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# **Study into the potential application of Administered Incentive Pricing to spectrum used for Terrestrial TV & Radio Broadcasting**

**Final Report for Ofcom  
Indepen and Aegis**

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This report was prepared by Indepen and Aegis for Ofcom. Dr Damian Tambini, head of the Programme in Comparative Media Law and Policy at Oxford University, provided input on issues concerning the public value of broadcasting.

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## Summary

### Scope of the study

This study is concerned with the application of administered incentive pricing (AIP) to terrestrial TV and radio broadcasting and a key requirement is that it addresses in detail the implications of broadcasting policy for the application of AIP. The study involves

- Reviewing previous approaches used to estimate opportunity costs for the UHF TV spectrum
- Identifying bands used by radio and TV broadcasting to which AIP might be applied
- Considering whether AIP should be applied to spectrum used by broadcasting using a forward looking analysis
- Providing a methodology for the calculation of opportunity cost, and so AIP, for broadcasting spectrum, including an analysis of whether or not social benefits from broadcasting should be taken into account when setting AIP
- Estimating AIP using this methodology
- Advising on the application of AIP and identifying technical, regulatory or other factors that would affect the successful application of the methodology to TV and radio broadcasting.

### Background

AIP is applied to some or all the spectrum used by business radio, public wireless networks, scanning telemetry, point to point fixed links, satellite services, the Ministry of Defence and emergency services. It is not applied to use of spectrum for broadcasting purposes, although Channel 3, Channel 5 and national commercial radio licensees pay Broadcasting Act licence fees which contain an implicit payment for use of spectrum.

The Government's response to the Cave Review in October 2002 stated that broadcasters should pay for spectrum. The issue was analysed at a high level by the Cave Review published in March 2002, a subsequent report on spectrum pricing and an Ofcom consultation on spectrum pricing in September 2004. This work did not examine in detail the interaction between constraints on spectrum use arising from broadcasting policy and the achievement of the spectrum efficiency objectives that AIP seeks to promote. Finally, we note that the 2005 Independent Audit of Spectrum Holdings is not looking at broadcasting spectrum.

### Economic issues

In Chapter 2 we consider the question of whether, taking account of wider public policy, social welfare would be enhanced if pricing for spectrum used for broadcasting departed from the approach used for other services, namely prices set on an opportunity cost basis. We conclude that



- Efficiency is promoted if opportunity cost based prices are applied to broadcasting use of spectrum and policies to achieve the social value of broadcasting are focussed on broadcasting outputs
- Opportunity cost estimates do not need to be adjusted to take account of the social value of broadcasting, as opportunity cost estimates are calculated in the presence of policies, such as coverage and content requirements and public funding of broadcasting, that are designed to achieve an efficient outcome in terms of broadcasting output
- Even if it was desirable to adjust opportunity cost estimates to take account of the social value of broadcasting (and we conclude it is not), this would not be practical because there are no reliable measures of social value.

Where we refer to “efficiency” we mean the benefits that flow to society as a whole from better use of spectrum. The main efficiency benefits from the application of spectrum pricing to broadcasting use of spectrum include

- Short run responses by existing users in terms of optimising the use of spectrum and other resources (such as transmission infrastructure), although in practice the scope for doing this may be rather limited
- Moderation of demands for more spectrum from either industry and/or government. When there is a cost to such demands the relevant “users” will weigh up the costs and benefits more carefully
- Long run changes to policy that result in the reallocation of spectrum from low to high value uses
- Increased incentives for users’ and manufacturers’ long term investment and research and development decisions to be aimed at economising on spectrum use
- Removing potential distortions to platform choices in a converged communications market
- Promoting fair competition between spectrum users who for historical reasons have gained access to frequencies through different mechanisms.

In Chapter 3, we propose that opportunity cost estimates for spectrum used for broadcasting should be applied as prices for the use of that spectrum, and in cost-benefit analysis of policy options. We considered an alternative option of applying spectrum pricing to those government agencies responsible for policies that have a major impact on the demand for broadcasting spectrum. We concluded this would have much weaker incentive effects than applying pricing to broadcasters/multiplex operators directly and direct pricing would change the policy dynamic, leading broadcasters themselves to promote alternative means of delivering broadcasting policy objectives.

We have argued that the subsidy provided through the present spectrum access arrangements should be focused on broadcasting outputs. Existing interventions involving



flows of funds to and from broadcasters<sup>1</sup> may need to be re-appraised before or after spectrum pricing is introduced to ensure that appropriate broadcasting outputs are delivered. In doing this, consideration needs to be given to opportunities to economise on spectrum use and any knock-on downward pressure on “rents” paid for other inputs which would reduce the overall financial impact of AIP. The possible options identified thus far are:

- The net anticipated impact on the BBC is addressed through a periodic adjustment to the Licence Fee
- The net anticipated impact on ITV, Channel 5 and national commercial broadcasters is addressed through a period adjustment to their broadcasting licence payments
- For TV and radio multiplex operators, no adjustment is required as multiplex charges already include the opportunity cost of spectrum
- In the case of local commercial radio broadcasters and Channel 4, the issue of whether a direct subsidy should be paid or licence obligations weakened needs to be considered.

We have not advised on which organisations would be responsible for deciding on and making these changes.

## **Demand and constraints on use**

Pricing should be applied on efficiency grounds if the opportunity cost of spectrum is greater than zero. Spectrum has a non-zero opportunity cost if there is excess demand for spectrum now or in the near future from current and potential alternative uses.

### **TV**

We find that there is likely to be excess demand for spectrum used by TV broadcasters. AIP should therefore be applied to this spectrum. AIP could play a role in rationing demand for new spectrum uses (e.g. High Definition TV (HDTV), mobile TV) as well as providing incentives for efficient use of spectrum by existing applications (e.g. analogue TV and Digital Terrestrial Television (DTT)). Where new spectrum is available to the market auctions may also be used to secure the efficient assignment of spectrum for new uses.

Analogue TV services have no scope to change their use of spectrum pre-switchover, largely because of policy requirements for service coverage and international planning constraints. There is therefore little merit in pricing the spectrum pre-switchover. However, pricing should be applied after switchover.

Efficient investment in the transmission infrastructure required to enable digital switchover is likely to be promoted by anticipated spectrum charges, since digital technology requires less spectrum and therefore lower spectrum charges to deliver the same output. Investment in spectrally efficient digital technology would also be promoted, along with business planning in relation to new services such as HDTV which recognised the opportunity cost of spectrum.

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<sup>1</sup> For example, TV licence fee payments to the BBC and Broadcasting Act licence payments from ITV, Channel 5 and national commercial radio licensees to government and the implicit cross subsidy between analogue and digital services (particularly in the case of radio) due to Broadcasting Act obligations to provide digital services

After switchover, spectrum pricing has a role in incentivising the appropriate use of spectrum, as users will face choices about whether to broadcast in standard or high definition TV formats and for mobile versus fixed use. For these reasons, it is important that spectrum pricing applies to both analogue and digital TV use of spectrum after the switchover date. Although it is unlikely that analogue use will persist post switchover.

## Radio

There is likely to be excess demand for spectrum in analogue and digital radio bands from organisations wishing to operate national and regional radio services, and possibly also DMB services in VHF Band III, over the next 5-10 years. In principle, AIP should therefore be applied to this spectrum. .

We find that there is some, albeit limited, scope for analogue broadcasters to change their spectrum use in the short term. In the longer term changes might be possible through re-planning the FM band and/or migration to digital technology. Digital Audio Broadcasting (DAB) users have more scope to change their spectrum use through the use of low powered Single Frequency Networks (SFNs) and there are potentially higher value uses of the spectrum (e.g. digital multi-media broadcasting).

## Approach to estimating opportunity costs

Opportunity cost estimates for spectrum used by mobile and fixed services have been calculated as the change in input costs that would occur if an average user was denied (given) access to a small amount of spectrum. The additional cost (cost saving) depends on the application and is calculated as the estimated minimum cost of the alternative actions facing the user. In principle, these alternatives may include

- Investing in more/less network infrastructure to achieve the same quantity and quality of output with less/more spectrum
- Adopting narrower bandwidth equipment
- Switching to an alternative band
- Switching to an alternative service (e.g. a public service rather than private communications)
- Switching to an alternative technology (e.g. fibre or leased line rather than fixed radio link).

This approach assumes that the output produced is the same before and after the change in spectrum access. If the only feasible changes in spectrum use are large, say because of indivisibilities in the amount of spectrum that can be used to provide the service, then the assumption of constant output could significantly bias the opportunity cost estimate. The optimal action for the user may be to make large changes in the level of output as well as, or instead of, increasing the amount of non-spectrum inputs. Alternatively, the user may move to another technology or platform when denied spectrum access. This situation may apply in the case of broadcasting use of spectrum.

We propose an extension to the least cost alternative approach to address these features of broadcasting use of spectrum. This involves estimation of values based on what a



representative or marginal user would pay for the spectrum in an auction (i.e. annualised values of the producer surplus from the use of the spectrum) in circumstances where the least cost alternative approach is not appropriate because the assumption of constant output does not hold.

We also suggest that market information obtained through spectrum trading, auctions or secondary markets (e.g. the market for multiplex capacity) could be used to derive opportunity cost values, so long as care is taken to make any adjustments required to give a “like for like” comparison with the situation for which opportunity cost estimates are required. We also note that if AIP was linked to observed trading prices this could result in disincentives to innovate. One option for dealing with this problem would be to commit only to using information from trading with a lag when setting AIP. Alternatively, traded prices from one area might inform the setting of AIP in another.

### **Setting AIP from opportunity costs**

A generalised approach to setting AIP using opportunity cost was presented in Indepen et al (2004)<sup>2</sup> and we have used it to determine AIP. It involves an iterative approach to setting prices which can be summarised as follows

- 1 For a given frequency band identify the current and other potential uses of the band
- 2 Calculate the marginal opportunity cost of spectrum for the current use of the band and other uses until a use is found which has a higher marginal opportunity cost than the current use
- 3 If there is a use with a marginal opportunity cost higher than the current use of the band, then set the AIP between the two values, but towards the bottom end of the range of values in the first instance
- 4 If there is no use with an opportunity cost higher than the current use of the band then set the AIP at the value for the current use.

### **Opportunity cost estimates - TV**

Table 1 summarises the opportunity cost estimates we have calculated for the UHF spectrum. We have argued that the DTT values are relevant for setting AIP, as the analogue TV values are upper bounds on opportunity cost and the Digital Video Broadcasting Handheld (DVB-H) values fall to near zero once five or six multiplexes are allocated to this use.<sup>3</sup> Figure 1 indicates, however, that the value of spectrum for DVB-H may be higher for one to three multiplexes than its use for DTT.

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<sup>2</sup> “An Economic Study to Review Spectrum Pricing”, Indepen, Aegis Systems and Warwick Business School, Ofcom, February 2004.

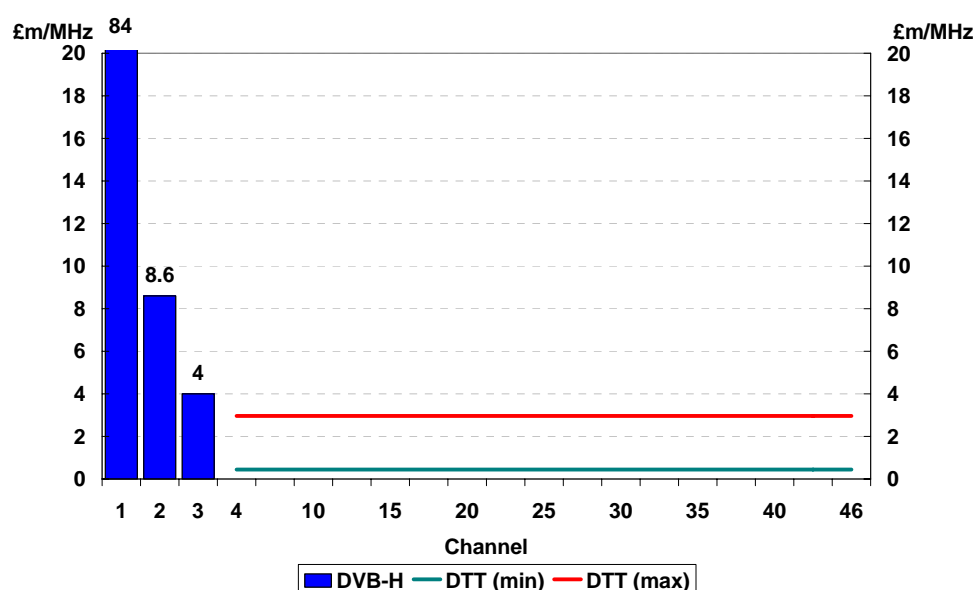
<sup>3</sup> It becomes cheaper for the residual content to be delivered over the 3G network.

