# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Executive Summary</td>
</tr>
<tr>
<td>2</td>
<td>History: the genesis of AIP</td>
</tr>
<tr>
<td>3</td>
<td>AIP Implementation – initial progress</td>
</tr>
<tr>
<td>4</td>
<td>Extending Pricing and Cave Review</td>
</tr>
<tr>
<td>5</td>
<td>Other spectrum market developments</td>
</tr>
<tr>
<td>6</td>
<td>AIP Implementation process</td>
</tr>
<tr>
<td>7</td>
<td>AIP Effects</td>
</tr>
<tr>
<td>8</td>
<td>Final Conclusions and Observations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annex</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AIP Fees for both WT Act Licences and Recognised Spectrum Access (“RSA”)</td>
</tr>
<tr>
<td>2</td>
<td>Mobile Cellular Fees</td>
</tr>
<tr>
<td>3</td>
<td>Point to Point – Fixed Links</td>
</tr>
<tr>
<td>4</td>
<td>Licence Fee Timelines</td>
</tr>
<tr>
<td>5</td>
<td>Glossary</td>
</tr>
</tbody>
</table>
Section 1

Executive Summary

Introduction

1.1 This document provides an evaluation of the policy of charging spectrum fees based on Administered Incentive Pricing (AIP) i.e. setting fees to reflect the opportunity cost of spectrum denied to other uses and users, rather than just the costs of managing the radio spectrum.

1.2 AIP is intended to provide long term signals of spectrum value to spectrum users. These long-term value signals are intended to help spectrum users (and their suppliers) make more efficient decisions concerning their use of spectrum and investment in radio technology. At the same time, given the significant investment that many users have tied up in radio equipment – which in most cases cannot easily and quickly be retuned to different frequencies and has a lifetime of many years – it cannot be expected that AIP will lead to significant changes to spectrum use in the short term; AIP is not intended to achieve any specific short term spectrum reallocation goals.

1.3 AIP was first introduced in the UK in 1998. As a new and fundamentally different approach to fee-setting, it has to date been applied in a conservative manner: implementation has been rolled out to different users of spectrum slowly, and fee levels have generally been set at most at around 50% of the estimated full opportunity cost. Significant fee increases have also been phased in over a number of years.

1.4 As a result of both these factors we would not expect to observe a significant impact of AIP on spectrum use at this relatively early stage. Nonetheless we would hope to be able to identify at least some examples of beneficial changes that might in part be attributable to AIP.

Overall conclusions

1.5 We believe that, in the main, AIP has met its primary objective in helping to incentivise spectrum users to consider more carefully the value of the spectrum they use alongside that of other inputs, and to take decisions that are more likely to lead to optimal use of the available spectrum. Because each individual user’s decisions reflect their particular circumstances and objectives, improvements in spectrum allocation are difficult to attribute, with confidence, solely to the influence of AIP. However in the course of this evaluation we have identified a number of important actions by users, in the period since AIP has been implemented, where we believe AIP may have contributed to incentivising more efficient use.

1.6 In particular:

- The removal of legacy fixed links in the 4 GHz band, generally regarded as technically inefficient due to the age of the equipment deployed;
- The removal of constraints on active services in spectrum bands, used by the Radio Astronomy Service, following the introduction of AIP fees for grants of Recognised Spectrum Access (RSA);
• The return of some UHF\(^1\) spectrum used by the police in Scotland.

1.7 We have found no evidence to suggest that the application of AIP has given rise to material adverse consequences for spectrum efficiency. In particular it has not resulted in demand for spectrum falling off significantly where AIP has been applied.
Section 2

Introduction

2.1 This document details Ofcom’s evaluation of our policy of using Administered Incentive Pricing (“AIP”)\(^1\) to set fees under the Wireless Telegraphy Act 2006 (“WT Act”) for the use of radio spectrum\(^1\) over the period 1998 to 2008. The evaluation process is an important part of Ofcom’s approach to policy making, and is an identified element in post policy implementation, in the timeline of all policy projects\(^2\). Therefore, this report represents an historical evaluation of AIP and not a forward look to the role of AIP in the future.

2.2 The National Audit Office has recently emphasised the importance of an effective and transparent approach to policy evaluation. Their report entitled “A Review of Economic Regulators’ Impact Assessments – for the House of Lords Select Committee on Regulators”\(^3\) reflected:

2.3 “Evaluation completes the policy cycle and allows policy officials to ascertain the extent to which a policy’s objectives have been achieved; assess the accuracy of the expected impacts; and identify any unintended or unforeseen consequences. Feedback from reviews can allow policy teams to identify where improvements can be made to optimise the benefit delivered or to reduce the regulatory burden. However this is rarely done in a systematic or proactive way. Often reviews of policies are not undertaken unless a problem is flagged up either by Government or stakeholders”.

2.4 This document summarises some key conclusions from the evaluation. We first outline, below, the background to Ofcom’s approach to licensing. We then set out the current objectives of AIP, against which we have assessed the impact potentially attributable to it. We then briefly summarise the history behind the establishment of AIP before identifying some of the impacts that might be associated with its implementation, as well as considering the potential impact and implications of other relevant developments such as spectrum awards and spectrum trading. However we have not considered the processes that led to the establishment of AIP itself nor those underpinning its application to specific wireless sectors, as most of these predate the current legal framework and, therefore, Ofcom’s current objectives.

2.5 A number of terms, particularly economic terms, are used in this document for which the exact meaning is important and that may not be the same as that which is commonly understood. These terms are therefore included in a Glossary, as Annex 5.

Background

2.6 Ofcom is statutorily required to licence exempt (“exempt”) radio stations, equipment or apparatus from the requirement for a Wireless Telegraphy Act licence (“WT Act Licence”) if the use of stations or apparatus is not likely to involve undue interference with wireless telegraphy\(^4\). As a result, our power to grant licences under the WT Act

---

\(^1\) Definitions for all terms are provided in the Glossary as Annex 5.
\(^2\) See paragraph 3.12.
\(^3\) See Section 3.13.
\(^4\) See section 8 of the Wireless Telegraphy Act 2006.
is exercised where it is judged that exemption is not appropriate for the purposes of spectrum management.

2.7 Where spectrum use is licensed, it normally attracts a licence fee. Ofcom has set these fees according to two alternative pricing methodologies:

- **“Cost Recovery”**, which enables us to recover the costs of administering and managing the radio spectrum (or part of such costs only, by means of a “contribution” to cost recovery), or

- **“Administered Incentive Pricing” (“AIP”),** which involves us setting licence fees by reference to our estimate of the “opportunity cost” of the relevant spectrum, so that the licensee is given a signal of the value of the spectrum to citizens and consumers.

2.8 AIP is applied to many licences granted under the WT Act. Ofcom’s opportunity cost estimates and relevant AIP-based fees are also used by Government in deriving the payments that should be made in respect of the spectrum used by the Ministry of Defence\(^5\) and some other Crown bodies under section 28 of the WT Act. Ofcom has also consulted on applying AIP to the aeronautical and maritime use of spectrum\(^6\). Additionally, AIP forms the basis of the fees applied to the non-Crown grants of Recognised Spectrum Access (“RSA”) for the Radio Astronomy Service (“RAS”).

2.9 AIP has now been in existence for nearly 10 years and Ofcom continues to revise both the level of fees and charges applied and how they are calculated according to AIP. In this context we are currently undertaking a Strategic Review of Spectrum Pricing\(^7\) (“SRSP”) which is examining the general principles and methods by which both Cost Recovery and AIP fees should be set and reviewed in future. The SRSP is a separate project to this policy evaluation and, in line with guidance on undertaking evaluations, is not directly linked to it. However this backward-looking evaluation is timely as relevant input evidence for the SRSP.

**Current objectives of AIP and evaluation criteria**

**The legal framework**

2.10 AIP is one of the pricing methodologies used by Ofcom to make decisions on the amount to be paid by licence holders for the use of the radio spectrum. In adopting any of these pricing methodologies (i.e. whether AIP or Cost Recovery) Ofcom is required to comply with a legal framework defined in the European Union (“EU”) and implemented in UK law, which sets out (i) overarching general duties applying across all our functions as well as (ii) specific duties concerning spectrum management.

**Ofcom’s general duties**

2.11 Ofcom’s principal duties under the Communications Act 2003 (“Communications Act”) are:

- to further the interests of citizens in relation to communications matters; and

---

\(^5\) Ofcom cannot require the Crown to pay AIP because the Wireless Telegraphy Act 2006 does not bind the Crown and, therefore, Crown bodies do not require authorisation to use spectrum. However, the Secretary of State may make payments to Ofcom in respect of the use of spectrum by Crown bodies in line with the Government’s policy that the public sector will pay for use of spectrum on a comparable basis to the private sector. See section 28 of the Wireless Telegraphy Act 2006.

\(^6\) [http://www.ofcom.org.uk/consult/condocs/aip/](http://www.ofcom.org.uk/consult/condocs/aip/)

\(^7\) [http://www.ofcom.org.uk/radiocomms/ifi/srsp/](http://www.ofcom.org.uk/radiocomms/ifi/srsp/)
to further the interests of consumers in relevant markets, where appropriate by promoting competition.\footnote{Section 3(1) of the 2003 Act.}

2.12 In securing the above duties, Ofcom is required to secure \textit{inter alia}:

\begin{enumerate}
\item the optimal use for wireless telegraphy of the electro-magnetic spectrum,\footnote{Section 3(2)(a) of the 2003 Act.}
\item the availability throughout the UK of a wide range of electronic communication services,\footnote{Section 3(2)(b) of the 2003 Act.} as well as of a wide range of television and radio services which (taken as a whole) are both of high quality and calculated to appeal to a variety of tastes and interests; and
\item the maintenance of a sufficient plurality of providers of different television and radio services.\footnote{Section 3(2)(d) of the 2003 Act.} In performing those duties, Ofcom is also required to have regard \textit{inter alia} to the different needs and interests of everyone who may wish to use the spectrum for wireless telegraphy.\footnote{Section 3(4)(f) of the 2003 Act.}
\end{enumerate}

\textbf{Ofcom’s duties in carrying out its radio spectrum functions}

2.13 In exercising its radio spectrum functions, Ofcom is required, under section 3 of the WT Act, to have regard \textit{inter alia} to:

\begin{enumerate}
\item the extent to which the electro-magnetic spectrum is available for use, or further use, for wireless telegraphy;
\item present and future demand for use of that spectrum for wireless telegraphy;
\item the desirability of promoting:
\begin{enumerate}
\item efficient use and management of the electro-magnetic spectrum
\item economic and other benefits arising from the use of wireless telegraphy
\item the development of innovative services, and
\item competition in the provision of electronic communications services
\end{enumerate}
\end{enumerate}

\textbf{Ofcom’s duties in setting licence fees under the WT Act}

2.14 In establishing the pricing methodologies to set licence fees under the WT Act, Ofcom is required to have regard to its relevant general duties as well as its specific duties relating to the carrying out of its radio spectrum functions. In particular, section 13 of the WT Act permits Ofcom to recover sums greater than those necessary to recover the costs incurred in connection with its radio spectrum functions (such as the sums payable through AIP) if Ofcom thinks fit in the light (in particular) of the matters to which Ofcom must have regard under section 3 of the WT Act 2006.

