Our objectives

2.13 From this consultation exercise we are seeking to:

- signal likely price increases in bands where mobile is identified as a feasible alternative use;[9]
- provide stakeholders with an indication of our timeline for reviewing these fees;
- validate the cost information underpinning the Plum estimates of opportunity cost; and

[6] See link: http://stakeholders.ofcom.org.uk/binaries/consultations/srsp/statement/srsp-statement.pdf
[7] AIP or administered incentive pricing is a fee charged to holders of spectrum licences to encourage them to make economically efficient use of their spectrum.
[8] See link: http://www.ofcom.org.uk/files/2014/03/Annual_Plan_1415.pdf
[9] We look to our Mobile Data Strategy (MDS) to provide an initial view of this possibility and complement it with a judgement on the timeframe that mobile use would be possible

- gather stakeholders' views on some possible changes to the pricing algorithms.

Background

2.14 This Consultation focusses on the fixed link and satellite service licence products for which we charge an AIP fee. We provide a short summary of the main products for which we charge AIP.

Fixed links services

2.15 Fixed links refer to terrestrial based wireless systems operating between two or more fixed points. They are typically used to provide network infrastructure and customer access applications across a wide range of frequency bands.[10] Spectrum bands used for fixed links are shared with a number of other services including the fixed satellite service.

2.16 In the UK, fixed links are an essential input to a wide variety of consumer and business services. These include:

- backhaul for mobile networks, for example provision to remote areas;
- distribution of broadcast TV content from studio to transmitter sites; and
- connecting nodes within public, private and corporate networks (e.g. local authorities, utilities, financial services, etc.).

2.17 The majority of fixed links in UK are currently used to provide backhaul for mobile networks and are licensed to Mobile Network Operators (MNOs) and fixed network operators. As a result over 90 per cent of links are licensed to eight companies. The remaining 10 per cent of links are licensed to over 300 other organisations.

2.18 Ofcom's Mobile Data Strategy (MDS) identified parts of the lower bands used for fixed links (1.4 GHz and 3 GHz) as high priorities for being made available for use by mobile data services.

Satellite services

Permanent Earth Stations (PES)

2.19 A PES is a satellite earth station operating from a permanent, specified location to one or more satellites in space. PES operate in a range of frequency bands, many of which are shared with fixed links.[11]

2.20 A PES is used for range of different applications including broadcast TV feeder links, telephony and data backhaul. Individual PES antennas are often located together at teleport sites, with one antenna often providing several radio links with satellites. In the UK, there are currently some 150 licensed PES sites[12] accommodating around 10,000 individual radio links across the various frequency bands.

[10] Annex 6 provides a list of bands that are made available in UK for fixed links
[11] Annex 6 provides a list of the frequency bands made available to PES
[12] Licensees are encouraged, through fees, to co-locate earth stations which minimises the impact on other spectrum users. A site is defined as any location within 500 metres of a specified central location.

Transportable Earth Station (TES)

2.21 A TES is a satellite earth station that can be transported to a fixed location where it then is able to communicate to satellites in space.

2.22 Typically, TES are used by Satellite News Gathering (SNG) organisations to provide live and breaking news stories via satellite for onward broadcast. Normally operating in the 14 GHz band, increased demand led to Ofcom making more spectrum available for TES at 6 GHz and 28 GHz.[13]

Recognised Spectrum Access (RSA) for Receive-Only Earth Stations (ROES)

2.23 RSA is a means for Ofcom, in its national spectrum planning, to take into account the use of frequencies for services that do not need to be licensed. Receive-only services that have no ability to transmit are exempted from the requirement to be licensed. ROES that are currently afforded protection through RSA operate in frequency bands at around 1.7 GHz, 4 GHz and 7.8 GHz. These earth stations can receive various types of information from satellites, including weather data and news broadcasts. Ofcom recently published a decision to extend RSA to the 7.9 GHz and 26 GHz bands. [14]

Related current consultations

2.24 We note the following consultations that are relevant to this initial consultation on fixed links and satellite fees:

- Spectrum above 6 GHz for future mobile communications;[15]
- Satellite and space science strategic review that we plan to publish in Q1 FY 2015/16; and
- Mobile data strategy below 6GHz.[16]

Our approach to spectrum fees

The legal framework

2.25 The legal framework within which we operate is set out in the Communications Act 2003, the Wireless Telegraphy Act 2006 (WT Act 2006) and applicable EU directives, including the Authorisation and Framework Directives.

2.26 The Authorisation Directive requires fees to be objectively justified, transparent, non-discriminatory and proportionate. The WT Act 2006 permits us to recover sums greater than those necessary to purely recover the costs incurred in connection with our spectrum functions. In such cases we must have regard to a range of factors,

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[13] See link: http://stakeholders.ofcom.org.uk/consultations/tes-additional-spectrum/statement/
[14] See link: http://stakeholders.ofcom.org.uk/consultations/rsa-earth-stations-statement/?utm_source=update&utm_medium=email&utm_campaign=rsaroes
[15] See link: http://stakeholders.ofcom.org.uk/binaries/consultations/above-6ghz/summary/spectrum_above_6_GHz_CFI.pdf. See update here: http://stakeholders.ofcom.org.uk/consultations/above-6ghz/update-apr15/
[16] See link: http://stakeholders.ofcom.org.uk/consultations/mobile-data-strategy/

including the supply and demand of spectrum and the desirability of promoting efficient use of spectrum, economic and other benefits, innovation and competition.

Administered Incentive Pricing (AIP)

2.27 Administered Incentive Pricing (AIP) is charged where spectrum is expected to be in excess demand and the aim is for fees to reflect the 'opportunity cost' of the spectrum used. "Opportunity cost" is the value of an asset to its next best use; therefore the goal of AIP is to estimate the value of the spectrum to the best alternative use, or user, denied access to the spectrum. When considering the opportunity cost of spectrum we consider both:

- the value to another user in the same use (known as "own use" opportunity cost); and
- the value to another user in a different use (known as "alternative use" opportunity cost.

2.28 The purpose of AIP is to provide users with a sustained long-term signal of the value of the spectrum and, as a result, to give spectrum licence holders incentives to use the spectrum in a way that maximises benefits for society over time. The general policy framework for AIP fees is set out in our SRSP statement. This includes eight core pricing principles and a methodology to be used to determine whether AIP is applicable when setting a fee for spectrum and at what level AIP fees should be set. The SRSP principles and methodologies that apply to the fixed link and satellite sectors are given in Annex 7.

2.29 We consider AIP to be complementary to other regulatory instruments used to manage spectrum, such as spectrum auctions, trading and liberalisation. Where AIP is not justified, we set fees that reflect our spectrum management costs ("cost-based pricing"). Cost-based pricing applies where spectrum is not scarce or where fees based on the value of the spectrum would be lower than spectrum management costs.

Structure of this document

2.30 The remainder of this document is structured as follows:

- Section 3 sets out our existing AIP fees and fee algorithms for fixed links, PES and TES;
- Section 4 discusses likely trends in demand and technology that might impact the opportunity cost of spectrum use;
- Section 5 considers estimates of opportunity cost (both own-use and alternative use);
- Section 6 considers potential improvements to the fees algorithms for fixed links, PES and TES;
- Section 7 sets out our next steps for this fees review;
- Annex 1 explains how to respond to this Consultation;
- Annex 2 sets our Ofcom's consultation principles;

- Annex 3 contains the contact response cover sheet;
- Annex 4 lists the questions in this Consultation;
- Annex 5 lists the products included in this review;
- Annex 6 lists the current spectrum bands made available to fixed link and satellite services;
- Annex 7 sets out our SRSP principles and methodologies for AIP fees reviews;
- Annex 8 sets out band factor tables for fixed links and PES; and
- Annex 9 contains a glossary.