**Table 1: Opportunity cost estimates for the UHF spectrum**

Service	Estimates
Mobile broadcasting (DVB-H)	Use of UMTS network: Values depend on assumed demand for mobile TV. With 3m subscribers, the estimated opportunity cost ranges from £4m/MHz for the third DVB-H multiplex to £84m/MHz for the first mux. (assuming SFN operation) Use of L-Band: £10m/MHz plus the cost of L-Band spectrum.
Analogue TV	Cost of migrating viewers to <ul style="list-style-type: none"> <li>• DTT implies a value of £1.1m/MHz</li> <li>• satellite implies a value of £2.4m/MHz</li> </ul>
DTT	Cost of migrating viewers to satellite reception implies a value of £2.96m/MHz Value of spectrum implied by traded value of multiplex capacity is £0.44m/MHz

This suggests initially setting a value for AIP towards the lower end of the range for DTT i.e. around £0.5m/MHz. This implies a fee per national DTT multiplex of around £22m.<sup>4</sup> These estimates do not include the value of spectrum in those parts of the country that are not sterilised by TV broadcasts. To obtain a reference value for a national channel the value of use (e.g. for programme making and special events) outside the areas sterilised by TV services needs to be added.

It is important to note that the estimates given in Table 1 are only relevant for a snapshot in time. Values will change over time as demand changes. If demand grows, for example, as a result of the success of consumer adoption of HDTV or demand for greater interactivity, then values could increase. By contrast, if spectrum availability increases after switchover or demand for terrestrial TV services declines, say, because of the growth of Internet Protocol TV (IPTV) or use of more spectrally efficient technology then values could fall.

**Figure 1: Opportunity cost estimates for DTT and DVB-H**

<sup>4</sup> This assumes 43 MHz is required per multiplex, as 256 MHz is used to deliver the existing 6 multiplexes.



There are a number of adjustments that will need to be made to the chosen AIP value to give prices for specific broadcasters. In particular, if use of any given frequency sterilises an area less than the whole of the UK (either because of international co-ordination constraints or other users can be accommodated in the spectrum) then the value should be scaled proportionate to the share of national population in the sterilised area. For example, a TV station in Croydon may sterilise spectrum in London even though its coverage is limited to Croydon.

AIP should be applied to all users of the UHF spectrum except those who obtain their spectrum through auction. We suggest that pricing is applied to analogue TV services after switchover (on a regional basis from 2008 on in line with the government's switchover plan) and to digital services from 2012 on once existing licenses expire. If it were decided to apply AIP later, then the beneficial long term impacts of AIP on investment, technology and spectrum use decisions could be substantially retained by early announcement, and commitment to, the policy.

## Opportunity cost estimates - Radio

Table 2 lists the opportunity cost estimates we have calculated for spectrum used by radio.

We do not have the data required to estimate opportunity cost values for local radio but have set out an approach for calculating these values, were the data to be available. We have also presented estimates based on payments made by national commercial licensees.

At first sight, it appears attractive to relate AIP levels to the area or population 'sterilised' by the use of a particular transmission network, as this represents the spectrum use denied to others. We show by example that applying this concept in practice is not straightforward in the case of FM and AM radio. However, one way through the practical complications would be to set AIP for a local station proportional to the population falling within a defined field strength contour, where the latter would be the contour that applies at the practical limit of the interference caused by the station. In practice, there will be an arbitrary element to the choice of this contour.<sup>5</sup>

In the case of DAB, national values of around £3.5m/MHz are suggested by our analysis though the fee for an individual multiplex would need to be set pro-rata to the population in the sterilised area. Again, as for TV, these are estimates at a point in time and could change over time as spectrum demand changes. If demand grows, for example, as a result of the success of consumer adoption of DAB, then values could increase. By contrast, if spectrum availability increases say through the auction of Band III spectrum then values could fall.

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<sup>5</sup> A decision will be required as to whether this is the contour for co-channel or adjacent or third channel interference.

**Table 2: Opportunity cost estimates for radio bands**

<b>Band</b>	<b>Estimates of opportunity cost on a national basis</b>
AM and FM bands	<p>Estimate based on producer surplus: we do not have the data required to produce estimates but values could be calculated from station financial data. Average station values could be calculated on per MHz basis and then factored up an average re-use factor to give opportunity cost values on a national basis</p> <p>FM based on national commercial station: £1.8m/MHz</p> <p>AM based on average for national commercial stations: £0.09m/kHz</p>
DAB band (VHF Band III)	<p>Cost of denying access to DMB: £27.6m/MHz for a third DMB multiplex</p> <p>Cost of using additional infrastructure: £3.6m/MHz</p> <p>Multiplex charges: At most £4m/MHz</p>

AIP could in principle be applied once all the practical issues around determining the appropriate level of AIP and any other funding arrangements have been ironed out. In the case of spectrum used by DAB services, AIP should be applied by the time any additional spectrum in VHF Band III is released either for auction or on an administrative basis. The benefits from doing this are as follows

- If the spectrum is auctioned, AIP provides for a degree of competitive neutrality between the different DAB bands. In this case, AIP should be set with reference to the market clearing price at auction.
- If the spectrum is released on an administrative basis (first come first served or a beauty contest) then AIP provides appropriate economic signals for those deciding the use of the spectrum (e.g. multiplex operators or government officials).

We have identified a number of practical difficulties with applying AIP to local commercial radio in particular. In this case, there is a choice between two imperfect alternatives

- Determine AIP for each of the 270 or so local radio stations based on estimates of the population in the areas they sterilise, apply these values and maintain output at current levels by giving direct subsidies. We anticipate the costs of negotiating and administering the subsidy could be significant because determining the area sterilised by a local radio station is not straightforward and determining the appropriate level of payment will not be easy not least because many of the existing stations are unprofitable.
- Apply AIP to the Department of Culture, Media and Sport (DCMS) on the grounds that their policies determine the current pattern and level of demand for spectrum by radio broadcasters. In this case, only an aggregate opportunity cost value would need to be calculated avoiding the difficulties in setting values on a per station basis. The practicalities of this approach would have to be worked through in discussion with Treasury and to be of value the arrangements would need to be set up so that the DCMS has incentives to economise on spectrum use. Current departmental budget processes appear to provide only weak incentives.



## Conclusion

There is a strong case in principle for applying AIP to the use of spectrum by broadcasters in order to promote efficient spectrum use, particularly in the long run, and to avoid competitive distortions between spectrum using services. In practice, there seems little merit in applying AIP to UHF spectrum before switchover because analogue TV services are to be switched off from 2008 and analogue broadcasters have little flexibility to respond to AIP under current policy. AIP should however be applied to the use of UHF spectrum after switchover as there are a number of potentially competing uses of the spectrum, and users have flexibility to change their spectrum use and/or change the policy constraints on that use.

In the case of radio there are a number of practical difficulties in applying AIP which may argue for applying AIP to the DCMS, so that it faces the right incentives when determining radio broadcasting policy, rather than applying the charge to broadcasters directly.

Our estimates suggest a value of at least £0.5m/MHz for UHF TV spectrum and higher values for spectrum used by radio broadcasting, in part reflecting the higher spectral efficiency of radio as compared with TV broadcasting. There are numerous uncertainties concerning the opportunity cost estimates we have produced. AIP may not be introduced for a number of years and in the intervening time, markets will evolve in ways we have not anticipated and the costs of providing services will differ from those we have assumed. More reliable estimates, possibly based on market transactions, should be produced nearer the time AIP is introduced.



# 1 Introduction

## 1.1 Background

Administered incentive pricing (AIP) is applied to some or all of the spectrum used by business radio, public wireless networks, scanning telemetry, point to point fixed links, satellite services, the Ministry of Defence and emergency services. It is not applied to use of spectrum for broadcasting purposes, although Channel 3, Channel 5 and national commercial radio licensees pay Broadcasting Act licence fees which contain an implicit payment for use of spectrum.<sup>6</sup>

The Government's response to the Cave Review<sup>7</sup> stated that broadcasters should pay for spectrum. The issue was analysed at a high level by the Cave Review,<sup>8</sup> a subsequent report on spectrum pricing (referred to as Indepen et al (2004))<sup>9</sup> and an Ofcom consultation on spectrum pricing.<sup>10</sup> This work did not examine in detail the interaction between constraints on spectrum use arising from broadcasting policy and the achievement of the spectrum efficiency objectives that AIP seeks to promote.

This study is concerned with the application of administered incentive pricing to terrestrial radio and TV broadcasting and a key requirement is that it addresses in detail the implications of broadcasting policy for the application of AIP. The study involves

- Reviewing previous approaches used to estimate opportunity costs for the UHF TV spectrum
- Identifying bands used by TV and radio broadcasting to which AIP might be applied
- Considering whether AIP should be applied to spectrum used by broadcasting using a forward looking analysis
- Providing a methodology for the calculation of opportunity cost, and so AIP, for broadcasting spectrum, including an analysis of whether or not social benefits from broadcasting should be taken into account when setting AIP
- Estimating AIP using this methodology
- Advising on the application of AIP and identifying technical, regulatory or other factors that would affect the successful application of the methodology to TV and radio broadcasting.

The Government's response to the Cave Review contained a number of important policy principles that should govern the way spectrum pricing (and other market based spectrum management mechanisms) is applied to the broadcasting sector, namely

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<sup>6</sup> Wireless Telegraphy Act (WTA) licence payments are made by all broadcasters to cover administrative costs.

<sup>7</sup> Government Response to the Independent Review of Radio Spectrum Management, HMT Treasury and DTI, October 2002.

<sup>8</sup> "Review of Radio Spectrum Management", Professor Martin Cave, DTI and HM Treasury, March 2002

<sup>9</sup> "An Economic Study to Review Spectrum Pricing", Indepen, Aegis Systems and Warwick Business School, Ofcom, February 2004.

<sup>10</sup> Spectrum Pricing, Consultation Document, Ofcom, September 2004.



- Valuations for spectrum used for broadcasting should be released into the public domain so that these costs can be factored into public debates about spectrum management and broadcasting policy
- Broadcasters should be encouraged to be as efficient as possible in their use of spectrum within the constraints of their public broadcasting and other obligations
- Incentive pricing for analogue TV spectrum should be implemented in a way that provides an additional incentive for broadcasters to do what they can to achieve switchover
- Charging for analogue TV spectrum will not start before 2006 at the earliest
- When introduced AIP will replace cost recovery charges
- There will be no double charging for spectrum use, in the sense that payments made by broadcasters that implicitly provide for access to the spectrum will be taken into account when setting AIP
- Spectrum pricing for digital terrestrial TV will not be applied before the end of the first licence period for each of the DTT multiplexes<sup>11</sup>
- Reduction or elimination of restrictions on the use of spectrum for non-programme related services on radio and TV multiplexes would be predicated on basis that spectrum used in excess of the relevant percentages of multiplex capacity (20% and 10% respectively) would be subject to spectrum pricing as appropriate for non-broadcasting use.

These policies are taken into account in our analysis.

## 1.2 This report

This report is based on desk research, discussions with Ofcom staff and interviews with representatives of the following organisations: the BBC, Capital Radio, the Cave Audit Team, Channel 4, Channel 5, the Commercial Radio Companies Association, Crown Castle, ITV, the Local Radio Company, Music Radio, ntl, Score Digital, SDN and HM Treasury.

The structure of the remainder of this report is as follows

- Chapter 2 gives the economic case for applying AIP to broadcasting
- Chapter 3 discusses policy issues that arise from the application of AIP to broadcasting
- Chapter 4 evaluates the extent of demand for and technical and policy constraints on spectrum currently allocated to TV broadcasting
- Chapter 5 evaluates the extent of demand for and technical and policy constraints on spectrum currently allocated to radio broadcasting

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<sup>11</sup> This is 2010 for the multiplexes assigned to S4C, Digital 3 and 4 and the first BBC multiplex (the PSB multiplexes, and 2014 for the other three multiplexes (the commercial multiplexes).



- Chapter 6 presents a general method for estimating AIP based on opportunity cost and discusses the role of market information in deriving estimates
- Chapter 7 contains illustrative opportunity cost and AIP estimates for spectrum currently allocated to broadcasting and discusses how AIP might be applied to broadcasting services.

Appendix 1 reviews literature on measuring the social value of broadcasting. Appendix 2 contains detailed calculations for some of the opportunity cost estimates.