2.15 Furthermore, under Article 13 of Directive 2002/20/EC on the authorisation of electronic communications networks and services (the “Authorisation Directive”), any fees imposed for rights of use of radio frequencies must reflect the need to ensure the optimal use of the resources. Such fees must be objectively justifiable,
transparent, non-discriminatory and proportionate in relation to their intended purpose and take into account the objectives set out in Article 8 of Directive 2002/21/EC (the “Framework Directive”). These objectives include, among other things, the promotion of competition in the provision of electronic communications networks, electronic communications services and associated facilities and services by *inter alia* encouraging efficient use and ensuring the effective management of the radio frequencies.

2.16 The policy objectives pursued by Ofcom by means of AIP must comply with this general legal framework.

**The role of AIP as a “complementary” policy**

2.17 Since its introduction in 1998, the key objective of AIP for Ofcom has been to further the achievement of our statutory duties and in particular to ensure the optimal use of spectrum and in this respect to have regard, in particular, to its efficient management and use. In this respect, it is important to note that optimal use may not imply that spectrum is utilised by particular radio transmissions at all times: there are many potential reasons why the best interests of citizens and consumers are met by temporary periods of excess demand as well as by licensed spectrum remaining “fallow” for periods (e.g. while technology is developed and rolled out).

2.18 Nevertheless, in the longer term it is unlikely that spectrum will be optimally used if there is either persistent excess demand for it, or if spectrum is not being used when there is demand for it (sufficient to cover the costs of managing it, including making it available for use). Accordingly, we set out in our Spectrum Framework Review a package of complementary policies aimed at using market mechanisms so that those who use, or are considering using, spectrum can make economically rational decisions that maximise welfare for society and therefore meet our duty to secure optimal use of spectrum. These further policies complementary to AIP are to:

- release available spectrum to the market as quickly as possible;
- enable released spectrum to be assigned to its highest value use over time, through the issue of Tradable and Liberalised licences; and
- incentivise such efficient, highest value, use through the continuation of AIP for spectrum which has not been released via auction, in order to signal the opportunity cost of spectrum to the market.

2.19 Because AIP was intended to be a complementary policy, it is inherently difficult to assess its impact in isolation, for two key reasons:

- It is difficult to infer from actual evidence how the spectrum market would have developed in the absence of AIP, given that AIP has been introduced progressively over a period or more than 10 years; and
- the respective impacts of AIP, other complementary policies, and wider market developments on the use of spectrum are impossible to isolate with confidence.

---

13 Article 8(1)(d) of the Framework Directive.
14 Communications Act 2003, Section 3(2)(a).
15 WT Act 2006, Section 3(2)(a).
2.20 Assessing the impact of AIP to date is further complicated by the fact that users need time to respond to AIP signals and, as noted above, AIP has only been in place for 10 years. Spectrum is used in combination with band-specific equipment with long lifetimes. As a result, many changes in spectrum use (such as moving to less congested bands, investing in more spectrum efficient technology or replacing spectrum with other inputs) are inevitably tied up with investment/divestment decisions and may only be considered periodically as equipment is needed to be replaced. Hence, the full impact of AIP can only be realistically assessed over long periods (which in many cases could be as long as 15-20 years) after users have had sufficient time to adjust to pricing signals.

Evaluation criteria

2.21 Despite these difficulties, in order for us to consider whether AIP has facilitated the allocation of spectrum into optimal use over the longer term, we have used the following evaluation criteria. Whether AIP:

- has facilitated the allocation of spectrum into optimal use over time, for example by encouraging trading or surrender of spectrum in lower value uses, and reducing excess demand for spectrum; or

- has disrupted the optimal allocation of spectrum, for example by causing it to be underused while demand for it exists.

2.22 In assessing the effects of AIP, we have also taken account of the fact that we have continued a policy of setting AIP rates conservatively, below our estimates of expected opportunity costs. This is because of the risks to optimal allocation posed by sustaining AIP above opportunity costs, as well as the difficulties of estimating opportunity costs with confidence. This conservative approach inherently limits the expected benefits from AIP. However, we also recognise that by adopting a conservative approach Ofcom has sought to minimise the risks of any inefficiency and detriment to citizens and consumers arising from the application of AIP.

2.23 We have also evaluated whether the process used to introduce AIP reflected regulatory good practice, which should also serve to limit the risks of unintended consequences from the policy.

Overall conclusions

2.24 We believe that, in the main, AIP is continuing to meet its primary objective in helping to incentivise spectrum users to ensure that the spectrum they have access to, is used optimally. In essence, the case for AIP is relatively simple. Due to increasing demand for applications and the introduction of new services, spectrum is scarce or in excess demand in many frequencies and geographical areas— not all potential users and uses can be accommodated in their preferred frequencies and locations, and there is a need to ration demand by means of a price. In the absence of price signals, users will lack incentives to economise in their use of scarce spectrum, and will tend to hoard it or use it in greater quantities than if it was realistically priced. Putting a price on scarce spectrum provides the necessary incentives and allows those who value it most to gain access to it thereby providing services of a greater economic value to the benefit of citizens and consumers.

2.25 Whilst improvements in spectrum allocation are seldom possible to attribute, with confidence, solely to the influence of AIP, as noted above, in the course of this evaluation we have identified a number of important individual areas where we
believe the use of AIP may have contributed to incentivising optimal use in the limited time in which AIP has been in place. In particular:

- The removal of legacy fixed links in the 4 GHz band, generally regarded as technically inefficient due to the age of the equipment deployed;
- The removal of constraints on active services in spectrum bands, used by the RAS, following the introduction of AIP fees for the grants of RSA;
- The return of some UHF$^1$ spectrum used by the police in Scotland.

2.26 Similarly, we believe that, for the case study examples identified, alternative use of a non-incentive pricing mechanism such as Cost Recovery would have been quite likely to allow inefficiencies to continue.

2.27 We believe that we have used all appropriate available evidence in assessing opportunity cost, and have applied sound regulatory principles in setting the associated fee levels for particular licence classes. We have reduced or increased fees where there have been sound reasons to do so, including evidence of a need better to reflect opportunity costs in fees.

2.28 We do recognise that the introduction of AIP has not always been well received by licensees when it has resulted in significant increases in their licences fees. However, given that on such occasions the pre-existing levels of fees were often well below the relevant estimates of opportunity cost, and AIP fees were set conservatively below expected opportunity costs, it is unlikely that the application of AIP-based fees, by themselves, made otherwise economic uses of spectrum uneconomic, in cases of existing use.

2.29 Our general requirement to assess the impact of specific changes in fees before implementing them should continue to guard against inefficient outcomes in future. However, if we follow the recommendation of the Cave Review$^{17}$ to move our AIP fees closer to opportunity cost in future (in order to provide more effective incentives), it is possible that this risk may increase, and accordingly we will need to continue to take short term impacts fully into account.

Section 2

History: the genesis of AIP

Before AIP: no pricing, cost-recovery pricing and sector-specific payments

3.1 Spectrum has been managed in the UK since the Wireless Telegraphy Act of 1904. From the outset, it was generally directed by Government to public purposes, such as defence. Up until the late 1970s much of the telecommunications infrastructure was also within state control: Post Office Telecommunications (1969 – 1981) and the Post Office prior to that. As the purposes of spectrum use were publicly defined and limited, the concept of charging anything for it (above administrative costs in the case of non-Crown users) was not a feature of sustained Government Policy. Users of spectrum, in general, did not pay proportionate to the amount or value of the spectrum they held even if they derived private commercial benefit from its use.

3.2 Fees could be set by the Secretary of State, with the consent of the Treasury, from 1904. Under standard fees and charging conventions, these could not be set higher than needed to cover administrative costs18.

3.3 Occasionally, the commercial value of spectrum and/or its accompanying business authorisations has been more or less reflected in specially-targeted statutory payments by users, although not through Wireless Telegraphy Act licence fees. Since 1964, the commercial C3 television franchisees have paid a percentage of specified income19 (mainly advertising) in return for their broadcasting authorisations. The national commercial radio companies also paid for their access to scarce national spectrum which could be used for advertising. However, most other commercial users of spectrum faced only administrative cost-based fees either in accessing spectrum, or exploiting it.

3.4 Regulators including Ofcom, for those fees not set by AIP, have used some discretion in setting fees within the ceiling of full cost recovery, with some fees well below this level and others closer to it. For example, the maximum fee for a Permanent Earth Station licence at one point was £10,000 per annum, which may have been higher than other fees charged for broadly comparable licences.

3.5 It appears that some costs of administering and managing spectrum licences, beyond core administrative licence processing costs were recovered under this approach by previous regulators. The fees would have enabled the regulator to recover some costs incurred in respect of the general administration and management of spectrum licences, as a whole, rather than the narrow licensing processes. For instance, costs such as radio propagation research, and training were fully or partly recovered from fees.

Reviews during the 1980s and 1990s

3.6 However the way in which radio spectrum was managed in the UK began to exercise Government as far back as the early 1980s, when the extent of commercial involvement in telecommunications began to gather pace. The Independent Review of the Radio Spectrum (30-960 MHz) - Dr J H H Merriman (published in 1983) was

---

18 Fees charged by government are generally limited to cost-recovery unless they are explicitly authorised by Parliament to be higher

19 Following a short-lived (3-year) experiment with a television advertising duty that was paid by television companies but was provided to be fully recouped from advertisers.
an early review of the way in which spectrum was managed in the UK. This was followed later by two additional reports in 1988 and 1991 (Sir Kenneth Corfield\textsuperscript{20}) which addressed the same basic questions. However these reviews mainly addressed the high level management approach to spectrum and, whilst they speculated on alternative ways to manage spectrum (and what the current and future uses were and might be) no key changes were recommended or implemented.

3.7 As time went on, some examples, which date back to the early 1990s, probably further exposed the need for a review of the status quo:

- In the mid 1990’s the use of a popular Private Mobile Radio\textsuperscript{21} (“PMR”) frequency band “VHF High Band”\textsuperscript{22} was closed to new assignments in the London area. This was due to the level of congestion experienced by users. The decision to close the band was based on a combination of the level of interference complaints received, and a decision by the spectrum planners themselves, who felt that to permit further increases in use would seriously limit the operational effectiveness of existing systems (although some two years later this technical decision to close the band was informally challenged, and the closure lifted);

- At the same time, the increasing popularity of cellular telephony, and its anticipated move from the existing analogue service to a more advanced digital service, illustrated that technologies were developing rapidly, and there were perceived to be significant markets for new services. This would, obviously, have a consequential impact on the commercial demand for spectrum, and its economic value (albeit that the extant management model did not allow for this value to be explicitly revealed).

3.8 More generally, it was apparent that the pressures on spectrum use and its availability, coupled with the general upturn in the global economic climate (and consequential increased interest in telecommunications) would increasingly put pressure on a wholly regulator-led spectrum management model.

3.9 In 1994 the Radiocommunications Agency (“RA”) published a consultation on the future management of the radio spectrum. This document was an initial look into using alternative ways of managing spectrum allocation other than technical management models. As well as AIP, potential mechanisms covered included auctions and secondary trading. However the main focus of the consultation was on proposals for AIP and there was general support, at that time, for this approach to be taken forward.