Section 3

Basis of current AIP fees and fees algorithms

Basis of current fees

3.1 Currently all AIP fees for fixed links, PES and TES are based on the value of the spectrum in "own-use" for fixed links. This means that when we last reviewed fees for these services we considered fixed links to be the highest value use of the spectrum in all bands.

3.2 The methodology used to estimate the value of the spectrum in "own-use" was the Least Cost Alternative (LCA) method. This is generally based on a study of the cost of long-term alternative network designs or technology choices that an average user would make in response to a small reduction in the amount of spectrum they hold. The size of this reduction is usually chosen to reflect the minimum amount of spectrum that is of practical benefit to the user (e.g. the smallest channel available in the 1.4GHz band is 2 x 25kHz.).[17]

3.3 The LCA method looks at the choices that would be made in the long-term, rather than short-term. In the short-term, users' options would usually be more limited and more costly.

Purpose of fees algorithms

3.4 Fees algorithms are used for spectrum bands shared by different individual licensees whose use is managed and co-ordinated by Ofcom. The algorithms are intended to reflect individual licensees' use of spectrum and incentivise the efficient use of the spectrum. As such, it is important that these algorithms incentivise behaviours that minimise any unnecessary impacts on other users. Therefore fees algorithms are designed to incentivise efficient use, rather than to reflect an "exact estimation" of opportunity cost.

3.5 When designing the algorithms we aim to capture the main choices licensees can make that would encourage them to use spectrum more efficiently (such as the bandwidth occupied by the user and the area denied to other users and uses). We generally try to avoid unnecessary complexity as such complexity can obscure the price signals, hindering users' ability to make informed decisions.

[17] For discussion see paragraphs 1.43-1.51, Appendix A: Our current practice in setting AIP fees An appendix to SRSP: The revised Framework for Spectrum Pricing. See link: http://stakeholders.ofcom.org.uk/binaries/consultations/srsp/appendixA.pdf

Fees algorithms

Fixed links fee algorithm [18]

Technically assigned fixed links

3.6 The majority of fixed links products are technically assigned by Ofcom in order to manage the interference environment and provide a specific level of availability.

3.7 Ofcom last reviewed fees for fixed links in 2004.[19] This review was modified in 2007.[20] The current algorithm used for bi-directional links endeavours to reflect the value, or opportunity cost of use, of the spectrum. This includes a number of factors that directly increase or decrease the opportunity cost of the use of spectrum. For instance, the frequency band factor reflects variations in the value of spectrum by frequency, i.e. the value (opportunity cost) of the spectrum tends to broadly fall as the frequency increases. This reduction is primarily driven by the change in the size of the area impacted by a link, which itself arises from the propagation characteristics of spectrum. In general, the effects of spectrum use travels further at lower frequencies and so impacts larger areas.

3.8 The fixed link algorithm is as follows:

AIP Fee = Reference fee x Bandwidth factor x Frequency band factor x Path length factor x Availability factor

3.9 The meaning of each of the parameters in this algorithm is as follows:

- reference fee – this is the reference spectrum price, and is currently set at £88 per 2x1 MHz for a bi-directional link;
- bandwidth factor – the value of actual system bandwidth (MHz);
- frequency band factor – the band factor is determined by the actual frequency band;
- path length factor – the path length factor is determined by the actual path length (Pl) and the minimum path length (Mpl) that is specified in Interface Regulation IR 2000 (March 2015);[21] and
- availability factor – determined from the required system availability.

3.10 The band factor table and other tables needed to calculate the fee are given in Annex 8.

3.11 Under the current regime, uni-directional links pay 75 per cent of the calculated fee. In instances in which additional links are operating co-channel and cross-polar over the same path as an existing assigned link,[22] the user pays 50 per cent of the fee.

[18] See link: http://licensing.ofcom.org.uk/binaries/spectrum/fixed-terrestrial-links/guidance-for-licensees/FeeCalcDoc.pdf
[19] See link: http://stakeholders.ofcom.org.uk/binaries/consultations/spec_pricing/statement/statement.pdf
[20] See link: http://stakeholders.ofcom.org.uk/binaries/consultations/pricing06/statement/statement.pdf
[21] See link: http://stakeholders.ofcom.org.uk/binaries/spectrum/spectrum-policy-area/spectrum-management/research-guidelines-tech-info/interface-requirements/IR2000.pdf

Other fixed links

3.12 In addition to the technically assigned fixed links, two other types of fixed links are included in this review, both of which are charged on the basis of cost:

- self-coordinated fixed link licences: for point to point fixed links that are made available on a self-coordinated basis; and
- light licences available for fixed links in the 5.8 GHz band.

Satellite services

PES and TES fee algorithm

3.13 The AIP fee algorithm for PES and TES aims to ensure that satellite earth station users face the same costs of spectrum as other users of spectrum in the UK, i.e. face the same price incentives. Therefore, underpinning the algorithm is the principle of charging an equivalent price to those faced by terrestrial links. To ensure that fees are consistent with other earth station types, the PES fee algorithm is used as a basis for setting fees for TES and RSA.

3.14 To provide a degree of consistency with fixed links fees, the reference fee for this algorithm was derived from the AIP fee for a typical unidirectional fixed link in the 14 GHz band. The 14GHz frequency was used because it is commonly used by satellite earth stations in the UK. Plum notes in its report that the link between satellite and fixed link fees is based on the assumption that a typical satellite transmitter can be characterised as a unidirectional fixed link.

3.15 The algorithm that currently applies to PES is:

$$\text{AIP Fee} = \sum_{bands}\left[\beta \times BF_{band} \times \sqrt{\sum_{paths_{band}}\left(P_{path} \times BW_{path}\right)}\right]$$

Where:

- β - the reference fee and has a value of £28 for a 2x 1MHz transmission path;
- Ppath - peak power delivered into the antenna for each transmission path (W);
- BWpath - transmit authorised bandwidth for each transmission path (MHz);
- BFband - band factor ranging from 2.33 (for frequencies less than 5 GHz) to 0.60 (for frequencies greater than or equal to 24 GHz). The 14 GHz band is defined as the reference band and has a band factor of 1;
- Band - five defined band ranges with boundaries at 5, 10, 16 and 24 GHz; and
- Path - between a transmit earth station and a satellite receiver being defined by frequency, polarisation, peak power and bandwidth.

3.16 We use the PES fee charging algorithm as a basis for calculating the appropriate fee for a TES. There are three broad categories of TES licence according to different

[22] And therefore are reusing the spectrum through polarisation

ranges of the product of the maximum power and bandwidth used by the TES. The fee for each category of terminal is calculated by substituting the appropriate values for β (28), Bf (1.0 for the 14-14.5 GHz band available to TES) and the product of maximum power and bandwidth into the PES fee algorithm.