## 2 Economics of Applying AIP to Broadcasting

### 2.1 Introduction

There is broad policy consensus that broadcasting produces benefits that go beyond individual utility. Public service broadcasters (PSB) (both in the public sector and the commercial sector with PSB obligations) variously receive public funding, access to spectrum and other benefits, in exchange for providing public service. The appropriateness of these policies is increasingly scrutinised, as regulators seek to ensure that scarce resources such as spectrum are used to the maximum public benefit.

Technological and market developments now call into question the appropriate economic policy framework for ensuring that optimum social welfare is realised through free availability of spectrum. Historically, there have been few possible alternative uses for the public resource of the electromagnetic spectrum used for conventional television and radio broadcasting. Now there is demand from many alternative uses, including mobile telecommunications and also new forms of broadcasting with new technical standards. Some bands of spectrum are increasingly in demand, and this pushes the question of spectrum allocation higher up the policy agenda. Convergence between the services offered over broadcasting and telecommunications networks strongly suggests that the spectrum inputs to these services should be regulated on the same basis. If this is not the case competition and consumer choices between different services and technologies may be distorted.

Responsible regulation and oversight of the spectrum resource requires that we periodically check that spectrum delivers maximum social benefit (including private and external benefits). Were spectrum not managed and allocated in a way that maximises social welfare, two principal problems would result. First, there is the simple point that the public interest is demonstrably not served if the existing use does not generate the maximum social benefit. Secondly, there is an arguably further-reaching problem: namely that innovation and development of new uses, standards and socially valuable externalities is hindered if spectrum is not made available for new uses.

In the case of the social value externalities generated by broadcasting, there are a number of other complicating factors. One key matter is that access to limited spectrum slots was in the past a way of guaranteeing high audiences for public service broadcasting, and therefore maximising externalities. Where regulators controlled tightly the permission to broadcast audio-visual material, they could easily impose rules to reduce negative and promote positive externalities (e.g. through content rules as licence conditions), and therefore have a large impact on social welfare. Increasing numbers of channel slots made possible by digitisation and new delivery platforms may have changed the need for intervention of this kind, and arguably controlling access to spectrum slots no longer delivers the beneficial impacts of public service broadcasting to the same extent.<sup>12</sup>

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<sup>12</sup> This effect is noted by Ofcom in its review of Public Service Television: 'The value for money of PSB subsidies is already declining as viewers have migrated to multi-channel TV. While the cost of programming on the five main terrestrial channels rose by 16 per cent between 1998 and 2003, the cost per viewer hour rose by 28 per cent'. (Ofcom PSTVR 4.3). This is discussed in more detail in Tambini, Cowling et al. "From Public Service Broadcasting to Public Service Communications". London, IPPR 2004.

The Government's response to the Cave review refers to the need to implement spectrum pricing "within a framework that allows Government and Parliament to ensure wider public policy is taken into account, including in respect to how spectrum is allocated to broadcasting and assigned between broadcasters".<sup>13</sup> The question we consider in this Chapter is whether, taking account of wider public policy, social welfare would be enhanced if pricing of spectrum used for broadcasting departed from the approach used for other services, namely prices set on an opportunity cost basis.

In answering this question there are a number of issues to be considered

- What is the economically efficient approach to pricing spectrum for broadcasting?
- Should spectrum pricing reflect the social value of broadcasting?
- Is the subsidised availability of spectrum appropriate as a quid pro quo for the additional costs incurred in meeting PSB obligations?

The focus on promoting an economically efficient approach to pricing spectrum for broadcasting deserves justification and explanation, since it motivates much of our subsequent analysis. The Communications Act 2003 obliges Ofcom to promote:

*"the efficient use in the United Kingdom of the electro-magnetic spectrum for wireless telegraphy"*<sup>14</sup>

*"Efficient management and use of the part of the electro-magnetic spectrum available for wireless telegraphy; the economic and other benefits that may arise from the use of wireless telegraphy; the development of innovative services; and competition in the provision of electronic communications services."*<sup>15</sup>

An economic definition of efficiency is a situation in which it is not possible to improve the well-being of one individual in the economy without harming the well-being of at least one other individual in the economy – this is known as the Pareto criterion.<sup>16</sup> This definition has intuitive appeal – though its implications for pricing may not be clear.

Another way of thinking about efficiency is that it maximises the total "surplus" in society i.e. the sum of benefits to consumers above and beyond the price they are paying plus the profit to producers (which is ultimately owned by citizens). Setting prices to reflect the opportunity cost of a resource – their value in the most attractive alternative use – turns out to maximise surplus and to be Pareto efficient.

In other words it is not necessarily to know or to calculate the costs and benefits of alternative prices in order to know that a price maximises net benefit. Provided the price reflects the opportunity cost of resources net benefits are maximised. Figure 2.1 illustrates this point.

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<sup>13</sup> Para 8.12, op cit.

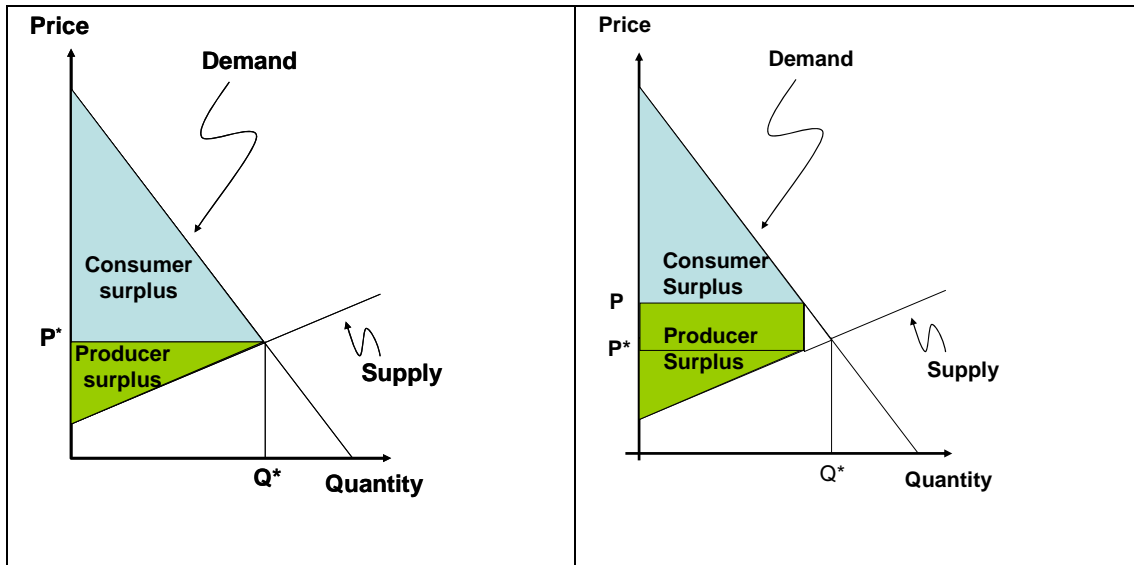
<sup>14</sup> Communications Act 2003, para. 152 section 5.

<sup>15</sup> Communications Act 2003, para. 154 section 2.

<sup>16</sup> The Pareto criterion means that economic outcomes (sometimes called states) can be compared without recourse to interpersonal comparisons of utility. Hence it is possible to compare two outcomes without comparing individuals' utilities.



Figure 2.1: Consumer and producer surplus



In Figure 2.1 “consumer surplus” is the area below the demand curve (consumers willingness to pay) and above price (what they have to pay), whilst producer surplus is the difference between the supply curve (marginal cost) and revenue (price times quantity).

The price that maximises the sum of the two areas is  $P^*$  - the price that precisely corresponds to the marginal cost of production at  $Q^*$ . This is illustrated in the left hand figure. The right hand figure shows consumer and producer surplus when the price is above  $P^*$ . In this case, consumer surplus is smaller and producer surplus is larger, but the total area is smaller by the small “missing” triangle just above the intersection of the supply and demand curves. Shouldn't producer surplus be even smaller? I.e. as the price increases the quantity demanded falls so some surplus under the  $p^*$  line is also lost.

There are two ways of getting to the Pareto outcome where total area is maximised. First, keep changing price until total area is maximised (which could be estimated using cost benefit analysis provided the shape of the supply and demand curves is known). Second, set price equal to marginal cost.<sup>17</sup> The latter generally requires less information.

## 2.2 Efficient spectrum pricing for broadcasting

Indepen et al (2004) concluded that setting prices of spectrum that promote productive efficiency<sup>18</sup> entails setting prices equal to marginal opportunity costs and is desirable for promoting efficiency more generally. It was argued that this conclusion held in a situation where spectrum using services created positive or negative externalities. This position was supported by reference to the Diamond and Mirrlees (1971) result that in setting policy to maximise welfare in a second-best situation it is not desirable to tax (or subsidise) the use of

<sup>17</sup> If demand and supply are initially away from an efficient equilibrium then the estimate of marginal cost used may not be the same as marginal cost at an efficient equilibrium – though the error would often be small.

<sup>18</sup> A given level of output is produced at minimum cost.

inputs.<sup>19</sup> This result provides a powerful general argument against adjusting spectrum prices to promote social welfare.

We develop arguments here that are likely to be more accessible than the Diamond Mirrless result and consider that elaboration of this argument is important given the differing views expressed in responses to the Ofcom consultation on spectrum pricing, as to whether spectrum pricing should reflect the opportunity cost of spectrum use when external benefits derive from the use of spectrum. We note in passing that this is a general issue that would have implications for spectrum use in areas other than broadcasting where externalities arise.

Intuitively an output objective, such as a particular level of broadcasting coverage or certain programme outputs, could be achieved via adjustments to the price (or free availability) of inputs, but to achieve the desired outcome efficiently, policy would have to target more than one input. The prices of other inputs to broadcasting, such as capital, labour, spectrum, and electricity, would likely all need to be adjusted.

We consider this argument by analogy with a problem that has been analysed elsewhere in the academic literature, before reinforcing the conclusions via exploration of the relationship between inputs and outputs for a simple broadcasting production function to reinforce the intuition for the conclusion we reach. We conclude that reducing the price of spectrum to promote use in broadcasting is an inefficient policy compared to instruments targeted directly at achieving the desired output i.e. any subsidy should be directed at broadcasting outputs not inputs.

### 2.2.1 Environmental analogy

The question of whether pollution (a bad external to the private interests of the producer) should be reduced by taxing inputs to production rather than by taxing the pollution itself has been analysed in the academic literature. This problem has mainly been considered in relation to agricultural run-off which is difficult to monitor and therefore tax by source, whereas in principle inputs such as fertiliser and pesticide use might be taxed.

This may seem somewhat removed from broadcasting, but the problem has been analysed in a sufficiently general form that the results hold if broadcasting outputs (a good) are substituted for pollution (a bad) and input subsidies are considered instead of taxes. Holtermann (1976) found that it is in principle feasible to achieve an efficient outcome via adjustments to the prices of all inputs and outputs<sup>20</sup>:

*"Where it is impossible to tax an externality directly, Pareto optimality can nevertheless be achieved by a set of taxes (subsidies) imposed on all of the other inputs and outputs of the agent creating the externality."*

However, Holtermann concluded that in practice instruments targeted on outputs rather than inputs are likely to be preferable given the complexity of the latter:

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<sup>19</sup> Peter Diamond and James Mirrlees. 1971. "Optimal taxation and public production 1: Production efficiency and 2: tax rules". *American Economic Review*, Volume 61.

<sup>20</sup> Sally Holtermann. February 1976. "Alternative tax systems to correct for externalities, and the efficiency of paying compensation." *Economica*, Volume 43169.

*"even when the production technology is such that not all of the other goods entering the production process have to be taxed, the imposition of these taxes can be expected to be rather complex, so that in general it is likely to be preferable on practical grounds to tax the externality directly whenever possible."*

In reaching these conclusions Holtermann sets up a model of the production sector of the economy, and shows that corrective taxation can be used to achieve an optimal outcome<sup>21</sup> without the externalities themselves being taxed. In general taxes or subsidies are required on all inputs and outputs (other than the externality) related to the output of the externality. This approach is simple in the case an externality such as CO<sub>2</sub> emissions from the combustion of fossil fuels, since there is a one to one relationship between one input – carbon – and the output of CO<sub>2</sub>. In other cases, the relationship will be far from simple, as can be expected to be the case in relation to inputs to broadcasting (e.g. talent, programmes, spectrum etc) and the generation of external social value from broadcasting outputs.