3.10 A report commissioned by RA from Smith-NERA in 1996\textsuperscript{23} was the main consultative report which specifically elaborated how AIP might be applied to range of licence classes. The 1998 Wireless Telegraphy Act (the “WT Act 1998”) provided for spectrum fees to be set above the level required to recover costs in certain cases. The WT Act 1998, however, was not addressed to Crown users, who continue to be able to use spectrum without the need for a WT Act licence because of the “Crown immunity”. At this stage, no spectrum auctions had been undertaken, although their

\textsuperscript{21}Private Mobile Radio. Closed user group systems (“PMR”).
\textsuperscript{22}VHF High Band – A historically popular frequency band between 165-173 MHz, used by taxis/mini cab firms, courier companies, private security organisations etc., where the equipment was of a practical size and costs were lower than the alternatives.
principles were being discussed by the regulator. These steps were the first moves towards the implementation of an AIP policy, which has been subsequently continued by Ofcom since it was provided its duties and powers by the Communications Act.
Section 3

AIP Implementation – initial progress

Own use opportunity cost

4.1 The WT Act 1998, as primary legislation, was the cornerstone in the development of AIP. This Act permitted the regulator to reflect considerations other than cost recovery when charging fees for spectrum use. Up until that point, the existing regulatory framework did not provide any means by which users could be incentivised to make efficient decisions about their spectrum requirements, based on the value of the spectrum to society at large, as the legislation in place would not permit it. Nevertheless, prior to the passing of the WT Act 1998, the foundations for AIP were already being laid. At that time the regulator undertook a major programme to consult and inform stakeholders as to the benefit that AIP would deliver. As AIP would result in the majority of licences classes having their fees increased, this could potentially have been a difficult policy to promote. However, AIP, as a principle, was in the main broadly welcomed by stakeholders.

4.2 The Smith NERA work in 1996 had proposed fee levels for, primarily, Mobile Business Radio (“BR”)24, Point to Point Fixed Links and Cellular. The methodology proposed in the report involved calculating the marginal value of the spectrum to the user: the “own use” opportunity cost. The approach estimated the minimum additional cost that an average, reasonably efficient user would have to incur in order to maintain output quantity and quality if denied access to a small amount of spectrum. This is one measure of the worth of the assignment, since it reflects the amount that the existing users would have to pay if deprived of the specific spectrum concerned, in order to maintain the same level and quality of service.

4.3 Smith NERA outlined what they felt were the key criteria when setting a more incentive based pricing regime:

- prices should be based on the estimated marginal value of spectrum;
- marginal spectrum values should be calculated by costing the alternatives faced by potential users denied access to the spectrum and then taking the difference between the costs of providing the service at current levels and the minimum cost of those alternatives;
- initially prices less than marginal values should be set, because the current allocation and assignment of spectrum was not an equilibrium position;
- initial prices should be set at a fraction of the estimated marginal values, but probably at several times the then current fee levels;
- prices should then be increased over, say, a five year timescale, depending on users' reactions. If significant amounts of spectrum were handed back to the RA, then there may be no need to increase prices. If, on the contrary, spectrum remained congested, then prices should be increased;

24 Business Radio is a collective term for systems that originally described services that carried private radio traffic limited to a companies business or systems where a company run a system for commercial gain for the benefit of others. Lately however it describes business radio use that is not regarded as cellular mobile.
hence, use of spectrum would need to be monitored over time and prices adjusted accordingly.

4.4 Smith NERA recommended that there should be a five year transitional period when AIP fees were introduced. This was because they recognised that there were potential transitional issues when moving to full opportunity cost rates. They also recommended that reviews be conducted to assess whether it was still right to keep fees on this same rising track, or if the path should be adjusted upwards or downwards. They recommended that the review process should take account of changes in technology, equipment costs and demand for spectrum. As it was foreseeable that the opportunity cost of the spectrum would change after fees were set, it would be possible that such reviews would result in a new transitional track, with a different end-level.

4.5 In addressing the latter recommendation, the RA/Ofcom undertook a full review in 2003/4, and we have now commenced the SRSP around five years later.

4.6 Smith NERA reflected that the then current cost recovery fee levels, in 1996, were so low as to be generally considered as de minimis, and suggested a number of revised fee levels. Smith NERA, in the main, recommended significant increases across a number of sectors. However, Smith NERA also concluded that:

“Even if spectrum pricing appears to be desirable, it may not be worth the effort of attempting to estimate appropriate prices or conducting an auction for applications which use very little spectrum”.

4.7 It is worth noting the levels recommended by Smith NERA in 1996. These recommended fee increases were not however implemented in full by Government (see paragraph 4.11).

Table 3.1: Smith NERA’s suggested Initial Prices for Mobile and Fixed Link Bands (1996)

<table>
<thead>
<tr>
<th></th>
<th>Then current licence fee (£s)</th>
<th>Marginal Values (£s)</th>
<th>Initial Prices (£s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMR/CBS(^i)</td>
<td>140</td>
<td>550</td>
<td>280</td>
</tr>
<tr>
<td>PAMR(^ii)</td>
<td>2,000</td>
<td>17,000</td>
<td>4,300</td>
</tr>
<tr>
<td>Cellular(^iii) (900 MHz bands)</td>
<td>28,800</td>
<td>325,000</td>
<td>77,000</td>
</tr>
<tr>
<td>PCN(^iii) (Cellular in 1800 MHz)</td>
<td>28,800</td>
<td>162,000</td>
<td>51,000</td>
</tr>
<tr>
<td>Fixed &lt; 15 GHz(^iv)</td>
<td>~ 700</td>
<td>5,300</td>
<td>1,800</td>
</tr>
</tbody>
</table>

\(^i\) PMR/CBS is for a shared 2x12.5 kHz channel, 10 mobiles, 25W, major urban area  
\(^ii\) PAMR is for a national 2x12.5 kHz channel. General public access systems such as Common Base Station systems (“PAMR”)  
\(^iii\) Cellular/PCN is for a national 2x200 kHz channel  
\(^iv\) Fixed links are for a 2x14 MHz channel in a high density area with transmitter power within current licensable specifications

Source: NERA/Smith estimates (April 1996)
**Table 3.2: Smith NERA suggested pricing levels for geographically congested areas (1996)**

<table>
<thead>
<tr>
<th></th>
<th>Mobile radio shared channel</th>
<th>Mobile Radio Shared Channel</th>
<th>Fixed Links</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major urban areas¹</strong></td>
<td>full price²</td>
<td>full price</td>
<td>full price</td>
</tr>
<tr>
<td><strong>Urban/Suburban areas</strong></td>
<td>50% full price</td>
<td>~10% full price</td>
<td>minimal price</td>
</tr>
<tr>
<td><strong>Rural areas</strong></td>
<td>minimal price³</td>
<td>minimal price</td>
<td>minimal price</td>
</tr>
</tbody>
</table>

¹ Major urban areas for mobile radio are London, Manchester and Birmingham whereas for fixed links they are London, West Midland, Manchester, Tyneside, Liverpool, Glasgow and Leeds.
² Note the value of the full price is different for each of mobile radio, shared and exclusive channels, and fixed links.
³ Minimal prices could be set at or even below current fee levels

*Source: NERA/Smith (April 1996)*

4.8 One early observation made by Smith NERA was that setting marginal values for the spectrum based on own-use opportunity cost necessarily produced differences between the values attributed to different services in broadly similar spectrum bands. At that time, both fixed links and mobile services operated in spectrum between 1 - 2 GHz (e.g. fixed links at 1.5 GHz and mobile cellular at 1.8 GHz). In the 1996 report, Smith NERA commented that the derived marginal value for mobile in 1-2 GHz was some 30 times greater than that established for fixed links in similar spectrum bands.

4.9 In light of this, and notwithstanding the initial approach of deriving own-use marginal value, Smith NERA recommended that the fee for fixed links in bands around 1-2 GHz be set at above the determined fixed link values concerned. This, they argued, would encourage a shift of fixed links to higher bands, which would in turn potentially release spectrum in the 1-2 GHz bands for mobile use. That is, without reverting to a management approach in which the regulator concluded definitively on the best use of the frequencies, they recommended a fee which would reflect a regulatory preference for such users to migrate out of particular frequencies, given the expectation that higher values could then be unlocked in alternative use.

4.10 The report also recommended major increase in fees for mobile cellular²⁵ use in both the 900 and 1800 MHz bands. The main rationale behind this recommendation was that the increasing popularity of mobile cellular, and the increasing use by existing operators, meant the band had an increasing marginal value. This, coupled with the fact that there were likely to be other potential operators keen to run services in these bands, meant the bands could be considered subject to excess demand.

4.11 In its consideration of this report, Government questioned some of the suggested licence fee increases for a number of the sectors. Even where phasing in of charges was to be undertaken, Government was concerned that the market would receive these rises (at least a doubling of fees in most cases) poorly. Furthermore Government felt that the rises would unnecessarily burden some sectors of the radio industry. Therefore, prior to the public consultation in 1997²⁶, Government reduced...

²⁵ For the purposes of this document ‘mobile cellular’ refers to TACS/ETACS and GSM use in the 900 and 1800 MHz bands.
the increases suggested by Smith NERA by half. Arguments against a full increase were that lower, but still noticeable, increases would allow industry to adapt and understand the implications of the change prior to any further increases.

4.12 It is important to bear in mind that we have since continued to develop AIP fees across a number of sectors from a base set by this general 50% reduction over 10 years ago. This generally reflects the assessment that the risks to optimal use posed by setting fees too high are more significant than those associated with setting them too low as setting them too high could result in the loss of existing services that are efficient in their use of spectrum, or the lack of new services that might otherwise have evolved if the spectrum was priced appropriately. As a result, almost all AIP fees have been below the corresponding estimates of full opportunity cost at the time (including those where there was no phasing or where the initial phasing period is now past). Nevertheless it was felt that this did not completely dilute the effect of AIP on those sectors affected, given that significant fee increases from very low bases were still implemented in many cases.

4.13 The results of the Smith NERA work and the subsequent views of Government led to various public consultations on Spectrum Pricing published over the period 1996 – 1997. These led to proposals, in a consultation document published in 1997 to phase in AIP over 3 years for the following sectors:

- Fixed Services (point-to-point links);
- Private Business Radio (including CBS use), and
- Public Mobile Communications (Cellular).

4.14 It is worth noting that, for the case of fixed links in the 1 - 2 GHz frequency range, the earlier Smith NERA recommendation for large fee increases was not followed. Again these were considered, by Government, to be too large, even where they were to be phased in.

4.15 A further consultation was held by the RA in September 1998, where they outlined their specific proposals for implementing AIP under the powers provided by the WT Act 1998. This continued to propose the approach outlined in the 1997 document, but focused on the phasing-in process for sectors (Public Telecommunication Networks, Private Business Radio and Fixed Links) while sustaining the general concept of an initial end-point of 50% of own-use opportunity cost. Generally speaking, this consultation drew qualified support from stakeholders. Notable exceptions to this were the large increases proposed for Public Access Mobile Radio (“PAMR”) services referred to as Common Base Stations (“CBS”), discussed below.

4.16 A number of sectors were expressly excluded by the RA from the proposed scope of AIP implementation at this initial stage (e.g. Broadcasting, Fixed Service other than Point to Point, Aeronautical, Maritime, Government users, Space Services etc.).