3.17 The current fees we charge for TES are set out in Table 1 below:

Table 1: Current fees schedule for TES[23]

Range of p	Fee per earth station in the band 5.925-7.075 GHz	Fee per earth station in the band 13.78-14.5 GHz	Fee per earth station in the bands 27.5-27.8185 GHz, 28.4545-28.8265 GHz, 29.4625-30 GHz
0 < p 100	£500	£300	£200
100 < p 2,500	£2,400	£1,400	£800
p > 2,500	£7,400	£4,300	£2,600

Where:

- "*p*" means the product of *OMP* multiplied by *WBW*;
- "*OMP*" means the number corresponding to the number of the Operational Maximum Power (in Watts) as declared by the licensee; and
- "WBW" means the number corresponding to the number of the widest bandwidth (in MHz) as declared by the licensee.

Fees for RSA for ROES

3.18 Fees for RSA for ROES are based on PES fees. The concept of impact area (i.e. the geographic area around a receiving earth station where it would be difficult to assign a co-frequency fixed link) is used to ensure parity with PES fees. The impact area concept ensures that a ROES is subject to a RSA fee that is comparable to the licence fee that would be attributable to a PES receiver having the same characteristics.

3.19 The fee charged for a grant of RSA for ROES depends on the frequency band, the required bandwidth and the recognised single-entry interference level.[24] For example, fees for RSA for ROES in the frequency band 1690 – 1710 MHz are shown in Table 2 below.

Table 2: Fees for RSA for ROES in the frequency band 1690 – 1710 MHz

	Recognised Interference Level		
	-156 dBW/MHz to less than -146 dBW/MHz	-146 dBW/MHz to less than -136 dBW/MHz	-136 dBW/MHz or higher

[23] See link: http://licensing.ofcom.org.uk/binaries/spectrum/satellite-earth-stations/fees.pdf. See also Annex 5, http://stakeholders.ofcom.org.uk/binaries/consultations/pricing06/statement/statement.pdf and Annex 5 in Additional spectrum for TES, Ofcom, Consultation, 2010 http://stakeholders.ofcom.org.uk/binaries/consultations/tes-additional-spectrum/summary/tes-additional-spectrum.pdf.

[24] This defines the level of protection afforded to the ROES

Sum/MHz	**£63**	**£37**	**£19**

3.20 In line with PES, fees for RSA for ROES are designed to encourage geographic co-location of earth stations which minimises the impact on other spectrum users. This is achieved by charging fees based on the total bandwidth used at a given site, irrespective of the number of receive-only terminals. As with PES, a site is defined as any location within 500 metres of a specified central location.

Charges for other satellite products

3.21 Three other main satellite licence products fall within the scope of this review, but are charged on the basis of cost. They are Satellite (Non-Fixed Satellite Service) Earth Stations, Satellite (Non-Geostationary) Earth Stations and Earth Station Network licences. [25]

[25] For VSAT use of spectrum

Section 4

Likely trends in demand and technology

4.1 We commissioned the report from Plum to support our review of AIP fees in the frequency bands licensed for fixed links, PES and satellite services. We sought advice from Plum on the demand, supply, technology and other trends that might, or were likely, to impact on the value of spectrum in the bands used by these services.

4.2 The spectrum considered by Plum's study comprises a range of bands between 1.4 GHz and 86 GHz which we manage and make available for fixed links and PES/TES services.

Mobile as a higher value alternative use

4.3 When estimating the longer run value of spectrum, it is important to consider future potential uses of spectrum. If a higher value feasible (i.e. realistic) alternative use is likely to exist for a particular band, then this will have implications for how we estimate the value, or opportunity cost, of the band.

4.4 When setting fees based on AIP we are looking to influence investment decisions by stakeholders by informing them of the likely value of the spectrum they plan to use, so they can make efficient investment decisions. When considering higher value alternative uses, therefore, it is important to understand whether the alternative use is feasible during the period of the investment decision being made. For radiocommunications equipment this is typically 10 years. If the alternative use is feasible, but only in a longer timeframe then it remains efficient for the existing use to invest.

4.5 Plum's report considers likely developments in spectrum use over the next five to seven years i.e. it considers current and potential alternative uses of the bands, taking account of international and European spectrum harmonisation activities. It finds that only the 3.6-3.8 GHz band is likely to have a higher value alternative use (mobile broadband) in this timeframe.[26] Plum suggests that the 1.4 GHz and 3.8-4.2 GHz bands might also be harmonised for mobile use in future.[27] However, it says this is highly uncertain and involves a longer timescale.[28]

4.6 Plum notes that the 3.6-3.8 GHz band has already been harmonised for mobile use at a European level (a band plan has been agreed)[29] and that Ofcom has designated the band for shared fixed and mobile use.[30] When deriving the estimated opportunity cost of spectrum in this band (and thus the AIP fees), Plum therefore considers it necessary to take account of the value of the spectrum to mobile as well as fixed link and satellite services. [31]

[26] Plum Report, p. 2.
[27] We note that in Ofcom's MDS these bands have been identified as a high priority
[28] Ibid, p. 2.
[29] The ECC has also updated its existing Decision on the use of 3.4-3.8 GHz for MFCN, ECC/DEC/(11)06, to provide harmonised technical conditions for coexistence between MCFN and other users in the band.
[30] Ibid, p. 2.
[31] Ibid, p. 2.

4.7 Further to these suggestions from Plum, we also note that the demand from 5G (fifth generation mobile) above 6GHz is currently under debate. Ofcom, for example, issued a consultation on this subject in January 2015, which was updated in April 2015.[32]

Question 1 Do you agree with Plum's view of the potential higher value alternative mobile use of the 3.6-3.8 GHz bands over the next seven to ten years?

Demand trends – fixed link use

4.8 Plum identifies the following trends with respect to fixed links spectrum demand from a variety of sources including an analysis of Ofcom's historical licensing data.

- Demand from fixed links at 1.4 GHz is broadly static and is low at 4 GHz;
- The frequency bands used by fixed links in the 6-10 GHz range are, and will continue to be, the most congested. This is because demand for wider bandwidth and high availability links will not always be met by optic fibre due to cost and performance differences;
- Demand from fixed links in the 10-20 GHz frequency range is unlikely to decline, meaning these bands will continue to be moderately congested; and
- There is less likely to be excess demand from fixed links in bands above 20 GHz. This is because of increased supply of spectrum in high frequency bands (as a result of spectrum awarded by auction in the 10-40 GHz range), high levels of reuse and, in some urban areas, increased availability of optic fibre, which can be a substitute for fixed links for some users. [33]

4.9 Plum foresees a continuing excess demand in bands below 20GHz, whereas they suggest that bands above 20GHz will remain relatively uncongested. [34]

Question 2 Do you agree with Plum's analysis of current and future demand for spectrum for fixed links? Please give your reasoning.

Demand trends – satellite services

4.10 Plum suggests that the use of spectrum by satellite earth stations (PES and TES) has not grown significantly in the last three years and that there is likely to be only modest future demand growth. [35] Plum suggests that the only potential exception to this is at Ka band (27.5-30 GHz), where consumer broadband services may cause a dramatic increase in demand. However, Plum argues that this is highly uncertain and will depend upon future government policies in relation to broadband coverage. As with fixed services, it suggests that mobile use in the 3.6-3.8 GHz band may have an

[32] See links: http://stakeholders.ofcom.org.uk/binaries/consultations/above-6ghz/summary/spectrum_above_6_GHz_CONSULTATION.pdf and http://stakeholders.ofcom.org.uk/binaries/consultations/above-6ghz/5G_CONSULTATION_Update_and_Next_Steps.pdf
[33] Plum Report, p. 28.
[34] Ibid, p. 28.
[35] Ibid. p. 45

impact on available spectrum, but that increased use of the 3.8-4.2GHz band and higher frequency ranges will probably mitigate this. [36]

Question 3 Do you agree with Plum's analysis of current and future demand of spectrum for PES and TES? Please give your reasoning.