A more recent survey of the literature by Helfand (1999) concluded:<sup>22</sup>

*"The problems in distinguishing instruments among sources, combined with lack of information about firms' production functions (and thus how firms will respond to input instruments), make it difficult to calculate the level of pollution reduction, if any, which can be achieved from applying suboptimal input instruments."*

Helfand (1999) also notes that:

*"As long as either the effects on cumulative damage of pollution from each source, or the contribution of input  $m$  to pollution from each source, differs among some firms, then separate input taxes need to be developed for all inputs that influence pollution and for each source of pollution. Even if total damage is the sum of pollution from each source, the input taxes must vary to account for the fact that sources do not have identical pollution functions."*

The counterpart of this conclusion, applied to broadcasting, would be that it would be difficult to calculate the level of external social benefits from broadcasting that can be achieved, if any, from applying suboptimal spectrum pricing. In addition, a different adjustment to all relevant input prices including spectrum would be required for each broadcaster.

Instruments targeted at inputs are therefore likely to be infeasible, or where feasible sub-optimal. This conclusion accords with the more general Diamond and Mirrlees (1971) result.

## **2.2.2 Relationship between spectrum and broadcasting outputs**

Another way of considering the problem is to envisage a social broadcasting objective, say coverage, as a function of inputs including spectrum and other inputs – capital, labour and factors such as electricity. As inputs are increased together in their optimal cost minimising

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<sup>21</sup> Formally this is a Pareto optimum.

<sup>22</sup> Gloria Helfand. November 1999. "Controlling inputs to control pollution: when will it work?" *Association of Environmental and Resource Economists Newsletter*, Volume 19(2). Page 17.  
[http://www.aere.org/newsletter/Newsletter\\_Nov99.pdf](http://www.aere.org/newsletter/Newsletter_Nov99.pdf)

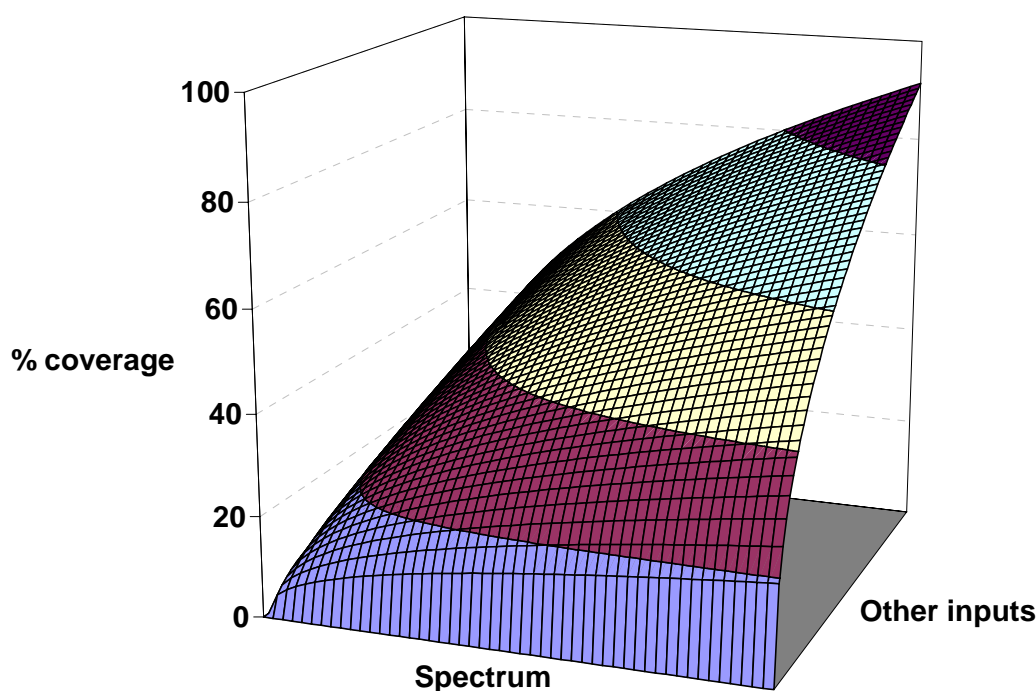


combination coverage will increase, though in general as a diminishing function of each incremental increase in inputs. Figure 2.1 provides an illustration of this concept.<sup>23</sup>

The figure illustrates that increasing spectrum and other inputs together increases, say, coverage most efficiently i.e. at least cost. With other inputs fixed at some positive level, increases in spectrum also increase coverage, but much less efficiently (following one of the rising arcs from left to right above the spectrum axis). In practice, the difference between increasing inputs together and increasing one input is likely to be even more pronounced with, for example, no increase in output beyond some point unless inputs other than spectrum are also increased (transmitter masts for example).

Another way of viewing the same function is to take two slices through the surface in Figure 2.1 – one through the efficient ridge and another away from the ridge – to illustrate how coverage changes with increases in both inputs together and with spectrum alone. To allow a two-dimensional representation both slices are plotted against the spectrum input alone in Figure 2.2.

**Figure 2.1: Illustrative depiction of broadcasting coverage in relation to spectrum and other inputs**



<sup>23</sup> The function here is a Cobb-Douglas function of the form  $Z (\text{coverage}) = X^{0.4} \cdot Y^{0.4}$ , where  $X$  is spectrum and  $Z$  is other inputs (transmitters etc). The coefficients of 0.4 add to less than 1, so an equal increment for both inputs of 1 would result in an increase in output of 0.8% i.e. the assumed function exhibits diminishing returns to scale. If the ratio of input prices for the factors is 1, then equal inputs of spectrum and other inputs are cost minimising, and expansion of coverage along the "ridge-line" of the function is the efficient expansion path. This function is chosen for its general properties, namely that output increases with increases in inputs, but on a diminishing returns basis. It should not be interpreted as a realistic depiction of the precise relationship between



**Figure 2.2: Broadcasting coverage as a function of spectrum (with and without complementary increases in other inputs)**

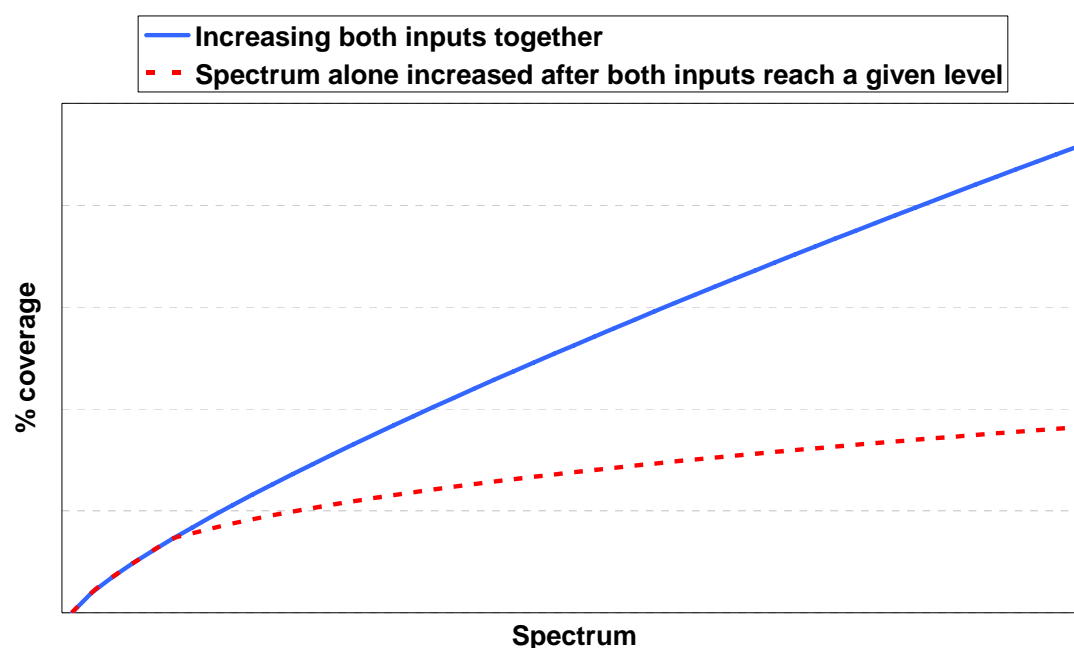


Figure 2.2 illustrates the much more sharply diminishing returns as one input alone is increased beyond a particular point compared to efficient increases in the combination of inputs required to raise coverage. While an increase in coverage beyond the privately profitable level may be socially beneficial, this would not necessarily be the case if spectrum alone were increased since the opportunity cost of spectrum forgone in other uses may exceed the social value of the relatively modest gains in coverage.

Thus setting prices for spectrum that encourage greater use of the resource (i.e. reduced prices) will not achieve the coverage objective in the least cost manner. This conclusion is consistent with the general result from Diamond and Mirrlees, and the literature reviewed in Section 2.2.1.

To recap, the prices of all inputs and (other) outputs related to the generation of external public benefits from broadcasting would need to be adjusted to achieve the optimal outcome via policy interventions targeted at inputs rather outputs. This approach can be expected to be infeasible in practice, and could also risk undermining the independence of broadcasters to a much greater extent than a simpler social contract focussed on public broadcasting outputs.

## 2.3 Should spectrum pricing explicitly reflect social value?

We now turn to the question of whether any adjustment to spectrum prices calculated using the opportunity cost methodology is required when account is taken of external social benefits derived from broadcasting. Two reasons for considering this issue are



- First, if opportunity cost estimates are used to inform public policy debates about spectrum management and broadcasting policy then they should properly take account of the positive externalities associated with broadcasting use of spectrum.
- Secondly, the BBC in its response to Ofcom's spectrum pricing consultation argued that *"unless the valuation of different spectrum uses takes account of a societal valuation of the services being delivered, the methodology will fail to deliver a social welfare maximising outcome"*.<sup>24</sup> The BBC appeared to be saying that an adjustment is required to opportunity cost estimates obtained by Ofcom and Indepen et al (2004) values as these are based on the private value of the spectrum.

Based on the analysis given below, we conclude that opportunity cost estimates do not need to be adjusted to take account of the social value of broadcasting – this is already factored into the methodology – and furthermore it is not practical to attempt to make such an adjustment.

### 2.3.1 Does opportunity cost take account of social value?

Moving away from the production function approach considered in Figures 2.1 and 2.2 to consider the derived demand for spectrum alone, we follow Indepen et al (2004) in representing this demand in terms of two competing uses for a finite amount of spectrum. Figure 2.3 illustrates the derived demand for spectrum for broadcasting on the left and a competing use on the right – with the x-axis showing a finite quantity of available spectrum. On the left two declining marginal benefit curves are shown, one with private benefits in the absence of any broadcasting regulation, and the other showing private benefits once policies are in place to promote production of external social benefits e.g. coverage and programme content obligations. It is important to note that the broadcasting output produced differs between the two curves, with unregulated output levels associated with the curve labelled "MB<sub>1</sub>" and regulated output levels associated with the curve labelled "MB<sub>1</sub> with policy constraints".

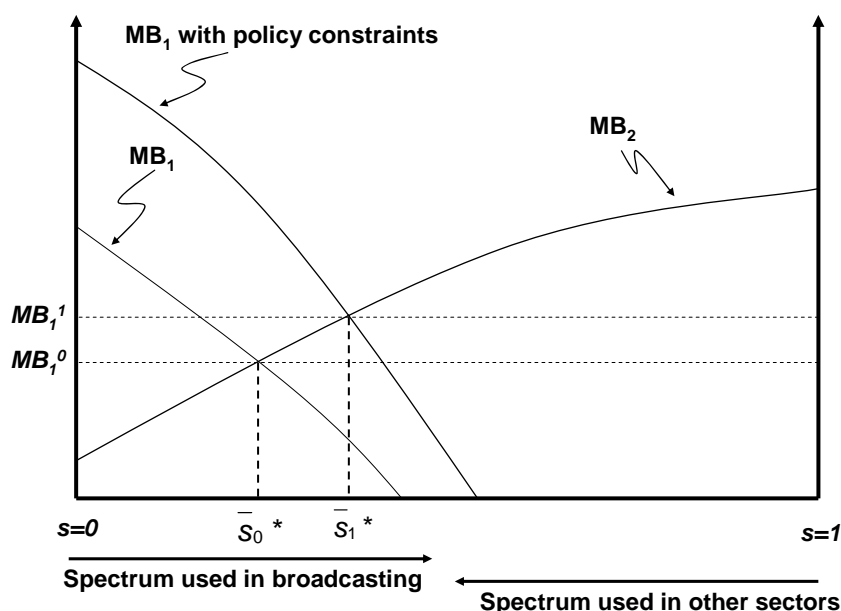
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<sup>24</sup> Response to Ofcom Consultation on Spectrum pricing, BBC, December 2004.