---


28 It should be noted that PAMR and CBS are a business radio licence classes that no longer exist. All business radio licence classes were reformed in December 2008. This lead to the consolidation of 24 licence classes into 3 broad licence classes.
4.17 At that time, a basic model was established to derive specific AIP licence fees, as shown below.

\[
\text{Licence Fee} = \text{[STU]} \times \text{[Bandwidth]} \times \text{[Area]} \times \text{[Modifier]}
\]

Where;

\[
\text{STU} = \text{Spectrum Tariff Unit, an average tariff per MHz of spectrum used. This average tariff was set at 50 per cent of the marginal values on which it was based.}
\]

\[
\text{Bandwidth} = \text{bandwidth in use}
\]

\[
\text{Area} = \text{geographical coverage area of the assignment}
\]

\[
\text{Modifier} = \text{modifier to the fee based on specific technical or commercial considerations}
\]

4.18 The spectrum tariff unit (or “STU”) was the main constant used to derive the overall fee for an individual licence. The variables, bandwidth and area, depended on the individual system that was to be licensed, and the fee would then be calculated according to the parameters submitted. These parameters would be unique to that licence, but would set the final fee to be charged. Therefore it was (and still is) possible to have varying licence fees for different fixed links even where they were operating within the same spectrum band.

4.19 The “modifier” factor was used for various purposes to reflect the particular circumstances of the spectrum being priced. It is worth bearing in mind that AIP priced spectrum constituted the minority (by volume) of licensed spectrum at the time, and there was very little direct market evidence of value. So AIP pricing was at a relatively early stage, methodologically.

4.20 One use of the “modifier” was to mitigate a perceived weakness of relying completely on estimates of own-use opportunity cost. For example, if the alternative technology was the same, or similar, for fixed-link use across various bands of spectrum, an own-use opportunity cost would assess those bands as having the same value, even when the observed likely alternative use value would be much higher in one band than another.

4.21 Another use made of the modifier was to take account of users’ own perceived short-term opportunity costs – to mitigate the risk of differential impacts arising from users’ different historic spectrum holdings, which had accreted over time within a non-AIP price framework. This is illustrated by the different fee schedules proposed for the mobile network operators, depending on whether they held “fragmented spectrum” or not; and even bespoke fee increase schedules which depended in part on when the licence had been granted.

4.22 Finally the modifier reflected the outcome of consultation in other respects. An example was the application of AIP to CBS systems. Historically these systems were popular where cellular networks were not as extensive and affordable as they are today. CBS systems were primarily maintained by companies that offered radio communications services to end users, which were mainly businesses that required...
radio contact with their employees over a wide area. A single CBS system would typically have a number of such companies taking service from that system.

4.23 The main reason for the large fee increases proposed by the RA in 1998 were that CBS assignments had been difficult to accommodate, due to a combination of the historical popularity of the service and the lack of useful service alternatives, which, in turn, led to high levels of congestion in the affected spectrum. However the 1998 proposals attracted negative comments from affected CBS system licensees and their associated trade bodies. In the event, modifiers were applied which lowered the fees from the levels originally proposed by the RA in 1998.

4.24 The modifiers were therefore used in an attempt to improve on the simpler own-use marginal values in terms of the signals that AIP fees sent to particular licensees, and the potential effects on users. However this approach was complicated and, in a traded and liberalised spectrum licensing context, would tend to make potential trade-offs harder for users to assess.

Implementation: AIP first wave

4.25 The basic AIP fee formula, with modifiers, was initially applied under the so called “First Wave”. Notable changes resulting from this were:

- major fee increases for the mobile cellular operators from 1999. Prior to this, the fees paid by these operators had been, pro rata, lower than those paid by some private business radio users;

For example:

<table>
<thead>
<tr>
<th>900 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1800 MHz Fees (for licensees who also had access to 900 MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1800 MHz (for other licensees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2001</td>
</tr>
</tbody>
</table>
For a period of time the 1800 MHz fees were split, between those operators who only had access to 1800 MHz GSM spectrum and those who also had access to 900 MHz. The main reasons were modifiers applied to the fee calculation (e.g. fragmented spectrum).

- changes to an existing licence class, on-site private users, which led to a reduction in fees for thousands of small business radio users in un-congested areas (i.e. £120 down to £75).

4.26 The RA actively engaged the then-existing mobile operators prior to implementing these increases, and although the operators expressed concerns, the fees were implemented as proposed by the RA. A detailed graphical breakdown of the fees paid by the four mobile operators (in 900 and 1800 MHz) now, and prior to the new approach, is given in Annex 2.

**Implementation: AIP second wave**

4.27 The Government then announced that the “Second Wave” of AIP would continue to re-adjust fee levels for public mobile operators (not just mobile telephony) and extend AIP generally to private business radio and point to point fixed links (i.e. those used for public telecommunication infrastructure). These were identified as licence classes where spectrum congestion was worst and where AIP might have the most effect.

4.28 The RA’s “Second Wave consultation in 1998” followed on from the 1997 consultation paper, and addressed how fees could be calculated for each class, and how any significant fee increases could be phased in over a number of years, rather than by a single stage process. There followed further consultations held in September 1999 and December 2000 following which the phasing in was implemented.

**Table 3.3: Phasing-in periods for licence classes, proposed in 1998**

<table>
<thead>
<tr>
<th>Licence Class</th>
<th>Phasing –in Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Links</td>
<td>4 Years</td>
</tr>
<tr>
<td>Cellular Radio</td>
<td>3 Years</td>
</tr>
<tr>
<td>Common Base Stations (“CBS”)</td>
<td>3 Years</td>
</tr>
<tr>
<td>Public Access Mobile Radio (“PAMR”)</td>
<td>3 Years</td>
</tr>
</tbody>
</table>
Policy evaluation report: AIP

Section 4

Extending Pricing and Cave Review

Cave Review

5.1 Following these initial staged implementations of AIP, the Government commissioned an independent review of spectrum management. This review was undertaken by a team led by Professor Martin Cave (the “Cave Review”) and the report was submitted in March 2002. The report recommended that greater use should be made of auctions and pricing to allocate spectrum and in particular recommended that:

- AIP should be applied at more realistic levels and more comprehensively across spectrum uses; and
- where AIP was already implemented and there is continuing evidence of spectrum shortage, prices should be set at full opportunity cost level.

5.2 The Government published its response in October 2002. The Government broadly agreed with the findings of the Cave Review. On AIP, the Government concurred that it would be timely to review the model and the methodology for valuing spectrum and for setting fees. The Government also agreed that the MOD should bear the full opportunity cost of spectrum with comparable tariffs as apply to commercial use.

Indepen report – own and alternative use opportunity cost

5.3 In order to update Smith NERA’s original spectrum valuation work, the RA commissioned a study in 2003 led by Indepen and which included Aegis and Warwick Business School. This study was subsequently completed and the final report delivered to Ofcom (which succeeded the RA before the report was finalised) in early 2004.

5.4 Indepen was asked to consider which types of spectrum use should attract AIP, to review and make recommendations about the methodology used, to provide illustrations of how the methodology could be applied, and to comment more widely on the use of spectrum pricing.

5.5 Indepen largely accepted the validity of the original Smith NERA approach. However, Indepen also widened the opportunity cost methodology, by recommending that estimates of the value of spectrum should reflect alternative uses in addition to the existing use in the spectrum band. Indepen's report also recommended the application of AIP to an increasing range of spectrum uses, and provided a new set of illustrative values for setting AIP based fees.

Figure 4.1: Comparison of marginal values determined by consultants’ work in 1996 and 2003, and the fees currently in force (for 2x1 MHz, UK National)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellular (900 MHz bands)</td>
<td>£1.63m</td>
<td>£1.68m</td>
<td>£0.71m</td>
</tr>
<tr>
<td>PCN (Cellular in 1800 MHz)</td>
<td>£0.81m</td>
<td>£1.68m</td>
<td>£0.55m</td>
</tr>
<tr>
<td>PMR</td>
<td>£1.75m</td>
<td>£1.24m</td>
<td>£0.79m</td>
</tr>
<tr>
<td>PAMR*</td>
<td>£1.36m</td>
<td>£1.27m</td>
<td>£0.79m</td>
</tr>
</tbody>
</table>

* The rate applied to the Emergency Service use in 380-400 MHz is discounted and therefore results in a fee rate equivalent to £0.66m for every 2 x 1 MHz Nationally.
Source: an Economic Study to Review Spectrum Pricing, Indepen, Aegis Systems and Warwick Business School

5.6 More recently within Ofcom, we have further extended and reviewed AIP for a number of licence classes. This is broadly within the scope of the recommendations outlined in the Indepen report of 2004:

- Ofcom managed Fixed Point to Point Links (further reviewed in 2005);
- Satellite Earth stations (two stage implementation in February 2008 and February 2009); and
- Certain Business Radio licence classes (implemented December 2008).

5.7 Further, in March 2006 the Government accepted the recommendations of the 2005 Cave Independent Audit of Spectrum Holdings conducted by Professor Martin Cave (the “Independent Audit”) that endorsed AIP, including for the public sector, and recommended its extension to a wider range of public sector spectrum bands and uses. The Government also confirmed its support for the principle that pricing for public sector spectrum should be set on a comparable basis to the private sector.

5.8 In addition we are progressively developing plans and proposals to extend the implementation of AIP to other sectors:

- In 2007 we confirmed our intention that the spectrum used by Digital Terrestrial Television (“DTT”) and Digital Audio Broadcasting (“DAB”) multiplexes should attract AIP from 2014;
- In July 2008 we set out initial proposals to introduce AIP for spectrum used by the Aeronautical and Maritime sectors following another of the recommendations of the Independent Audit;

---

* http://www.ofcom.org.uk/research/radiocomms/reports/independent_review/spectrum_pricing.pdf
• In July 2008 we also began a process of consulting on the implementation of AIP-based fees for the proposed Band Manager to be awarded spectrum as an outcome of the Digital Dividend Review; and

• The up and coming UK licensing of Complementary Ground Component (“CGC”) systems at 2 GHz required us to consider the fees for this spectrum, as it must be awarded in line with the European selection and authorisation process for Mobile Satellite Service (“MSS”) that was recently undertaken.

5.9 As a result we currently have a large portion of spectrum and users either already subject to AIP, or proposed to be in scope of AIP as illustrated in Figure 4.2, below.

Figure 4.2: AIP across different service sectors (for 30 – 3300 MHz)

AIP Levels

5.10 Where users gain access to spectrum on a national basis, fees reflect that national coverage potential. Below is a comparison of charges set for national coverage spectrum, across a variety of licence classes, and the sums paid for use by the MOD.

---

34 Complementary Ground Component – A terrestrial radio network which forms an integral part of a Mobile Satellite System and uses the same frequencies, in the same direction as the satellite component.


36 This has been weighted such that a 1MHz allocation at 100MHz is given equal weighting to a 10MHz allocation at 1GHz.
Table 4.3: Equivalent AIP rate for a 2 x 1 MHz national channel

<table>
<thead>
<tr>
<th>User/Licence Class</th>
<th>per annum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Wireless Networks (2G Cellular) in the 880.0-960.0 MHz band</td>
<td>£712,800</td>
</tr>
<tr>
<td>Public Wireless Networks (2G Cellular) in the 1717.0-1880.0 MHz band</td>
<td>£554,400</td>
</tr>
<tr>
<td>Business Radio (GSM-R Railway use in 900 MHz)</td>
<td>£792,000</td>
</tr>
<tr>
<td>Business Radio (Public Wide Area Paging) in the 137-172 MHz, 449-470 MHz or 870-871 MHz</td>
<td>£792,000</td>
</tr>
<tr>
<td>Ministry of Defence use of bands in the range 960-1452 MHz</td>
<td>£593,400</td>
</tr>
<tr>
<td>Ministry of Defence use of bands in the range 2245-3100 MHz</td>
<td>£473,800</td>
</tr>
</tbody>
</table>

* Note: The published AIP rate and reference bandwidths are not the same in all cases therefore an equivalent AIP rate for a 2 x 1 MHz national channel has been calculated
Section 5

Other spectrum market developments

Introduction

6.1 In this section we discuss the relevance of other parallel spectrum market developments to the impact of AIP over recent years. As set out in our Spectrum Framework Review\(^\text{16}\), AIP was retained as a complementary market-based incentive mechanism, alongside the increased use of market allocation mechanisms – auctions and trading – to optimise the use of spectrum. It is therefore relevant to understand the extent to which AIP and other market mechanisms have served to complement each other, and how the market prices that can be indicated by these other allocation mechanisms relate to AIP. Both issues are discussed below.