[36] Ibid, p. 45.

Section 4

Estimates of opportunity cost

5.1 We also commissioned Plum to provide revised estimates of the value of spectrum to fixed links using the least cost alternative (LCA) methodology (i.e. value in own use). We also asked them to provide estimates of the value (opportunity cost) of the spectrum to mobile (where it was a feasible alternative use of the spectrum).

5.2 In order to validate the cost information that Plum used in its report, it would be useful to test the assumptions they used and, if necessary, gather additional evidence about these costs through this Consultation.

LCA Methodology

5.3 As explained in section 2, previous estimates of the value of spectrum using the LCA methodology concentrated on a hypothetical scenario whereby a small block of spectrum was removed from a typical user. In Plum's report they have used a slightly revised scenario of a typical user requiring additional spectrum for a whole new link. [37] They suggest this approach is likely to provide a more conservative (i.e. lower) opportunity cost than the previous method.[38]

Question 4 Do you agree with the approach taken by Plum to calculate the opportunity cost of the spectrum? If not, how would you suggest the LCA is calculated? Do you also agree that this methodology is likely to provide a more conservative estimate?

5.4 In a previous study for Ofcom in 2004, the LCA value for fixed links was based on the additional cost of more efficient – i.e. higher modulation – fixed link equipment. However, Plum considers that this approach can no longer be used because there is no additional cost for higher modulation equipment. In other words, Plum considers that a new user will use the highest modulation available because it reduces the fees paid.[39]

5.5 Therefore, in its analysis, Plum focuses on two options for a new link: choice of a higher frequency band (i.e. a less congested band) and deploying a wired alternative. They recognise that neither of these will be a perfect substitute for a fixed link in the lower band.[40]

Question 5 Do you agree that Plum has identified the correct options for its LCA analysis? If not, what option(s) do you suggest we consider for the Least Cost Alternative?

Cost Assumptions

5.6 Plum obtained fixed link equipment costs from a range of manufacturers and suppliers. It considers that these are reasonably representative of the costs facing a user seeking to deploy a new link. Plum estimated the costs to a fixed link user of renting space, cabinets and mast capacity at different locations based on land/space rental costs and mast build costs and using industry rules of thumb concerning the

[37] Plum Report, pp. 52-4.
[38] Ibid, p. 53.
[39] Ibid, p. 53.
[40] Ibid, pp. 55-8.

relationship between equipment costs and the costs of installation, commissioning, site infrastructure and maintenance. In all cases, capital costs were annualised using a 9 per cent nominal discount rate.[41]

5.7 One of the reasons for issuing this Consultation is to test Plum's cost estimates. For ease of reference, these are set out in Table 3 below.

Table 3: Plum's Cost Assumptions[42]

Cost Element	Frequency Band	Cost Assumptions
Radio equipment	< 10 GHz (excluding the 1.4 GHz band)	Total equipment cost taken to be £12,000.
	≥ 10 GHz	£7,000 taken as representative for two transceivers / antennas (though bulk purchases may attract significant discounts).
Site construction costs	≤ 20 GHz	A mid-range rural construction cost of £200,000 assumed.
		Costs for roof-top sites in urban and suburban areas taken to be £25,000
	> 20 GHz	£100,000 cost in rural areas.
		£10,000 for roof-top sites in urban and suburban areas.
Site rental (i.e. excluding equipment costs etc.)	≤ 20 GHz	£1,000 per annum in rural areas.
		£11,000 per annum for roof top sites in urban and suburban areas.
	> 20 GHz	£1,000 per annum in rural areas.
		£5,000 per annum for urban and suburban areas.
Installation and commissioning	≤ 20 GHz	Labour cost incurred taken to be equal to 100% of the annualised capital cost of radio equipment.
	> 20 GHz	Labour cost incurred taken to be equal to 50% of the annualised capital cost because radio equipment is smaller and more manageable.
Infrastructure – equipment accommodation and power supply	≤ 20 GHz	Taken to be 100 % of the annualised capital cost of the radio equipment.
	> 20 GHz	Taken to be 50 % of the annualised capital cost because radio equipment is smaller.
Maintenance	All frequencies	Taken to be 12% of the total capital cost of the radio equipment.

Question 6 Do you agree with the cost assumptions that Plum has used in its analysis? Please provide documentary evidence if you disagree.

5.8 We are aware that some of the cost information we are requesting is commercially confidential, including volume discount rates operators may have negotiated. However, we are keen to encourage as detailed responses as possible. Please note that, under section 111 of the Wireless Telegraphy Act 2006, Ofcom (and personnel

[41] Ibid, pp. 112-3.
[42] Ibid, pp. 112-5.

at Ofcom) are prohibited from disclosing information about a particular business which has been acquired in exercise of a power conferred by the Wireless Telegraphy Act 2006, without the consent of that business. Breach of this provision is a criminal offence. However, there are certain exceptions to the prohibition.

5.9 We are, however, not in a position to give absolute guarantees that information supplied to Ofcom will never be disclosed by Ofcom to third parties. This is because Ofcom can in some circumstances be required by law to disclose information. This can happen, for example, in relation to litigation or under Freedom of Information legislation (although normally business sensitive information would be exempt from disclosure even under Freedom of Information legislation).

5.10 Please ensure that confidential information is clearly marked as such, and if possible contained within a separate annex. We would prefer that the bulk of any response is made non-confidential to aid the transparency of the consultation process.

Opportunity cost for mobile as an alternative use

5.11 Plum identifies some spectrum bands used by fixed links, for which mobile is a feasible alternative use. Therefore, we asked it to provide us with an estimate of the value of these bands to mobile use (the opportunity cost of the band in terms of mobile use). Plum notes that there is limited recent evidence on which to base an estimate of the value of the band to mobile use. Auction values for the 1.4 GHz band date from 2008 and those for the 3.4 GHz band from 2003. However, both suggest that the value (opportunity cost) of spectrum in the 3.6 to 3.8 GHz band could be much higher than current fee levels. Plum also considers that it is likely that the value of these bands have risen significantly since these auctions, as they have recently been harmonised (at European level) for LTE. [43] Plum notes the substitutability of 3.4 GHz spectrum being auctioned as part of the Public Sector Spectrum Release (PSSR) programme and spectrum between 3.6-3.8 GHz. It suggests, therefore, that the future auction of 3.4 GHz could provide good evidence for the market price of the 3.6-3.8 GHz spectrum. [44]

5.12 However, we would welcome any additional information from stakeholders relevant to determining the value (opportunity cost) of the 3.6-3.8 GHz bands to mobile use.

Question 7 Are there any other pieces of publicly available evidence we could use to estimate the opportunity cost of the use of 3.6-3.8 GHz for mobile use now?

[43] Ibid, p. 59.
[44] Ibid, p. 59.

Section 6

Potential improvements to the fees algorithms

6.1 Plum was asked to assess the appropriateness of the different components of the current pricing algorithms for fixed links, PES and TES. We asked Plum to review the algorithms currently in use by Ofcom to determine whether they generate sufficient price incentives for licensees to use spectrum efficiently. We also asked Plum to recommend changes if it believed that these would improve the efficient use of spectrum. This included assessing whether to consider additional factors.