Figure 2.3: Marginal benefit functions with allowance for social value



When social benefits are taken into account more spectrum is now demanded by broadcasting in order to meet the social objective (assignment  $S_1^*$  versus  $S_0^*$ ), and the implied price of spectrum that is consistent with this outcome is higher ( $MB_1^1$  versus  $MB_1^0$ ).<sup>25</sup>

Provided AIPs are calculated using the opportunity cost methodology in the presence of policies, such as coverage and content requirements and public funding of broadcasting, that are designed to achieve an efficient outcome in terms of broadcasting output, then the calculated opportunity costs and so prices will be the correct (higher) ones. No further adjustment is required, provided output is held at current levels.

It is important to reiterate that Figure 2.3 illustrates derived demand for spectrum in the presence of other policies targeted at broadcasting policy objectives. It would, for example, be incorrect to infer from Figure 2.3 that an increase in spectrum alone from  $S_0^*$  to  $S_1^*$  would result in a corresponding increase in output to the socially optimal level. Or correspondingly, that a lower price of spectrum for broadcasting – and higher price for other sectors – would achieve socially desired levels of broadcasting outputs. The reason being that other inputs would have to be increased at the same time to achieve the social optimum ( $S_1^*$ ,  $MB_1^1$ ) indicated in Figure 2.3.

<sup>25</sup> One would expect demand for spectrum input to increase when account is taken of policies targeting the production of public broadcasting outputs. However demand for spectrum could decrease, for example, policies targeted at promoting very local low powered radio services may reduce overall demand for radio spectrum as frequency re-use would be high. Services would be delivered using more infrastructure and less spectrum than is currently the case. The same conclusion nevertheless holds, namely that provided the marginal benefit curve already reflects other interventions then the calculated spectrum price is the correct price including allowance for public benefit.



### 2.3.2 Measuring the social value of broadcasting<sup>26</sup>

There is broad policy consensus on the need for valuation of public service broadcasting beyond individual utility because of market failure/externality and public policy concerns peculiar to broadcasting. There is however little consensus on how to measure the 'social' value of broadcasting and a significant body of expert opinion is of the view that it is unquantifiable. Appendix 1 provides a survey of recent methods for measuring the social value of broadcasting, drawing both on academic approaches and on particular solutions and proposals within regulatory policy (at Ofcom for instance). We examine government decisions, both in terms of the wider policy context for PSB (e.g. in the recent Green Paper on the BBC) and in terms of approvals of new BBC services. Independent, Government commissioned reviews of new BBC services (which are to be replaced with a 'Public Value Test') offer some tools for measuring the social value of broadcasting. We also review the recent contributions of the BBC through its submissions to the Government on Charter Review, and other contributions to public debate in the context of the Charter Review.

We argue overall that whilst a definitive measure of social value capable for example of determining spectrum subsidies is not possible, a basket of available measures could be useful in the context of spectrum policy decisions. To illustrate: our review of a basket of potential measures of social value of broadcasting confirms that measures of consumer value alone do not capture the total value of broadcasting. It shows that contingent valuation methods have been proposed for calculating social value, but the key policy decisions in broadcasting are not based on calculated quantifiable cash values for social value. Rather, they are based on policy objectives and benchmarks of the public purposes of broadcasting.

Were it thought desirable to adjust AIP for social value (and we argue above that it is not) significant barriers remain to the incorporation of social value in a robust AIP methodology for broadcast or indeed other spectrum

- Measurement of the social value of broadcasting is a new, and not an exact, science. There are major methodological problems. Many of the key regulatory decisions based on social value (e.g. decisions on new services) are based on procedures for identifying public purposes, benchmarks and targets, rather than methods of calculating a value that would provide the units necessary for comparison with other potential uses of the same spectrum.
- No methodology or procedure for calculating social value for other bands of spectrum and uses of spectrum has been developed. Clearly, alternative and potential uses of spectrum, including for non-broadcast uses, have social values. Whilst in theory it is attractive to be able to evaluate the social value of police, military or telecommunications use of spectrum against the social value of broadcasting this has never been developed. On the contrary in telecommunications, for example, the social value of universal service and network externalities are dealt with through adjustments to interconnect prices and final prices for voice services. For defence and emergency services adjustments are made to the total public funds allocated to these services.

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<sup>26</sup> Damian Tambini contributed the discussion on this topic here and in Appendix 1.



In simple terms, this overall position within broadcasting policy –and one clearly endorsed by the Ofcom reviews - suggests the very simple conclusion that it will not be possible to neatly quantify social value of broadcasting. More research on these measures of value would be necessary before they could reliably be used in key regulatory decisions.

## 2.4 Spectrum as a *quid pro quo*

An alternative argument is that subsidised spectrum should be supplied to broadcasters as part of their compensation for meeting public broadcasting obligations.<sup>27</sup> However, there are strong efficiency and public interest grounds for moving away from subsidised availability of spectrum for broadcasting and moving to a new "contract" where all users of spectrum face the full opportunity cost of spectrum and the socially desired level for specific broadcasting outputs are promoted directly.

First, there are socially valuable opportunities to economise on spectrum use in a digital world which spectrum pricing would promote and this could deliver benefits through allowing innovation and development of new services. Second, subsidised availability of spectrum is very poorly targeted policy instrument in relation to the promotion of the social benefits of broadcasting. Third, foregone public revenues flowing from the absence of a charge reflecting the opportunity cost of a publicly owned input mean that overall taxes (or public borrowing) is increased and this in turn involves an overall cost to the economy. Fourth, pricing the use of spectrum by some services but not others could lead to competitive distortions in convergent markets.

The introduction of AIP for spectrum for broadcast use would generate revenue less than or equal to the current use of the spectrum times the price. This revenue could be used to promote social value from broadcasting via reductions in Broadcasting Act licence fees, augmentation of the television licence fee and other mechanisms. Assuming an overall approach which is revenue neutral the same social value may be generated with less use of spectrum. The mechanisms for doing this are discussed more fully in Chapter 3.

## 2.5 What are the benefits from spectrum pricing?

The response to spectrum pricing has two components: the immediate response to the current price and the response to anticipated future prices. In terms of a short run optimisation of production it is the former that matters; while in terms of long run decisions involving capital spending, research and development and changes in policy direction it is the latter that matters.

As is discussed in more detail in Chapters 4 and 5 policy, in respect of broadcasting use of spectrum may limit the extent to which short term responses to spectrum pricing are feasible. However, some changes, particularly in relation to TV in a digital environment, would be feasible. Larger gains can be expected over time as opportunities to change the policy environment arise. For example, a decision over coverage requirements or whether and how

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<sup>27</sup> Such an implicit "contract" has arisen via an historical anomaly whereby spectrum was assigned at low or no cost to most users, when spectrum was relatively abundant. In broadcasting, the BBC, Channel 4 and local commercial radio operators currently receive subsidised spectrum. National commercial radio, ITV and Channel 5 make licence payments which implicitly include a payment for spectrum access.

much spectrum to allocate for high definition broadcasting could have very different outcomes if the full opportunity cost of spectrum explicitly confronted those in industry and decision makers.

Expectations over future spectrum prices are also important since they will shape behaviour in the short-term. For example, if it were anticipated that broadcasters would have to pay the full opportunity cost of spectrum at some point in the future their demands for future spectrum allocations would likely differ. A counterpart of this is that phasing the introduction of spectrum charges may only marginally reduce incentives in the near term.

Convergence between telecommunications and broadcasting uses of spectrum, increasing competition between services offered on telecommunications and broadcasting networks and increased flexibility in spectrum use all argue for a common spectrum management regime across broadcasting and telecommunications to promote fair competition and ensure choices between transmission networks are not distorted. For example, if mobile TV services can in future be offered over 3G or broadcasting networks then decisions over choice of platform could be distorted if the spectrum used by some but not other platforms was priced. Furthermore, if some users offering particular services buy their spectrum through auction while others acquire theirs through administrative means then it might be argued that the latter should pay for their spectrum on fairness grounds.

## 2.6 Conclusions

In summary, we conclude that

- Efficiency is promoted if opportunity cost based prices are applied to broadcasting use of spectrum and policies to achieve the social value of broadcasting are focussed on broadcasting outputs
- Opportunity cost estimates do not need to be adjusted to take account of the social value of broadcasting because they are calculated at the socially desired level of output that results from the policies already in place to deliver universal coverage, quality content and so forth.
- Even if it was desirable to adjust opportunity cost estimates to take account of the social value of broadcasting (and we conclude it is not), this would not be practical because there are no reliable measures of social value. Furthermore, for reasons of consistency the social value of other services would also need to be taken into account though this is likely to be difficult to achieve in practice.
- The benefits from applying spectrum pricing to broadcasting are likely to mainly arise from longer term changes in spectrum allocation decisions and in increased investment in approaches to economise on spectrum use. Competition between different communications services will be promoted and distortions in choices between communications platforms reduced.



### 3 Policy Issues in Applying AIP

There are a number of practical policy issues to consider in applying opportunity costs estimates to spectrum used for broadcasting and broadcast policy. We consider the following questions:

- How should pricing be applied?
- What response would be anticipated?
- What is the interaction with associated policies?

#### 3.1 How should AIP be applied?

There are two broad ways of applying the opportunity cost of spectrum for broadcast use to improve decision making and resource allocation

1. Apply the opportunity cost as a price for spectrum to end users, be they multiplex operators, broadcasters or transmission operators; or to spectrum “used” directly, or indirectly in relation to “use” that is a consequence of policy by government agencies (an extension of the concept that government agencies should pay a “capital charge” on the land and buildings they use directly)
2. Utilise an opportunity cost estimate in the cost-benefit appraisal of public policy options, for example, as has been done in relation to the economics of digital switchover

The Independent Audit of Spectrum Holdings “Emerging Issues” consultation paper by Martin Cave (July 2005) comments on incentive arrangements in relation to spectrum held by Government agencies (paragraphs 2.10 and 3.15), but does not consider the possibility that government agencies would incur a charge for spectrum use by others consequent to public policy decisions and constraints.

##### 3.1.1 Apply the opportunity cost estimates via a price

The advantage of applying a price is that it economises on the information burden on any one individual since the price is automatically reflected in private and public decisions as a cost; and crucially responses are “truthful” in the sense that spectrum will end up in the hands of those who value it most highly (either in terms of private use or, ultimately, via policy choices that make best use of spectrum in relation to public policy goals).

If pricing is applied, then there is a choice about who the price is applied to. First, should it apply to public agencies whose decisions influence the demand for spectrum in broadcasting (e.g. Ofcom, DCMS) or to those in the sector? Second, who should it apply to in the sector (broadcasters or multiplex operators for example)?

On incentive grounds we consider that it is preferable to apply pricing to broadcasters rather than public agencies for the following reasons:

- Direct pricing would result in additional incentives to use spectrum efficiently, beyond the incentives which flow from the professional desire by spectrum managers to use spectrum efficiently and the constraints imposed by spectrum scarcity.
- Incentives applied to public agencies are likely to be weaker than those resulting from application to broadcasters for the reasons set out in Box 3.1. Whether such incentives are effective or not depends on the objectives of such agencies and the source and destination of funds, and the timing of transfers, related to the sale or holding of spectrum. Our expectation is that such arrangements will be weak.
- Charging users provides incentives via the sense of realism charging would bring to consideration of possible future uses of spectrum, for example, as new technologies such as high definition television develop. Direct pricing would change the policy dynamic, potentially leading broadcasters themselves to promote alternative means of delivering broadcasting policy objectives and to seek greater flexibility in the terms of spectrum use in broadcast/multiplex licences.

Our key conclusion is that spectrum inputs to broadcasting should be priced where the opportunity cost of use is non-zero.

### **Box 3.1: Incentives in private and government agencies**

A for profit entity has a strong incentive to maximise profit by maximising revenues and minimising costs – in other words to choose those outputs that have the highest private value and to minimise their cost of production. Not for profit organisations may also have closely related incentives, namely to produce outputs consistent with their mandate to produce some kind of public value and to minimise unit costs in order to maximise production of their mandated output.

The incentives in government agencies can be very different, in particular in relation to costs. To the extent that a reduction in resource use is expected to result in smaller budgets in future there can be an incentive to spend up to the allowed budget rather than to reduce actual costs relative to budget. There is also an incentive to hoard assets that might be required in future such as land and spectrum.