Relationship between AIP and Auctions and Trading

6.2 Since 2000, spectrum auctions have been the regulator’s preferred method of making significant quantities of unused spectrum available to the market. In particular, the major “3G” auction of spectrum at 2100 MHz was undertaken in 2000 by the RA. Since the establishment of Ofcom (in late 2003), there have been five spectrum auctions, as shown below\(^\text{37}\).

Table 5.1: Spectrum Auctions held by Ofcom (since 2004)\(^\text{38}\)

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>Date</th>
<th>Auction Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>1781.7-1785 MHz/1876.7-1880 MHz</td>
<td>April 2006</td>
<td>Sealed Bid</td>
</tr>
<tr>
<td>412-414 MHz/422-424 MHz</td>
<td>October 2006</td>
<td>Sealed Bid</td>
</tr>
<tr>
<td>1785-1805 MHz (Northern Ireland only)</td>
<td>May 2007</td>
<td>Sealed Bid</td>
</tr>
<tr>
<td>10, 28, 32 and 40 GHz</td>
<td>February 2008</td>
<td>Combinatorial Clock</td>
</tr>
<tr>
<td>1452-1492 MHz (L Band)</td>
<td>May 2008</td>
<td>Combinatorial Clock</td>
</tr>
</tbody>
</table>

6.3 These competitively awarded licences are not subject to AIP during their initial term. In addition, the licences competitively awarded since the establishment of Ofcom can be traded. Further, at the end of 2004, spectrum trading was also introduced for a number of existing licence classes.\(^\text{39}\). Consequently, both auctioned and some non-auctioned licences (the latter generally subject to AIP) may be traded. The number of

---

\(^{37}\) A sealed bid award is one run over a single round where participating parties place a valuation on the spectrum lots on offer. The successful party is the one that places the highest valuation as their single participating bid. Dependant upon the auction design (i.e. lots on offer and/or licences to be awarded), the 2nd pricing rule may be applied (i.e. the winning party pays the 2nd highest valuation). The combinatorial clock auction differs from a sealed bid in that the auction is held over a number of rounds rather than just a single one. This is a more complex auction design, but is used because it allows participants to bid on differing combinations of spectrum lots, over a number of rounds, where those lots are potentially complementary.

\(^{38}\) Excludes two awards of geographically constrained interleaved spectrum as part of the Digital Dividend, where competing bids were not received.

\(^{39}\) Spectrum Trading has been facilitated across a variety of licence classes in a number of spectrum bands, for example; Fixed and Broadband Wireless Access, Fixed Links. Trading is currently being phased in across the remaining licence classes and is permitted for all spectrum awarded through auction since 2004.
licensure classes that can be traded continues to increase, with certain remaining Business Radio licence classes made tradable in December 2008.

6.4 Following these initiatives, there has been some limited trading, although the number of transactions remains comparatively low at present relative to the overall number of tradable licences. For recently auctioned licences, the bulk of the expected efficiency benefits associated with the licensed use of the spectrum concerned are likely to have been reflected during the bidding in the relevant award. Awarding spectrum by auction seeks to ensure that the spectrum is acquired by those who value it the most. Bidders assess their own value for spectrum in light of their commercial (market) information and technical information we publish before the auction.

6.5 In practice, the evaluation of whether AIP succeeded in recent years in complementing the other market mechanisms in securing optimal use of the spectrum, by incentivising efficient trades and surrenders in this way, is difficult. This is not least because there is no comparable base case period to observe (when an equivalent level of spectrum release and trading was enabled, but without AIP). Nevertheless some general observations on this question are made below.

Spectrum Award outcomes and AIP

6.6 Tables 5.2 and 5.3 below compare the basic annual cost per MHz associated with two spectrum awards by Ofcom with broadly equivalent bands where AIP fees are applied. Where there is significant competition for spectrum in an award, the value reflected in an auction payment based on a “second price” rule should, all other things being equal, equal the marginal commercial value of the spectrum over the assessed life of the licence concerned. Spectrum trading values are not disclosed to Ofcom by the affected parties, and therefore we cannot examine and compare trading prices in this evaluation.

Table 5.2: Spectrum at around 400 MHz which could be used for PAMR services

<table>
<thead>
<tr>
<th>Awarded Spectrum in 2006</th>
<th>Total Bandwidth awarded (MHz)</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>412-414 MHz paired with 422-424 MHz</td>
<td>Fee paid at award</td>
<td>£1,500,025</td>
</tr>
<tr>
<td></td>
<td>Annualised price £k per MHz/year - 15 year term</td>
<td>£49k</td>
</tr>
</tbody>
</table>

| AIP Comparator | National UHF channel (2 x 12.5 kHz) AIP rate per year | £9.9k |
|                | AIP price £k per MHz/year | £396k |

Table 5.3: Spectrum around 27 GHz which could be used for FWA and cellular backhaul services

40 The competitively awarded element; this is annualised from its initial 15 year term to at 10% cost of capital (assuming no residual value after the initial term) to derive a per annum rate, and then divided by the total spectrum available. AIP equivalent; the rate here is already a per annum rate, but this is simply multiplied by the ratio required to place the spectrum amount into a per MHz figure.
6.7 From Tables 5.2 and 5.3 above, the AIP fees/MHz (on an annualised basis), generally, differ significantly from those paid by the winning bidders in recent spectrum awards for spectrum of similar frequency. Ofcom considers that these differences are the result of a range of factors, and that no general conclusions can be drawn from a simple comparison of auction values and AIP fees. In particular, differences between auction values and AIP fees may reflect:

- differences between the value of spectrum in the developed bands where AIP is typically paid, and the marginal value of auctioned spectrum, which is typically only available when new or developing uses for it are coming onto the market;

- the need for the bidders for spectrum acquired at auction to take into account, and effectively net off their bids, the associated costs of any spectrum management then required to ensure its productive use (e.g. coordination of multiple geographic assignments within national frequencies);

- the impact of underlying differences specific to individual awards and bands, such as network roll-out periods, future growth in use values, whether use is Liberalised at the time of award, and assumed terminal values of licences;

- the fact that observed auction prices may reflect option values or the existence of market power in the downstream market for services, none of which is reflected in AIP fees;\textsuperscript{42}

- differences in auction design and the impact of spectrum packaging, activity and price rules (such as second price rules) on bid behaviours in each case;

- differences in the licence conditions attached to spectrum (for example the different technical conditions attached); and

- intermediate fluctuations in underlying market conditions and technologies available at different times, which AIP, as a longer term signal using a variety of evidence of prospective demand in the long term, is only intended to reflect through less frequent reviews.

\textsuperscript{41} Correct as April 2008

\textsuperscript{42} An option value refers to the value that the user attaches to the option to use spectrum or trade it in future.
6.8 On a practical level, the comparison of annual AIP rates with auction outcomes requires the annualisation of auction bids, which implies a need for third parties to make speculative assumptions over bidders’ own costs of capital and option values (for the potential term of licences beyond the initial term).

6.9 Notwithstanding these caveats, various illustrative comparisons of this type can be made, and have been noted by affected stakeholders (including licensees paying AIP) underpinning views that particular AIP fees have not been representative of recent market valuations of spectrum and need to be revised.

6.10 However, while in principle it is helpful to understand the potential bases of differences between AIP levels and auction values, and this understanding will be relevant for our future pricing policy work, direct comparisons between particular individual historic auction outcomes and AIP rates are very unlikely to be robust for the reasons set out above. This is particularly true for this evaluation, when only a few relevant auction value points can be identified. For these reasons we do not believe that AIP fee rates can be directly compared with annualised fees paid for competitively awarded spectrum in recent auctions when evaluating the impact of AIP at this stage.
Section 6

AIP Implementation process

AIP Implementation – the regulatory process

7.1 As indicated in Section 1 we have also evaluated whether the processes used to introduce AIP have been in line with good regulatory practice.

7.2 Since 2004, Ofcom has continued the implementation of AIP that was started by the RA. As discussed above, the RA consulted before introducing AIP fees, and took account of stakeholders’ views. In line with our regulatory principles and our Consultation Guidelines, we also have consulted widely with all relevant stakeholders before introducing significant fee changes.

7.3 A typical project to introduce a fee for a band or licence class, or to make major changes to the level of existing fees, will involve:

- At least one policy consultation stage;
- Publication of any consultants’ reports commissioned to inform our policy, or any specific part of the consultation (e.g. the Impact Assessment); and
- Following the determination of policy through a policy statement, a statutory consultation on the Regulations needed to implement the fee change.

7.4 To date, the processes by which the fees for a number of licence classes have been set according to AIP have taken anything from 1 to 3 years to complete, from our first declaration of our intention to set AIP fees through to the final publication of fees regulations. A detailed breakdown of the process timelines for these licence classes is illustrated in Annex 4.

7.5 The varying time requirements on each project reflect a combination of:

- Technical or analytical complexity;
- The impact of spectrum pricing changes on affected stakeholders;
- Co-ordination/recognition of other milestones and/or previous commitments (which can include the completion of other planned changes to the management of a band or licence class, the most obvious being in relation to the UHF spectrum used for analogue and DTT, where in consequence of the ongoing Digital Switchover programme which will change the use of spectrum, we are committed not to charge for the existing multiplexes’ spectrum before 2014); and
- Resource constraints, where in parallel there is a need to progress, and determine the respective priorities of, other policy initiatives of significant benefit to citizens and consumers (e.g. major awards or Liberalisation of existing licences).

---

AIP Implementation – assessment

7.6 Unsurprisingly, to date stakeholders have expressed some general concerns around the long timelines that the above factors can create for the delivery of our AIP policy changes. Nevertheless we have not ourselves identified significant concerns regarding citizen or consumer harm, nor received evidence of fundamental issues to address, in regulatory process terms, such as a need to remove or shorten particular stages, or to add additional ones, in the case of specific major pricing policy changes.

7.7 However, with AIP now already implemented for the first time in many cases, we have begun to move into a period where the focus of work shifts towards the review of existing AIP rates and structures, rather than introducing new ones. In such an environment, particularly where there could be evidence that rates should be reduced, there may be stakeholder interest (and citizen and consumer benefit) in our implementing more rapid processes than we have be able to follow in the past.
Section 7

AIP Effects

Effects – In general

8.1 The use of AIP spectrum pricing principles has now been in place since 1998, and in the main, it has led to fee increases across the majority of affected licence classes. The cost recovery model it superseded did not reflect the actual value of the spectrum, and so it did not provide signals for users to take decisions on the efficient use of spectrum, because the cost of different frequencies were not related to their different value nor, often, to how much spectrum was held.