6.2 As a result, we are considering the following potential changes:

- removal of the path length factor;
- inclusion of a location factor;
- revision to the bandwidth factor;
- inclusion of a factor to take account of high performance antennas; and
- inclusion of an Automatic Transmit Power Control ATPC factor.

Potential improvements to the fixed link fee algorithm

6.3 In section 2, we presented the existing fee algorithm for fixed links. The revised algorithm that Plum suggests for fixed links is as follows. :

AIP Fee = Reference fee x Bandwidth factor x Frequency band factor x Availability factor x Location factor[45]

6.4 Plum suggests that the bandwidth and availability factors should be retained in their current form. Similarly, uni-directional links and bi-directional links operating co-channel and cross-polar over the same path as an existing assigned link should continue to pay 75 per cent and 50 per cent of the calculated fee respectively.[46]

6.5 The areas in which we are considering changes in the light of Plum's recommendations are discussed individually below.

Removal of the path length factor

6.6 Plum suggests revising the existing algorithm by removing the path length factor. Plum suggests that the path length factor provides an unnecessary and additional incentive to move to higher bandwidths, given that the band factor already provides an incentive to use higher frequency bands for shorter links.[47] We are still considering whether there is value in retaining the path length factor and are keen to understand stakeholders' views on the need for this factor.

[45] Plum Report, p. 5.
[46] Ibid, p. 74.
[47] Ibid, pp. 68-9.

Question 8 Do you have any comments on Plum's suggestion to remove the path length factor?

Introduction of a location factor

6.7 Plum also recommends that we introduce a geographic location factor, with fees discounted in areas of low spectrum demand. Plum suggests that a location factor would be of particular value in bands where mobile is deemed a feasible alternative use.[48]

6.8 Plum has not provided any detail as to how Ofcom would implement the location factor (other than an intention to mirror the reduced opportunity cost of the spectrum). We consider the issue of implementing a location factor in both the fixed link and satellite algorithms below, in paragraphs 6.27 to 6.27 5.30.

6.9 Ofcom agrees that there may be potential value from the inclusion of a location factor, particularly where mobile is an alternative use. Hence, we are minded, subject to overcoming implementation issues, to propose this.

Question 9 Do you have any comments on Plum's suggestion to add a location factor?

Bandwidth factor

6.10 Plum does not suggest changing the bandwidth factor. However, Ofcom has considered the effect of the bandwidth factor at, and between, the extremes of the algorithm (i.e. at 1.4 GHz and at 70/80 GHz), and we note that the channels sizes available make up different proportions of the available bandwidth in any specific band (and therefore a different proportion of the opportunity cost of each band).

6.11 This means that the use of a "flat" bandwidth factor in all bands, with one MHz at 1.4 GHz having the same weight as one MHz at 80 GHz, risks not correctly reflecting the value (or opportunity cost) of spectrum use by individual links at different bandwidths. Therefore, we are, therefore, also considering whether there is a case to apply a revised bandwidth factor that reflects these differences and seek stakeholders' views on whether this would be appropriate.

Question 10 What are your views on the need to revise the bandwidth factor in the fixed link algorithm?

High performance antennas

6.12 Plum suggests that the use of high performance antennas should be encouraged, but that the overall benefit is difficult to quantify and further investigation is required. Plum suggests that the increased discrimination available from higher class antennas might lead to benefits for the planning of fixed links by allowing a higher density of links in a geographical area. However, it states that the exact improvements in antenna discrimination depend on the geometry involved and can fall in the range 2 to 15 dB between the different antenna classes. [49]

6.13 Plum suggests that in bands that are likely to become congested (e.g. below 20GHz) there should be incentives to use higher performance antennas. It notes that existing

[48] Ibid, pp. 71-3.
[49] Ibid, p. 70.

assignment policy (Point-to-point Fixed Wireless Interface Requirement IR 2000) encourages their use, but only where it is needed to enable the co-ordination of an additional link. However, Plum recommends that these rules be made more demanding in areas with high spectrum demand, i.e. they suggest that use of higher performance antennas be made a requirement rather than optional.[50]

6.14 We are minded to consider further whether, and how, the use of high performance antenna could be included in the fixed link fee algorithm and seek stakeholders' views on this.

Question 11 What are your views on the benefits of additional incentives for the use of high performance antennas? How might these best be implemented in our fees algorithm?

Automatic Transmit Power Control (ATPC)

6.15 Plum also suggests that, rather than basing link operations on a static (worst case) transmit power level and throughput / bit rate, it is possible to obtain advantages by varying the transmit power level or the bit rate. Both automatic transmit power control (ATPC) and bit rate power control increase the efficiency of spectrum use. Most recent equipment supports ATPC but there is no significant benefit to the user in using the equipment.[51]

6.16 Plum flags the possibility of including a factor for power control in the fixed link fee algorithm in order to incentivise its use. However, it identifies two questions that Ofcom needs to consider before it can include a power factor. These are as follows.

- Is Ofcom able to include ATPC in its planning processes?
- What is the efficiency gain from ATPC?

Plum notes that deriving an answer to this second question constitutes a significant piece of work.[52]

6.17 Having considered Plum's suggestion, we note that the inclusion of a factor to take account of the use of ATPC would require us to fundamentally revise our planning process. We would need to move away from a probability based planning process assessing worst case scenarios to one that could make adjustments dynamically in real time; reacting to the specific propagation conditions at the fixed link locations. Even if we were able to do this, it is not clear to us whether there would be any real benefits gained, given that changes in propagation are likely to affect a large area at any one time and so all users are likely to need to transmit at higher levels. We are, therefore, minded not to progress with this suggestion, but would like stakeholders' views on any potential benefits that might be gained through Plum's proposed approach and any suggestions they have on how it might be implemented.

Question 12 What are your views on the suggestion that we further consider ways to incentivise the use of automatic power control, a suggestion we are minded not to take up?

[50] Ibid, p. 71.
[51] Ibid, p. 69.
[52] Ibid, p. 70.

Potential improvements to the PES and TES fees algorithm

Permanent Earth Stations

6.18 Plum suggests that the factors and the structure of the current PES/TES algorithm should be retained, with the addition of a location factor as in the fixed link algorithm.[53]

6.19 We set out the existing PES algorithm in section 2. For PES, Plum proposes that we use the following revised algorithm for calculating AIP fees:

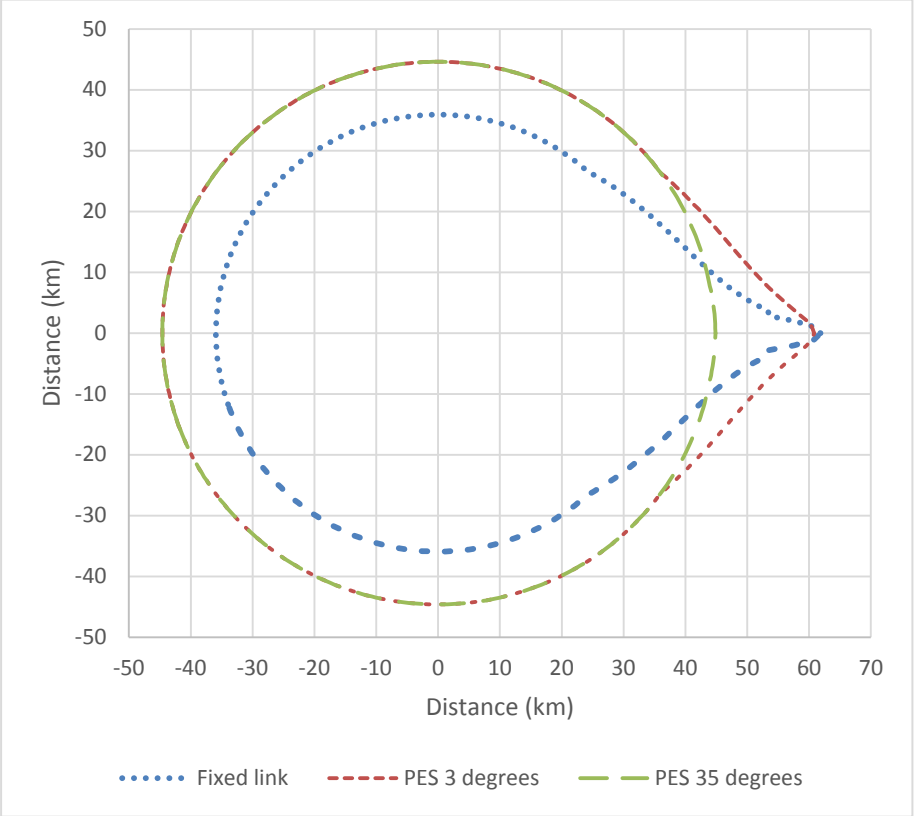
$$\text{Fee} = \sum_{bands} \left[\text{Reference fee} \times BF_{band} x\ Location\ factor \times \sqrt{\sum_{paths_{band}} \left(P_{path} \times BW_{path}\right)} \right]$$ [54]

6.20 Plum suggests that the PES reference spectrum fee should be based on the fixed link reference fee for a unidirectional link and adjusted to reflect the difference in denial areas for a representative fixed link and representative PES. This is a more refined method of ensuring that fixed links and satellite earth stations are charged the same opportunity cost for their use than that currently used.[55]

6.21 Using ITU parameter values, Plum derived the relative areas denied by PES and fixed link services as a PES / fixed link ratio. For a transmitting PES, the ratio falls in the range of 1.42 ± 0.04. This can be seen in Figure 1, overleaf.

[53] Ibid, p. 84.
[54] Ibid, p. 6.
[55] Ibid p .78.

Figure 1: Relative transmit denial areas of a PES and a fixed link – using ITU parameter values[56]



Source: Plum and Aegis analysis using parameters supplied by Ofcom

6.22 Plum also suggests that RSA fees (which provide protection to receive-only stations) should be based on their relative denial area.[57] We are minded to agree and will consider this suggestion when we develop our fees proposals. As a result of future analysis of the relative denial areas, fee levels for PES, TES and RSA may be higher than that needed to simply reflect changes in the value of the spectrum. i.e. the reference rate.

6.23 Plum also suggests that we incorporate a location factor, which they suggest should be based on the location factor applicable to fixed links.[58] As the area impacted by earth stations is unlikely to be the same as for fixed links, how we implement this with respect to PES will by necessity be different. This is discussed further in paragraphs 6.27 to 6.31.

[56] See Ibid, pp. 78-82 for explanation of this diagram.
[57] Ibid. p. 85
[58] Ibid, p. 83.

Transportable Earth Stations

6.24 Plum notes that TES fees are proportional to the reference fee and band factor in the PES algorithm. It points out that proposed fees for TES can therefore be calculated by multiplying the current TES fees by the following ratio of reference fees and band factors:

(Proposed reference fee x Proposed band factor) / (Current reference fee x Current band factor)[59]

6.25 Plum suggests that it is assumed that all use is in congested locations on the grounds that the location of use of a TES can change from day to day.[60]

6.26 Plum's proposed fee schedule for TES can be found in Table 7-3 on p. 84 of its report.

Question 13 What are your views on the proposed revisions to the PES algorithm and the TES ratio? In particular, do you agree we should use the relative denial areas to reflect the difference in opportunity cost between PES, TES and fixed links? Do you have any other suggestions for improvement?

Geographic pricing implementation challenges

6.27 Plum suggests that there are two scenarios in which we might want to include a location factor in both the fixed link and PES/TES algorithms:

- In bands where mobile **is** a higher value alternative use, lower fees should apply in areas of low population density, as is the case when it comes to setting Business Radio fees;[61]

- In bands where there **is no** alternative use, lower fees should apply in bands where there are relatively few fixed link assignments in and crossing an area. If it is not practical to assess this, then they suggest the number of assignments could be used as a proxy.[62]

6.28 This, Plum says, is because in bands where mobile is an alternative use, arguably the value of spectrum to MNOs is greater in areas of high population density. Therefore, to give appropriate incentives for use by services in areas where mobile is a higher value alternative use, fees should be higher in areas where demand for frequencies for mobile use is greatest.[63]

6.29 Where there is no alternative use Plum suggests a range of possible measurements of congestion. If these prove too costly or difficult to implement, then they suggest that a location discount could be justified in areas with low population density. Plum notes that this approach is approximate, but that such an approach is superior to no differentiation by location.[64]

[59] Ibid, p. 83.
[60] Ibid, p. 83.
[61] Ibid pp. 71-2.
[62] Ibid pp. 72-3.
[63] Ibid pp. 71-2.
[64] Ibid pp. 72-3.

6.30 Plum suggests that Ofcom should consider the use of larger grid squares (e.g. 100km x 100km) than those used in business radio to demarcate higher value areas.[65] This is because the impact areas for both fixed links and satellite use at low frequencies are likely to be larger than those for Business Radio.

6.31 We are aware of the difficulty of defining the impact area of satellite earth stations and fixed links on mobile services and would need to undertake more work to consider this. However, we believe that there would be significant value in developing a location factor where mobile is an alternative use. Where mobile is not an alternative use we are less convinced that any potential benefits would outweigh the cost of implementing this factor at this time.

6.32 However, with the increasing focus on, and reliance on, spectrum sharing to meet future demand there is an argument that we should consider how pricing can help support greater sharing, even if the exact form of sharing is not yet understood. Thinking about retaining the flexibility to share in the longer term could mean, for example, that we should consider timeframes over which fees decisions might need to influence investment decisions that are longer than we have previously.

6.33 This is because many investment decisions, once made, are very difficult/expensive to change and in particular some assets (e.g. buildings, masts) can often have a lifetime long beyond the equipment life that we typically consider when setting fees. When we consider fees for services (particularly if they do not a have a strong geographical dimension to their demand) we may want to incorporate location factors at a much earlier point than we have historically.

Question 14 Do you agree that the benefits of implementing geographic pricing are sufficiently high to warrant us considering this further? Should we look at both where mobile is, and is not, an alternative use? Do you have ideas on how this could be implemented?

[65] Ibid. p. 72.

Section 6

Next steps

Likely direction of fees

7.1 As previously stated, Plum's recommendations will be the starting point for our fees proposals and we will use stakeholder input to this Consultation to build on these.

7.2 However, we agree with Plum that for the band 3.6-3.8 GHz, we are likely to propose significantly increased fees to reflect the higher opportunity cost of alternative mobile use in this band.

7.3 For the other bands, if we follow Plum's recommendations then based on the recognisible trends in demand on own-use opportunity cost of the spectrum:

- below 20 GHz, where mobile is not deemed a feasible alternative use, we are likely to propose marginally higher fees to reflect higher LCA; and
- above 30 GHz, we are likely to propose lower fees – perhaps as low as a cost-based floor. However, we would need to be careful of creating perverse incentives given the substitutability between spectrum bands close in frequency.