Mechanisms have been devised to allow government agencies to keep the benefits of the efficiency savings they make (e.g. the Wider Markets Initiative) and the Independent Audit of Spectrum Holdings<sup>28</sup> has suggested that public bodies disposing of spectrum should be allowed to benefit from any gains they make. However, for such mechanisms to work as well as incentives on private sector bodies government must make a credible commitment not to revisit the terms of the "contract" *ex post* when surpluses or profits are realised and efficient spectrum use is common knowledge. For example, if the level of spectrum charges was large relative to existing budgets there may be a reluctance to allow agencies to "profit" from decisions that free up spectrum in which case incentives would be weak.

New institutional arrangements and processes that provide commitment not to remove gains from more efficient spectrum use for a given period of time will be required. The multi-year price cap regime used in the utilities sector provides a model with commitment safeguarded through transparency in decision making and the possibility of appeal against regulators' decisions.

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<sup>28</sup> "Emerging Issues", Independent Audit of spectrum Holdings, July 2005.



### **3.1.2 Apply the opportunity cost estimate in policy appraisal**

Within the current policy framework opportunity cost estimates are sometimes applied in making policy decisions in relation to broadcast use of spectrum, for example, in relation to the cost benefit analysis of digital switchover. Pricing of that spectrum would promote more systematic appraisal of commercial and policy alternatives by multiplex operators, broadcasters and policy makers alike, and would ensure the use of a common opportunity cost estimate.

We note that the application of a single opportunity cost in policy appraisal of a range of problems involving different operators is only possible if mechanisms for delivery of public broadcasting outcomes are directly targeted at outputs rather than inputs. If public broadcasting outputs are promoted via adjustments to input prices, including the price of spectrum, then different adjustments are required for each firm (as discussed in Section 2.2.1) to achieve socially optimal outcomes i.e. a single spectrum price cannot deliver optimal outcomes if it is used as an instrument for achieving public broadcasting objectives.

If pricing is not applied, constant administrative effort will be required to promote quantitative appraisal of policy options. Even with such efforts agency incentive problems and information asymmetries will limit the accuracy and effectiveness of such analysis relative to outcomes where an explicit price is in place. We conclude that direct pricing would provide both an effective substitute for some cost benefit analysis by public agencies, and a complement where the need for public policy appraisal remains.

## **3.2 What response should be anticipated?**

Even if there were no short term change in spectrum use behaviour in response to spectrum pricing, pricing would be desirable for two reasons. First, pricing would allow the existing implicit spectrum subsidy to be focused on delivering public broadcasting outputs and other public policy objectives. Second, there are periodic choices over technologies and services which should be informed by pricing, for example, the extent to which spectrum is provided for high definition TV in future.

The issue of whether broadcasters can react to AIP by adjusting their spectrum use is considered in detail in Chapters 4 and 5. Here we consider possible complexities in terms of the response to spectrum pricing that arises from

1. Existing opportunities to trade spectrum by proxy via the sale of multiplex capacity.
2. Differences in ownership and potentially incentives among broadcasters.
3. The point at which spectrum pricing is applied in the value chain of broadcasters, multiplex operators and transmission operators

### **3.2.1 Trading of multiplex capacity**

Trading of capacity on non-commercial multiplexes is somewhat constrained by regulatory measures. ITV must retain editorial control over the capacity it has been gifted and whilst in the case of the BBC there are no explicit rules in respect of Multiplex 1, it is doubtful that it could be used for non-PSB purposes. For multiplex B the capacity is only allowed to be used



for free to air channels. These constraints potentially reduce the value of capacity on non-commercial multiplexes.

There have been some instances of trading of multiplex capacity (on SDN's multiplex) and indeed recently the sale of a complete multiplex (from SDN to ITV). An important question is whether the value of scarce spectrum is reflected in multiplex trades, and whether multiplex trading provides some or all of the benefits that would flow from spectrum pricing in terms of optimal use of spectrum over time.<sup>29</sup>

Trading of multiplex capacity alone would not be expected to lead to optimal spectrum use since it does not provide an incentive to relinquish spectrum when it is more highly valued in other uses, or to refrain from seeking additional spectrum. The reason for this is that without further policy changes the spectrum cannot be traded to another higher value use and use of more/less spectrum by a multiplex operator does not result in a higher/lower cost.

Introducing spectrum pricing would diminish the value of traded multiplex capacity, and might therefore be viewed simply as rent extraction. However, this conclusion ignores the dynamic effects discussed above, namely that pricing provides multiplex operators and broadcasters with an incentive to optimise spectrum use over time.

### 3.2.2 Incentive structures

Incentives for efficient spectrum use may differ across broadcasters and multiplex operators depending on whether they are profit maximising or not.

**Table 3.1: Incentive structures in the broadcasting sector**

	Broadcasters	Multiplex operators
Profit maximising	Channel 3, Channel 5 Commercial radio companies	Digital 3 and 4 ITV Crown Castle Commercial radio multiplex operators
Not for profit	BBC, Channel 4, community radio	BBC

A difference could arise in terms of the response to spectrum pricing if profit maximising institutions had stronger incentives to economise on spectrum use than others. However, not-for-profit entities pursue objectives, such as seeking to maximise their output that would also lead them to economise on spectrum use. Organisations also have incentives to hoard spectrum so long as it is not priced, in particular if they consider that it might be difficult to win back, or buy back, spectrum released now in the event of future needs.

In principle, if spectrum prices are a proxy for traded prices one would not expect a differential impact. However, some institutions – particularly publicly owned not-for-profits – may be more responsive to a cost felt through cash flows (i.e. an annual payment to government)

<sup>29</sup> We note that prices for traded multiplex capacity could also reflect market power. If this were the case the price of multiplex services might be higher than that implied by spectrum scarcity.





than an opportunity cost related to the balance sheet (i.e. a notional traded value). Spectrum pricing and trading (or spectrum trading by proxy) may therefore have different impacts depending on ownership.

### 3.2.3 Application of price in the value chain

AIP would apply to the holder of the WTAAct licence. Ofcom, in its consultation paper on spectrum pricing proposed an overhaul of the WT Act Licensing regime within the broadcast industry. As part of the preparations for digital switchover, and in order to ensure that WT Act Licences for broadcasting purposes are in line with all other licences, Ofcom is proposing to issue the WT Act Licences to the relevant holder of the Broadcasting Act Licence. In the case of digital services this would be the multiplex operator.

Currently, the WTAAct licences are generally held by transmission operators, though in the case of radio some broadcasters/multiplex operators hold WTAAct licences. Conditions on spectrum use are also written into Broadcasting Act licences and constraints on use flow from these licences to WT Act Licences. Thus any changes to spectrum use must be sanctioned by the broadcaster/multiplex operator otherwise it may be in breach of its licence.

Contractual relationships could alter the initial incidence of spectrum pricing. However, if economies in spectrum use can be made at some point in the value chain we would expect commercial incentives to operate.<sup>30</sup> From our discussions with stakeholders we understand that this is likely to be the case in practice.

We also note that the cost of spectrum pricing may, to some extent, be borne by providers of other inputs (for example "talent" and holders of film, other programme and sports rights) which currently earn economic rents. This point is relevant to any consideration of the impact on overall policy, and is considered in Section 3.3.

## 3.3 What account should be taken of associated policies?

We have argued earlier that there is no need to take any special account of other broadcasting policies in calculating opportunity costs since the relevant impacts are captured indirectly. Here we are concerned with the question of whether and how other policies would need to be adjusted in light of spectrum pricing, and whether there would be any consequential implications for incentives or the independence of broadcasters.

### 3.3.1 Would other policies need to change?

Existing policies involve revenue flows to and from broadcasters (e.g. Licence fee payments from households to the BBC and Broadcasting Act licence payments from ITV, Channel 5 and national commercial radio licensees to government). If as part of a wider Government policy assessment it were decided that public broadcasting should be maintained at current levels then it might be necessary to adjust these flows. In addition, in the case of local commercial

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<sup>30</sup> A general result of the theory of tax (or charge) incidence is that the economic incidence of a tax is rarely the same as the legal incidence, and that changing the legal incidence may not change the economic incidence (imperfect competition does not necessarily change this conclusion). Harberger. 1962. "The incidence of the corporation income tax." *Journal of Political Economy*, 70. Tax incidence is also discussed extensively in public economics books, for example: Gareth Myles. 1995. *Public economics*. Cambridge University Press.

radio licensees analogue licences are automatically renewed if licensees simulcast over DAB i.e. analogue radio services are expected to cross subsidise DAB services. Similarly, digital TV multiplex operators do not currently make any payment for their licences though in principle a payment related to revenues could be levied when the licences are renewed.

If these arrangements are to be changed in light of spectrum pricing, a careful assessment would need to be made of what, if any, adjustment would be appropriate. In particular, it is by no means clear that a one-for-one adjustment corresponding to spectrum charges based current use would be appropriate for the following reasons:

- First, if demand for spectrum was reduced in response to spectrum pricing through greater efficiency of use, holding outputs constant, then an estimate based on current spectrum demand would overstate the cost to broadcasters.
- Second, the price paid for other inputs such as “talent” may fall when spectrum pricing is introduced, as broadcasters would have less revenue to spend on these inputs. In other words, there may be economic rents in the industry that are not apparent from a direct examination of the broadcaster’s commercial position in isolation from factor input markets. While competition for some of these inputs from cable and satellite broadcasters will place a limit on the extent to which prices may fall, we do not believe terrestrial broadcasters are always simply price takers in the markets for talents and secondary programme rights.
- Finally, the shift away from a “hidden” implicit subsidy to broadcasting to spectrum pricing could lead to a reassessment of the appropriate level of public broadcasting that should be supported via public funding.

### **3.3.2 How might policies be changed?**

If it was decided that an adjustment to other policies which directly effect the net revenues of broadcasters was required alongside the introduction of spectrum pricing to fully or partially offset the implied increase in broadcasters’ cost, there would be time to develop and implement the relevant policies in anticipation of spectrum pricing.

Changes that could, in principle, be implemented are listed in Table 3.2. Some are directed towards increasing broadcasters’ revenues while others are aimed at reducing their costs by changing broadcasting outputs. Of these, adjustments to the TV licence fee and broadcasting licence payments can be readily implemented (assuming Treasury agreement) and, as there are existing structures for collecting these revenues, there should be no additional collection costs.

This will not be case however with the payment of direct subsidies to broadcasters. Administrative arrangements to determine an appropriate level of subsidy would need to be put in place and these levels would need to be agreed with Treasury. Subsidy levels would ideally be agreed for a number of years (say five) both to reduce administrative costs and to give broadcasters certainty for planning purposes. We expect that the costs of negotiating and administering subsidy arrangements for local commercial radio broadcasters could be significant relative to the sums involved. This is for two reasons

- most small and medium local stations are already not profitable<sup>31</sup>, and spectrum pricing will make them less profitable assuming they continue to operate. These stations account for over 50% of all commercial radio stations (there are around 270 in total).
- as discussed in Chapter 7, setting AIP in the case of local radio is not straightforward and a number of arguably arbitrary assumptions will have to be made about the area sterilised by a particular station to arrive at values for local stations from national estimates. Decisions could have very different impacts on different stations and we expect that this will be contentious.

**Table 3.2: Impact of AIP and policy options to address the financial impact of spectrum pricing**

	<b>Short term financial impact</b>	<b>Potential revenue adjustment</b>	<b>Potential cost adjustment</b>
<b>BBC (TV and radio)</b>	Negative direct impact, less adjustments in prices of other inputs	Change Licence Fee: no economic cost (as is a lump sum tax); administrative costs should not change	Change output requirements through charter process and "licences"
<b>ITV, Channel 5 &amp; national commercial radio</b>	Negative direct impact less adjustments in prices of other inputs	Adjust broadcasting licence payments: an economic cost if general taxes rise as a consequence; minimal administrative cost	Relax licence conditions governing content/format
<b>Channel 4</b>	Negative direct impact less adjustments in prices of other inputs	Direct subsidy: an economic cost through impact on taxes; negotiation and administrative cost	Relax licence conditions
<b>Commercial DTT multiplexes</b>	Removes surplus	n.a.	n.a.
<b>Local commercial radio</b>	Negative direct impact less adjustments in prices of other inputs. The latter may only occur in the case of large stations that buy "talent"	Direct subsidy: an economic cost through impact on taxes; negotiation and administrative cost	Relax format in some cases, but may not have much impact on costs for small loss making stations. Significant change to coverage areas only possible if whole band replanned
<b>DAB multiplexes</b>	Removes surplus	n.a.	n.a.

If Treasury decides that subsidies are not justified i.e. it is not prepared to pay for current levels of broadcasting output, but DCMS disagrees with this conclusion, then the only remaining option for is to relax one or more of broadcasters' costly licence obligations (e.g.