8.2 Increasingly, market-led decisions have started to influence who holds spectrum, as intended by our market-led approach to spectrum management policy, within which AIP has been an important component, along with auctions, trading and liberalisation. Spectrum that is currently unused and therefore available for new uses is generally auctioned and many licences are now tradable. Both auction winners and licence buyers in the secondary market are facing prices for their spectrum derived from either the revealed value placed on it by other bidders or via traded prices. So in the years since Ofcom was created, a growing proportion of spectrum holdings, and spectrum use, has been determined by users taking into account the value of the spectrum as well as the costs of all other inputs required for (public or private) service provision.

8.3 From the anecdotal evidence and stakeholder feedback we have gathered, it appears that the use of AIP has improved information for all users and potential users on the value of scarce spectrum during the early transition to a market-based approach to spectrum allocation. By way of example, there is anecdotal evidence that potential award participants take into account the likely AIP fees on spectrum that is substitutable for the award spectrum.

Effects – existing licensees

8.4 As noted in Section 1, one apparently simple way to measure the aggregate effectiveness of AIP would be to observe whether spectrum in bands where AIP had been introduced had, overall, less excess demand as a result (e.g. from fewer new users seeking access and being denied it, and/or more existing users migrating to cheaper bands). However, we recognise that:

- As noted, the initial phase of AIP implementation has seen licence fees which are, in general, below our assessment of relevant opportunity costs, so the incentives for changes in spectrum use will be muted, except for the most marginal (and hence, with excess demand, uneconomic) users of the frequencies concerned;

- As noted above, users may need time to respond to AIP signals given that spectrum is used in combination with band-specific equipment that have long lifetimes. Changes in spectrum use may only be observed over periods longer than the ten years that have elapsed since AIP was first introduced in some sectors;

- Over the time period reviewed, only a limited amount of spectrum has been returned to Ofcom and so could potentially have been reassigned. Further to this,
reassignment to new uses, rather than to more users for the same use, may require spectrum first to be surrendered in amounts that can be re-aggregated, for example if the new use has different geographical or bandwidth requirements. So while existing users may change their frequencies relatively quickly, the transition of the surrendered spectrum to new uses – the second element of improving the efficient allocation of spectrum – may often take a longer time;

- Where change of use does actually happen as a result of AIP, there may be no compelling external evidence to support the hypothesis that licence fee rates were the sole or even the major drivers of observed changes. However, it can be assumed that significant fee changes are likely to be at least one of the relevant factors in a number of observable spectrum use decisions.

8.5 For these reasons, as noted in Section 1, we acknowledge that illustrations of the aggregate demand effects of AIP (relative to other factors) might not be conclusive, due to the difficulties encountered in trying to identify such effects over short timeframes, and to isolate the role of AIP relative to other factors.

8.6 Further, the same difficulties are also relevant to assessing the effects of recent AIP implementations on specific existing spectrum holders. However, we set out in Table 7.1, and discuss in the paragraphs below, some illustrations where there appear to be strong temporal (and hence potentially causal) associations between the introduction of AIP and spectrum holding decisions.

Table 7.1: Spectrum releases since 2004 that might be linked to AIP (Source “Ofcom - Spectrum Framework Review of the Public Sector – July 2007”)

<table>
<thead>
<tr>
<th>Original user</th>
<th>Change</th>
<th>Bandwidth</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOD 44</td>
<td>Release of 2290–2300 MHz</td>
<td>10 MHz</td>
<td>2004</td>
</tr>
<tr>
<td>MOD</td>
<td>Release of 8400–8500 MHz</td>
<td>100 MHz</td>
<td>2004</td>
</tr>
<tr>
<td>Commercial</td>
<td>Release of spectrum at 10 GHz</td>
<td>60 MHz</td>
<td>2004</td>
</tr>
<tr>
<td>Commercial</td>
<td>Release of spectrum at 410-415 420-425 MHz</td>
<td>10 MHz</td>
<td>2004</td>
</tr>
<tr>
<td>Radio astronomy</td>
<td>Release of spectrum at 37.75-38.25 MHz</td>
<td>0.5 MHz</td>
<td>2007</td>
</tr>
<tr>
<td>Radio astronomy</td>
<td>Remove constraints on active services at 150.05-152 MHz</td>
<td>2 MHz</td>
<td>2007</td>
</tr>
<tr>
<td>Radio astronomy</td>
<td>Remove constraints on active services at 80.5-82.5 MHz</td>
<td>2 MHz</td>
<td>2007</td>
</tr>
<tr>
<td>Radio astronomy</td>
<td>Release of spectrum at 10.60-10.68 GHz</td>
<td>80 MHz</td>
<td>2007</td>
</tr>
<tr>
<td>Radio astronomy</td>
<td>Remove constraints on</td>
<td>300 MHz</td>
<td>2007</td>
</tr>
</tbody>
</table>

44 Note that MOD releases took place before MOD became liable for payments under the Government agreement, but after the agreement was struck in principle – HMT and MOD agreed an incentive structure in the CSR that targeted certain bands for release, against the background of an agreement MOD would pay.
active services at 31.5-31.8 GHz

| Police in Scotland | Release of non-contiguous spectrum in 450-462.5 MHz range | 1 MHz | 2007 |

Radio Astronomy

8.7 Recent changes in use by Radio Astronomy have the strongest probable link to AIP. Prior to the introduction of AIP for Radio Astronomy, fees were set to cover administrative costs only. The fees reflected a calculation linked to the amount of spectrum used and cost attributed to the administrative overhead (e.g. regulator attendance at international meetings addressing Radio Astronomy interests and general administrative servicing etc.). The nature of individual spectrum allocations was not explicitly linked to the fees.

8.8 Since AIP and through the application of RSA, it has been far easier for the Radio Astronomy community to identify the value of individual pieces of spectrum they have access to. As total annual spectrum holding costs were set to rise from around £350k to some £1.4m, spectrum in various bands was returned. This has resulted in prospective fee savings of over £500k for the Radio Astronomy community. Also, the return of some spectrum enabled the removal of some legacy technical limitations imposed on the spectrum, thereby increasing its value for alternative uses.

8.9 Similarly, we have recently been able to consult on a proposal to allocate channel 38, as an alternative to channel 69, to the band manager being awarded spectrum with responsibilities towards PMSE users as part of the Digital Dividend process. In our consultation we assessed the benefits to citizens and consumers of this proposal to clear channel 69 of existing PMSE use to be over £1bn.

8.10 That proposal was only enabled by the prior decision of the Radio Astronomy community to cease the use of channel 38 before the completion of Digital Switchover in the UK. This decision was taken with an awareness of the economic value of the particular frequency concerned (which is signalled via AIP where the spectrum is not auctioned). Accordingly, limited changes of frequency use of this type, which the incentive framework is aimed at encouraging, can have major benefits for citizens and consumers.

Emergency Services use of UHF spectrum in Scotland

8.11 The return of UHF spectrum by one of the emergency services in Scotland may plausibly also have its roots in AIP. Since the introduction of AIP for the emergency services in 1998-99, one of the Scottish emergency services have returned individual channels to the regulator. The roll out of the Airwave system, to support the emergency services throughout the UK, has enabled some to re-assess their spectrum requirements in the knowledge there was a readily available alternative, and identify spectrum holdings where the incremental value (given the available alternative) had fallen below the financial cost of continuing to hold the spectrum concerned.

---

45 Airwave – project commenced in the mid 1990’s to replace the UK police analogue radio network with a digital one. As this was on different frequencies to those used by the analogue service. The Airwave service is licensed by Ofcom and is subject to an AIP fee.
Fixed link use of the 4 GHz band

8.12 We have also seen the decommissioning of fixed point to point links in the 4 GHz band. These links had arguably become highly inefficient in spectrum use terms when compared with readily available alternatives. Generally speaking, these legacy fixed links occupied nearly 4 times the amount of spectrum required by broadly equivalent alternative technologies in this and other point-to-point bands.

8.13 AIP was introduced for fixed links in 1998 but initially using a simple approach based on the results of the original Smith NERA work in 1996. The fees applied to the fixed links ranged from around £925 per link to £3600 over the period from 1998 to 2005. From 2005, following a review, licence fees for these links were increased, and ranged between £8000 and approximately £32,000.

8.14 While link decommissioning had been occurring since around 1999, the rate accelerated noticeably from 2004/5 when the revised AIP fee structure was being finalised and implemented. Fixed link users’ use of alternative technology since then has released spectrum in the band concerned for alternative uses (including for Broadband Wireless Access) and users, for whom alternative spectrum or technologies may not be available or may be more expensive. Ofcom has been able to lift restrictions on the licensing of lower frequency spectrum, which had previously been used to ration excess demand for it administratively and for demand to subsequently be managed via market signals.

8.15 Once again therefore, a spectrum price which signalled that the value of decommissioning (and avoiding AIP) exceeded the costs of the alternatives was potentially useful in encouraging efficient marginal decisions to decommission and surrender spectrum, particularly in a band where bilateral spectrum trading decisions are rendered less easy to make, given Ofcom’s current role in managing the band concerned. Nevertheless, such a decision may well also have been affected by the particular age of the inflexible equipment (so that sunk costs had become relatively low). This observation underlines that, despite its potentially important contribution at the margin, AIP is unlikely to be the sole, or sometimes even predominant, driver of business decisions by existing spectrum holders.

CBS licences

8.16 For other examples of observed changes in spectrum use, it is more difficult to draw a robust inference in terms of a specific direct short-term causal link between such changes and AIP. For example, as noted in section 5, AIP was first applied to CBS licences in 1999. While these licences are available in a number of frequency bands, the 160-175 MHz band, also used by private radio users such as taxis, couriers, security companies, etc, has proved the most popular.
The graphic above shows the reduction since 1997 in the number of licences issued for individual CBS systems, so that last year they were around 50% of peak levels. These CBS licences are annually renewable with an indefinite term. In the year prior to AIP implementation, the annual licence fee was a flat £675 for the most common service using a duplex 12.5 kHz channel. Following the introduction of AIP, the equivalent annual fee in a heavily congested area rose to £1200. Since then the AIP fees have, on average, reduced in real cost terms.

We do not have evidence as to the specific impact of AIP fees on licence demand in this period. More important drivers of the licence reductions were likely to have been parallel changes in the telecommunications market in this period. Since 1998 there have been very substantial increases in the use of mobile cellular systems by the businesses concerned. Hence the most important driver of the observed reduction in the demand for CBS licences is likely to have been the increased availability of low cost mobile telephony services.

CBS licensees have made this very observation to argue for reductions in their fees, on the basis that the value of the service is effectively driven by the costs and quality (convenience, flexibility and reliability) of mobile telephony substitutes.

However, as with the previous fixed links example, regardless of the relative impact of different drivers (including AIP), there is no specific reason to conclude that the changes to date have been inefficient, with the implication that the spectrum used by all the affected users – both those continuing with CBS and those switching technology – should still be efficient. Users switching technology will have moved to more efficient use (given their requirements), while remaining CBS users will have adjusted their activities over time in response to various input cost changes (including spectrum fees).

Mobile Cellular

AIP for mobile cellular services was introduced in 1998. A graphical representation of the fee development over time is shown in Annex 2. Over the time that mobile cellular services have been in existence, the only major technical transition that has
affected fees has been the move from the initial analogue cellular network to the more efficient digital GSM network.