Next Steps

7.4 Going forward, we intend to take input from this Consultation and use it to develop fees proposals for consultation. This will include examining in detail how we would take forward Plum's recommendations concerning changes to the fees algorithm, such as its proposals for a location factor and the removal of the minimum path length factor. We will also decide whether or not to consider further the suggestion that we include factors to incentivise high performance antenna and ATPC.

7.5 In addition, we will need to undertake further analysis to understand the spectrum management costs we incur for those licence products and authorisations whose prices are set to reflect our costs.

7.6 Finally, we will need to decide how best to estimate the value (opportunity cost) of bands for which mobile is a realistic alternative use.

Question 15 Do you have any comments to make on any issues related to next steps and implementation?

Further communication with stakeholders

7.7 We recognise that some of the cost information we have asked stakeholders to provide may be considered confidential and we would be happy to hold one-to-one meetings with any stakeholder who wishes to speak with us.

7.8 If stakeholders would prefer us to hold a public meeting to discuss these issues further, please contact us using the email provided in Annex 1. If we receive sufficient interest, we will endeavour to set up such a meeting.

Annex 1

Responding to this Consultation

How to respond

A1.1 We invite written views and comments on the issues raised in this document, to be made **by 5pm on 30 July 2015**.

A1.2 We strongly prefer to receive responses using the online web form at http://stakeholders.ofcom.org.uk/consultations/review-spectrum-fees-fixed-links-satellite/ , as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

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

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

Consultation: Fee Review (Fixed links & Satellite Services)

Spectrum Policy Group
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

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

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

Further information

A1.5 If you want to discuss the issues and questions raised in this Consultation, or need advice on the appropriate form of response, please contact Nigel Gunn either by email at nigel.gunn@ofcom.org.uk or by telephone on 020 7981 3121.

Confidentiality

A1.6 We believe it is important for everyone interested in an issue to see the views expressed by respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether all of your response

should be kept confidential, and specify why. Please also place such parts in a separate annex.

A1.7 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.8 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Our approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A1.9 Going forward, we intend to take input from this Consultation and use it to develop fees proposals for consultation.

A1.10 Please note that you can register to receive free mail Updates alerting you to the publications of our relevant documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Our consultation processes

A1.11 We seek to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.12 If you have any comments or suggestions on how we conduct our consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how we could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.13 If you would like to discuss these issues or our consultation processes more generally you can alternatively contact Graham Howell, Secretary to the Corporation, who is our consultation champion:

Graham Howell
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 020 7981 3601

Email Graham.Howell@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 We have published the following seven principles that we will follow for each public written consultation:

Before the consultation

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

During the consultation

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

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

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 We will appoint someone to ensure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Our 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we will publish all responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

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

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

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation or Consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing ☐

Whole response ☐

Part of the response ☐

Name/contact details/job title ☐

Organisation ☐

If there is no separate annex, which parts?

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name

Signed (if hard copy)

Annex 4

Consultation questions

A4.1 This Consultation seeks input from stakeholders on the following questions:

Question 1 Do you agree with Plum's view of the potential higher value alternative mobile use of the 3.6-3.8 GHz bands over the next seven to ten years?

Question 2 Do you agree with Plum's analysis of current and future demand for spectrum for fixed links? Please give your reasoning.

Question 3 Do you agree with Plum's analysis of current and future demand of spectrum for PES and TES? Please give your reasoning.

Question 4 Do you agree with the approach taken by Plum to calculate the opportunity cost of the spectrum? If not, how would you suggest the LCA is calculated? Do you also agree that this methodology is likely to provide a more conservative estimate?

Question 5 Do you agree that Plum has identified the correct options for its LCA analysis? If not, what option(s) do you suggest we consider for the Least Cost Alternative?

Question 6 Do you agree with the cost assumptions that Plum has used in its analysis? Please provide documentary evidence if you disagree.

Question 7 Are there any other pieces of publicly available evidence we could use to estimate the opportunity cost of the use of 3.6-3.8 GHz for mobile use now?

Question 8 Do you have any comments on Plum's suggestion to remove the path length factor?

Question 9 Do you have any comments on Plum's suggestion to add a location factor?

Question 10 What are your views on the need to revise the bandwidth factor in the fixed link algorithm?

Question 11 What are your views on the benefits of additional incentives for the use of high performance antennas? How might these best be implemented in our fees algorithm?

Question 12 What are your views on the suggestion that we further consider ways to incentivise the use of automatic power control, a suggestion we are minded not to take up?

Question 13 What are your views on the proposed revisions to the PES algorithm and the TES ratio? In particular, do you agree we should use the relative denial areas to reflect the difference in opportunity cost between PES, TES and fixed links? Do you have any other suggestions for improvement?

Question 14 Do you agree that the benefits of implementing geographic pricing are sufficiently high to warrant us considering this further? Should we look at both where

mobile is, and is not, an alternative use? Do you have ideas on how this could be implemented?

Question 15 Do you have any comments to make on any issues related to next steps and implementation?

Annex 5

Licence products and other authorisations included in this review

Table 4 Fixed link and satellite products included in the review

Sector	Product Code	Product Name	Price Basis
Fixed Links	301010	Point to Point Fixed Links	AIP
Fixed Links	305010	Self-Coordinated Links	Cost-Based
Satellite	306040	Satellite (Permanent Earth Station)	AIP
Satellite	308040	Satellite (Non-Fixed Satellite Earth Station)	Cost-based
Satellite	308050	Satellite (Non-Geostationary Earth Station)	Cost-based
Satellite	308010	Satellite (Earth Station Network)	Cost-based
Spectrum Access (Satellite)	551020	Recognised Spectrum Access for Receive-Only Earth Stations	AIP

Satellite	307030	Satellite (Transportable Earth Station Category 1)	AIP
Satellite	307040	Satellite (Transportable Earth Station Category 2)	AIP
Satellite	307050	Satellite (Transportable Earth Station Category 3)	AIP

Annex 6

Current spectrum bands made available to fixed link and satellite services[66]

Table 5 Fixed link bands[67]

Band	Frequency (GHz)		Bandwidth (MHz)	Shared with
	Bottom	Top		
1.4 GHz	1.35	1.517	48	
4 GHz	3.6	4.2	372	C-band satellite receive
5.8 GHz	5.725	5.850	105	
6 GHz	5.925	7.125	1114	C-band satellite transmit
7.5 GHz	7.425	7.9	448	
13 GHz	12.75	13.25	448	Ku-band satellite transmit
15 GHz	14.5	15.35	224	
18 GHz	17.7	19.7	1836	Ka-band satellite receive
23 GHz	22	23.6	1120	
26 GHz	24.5	26.5	1792	
38 GHz	37	39.5	2240	
52 GHz	51.4	52.6	1008	
55 GHz	55.78	57	1008	
60 GHz	57	64	6800	
65 GHz	64	66	2000	
70 GHz[68]	71.125	75.875	4500	
80 GHz[69]	81.125	85.875	4500	

Table 6 Satellite spectrum bands

Band	Frequency (GHz)		Use	Bandwidth (MHz)	Shared with
	Bottom	Top			
1.7 GHz receive	1.69	1.71	MetSat RSA	20	
2 GHz transmit	2.025	2.110	S-band	85	
2 GHz receive	2.200	2.290	S-band	90	
4 GHz receive	3.6	4.2	C-band	600	Fixed links 3.6 - 4.2 GHz
5 GHz transmit	5.15	5.25	MSS NGSO feeder	100	
6 GHz transmit	5.725	7.075	C-band	1350	Fixed links 5.925 - 7.125