<sup>31</sup> "Economic Study of Commercial Radio Licensing", Spectrum for Ofcom, December 2003.

format controls). However, in the case of small and medium sized local radio stations this may have little impact on costs as the main problem these stations face is that there are significant fixed costs to operating a radio station and their coverage areas are small.

Finally, we note that charges for multiplex capacity would already be expected to include the opportunity cost of spectrum and so applying AIP in these instances simply removes this surplus from multiplex operators' revenues.

### **3.3.3 Impacts on incentives and independence**

Two additional issues need to be taken into account in formulating the appropriate policy response, namely the possible impacts on incentives and independence.

In relation to incentives, provided there is a clear disconnect between the response to spectrum prices and future levels of Broadcasting Act licence fees paid by Channels 3 and 5 and National Radio, television licence fee revenue received by the BBC or any compensating payments that might be made to other broadcasters<sup>32</sup>, then there are no incentive problems. What this means in practice is that the broadcaster/multiplex operator must be able to keep some of the benefit from economising on spectrum use beyond what is assumed in any initial adjustment. This can be achieved by either a one-off or periodic adjustment to licence fees (to take account of the application of AIP) much in the same way that price caps are reset periodically for regulated utilities.

In relation to independence, we do not see any fundamental change which would be detrimental to independence arising from spectrum pricing. There are a number of existing interventions in the sector, and these are subject to periodic review in any case (for example, the BBC Charter Review, Channel 3 and 5 licence renewal and the Public Service Broadcasting and Radio Reviews conducted by Ofcom).

## **3.4 Conclusions**

We conclude that opportunity cost estimates for spectrum used for broadcasting should be applied as prices, and in cost-benefit analysis of policy options.

Two responses to spectrum pricing are anticipated. First, it would provide an incentive for the efficient use of spectrum in existing uses. Second, it would provide policy makers, multiplex operators and broadcasters with incentives for the development of optimal policies in relation to broadcasting and the use of spectrum over time.

We propose that spectrum pricing for broadcast use of spectrum should be announced in advance of digital switchover, and should apply equally to both analogue and digital use of that spectrum post-switchover to ensure incentives for switchover and to increase investor certainty. This should give ample time for broadcasters to adjust to the change in policy in which case there is little economic rationale for phasing the introduction of spectrum pricing. However, the values we calculate in later chapters would need to be revisited nearer the time of implementation i.e. nearer 2013.

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<sup>32</sup> State aid issues that might arise from making such payments would need to be addressed.



Other interventions involving flows of funds to and from broadcasters may need to be re-appraised before and after spectrum pricing is introduced to ensure that appropriate public broadcasting outputs are delivered. In doing this, consideration needs to be given to opportunities to economise on spectrum use and any knock-on downward pressure on “rents” paid to talent and programme rights which would reduce the overall financial impact of AIP. Given that pricing can be anticipated there is time to consider these issues in advance and make any necessary adjustments.

Some commercial local radio broadcasters may nevertheless find that they are no longer viable with AIP if no special support mechanisms are put in place. Applying AIP could also make it more difficult for some stations to offer stations in digital format, given these stations are generally loss making. We anticipate that the negotiation and administrative costs of any scheme to support these broadcasters could however be high, and it may be difficult to target support to meet public policy goals. An alternative option in this instance would be to apply AIP to DCMS for the aggregate of spectrum used by local commercial radio, but arrangements for doing this in a way that provided appropriate incentives would need to be agreed with Treasury. In summary, the public policy issues involved in deciding how to apply AIP to radio deserve consideration by a range of agencies.



## 4 Television – Demand and Constraints

### 4.1 Introduction

Pricing should be applied if the opportunity cost of spectrum is greater than zero.<sup>33</sup> Spectrum has a non-zero opportunity cost if there is excess demand for spectrum now or in the near future from current and potential alternative uses. The short term efficiency gains from applying AIP are likely to be greater the fewer the number of regulatory and technical constraints there are on users' ability to change their spectrum use in response to prices.<sup>34</sup> In the longer term regulatory and technical constraints may change and so greater efficiency gains may be possible.

This and the following Chapter consider the current and future demand for radio frequencies in the TV and radio broadcast bands, respectively. We also assess the nature of constraints on use of this spectrum and the implications for applying pricing. The results of these analyses are used to draw conclusions about whether to apply pricing to spectrum used by broadcasters and how this might be done in practice.

### 4.2 Demand in UHF TV Bands

#### 4.2.1 Current Situation

There are currently 46 channels in UHF bands IV and V (470 – 862 MHz) that are used for analogue and digital TV broadcasting in the UK. Three further channels are currently reserved for aeronautical radar (channel 36), radio astronomy (channel 38) and radio microphones (channel 69). Unlike most other countries, the UK does not use additional spectrum in VHF Band III (174 – 216 MHz) terrestrial TV broadcast as these frequencies have been re-allocated to mobile and could in future be used for digital radio services.

An international re-planning exercise is currently underway under the auspices of the ITU to prepare the ground for the eventual switch-off of analogue TV services. The re-planning process takes the form of a two-stage Regional Radiocommunications Conference (RRC), the first stage of which was held in 2004 with the second stage to follow in 2006. The first stage agreed the technical principles for co-ordinating frequencies between different countries and the second stage will determine specific frequency allotments<sup>35</sup> for each country. It is likely that each country will be allotted specific channels to cover specific geographic areas, the boundaries of which will be subject to pre-defined interference limits, and entitled to a pre-defined level of protection from interference from transmissions in other countries. So long as the geographic boundaries and interference limits are complied with there should in principle be no further international constraint on how the spectrum may be used.

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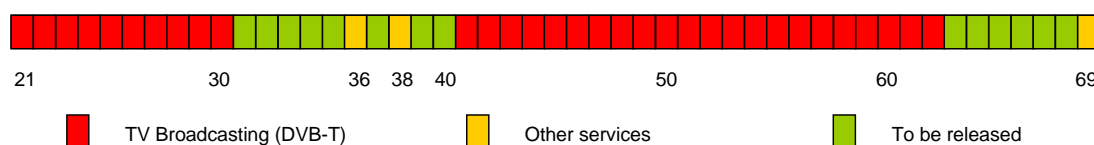
<sup>33</sup> See Recommendation 7.1, Independent Spectrum Review, March 2002.

<sup>34</sup> If there is no prospect of pricing influencing spectrum use in the short and long term then there would be more limited benefits from applying the policy, comprising for example a reduction in the deadweight loss from taxation.

<sup>35</sup> Traditionally, the international coordination of broadcast stations has been achieved by means of 'assignment planning'. In this case, it is assumed that specific transmitter locations, mast heights, aerial patterns and powers are known in advance of the frequency coordination. In 'allotment planning', frequencies are assigned for use within a geographical area, with no assumptions being made regarding the actual sites used.



The UK Government is currently proposing to switch off all analogue TV services by 2012, with a regionally phased programme starting in 2008.<sup>36</sup> Upon completion of switchover, up to 14 channels, in two contiguous blocks, are expected to be released for possible use by other services (see Figure 4.1)<sup>37</sup>. No decision has yet been made on how these released channels might be used, however as part of the UK Government's 2003 cost-benefit analysis of digital switchover, two possible uses were considered, namely additional DTT broadcast channels and mobile communications. The latter yielded the higher net benefits (as measured by consumer surplus), which were estimated to be in the range £220m - £790m per annum for the 14 channels<sup>38</sup>.



**Figure 4.1 Proposed UK allocation of UHF Bands IV and V post-switchover**

The European Commission has taken the view that switchover should be completed in Member States by 2012 and that Member States' spectrum plans should be flexible enough to allow the introduction of other electronic communications services, in addition to DTT.<sup>39</sup> It is expected that the interference criteria agreed at the RRC should be sufficiently flexible to enable a range of uses, including mobile and indoor applications, to be accommodated.

#### 4.2.2 Alternative uses

Potential alternative uses of the UHF TV spectrum include:

- i) An increased number of programme services and/or an enhanced TV experience (e.g. multi-camera angles for sports, individual news streams and other quasi-interactive options that are accessed using the remote control);
- ii) Delivery of video/programme services with higher technical quality notably HDTV
- iii) Delivery of audio-visual services to portable and mobile receivers;
- iv) Programme making and special events (PMSE) applications
- v) Local or wide area broadband wireless access
- vi) Conventional two-way mobile services.

<sup>36</sup> Ofcom spectrum management update: technical planning for digital switchover around the UK, 9<sup>th</sup> February 2005

<sup>37</sup> See UK Government document "A guide to digital television and digital switchover", available at [www.digitaltelevision.gov.uk](http://www.digitaltelevision.gov.uk)

<sup>38</sup> See "Cost-benefit analysis of digital switchover", available at [www.digitaltelevision.gov.uk](http://www.digitaltelevision.gov.uk)

<sup>39</sup> "Communication on accelerating the transition from analogue to digital broadcasting", COM(2005) 204 final, 24 May 2005.





#### **4.2.2.1 More DTT**

The recent rising prices of multiplex capacity suggests there is growing demand for spectrum for standard DTT services.<sup>40</sup> The fact that competing platforms (cable, satellite and in time DSL) are able to support more services than terrestrial transmission also suggests there may be demand for additional capacity from broadcasters seeking audiences primarily on the terrestrial platform.

Demand for additional multiplex capacity from standard TV services could also arise as a result of viewers' demand for enhanced picture quality short of HDTV, as viewers come to expect DVD quality pictures and a quasi-interactive viewing experience.

#### **4.2.2.2 HDTV**

In respect of HDTV, satellite services are likely to commence in the next year and this will put competitive pressure on terrestrial broadcasters to offer this format. Press reports suggest that the BBC is preparing to launch a high definition television service early next year.<sup>41</sup> The BBC has suggested to us that if it broadcasts services in HDTV via satellite then it is likely to come under pressure to offer HDTV terrestrially.

Adoption of HDTV could lead to a significant increase in demand for spectrum for digital TV. Using MPEG2, a whole multiplex is required to transmit a single HDTV channel but MPEG-4 (H.264) can reduce this bit rate by ~50%-70%.<sup>42</sup> What this means is with MPEG4 a multiplex could support 2-3 HDTV channels. Application of AIP could provide an incentive to economise on the use of spectrum for HDTV, for example, through the use of more efficient coding schemes such as MPEG4<sup>43</sup> and transmitting HDTV programming as an overnight trickle to personal video recorders (PVRs).

#### **4.2.2.3 Mobile services – DVB-H**

Mobile video services are now available over 3G networks in a number of European countries, including the UK.<sup>44</sup> There is also growing interest around Europe in the use of UHF TV spectrum to support delivery of audiovisual content to mobile devices,<sup>45</sup> because delivering conventional TV programmes or other "live" material aimed at a large audience over a mobile network could be uneconomic (depending on the number of subscribers) since network capacity is required for every individual viewer. Broadcast technology could provide a much more effective solution, hence the interest in mobile-optimised standards like DVB-H. Trials involving DVB-H transmissions to integrated DVB-H/3G handsets are currently underway or about to start in many European countries including Finland, Germany, the UK

<sup>40</sup> Contracts for single channels on multiplexes C and D are understood to have been signed for annual payments of more than £5m p.a. The SDN multiplex was recently sold to ITV for over £150m.

<sup>41</sup> Guardian, 12 July 2005

<sup>42</sup> It is important to realise that the picture material, the HDTV mode adopted (number of lines, etc) and the desired picture quality will have a large impact on these figures.

<sup>43</sup> Broadcasters would need to signal their future use of such coding techniques to set top box manufacturers so MPEG4 compatible STBs were available in the UK.

<sup>44</sup> For example, Orange UK has recently launched a mobile TV bundle that is delivered over its UMTS network for a fixed subscription of £10 a month, whilst Three offers unlimited music video downloads for the same price.

<sup>45</sup> In addition, we note that Qualcomm has purchased UHF spectrum in the US to provide TV to mobile devices using its "Mediaflo" technology.



and France. If successful, there is likely to be much lobbying for access to UHF frequencies to support these new services.<sup>46</sup>

The timing of demand for spectrum from mobile TV services is uncertain though a firm indication may be required as early as 2006/7, to allow handset and network development. As channels released by digital switchover may not be available before 2012,<sup>47</sup> this possibly puts a question mark over the feasibility of introducing the service in this band.

Mobile TV services could alternatively use spectrum at L-band which may be auctioned by the end of 2007.<sup>48</sup> The principal differences relating to the use of this spectrum, rather than that at UHF, are:

- The band is subject to a European Band plan (agreed at Maastricht in 2002) for use largely by terrestrial DAB, in 1.5 MHz channels. The top portion of the band is currently reserved for satellite broadcast use. Any change to this planned usage would either have to be negotiated, or would have to operate on a 'no interference' basis.
- The propagation characteristics of the two frequencies imply that a network at 1.5 GHz would require a larger number of transmitters than one at around 600 MHz, possibly up to twice the number.