8.22 This analogue to digital transition was only applicable to the two initial mobile cellular operators\textsuperscript{46}. During this transition, the fees levied on the licensees\textsuperscript{47} for both GSM and analogue use were independently adjusted to encourage the use of GSM in preference to the less efficient and legacy analogue system. But whether the fees differential was a major influencing factor in driving the way in which that change was managed in the UK is now difficult to judge definitively, as a large number of other major changes were occurring in the market as well (not least competitive entry using digital technology).

8.23 There are other factors to consider, notably the general improvement in the technologies. The changes from analogue to GSM internationally, in terms of development of the technologies and the emerging regulatory framework, probably had significantly greater weight on how spectrum was used in these bands than the use of AIP.

8.24 Looking at the operators that only have access to the GSM 1800 MHz band, over time there has been a huge increase in the number of systems and users so that saturation of the GSM market may now have occurred. Here, a key achievable efficiency effect from spectrum pricing in the past (in advance of Liberalisation to facilitate choice of technology and service) might have been encouraging investment in utilisation of the spectrum, to enable increases in the numbers of citizens and consumers benefiting from early access to GSM services, such as has occurred. Again, however, it is very difficult to ascribe particular impacts specifically to AIP, particularly as post-GSM technology and investment has begun to dominate future industry decisions.

**Historical impact of AIP on spectrum utilisation**

8.25 In the illustrative examples above, we reviewed evidence where AIP could have contributed positively to optimal spectrum use including:

- encouraging changes to the use of a band when the relevant spectrum market was immature – as in Radio Astronomy and, potentially, CBS (though additional factors might have played a role in relation to CBS);
- reducing inefficient excess demand where use in a band could not economically be easily changed via direct market trading – as in Fixed Links bands; and
- encouraging efficient investment where licences were not easily tradable – as in historically in the GSM bands.

8.26 However, we also need to examine any evidence where AIP has led to short-term reductions in spectrum demand so that spectrum was left underutilised, where alternative use is only possible in the longer term, if at all. In such cases, AIP would potentially have reduced the short-term efficiency of spectrum allocation which, if persistent, could have negative consequences for citizens and consumers.

8.27 However, unless the relevant vacated spectrum was be made available for other users within a reasonable timeframe, the simple observation that reductions in

\textsuperscript{46} Racal Vodafone and BT Cellnet
\textsuperscript{47} Now Vodafone and O₂
licences have occurred may not imply that the new situation is further from or closer to optimal spectrum use. In this (and other bands), both international and domestic regulatory constraints over changing spectrum use, and/or private transactions costs, may have result in a temporary period when some spectrum was left unutilised until an alternative use in the band was effected.
Section 8

Final Conclusions and Observations

9.1 In Section 1 we explained that ensuring the optimal use of spectrum is the central objective of our market-based reforms to spectrum management, of which AIP is a “key” element, though being complementary to auctions, trading and liberalisation:

9.2 In addition to reviewing whether the implementation of AIP policy has achieved this objective, we have reviewed the process by which AIP has been introduced and noted that, while this regulatory process can typically be lengthy and involve gradual phasing in of AIP fees, this has generally been the result of following wider regulatory policy practice and a conservative approach to fee changes, to mitigate the risks of transitional disruption to affected spectrum use.

9.3 In Section 1 we also indicated that, based on the evidence available, it would be difficult in practice to infer whether the introduction of AIP – both from its first inception by the RA in 1998, and more recently its extension by Ofcom since 2004 – had played a predominant role (compared to other potential causal factors) to meet this objective, particularly in view of the time required for users to alter their spectrum use and of our conservative policy in setting AIP fees.

9.4 We have however set out in this document a summarised history of the implementation of AIP and parallel and complementary spectrum market mechanisms, and then examined some illustrative examples where AIP may plausibly have contributed to material improvements in the efficient allocation and use of spectrum, even if it was not their sole or even primary cause.

9.5 Using these examples, we can conclude that AIP is, as a minimum, likely to have contributed to our wider policy objectives in the following situations:

- Where potential excess demand for alternative uses of spectrum is significant but secondary market trading mechanisms are not yet sufficiently mature to secure efficient reallocation: we cited the example of Radio Astronomy where, in response to AIP signalling the value of spectrum in alternative use, a decision to surrender spectrum has been taken. This has enabled us (in the case of channel 38) to propose a new primary award, which is expected to produce highly valuable benefits in terms of new services;

- Where the nature of the current use of spectrum requires the coordination of multiple users sharing frequencies, and the costs that would arise if multiple parties attempted to trade with each other directly would be prohibitive, limiting the ability of a trading environment to lead to more efficient allocation of the spectrum: we cited the example of fixed links’ use of the 4 GHz band where AIP may have stimulated or accelerated the replacement of legacy equipment and technology to enable more efficient spectrum use, and also enabled us to remove administrative restrictions previously used to manage excess demand;

- Where sunk costs and/or regulatory restrictions on the alternative use of the band mean that changes of use are constrained and so, in the short to medium term, efficiency gains are limited to optimising utilisation in existing use: we cited the example of the 900 MHz GSM band where AIP may have encouraged utilisation and in any event does not appear to have discouraged widespread roll-out of the services concerned to citizens and consumers.
9.6 We also examined cases where AIP has been implemented in bands adjacent to those where it has not, and did not identify evidence that AIP has resulted in significant underutilisation of spectrum where it has been introduced. Given this, overall we judge AIP to have been a valid complementary mechanism to facilitate a market-based approach to spectrum, which has appeared to have met its core policy objective to ensure the optimal use of spectrum, as far as the available evidence can indicate. However, given that AIP is intended to provide longer term signals to sectors where development lead times and the economic lives of assets are long, it is quite simply “too soon to say” conclusively what relative contribution AIP has already made.

9.7 Furthermore, the environment in which users’ access and use spectrum has been continually changing over the period, and continues to change. For example, in the coming years, significantly more spectrum licences will explicitly be technology and service-neutral from the date of issue, and so may be more easily traded as well as more easily put to new uses. There remains a tension between sustaining consistent policies and signals over the longer term (to promote regulatory stability and encourage efficient longer term investment) and adjusting policy to reflect changes in market conditions.

9.8 The questions such known changes pose therefore need to be periodically re-examined in AIP policy and this is a core objective of the SRSP. In addition, the evaluation and previous external reviews have both highlighted more specific issues with the historic implementation of AIP which will also need to be examined in future fee reviews including:

- How to reflect opportunity costs in bands which can be used by more than one type of network – notably “fixed versus mobile” rates;
- How and when to reflect available market evidence (such as observed auction prices) in setting AIP fee rates; while such evidence relating to the evaluation period was not adequate for us to draw conclusions about past policy, this may change in the future in some cases;
- How close to expected “full opportunity cost” levels to set conservative AIP rates, given the fluctuations and uncertainties in market rates and the attendant risks of regulatory failure;
- How to reflect the principle of technology-neutral licensing in AIP for bands where value is driven by technology-specific factors (such as the modifiers in fixed links bands);
- How to identify Ofcom spectrum management costs within AIP fee structures in an environment when commercial band managers could emerge; and
- How to measure the success of AIP in meeting its objectives in the future.

9.9 Overall therefore we consider that the application of AIP has so far complemented other policies designed to secure the optimal use of spectrum as it was intended to do. Its cautious introduction to date was based on the presumption that, in spectrum markets where there were good grounds for expecting some ongoing market failure, it provided superior incentives to administrative cost-based pricing in encouraging the optimal use of spectrum. Future reviews will be needed to ensure that fee-setting policy remains appropriate to secure this objective as spectrum markets evolve.
Annex 1

AIP Fees for both WT Act Licences and Recognised Spectrum Access ("RSA")

A1.1 There are fee regulations currently in place for both (i) Wireless Telegraphy Act licences and (ii) grants of Recognised Spectrum Access ("RSA"). Licence fees and sums payable in respect of grants of RSA are currently set either according to the cost recovery or AIP methodologies.

A1.2 For Wireless Telegraphy Act licence charges, the current regulations came into force in 2005 and following on from this there have been a number of Amendment Regulations. These Regulations provide for fees to be paid in respect of Wireless Telegraphy licences granted under section 8 of the Wireless Telegraphy Act 2006 (the "2006 WT Act") (previously the Wireless Telegraphy Act 1949).

A1.3 The Communications Act 2003 facilitated the ability to charge fees for the granting of rights of Recognised Spectrum Access ("RSA") under section 161 (subsequently repealed by the WT Act 2006). Ofcom’s power to charge for grants of RSA is currently set out in sections 21 and 22 of the Act. In 2007, Regulations setting out charges for RSA grants came into force. RSA may be granted in relation to both transmission and reception. RSA confers formal recognition of, but does not authorise, spectrum use. It remains lawful for bodies that do not require a 2006 WT Act licence to use spectrum without applying for a grant of RSA in the frequency bands in which RSA has been introduced. RSA is explicitly a voluntary mechanism.

Wireless Telegraphy (Licence Charges) Regulations

2005

May 2005 (S.I. 2005/No. 1378)


Under the Regulations 2005 additional fees were added, e.g. Community Radio Licence under the Broadcasting sector, the Fixed Wireless Access (3.4, 3.6-4.2 GHz for Guernsey, the Isle of Man and Jersey), along with amendments to PMSE, Fixed Links and Business Radio licence classes.


2006

Amendment; December 2006 (S.I. 2006/No. 2894)

This S.I. amended the Regulations 2005 in respect of the Amateur Radio and Maritime Ship and Portable radio fees, mainly to enact the free electronic licence for both categories.

2007

Amendment; August 2007 (S.I. 2006/No. 2326)

This S.I. amended the Regulations 2005 by introducing Community Television fees, fees for the National Public Safety licences (e.g. WT Act fees for the Airwave service) and new licence classes for the Science and Technology sector. It also detailed charges applied to Broadcasting Television and modified charges applied to Programme Making Special Events (“PMSE”)


2008

Amendment No.1; February 2008 (S.I. 2008 No. 139)

This S.I. amended the Regulations 2005 by introducing fee modifications for Satellite Earth Station licences, primarily through modification of the fee algorithm.


Amendment No.2; August 2008 (S.I. 2008 No. 2106)

This S.I. amended the Regulations 2005 by introducing fee modifications for a number of Business Radio Licences which adjusted the fee calculation algorithms and mechanisms as a result of earlier consultations on Business Radio.


2009

Amendment; February 2009 (S.I. 2009 No. 66)

This S.I. amended the Regulations 2005 by (i) removing the Satellite (Aircraft Earth Station) and Satellite (Earth Station on Board Train) licence classes in the Satellite Services sector and (ii) increasing the fees for the Satellite (Permanent Earth Station).

Wireless Telegraphy (Recognised Spectrum Access Charges) Regulations

March 2007 (S.I. 2007/No. 392)

This S.I. provides the sum to be paid to Ofcom in respect of grants of RSA for the Radio Astronomy Service made under section 18 of the WT Act 2006.


March 2007 (S.I. 2007/No. 393)

This S.I. provides the circumstances of use for which grants of RSA may be made by Ofcom.

http://www.opsi.gov.uk/si/si2007/uksi_20070393_en_1
Annex 2

Mobile Cellular Fees

Analogue 900 MHz, GSM 900 MHz and GSM 1800 MHz

A2.1 This Annex illustrates the changes in fee rates and structures for mobile cellular in 900 and 1800 MHz from the initial licensing through to the present day.