[66] This annex includes bands for which authorisations are charged at cost as well as AIP and is therefore more comprehensive than the bands considered in the Plum report
[67] To note that there are also several legacy bands with which point to point links operate
[68] To note this covers both the Ofcom coordinated and self-coordinated bands
[69] To note this covers both the Ofcom coordinated and self-coordinated bands

					GHz
7.8 GHz receive	7.75	7.85	MetSat RSA	100	Fixed links 7.425 - 7.900 GHz
11 GHz receive	10.7	12.75	Ku-band	2050	
13 GHz transmit	12.75	13.25	Ku-band	500	Fixed links 12.75 - 13.25 GHz
14 GHz transmit	13.75	14.5	Ku-band	750	
17/18 GHz transmit	17.3	18.4	BSS feeder	1100	Fixed links 17.7 - 19.7 GHz
18 GHz receive	17.7	19.7	Ka-band	2000	Fixed links 17.7 - 19.7 GHz
20 GHz receive	19.7	20.2	Ka-band (exclusive)	500	
28 GHz transmit	27.5	29.5	Ka-band (exclusive segments)	728	
30 GHz transmit	29.5	30	Ka-band (exclusive)	500	

Annex 7

SRSP principles and methodologies

Table 7 SRSP Principles

AIP principle 1	Role of AIP	AIP should continue to be used in combination with other spectrum management tools, in both the commercial and the public sectors, with the objective of securing optimal use of the radio spectrum in the long term. AIP's role in securing optimal use is in providing long-term signals of the opportunity cost of spectrum.
AIP principle 2	When AIP should be applied	AIP should apply to spectrum that is expected to be in excess demand from existing and/or feasible alternative uses, in future, if cost-based fees were applied. In determining feasible alternative uses, we will consider over the relevant timeframe, any national or international regulatory constraints, the existence of equipment standards, and the availability and cost of equipment as well as other factors that may be appropriate.
AIP principle 3	The 'relevant timeframe' to assess future demand of spectrum	In general we need to determine the time period over which we will seek to assess excess demand, congestion and feasible alternative use. We will do so over a timeframe that reflects the typical economic lifetime of existing users' radio equipment.
AIP principle 4	AIP and spectrum trading	Many secondary markets are unlikely to be sufficiently effective to promote the optimal use of the spectrum without the additional signal from AIP. Therefore AIP will likely continue to be needed to play a role complementary to spectrum trading for most licence sectors.
AIP principle 5	Role of AIP in securing wider social value	Uses of spectrum that deliver wider social value do not, as a general rule, justify AIP fee concessions, because direct subsidies and/or regulatory tools other than AIP are normally more likely to be efficient and effective.
AIP principle 6	AIP concessions and the promotion of innovation	It will generally not be appropriate to provide AIP concessions in order to promote innovation.
AIP principle 7	Use of market valuations	We will take account of observed market valuations from auctions and trading alongside other evidence where available when setting reference rates and AIP fee levels. However, such market valuations will be interpreted with care and not applied mechanically to set reference rates and

		AIP fees.
AIP principle 8	Setting AIP fees to take account of uncertainty	Where there is uncertainty in our estimate of opportunity cost, for example arising from uncertainty in the likelihood of demand for feasible alternative uses appearing, we will consider the risks from setting fees too high, or too low, in light of the specific circumstances. When spectrum is tradable we will consider the extent to which trading is expected to promote optimal use, and will also have particular regard to the risk of undermining the development of secondary markets.

Table 8 SRSP Methodologies

AIP methodology 1	AIP and congestion	In setting AIP fees, we will assess current and future congestion in existing use and demand for feasible alternative uses in the frequency band in question and at different geographic locations over the relevant timeframe, given technological, regulatory and international constraints and using readily available evidence
AIP methodology 2	Reference rates	Reference rates will be based on the estimated opportunity cost of spectrum use, considering both the current use and any feasible alternative uses. These estimates will be informed, where appropriate, by the available market information (if any), and economic studies of the value of spectrum in different uses.
AIP methodology 3	Calculating individual licence fees	In converting reference rates to fees, we will take account of the opportunity cost and the amount of spectrum denied to others. This will generally be based on frequency, geographical location, bandwidth, geographical coverage or other measure that reflects the geographical extent of coordination requirements and in some cases the exclusivity of an assignment.
AIP methodology 4	Impact assessments	We will undertake Impact Assessments on our fee proposals to identify any potential detrimental impacts to spectrum users, consumers and citizens. We will need to consider carefully the balance of benefits and risks of the implementation of all changes in fees.

Annex 8

Band factor tables

Table 9 Current fixed link bands

Range of frequency band (GHz)	Band Factor
1.350-1.517	1.0
1.450-1.530	1.0
1.672-1.690	1.0
1.900-2.690	1.0
3.600-4.200	1.0
5.925-6.425	0.74
6.425-7.125	0.74
7.425-7.900	0.74
10.700-11.700	0.43
12.750-13.250	0.43
14.250-14.499	0.43
14.500-15.350	0.43
17.300-17.699	0.30
17.700-19.700	0.30
21.200-21.999	0.30
22.000-23.600	0.30
24.500-26.500	0.26
27.828-29.060	0.26
31.000-31.799	0.26
31.800-33.400	0.26
37.000-39.500	0.26
49.200-50.200	0.17
51.400-52.600	0.17
55.780-57.000	0.17

Table 10 Current PES bands

Range of frequency band (GHz)	Band Factor
fb < 5	2.33
5 ≤ fb < 10	1.72
10 ≤ fb < 16	1.00
16 ≤ fb < 24	0.70
fb ≥24	0.60

Annex 9

Glossary

5G	Fifth generation mobile phone standards and technology
AIP	Administered incentive pricing – a fee charged to users of the spectrum to encourage them to make economically efficient use of their spectrum
Assignment	Authorisation given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions
ATPC	Automatic Transmit Power Control – an electronic process for controlling the transmission power depending on the power level received by the receiver
Fixed link	A terrestrial based wireless system operating between two or more fixed points
Frequency band	A defined range of frequencies that may be allocated for a particular radio service, or shared between radio services
GHz	Gigahertz – a unit of frequency of one billion oscillations per second
LCA method	Least Cost Alternative method – a method used to estimate the opportunity cost of spectrum by estimating the value to an average user of a small additional block of spectrum in the band, in terms of avoided cost
LTE	Long-Term Evolution is a standard for communication of high-speed data for mobile phones and data terminals. The term 4G is generally used to refer to mobile broadband services delivered using the next generation of mobile broadband technologies, including Long Term Evolution (LTE) and WiMAX
MHz	Megahertz – a unit of frequency of one million cycles per second
MNO	Mobile Network Operator
Opportunity cost	The cost of a decision or choice in terms of the benefits which would have been received from the most valuable of the alternatives that was foregone
PES	Permanent Earth Station – a satellite earth station operating from a permanent, specified location to one or more satellites in space
PSSR	Public sector spectrum release
Radio Spectrum	The portion of the electromagnetic spectrum below 3000 GHz used for radiocommunications
ROES	Receive-only earth station – a satellite earth station which receives radio signals but does not transmit.
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 licence exemption.

TES	Transportable Earth Station – a satellite earth station that can be transported to a fixed location where it then is able to communicate via satellites in space
WT Act 2006	Wireless Telegraphy Act 2006