A2.2 The convention, early on, was to establish fee rates for licences in the first year from issue (shown as the white bars in the figures below) and additionally set rates for each anniversary of the licence (e.g. first anniversary shown as light grey, with second, third, fourth etc. anniversaries, in shades darkening to black). Therefore when this convention was used the fees regulation that was in force in any one year would set down a number of different fees, and those in force for a particular user would depend on the issue and anniversary status of the cellular licence. The rationale behind this was to enable new, later entrants to this market to start their businesses from the same, relatively low, fees base that the earlier entrants had benefited from in the initial years of their licences.

A2.3 As licensing of mobile cellular services continued, it became apparent that further operators were unlikely to be licensed in the short to medium term. So a single fee, per channel per year, was set (as illustrated). These decisions were taken prior to the 3G spectrum award in 2000 at a time where it was unclear how future mobile cellular spectrum was to be awarded and/or allocated in future.

Figure A2.1: Analogue 900 MHz licence fees (Cost per channel - £ per 2 x 25 kHz)
Figure A2.2: Digital 900 MHz licence fees (Cost per channel - £ per 2 x 200 kHz)

Figure A2.3: Digital – GSM1800 MHz licence fees: for licensees that also hold 900 MHz licences (Cost per channel - £ per 2 x 200 kHz)
Figure A2.3: Digital – GSM1800 MHz licence fees (Cost per channel - £ per 2 x 200 kHz)
Annex 3

Point to Point – Fixed Links

The ‘Minimum Path Length’, Fee Formula and Fee determination

Figure A3.1: The minimum path length consideration

Of the bands available for fixed links and point-to-point licensing, the lower frequency bands are, purely from a technical perspective, more suitable for links that can be used over greater distances than the higher-frequency available bands. Links over relatively shorter distances can be facilitated by a greater number of the frequency bands available: that is, not only at lower frequencies but in higher frequency bands which are unsuitable for long-distance links. Hence, therefore, to ensure the ongoing availability of these lower frequency bands, operators are encouraged, through modifiers in the fee formula, to select the highest frequency band available relative to the physical distance over which the link operates. This consideration is referred to as the Minimum Path Length ("MPL").

For example;

A point to point link over a relatively long path (in terms of distance between points) is illustrated above. In this situation, purely from a technical perspective, of the bands available for point-to-point licensing, the higher frequency bands are, in the main, less suitable. Here the lower available frequencies are the most suitable.

A point-to-point link over a relatively much shorter path is illustrated above. Here, again from a technical perceptive, all frequency bands are suitable (both the low frequency and high frequency bands). Here the modifier will proportionally increase the final fee where the lower bands are licensed. This is a spectrum management incentive introduced into the fee structure to try and ensure ongoing availability of these lower frequency bands for the longer links which can only be accommodated in lower frequencies. While these price incentives are aimed at encouraging efficient choices about frequency requirements, users had historically also been physically denied access to bands where this distance against band relativity element was not met.
In the example above, the modifier that increases the price of lower frequency spectrum seeks to incentivise potential users to use higher frequency bands when contemplating new licences. Its continued use on existing links has less of an incentive on decisions following licensing, where the operator will typically have taken a judgement over the respective fee and non-fee costs involved, and will have sunk non-fee costs accordingly (e.g. in link deployment).

A3.1 The formula applied to fixed links is driven by the technical nature of the fixed link being licensed. As a result the modifiers used in the formula are based around these specific system metrics. The fee formula is generally expressed as:

\[ AS = Sp \times Bwf \times Bf \times Plf \times Av \]

where

- **\( AS \)** is the final sum (“Appropriate Sum”) paid for the link concerned;
- **\( Sp \)** is the Spectrum Price (e.g. £88 pounds for every 2 x 1 MHz used). Most licensed links use paired spectrum; those using unpaired spectrum (i.e. a single frequency) are discounted by around 25%\(^{48}\) of the total fee;
- **\( Bwf \)** is the Bandwidth Factor - the bandwidth, in MHz, used by the licensed link;
- **\( Bf \)** is the Band Factor, which is a discount rate which varies inversely with frequency for the licensed fixed links bands available for the link concerned;
- **\( Plf \)** is Path Length Factor which is varies above and below 1 in line with a relatively complex relationship between the stated minimum path length for each band available for licensing, and the relationship of this path length against the data rate to be used by a link. Fees therefore have an upwards modifier for low data rates in low frequency bands over short distances, and a downwards modifier where relatively high data rates in high frequency bands over longer distances are used; and
- **\( Av \)** is Availability, defined as the percentage of time the radio link is required to offer reliable operation (in absence of external interference), so that links requiring the highest availability (effectively service quality arising from its technical planning) will pay the highest fee, other things being equal.

---

\(^{48}\) The administrative processing of a bi-directional and uni-directional link is the same, a 25% discount is applied as only half the spectrum is used, but the administrative burden is not half.
Annex 4

Licence Fee Timelines

Timelines for Ofcom pricing decisions since 2004

A4.1 In some cases other Regulations were changed, for example to amend licence classes or licence terms – some of these are omitted from this table.

<table>
<thead>
<tr>
<th>Pricing policy</th>
<th>1st consultation</th>
<th>Statement</th>
<th>Statutory consultation</th>
<th>Pricing regulations in force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point to Point Fixed Links</td>
<td>September 2004</td>
<td>February 2005</td>
<td>February 2005</td>
<td>June 2005</td>
</tr>
<tr>
<td>PMSE</td>
<td>September 2004</td>
<td>February 2005</td>
<td>February 2005</td>
<td>June 2005</td>
</tr>
<tr>
<td>Scanning Telemetry</td>
<td>September 2004</td>
<td>February 2005</td>
<td>February 2005</td>
<td>June 2005</td>
</tr>
<tr>
<td>Traded Licences (general)</td>
<td>September 2004</td>
<td>February 2005</td>
<td>February 2005</td>
<td>June 2005</td>
</tr>
<tr>
<td>5.8 GHz FWA (same fee as previous temporary charge introduced at end of 2003)</td>
<td>September 2004</td>
<td>February 2005</td>
<td>February 2005</td>
<td>June 2005</td>
</tr>
<tr>
<td>3.6-4.2 GHz FWA Jersey, Guernsey and Isle of Man</td>
<td>September 2004</td>
<td>February 2005</td>
<td>February 2005</td>
<td>June 2005</td>
</tr>
<tr>
<td>Service Type</td>
<td>Time Period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satellite Earth stations on Vessels, Earth stations on Aircraft, Earth stations for non fixed satellite services, Earth stations for non-geostationary services</td>
<td>September 2004, February 2005, February 2005, June 2005</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terrestrial Broadcasting</td>
<td>September 2004, and June 2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ship’s Radio (combined with internet licensing fee proposal, April 2006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amateur Radio (combined with internet licensing fee proposal, April 2006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Description</td>
<td>Start Date</td>
<td>End Date 1</td>
<td>End Date 2</td>
<td>End Date 3</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------</td>
<td>------------</td>
<td>------------</td>
<td>-------------</td>
<td>------------</td>
</tr>
<tr>
<td>Public Wireless Networks (Channel Islands and Isle of Man)</td>
<td>July 2006</td>
<td>January 2007</td>
<td>May 2007</td>
<td>August 2007</td>
</tr>
</tbody>
</table>
Annex 5

Glossary

AIP
Administered Incentive Pricing— a methodology used to set charges for spectrum holdings to reflect the Opportunity Costs (see definition below) of the spectrum.

Cave Review

CGC
Complementary Ground Component. A terrestrial mobile network that is complementary to a Mobile Satellite System.

Combinatorial Clock Award
An auction held over a number of rounds rather than just a single one. This is a more complex auction process, but is used because it allows for participants to bid on differing combinations of spectrum lots, over a number of rounds, where those lots are potentially complementary.

Communications Act
The Communications Act 2003, which sets out Ofcom’s powers, functions and duties.

Cost recovery
A methodology to set charges for spectrum holdings no greater than the sums necessary to recover costs incurred by Ofcom in connection with its radio spectrum functions.

DAB
Digital Audio Broadcasting.

DTT
Digital Terrestrial Television.

EU
European Union.

Excess demand
A band is said to be in excess demand (in a given area) if the number of assignments desired by potential users at the relevant price exceeds the maximum capacity of the band (both being measured over an appropriate period or at a point in time, depending on the purpose).

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

GHz
Gigahertz — unit of frequency equal to one thousand MHz.

Hz
Basic unit of frequency — one hertz is equivalent to one cycle per second.

Independent Audit

Interference
Unwanted disturbance caused in a radio receiver or other electrical circuit by electromagnetic radiation emitted from an external source.

Liberalised licence
A licence that allows holders to change the use to which they put spectrum, within constraints to prevent harmful interference.

Licence Exemption
Exemption regulations made by Ofcom to allow anyone to use specified radio equipment without the need to have a WT Act licence.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHz</td>
<td>Megahertz – unit of frequency equal to one million Hz</td>
</tr>
<tr>
<td>MOD</td>
<td>Ministry of Defence</td>
</tr>
<tr>
<td>Ofcom</td>
<td>Office of Communications. Ofcom is the regulator for the UK communications industries, with responsibilities across television, radio, telecommunications and wireless communications services</td>
</tr>
<tr>
<td>Opportunity Cost</td>
<td>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 forgone</td>
</tr>
<tr>
<td>PAMR</td>
<td>Public Access Mobile Radio services also referred to as Common Base Stations</td>
</tr>
<tr>
<td>PMR</td>
<td>Private Mobile Radio</td>
</tr>
<tr>
<td>Radio Spectrum</td>
<td>The portion of the electromagnetic spectrum below 3000 GHz that is used for radiocommunications</td>
</tr>
<tr>
<td>RA</td>
<td>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 were transferred to Ofcom in December 2003</td>
</tr>
<tr>
<td>RAS</td>
<td>Radioastronomy service. The scientific endeavour of observing deep space by means of receiving radio frequency signals emitted by celestial bodies</td>
</tr>
<tr>
<td>RSA</td>
<td>Recognised Spectrum Access is 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</td>
</tr>
<tr>
<td>Sealed Bid Award</td>
<td>A sealed bid award is an auction run over a single round where participating parties place a valuation on the spectrum lots on offer. The successful party is the one that places the highest valuation as their single participating bid. Dependant upon the auction design (i.e. lots on offer and/or licences to be awarded), the 2nd pricing rule maybe be applied (i.e. the winning party pays the 2nd highest valuation)</td>
</tr>
<tr>
<td>SRSP</td>
<td>Strategic Review of Spectrum Pricing</td>
</tr>
<tr>
<td>STU</td>
<td>Spectrum Tariff Unit, proposed by Smith NERA to represent an average tariff per MHz of spectrum used</td>
</tr>
<tr>
<td>Tradable licence</td>
<td>A licence that allows holders to transfer the rights and obligations under the WT licence to another person in accordance with regulations made by Ofcom</td>
</tr>
<tr>
<td>UHF</td>
<td>Ultra High frequency</td>
</tr>
<tr>
<td>VHF High Band</td>
<td>A historically popular Business Radio frequency band between 165-173 MHz</td>
</tr>
<tr>
<td>WT Act</td>
<td>The Wireless Telegraphy Act 2006, which sets out the statutory framework for management of the radio spectrum consolidating a number of older Acts dating back to 1949</td>
</tr>
</tbody>
</table>
WT Licence

Licence granted by Ofcom to authorise installation or use of radio equipment as required by section 8(1) of the WT Act