Discussion of the use of 1.5 GHz for these mobile applications has generally assumed that Digital Multimedia Broadcasting (DMB) technology would be used. This is an adaptation of the standard DAB system, to allow greater flexibility and spectrum efficiency, and is targeted particularly at mobile multimedia use. The use of this system would have the advantage of operating within the existing 1.5 MHz raster with which the band is planned, and maintaining some compatibility with any DAB use of the band. It would however, be technically possible to use DVB-H technology in this band (and vice-versa) if the channel raster were modified (for example, the existing DVB-H standard caters for 6 MHz channels, which would fit into four adjacent DMB channels).

In principle mobile TV services could also operate in Band III at lower cost than at UHF, but there would be less capacity available, terminal antennas would be less efficient and antennas for transmission larger.

We conclude that there is likely to be demand for UHF channels for use by mobile TV services, but that this will depend in part on the timing of release of spectrum for this application. If channels only become available after 2012 then mobile TV services might be offered on Band III or L band.

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<sup>46</sup> For example, the UMTS Forum has already argued for a harmonised digital dividend below 600 MHz. [www.ums-form.org](http://www.ums-form.org)

<sup>47</sup> Although it is possible Channel 36 could be made available for alternative uses before this date, assuming the current radar systems were moved to another band.

<sup>48</sup> "Spectrum Framework Review: Implementation Plan", Ofcom, January 2005.



#### **4.2.2.4 Conventional mobile services**

Although, in principle, it would be possible to use the UHF bands for conventional 2-way mobile services there are a number of reasons why this is likely to be unattractive in the UK, notably:

- harmonised bands might be required to create a market sufficiently attractive for manufacturers to make terminal equipment at an acceptable cost. However, it seems unlikely harmonised bands will be realised given different countries in Europe have different plans for use of the spectrum after switchover
- it would be necessary to define specific sub-bands for base station and mobile transmission, which would lead to restrictions on the transmission of high power broadcasts in the mobile transmit bands, again to avoid interference to the mobile base station receivers
- alternative spectrum is available in higher frequency bands, such as 2.6 GHz and in the GSM bands, where smaller antennas and higher re-use potential are advantageous
- while using lower frequencies for conventional mobile services could allow cheaper coverage in rural areas, in the UK where existing GSM coverage is virtually ubiquitous, any benefit this would provide would almost certainly be negated by the additional costs of providing new handsets to rural subscribers.

We therefore conclude that conventional mobile services are not a likely candidate for use of the UHF band.

#### **4.2.2.5 PMSE**

Ongoing and increasing demand for spectrum to support programme making and special events applications (e.g. radio microphones, talk back and video and audio links) can also be anticipated. Although much of this demand could be accommodated in the broadcasters' own spectrum (by using channels locally where they are not used for broadcasting), this reduces the likelihood that channels could be used on a localised basis for other applications.

Currently, most use of the UHF spectrum by PMSE is for radio microphones. These typically operate with 200 kHz bandwidth, and a power of ~10mW. Frequencies are assigned on the basis of interleaving with broadcast use, taking all existing 1,154 TV transmitters into account and using detailed propagation models. As the UHF band is currently used for simulcasting of both digital and analogue services, congestion is a problem in some areas. Digital switchover will be on the basis of transferring three of the existing four TV frequencies at each transmitter site to DVB-T (for the PSB multiplexes), whilst the remaining three multiplexes will operate from only ~80-200 sites. As the analogue transmissions will be discontinued, it might be thought that the situation would improve for PMSE. This will only be the case if PMSE services are able to secure access to one or more of the 14 channels released as part of the 'digital dividend', say through winning access to channels in an auction.



#### **4.2.2.6 Broadband Wireless Access (BWA)**

It is possible that demand could emerge for BWA applications in the band. For example, in the USA there has been industry lobbying recently to permit the use of smart radio technology in the UHF TV bands, so that TV channels that are not in use at a particular location could be used for licence-exempt wireless transmissions similar to the WiFi systems that currently operate in the 2.4 GHz band. In 2004, the Federal Communications Commission (FCC) proposed a rulemaking that would permit such systems in the UHF TV bands.

The FCC proposal envisages two applications, namely indoor WLAN type systems and local area fixed wireless services, delivering wireless internet access over ranges of up to several km. Devices would have to incorporate smart-radio features to avoid interfering with existing TV broadcasts by using a combination of geo-location techniques and other as yet unspecified methods. The FCC hopes to establish separate interference rules for personal wireless devices and fixed access transmitters. A new standard, IEEE 802.22, is being developed to cater for the latter application. This will be similar to the existing WiFi standard (802.11) but would have significantly longer range and provide much more reliable indoor coverage.

Whether the FCC's approach could or would be applied in Europe is questionable. The UHF bands are much more intensively used in Europe, particularly in the UK where the VHF bands are not used for TV, and if new service concepts like mobile TV are successful there is likely to be strong demand to support these post-switchover. Assuming Ofcom proceeds to auction any spectrum that is released on switchover, it is very unlikely that buyers of this spectrum would tolerate any licence-exempt applications on their frequencies.

#### **4.2.2.7 Conclusions**

Table 4.1 summarises our current views on the likely level of demand over the next five years for existing and alternative applications in each of the bands considered. Our view is that there is likely to be excess demand for UHF broadcasting spectrum in Bands IV-V, suggesting that in principle AIP should be applied in these bands.

**Table 4.1: Conclusions on spectrum demand in Band IV/V**

<b>Application</b>	<b>Likely demand</b>
TV – standard and HDTV	Demand for spectrum from digital services – now and post-switchover. HDTV could significantly increase demand from existing and new channels.
Mobile	Growing interest in use of DVB-H to deliver mobile content more cost-effectively could make band attractive to mobile operators. Timing of the availability of spectrum will be important. L band may provide a substitute.  Conventional (two-way) mobile services are unlikely to be so attractive due to difficulty of return path coexisting with high power continental TV transmissions, lack of harmonised duplex bands and availability of spectrum in higher bands.
PMSE	Demand likely to grow over time while supply of UHF and other spectrum made available for PMSE on a non-market basis is likely to decline.
BWA	Possible demand but unlikely to be accommodated by incumbent licensees

### 4.3 Constraints on changing spectrum use

TV broadcasters' flexibility to use spectrum is constrained by

- international controls to avoid harmful interference
- technical transmission parameters set by Ofcom
- controls on the allocated use of spectrum
- within the allocated use, controls on the type of programme service offered
- Ofcom's plan for digital switchover.

Environmental planning regulations and procedures comprise a further category of constraint on the location of masts and so transmission sites. We assume that these regulations and public attitudes to the location of masts mean that the location of high powered TV transmission sites cannot be changed.

The consumer costs associated with modifying or replacing domestic receiving aerials that would be required if the power of signals was reduced or the frequencies used at a particular site were outside the planned frequency group for that location also place a practical constraint on changing TV transmissions.

To appreciate the implications of these constraints it is important to note that the allocation of spectrum to TV broadcasting (digital or analogue) at the 80 main sites exhausts the available supply of spectrum that can be used at these sites. All additional broadcast sites (around 1000) in effect reuse the available spectrum. As broadcasts from the 80 sites reach 80-90% of the UK population, transmissions from additional sites are of relatively low commercial value.

#### 4.3.1 International constraints

Our starting point is to assume that the Stockholm Plan for analogue TV and the plan for digital TV to be agreed at the RRC 2006 and bilateral agreements between the UK and other



countries concerning spectrum use cannot be breached. The plans and agreements specify the location, power and frequencies used by certain (high powered) TV transmitters. We assume that, as a result of international agreements, the location of the main analogue TV transmission sites and the frequencies used at these sites cannot be changed in a manner that would impact on interference to other countries. In practice, this means that transmissions at these sites cannot be changed.

There will be greater flexibility, in principle, built into the plans for digital services that will be negotiated at RRC 2006, in that planning will be based on an allotment of frequencies to areas, rather than the assignment of specific parameters to specific transmitter sites.<sup>49</sup> Hence changes that do not cause agreed interference limits to be exceeded need not be co-ordinated. It is, however, likely to be very difficult to change the pattern of use greatly (e.g. moving from a multi-frequency network to a single frequency network), without updating the plan. This could take many years to negotiate.

#### **4.3.2 Technical transmission parameters**

Technical transmission parameters, such as the transmission frequency, power, transmission site location, height of aerial, and mode of transmission are specified variously in Wireless Telegraphy Act (WT Act) and Broadcasting Act licences and in technical codes issued by Ofcom.<sup>50</sup> The purpose of these restrictions is to avoid harmful interference, and to achieve a desired level of coverage and desired levels of picture and sound quality.

##### **4.3.2.1 Coverage obligations**

The broadcasters' coverage obligations vary. The BBC has rather loose obligations that derive from the Charter and the Agreement, to provide national and regional TV services.

Under the Broadcasting and Communications Acts, Channels 3 and 4 are required to provide near national coverage (interpreted as 98.5% of the population<sup>51</sup>) in analogue and post-switchover in digital form. Channel 5 will provide national digital coverage post switchover but its analogue coverage is limited by spectrum availability.

Commercial multiplex operators must broadcast from the existing 80 sites and achieve a minimum of 73% coverage. They have discretion, however, as to whether they increase coverage beyond this at switchover by increasing transmission powers and/or extending coverage to up to a maximum of 200 sites, which would give coverage of around 90%.

For national TV services there is little room for manoeuvre unless services are shutdown. Only if several of the main 80 sites are turned off can spectrum be released for alternative uses on a national basis. We do not believe that in practice a commercial broadcaster would voluntarily turn off a main site because of it would not be justified by the loss of revenues, unless AIP was set at a high level. Setting a high AIP might be justified if incumbent

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<sup>49</sup> Although the existing assignments at the main sites will be 'embedded' within the allotment plan.

<sup>50</sup> For example, the "Television Technical Performance Code" and the "Code of Practice on Changes to Existing Transmission and Reception Arrangements".

<sup>51</sup> "Planning Options for Digital Switchover", Statement, Ofcom, June 2005

broadcasters were highly inefficient, or if there was a higher value use of the spectrum than TV broadcasting.

#### **4.3.2.2 TV picture quality**

In principle, it is possible to relax picture quality constraints for analogue TV, though the impact is likely to be variable. If the wanted signal is reduced, the degradation to the picture will vary over time, as noticeable interference from distant stations rises and falls. While a reduction in the quality of a service on a digital multiplex will immediately release bit rate for other uses, the equivalent analogue degradation would require replanning of all TV networks for a similar capacity gain.

In a digital environment, low picture quality would mean that services would simply have a lower bit rate and so more services could be accommodated on a multiplex. Audio and video quality requirements are effectively a constraint currently in that demand for multiplex capacity exceeds supply.<sup>52</sup>

Only PSB broadcasters have DTT picture quality obligations. Broadcasters seeking capacity on commercial multiplexes (for DTT) already face the opportunity cost of multiplex capacity and this is in part related to the scarcity value of the spectrum. These broadcasters therefore face some incentive to economise on the service bit rate. However, we note that increased use of DVDs and the advent of HDTV could both lead TV broadcasters to seek to increase picture quality voluntarily.

#### **4.3.2.3 Discussion**

There may be an opportunity to relax some of the technical parameters while having no impact on the interference experienced by neighbouring transmissions, coverage of services and offering the possibility of releasing spectrum for other services. The opportunities differ by service.

In the case of analogue TV, we do not consider there is any opportunity to vary the transmission parameters at any of the main sites and maintain existing levels of coverage, without the UK being in breach of international regulations and/or causing interference to other TV transmitters or services in other bands (e.g. radio astronomy use at UHF). Changing transmission parameters at sites other than the main 80 (and even ceasing transmissions altogether at these sites) is unlikely to release spectrum that could be used by most other services. The interference environment is such that any other service would have to be relatively low powered. PMSE and licence exempt applications such as the emerging "smart radio" technologies<sup>53</sup> that have been proposed in the US might be possibilities.

Similar considerations apply in the case of digital TV, although here there may be the opportunity to change the transmission mode from 16 to 64 QAM and thereby increase the capacity available on a multiplex by around 30%. However, Ofcom has decided that the three PSB

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<sup>52</sup> We understand that at present the highest PSB bit rate is around 6Mb (BBC1) and the lowest commercial rate is around 1.5Mb.

<sup>53</sup> The FCC has proposed making UHF frequencies available in areas where they are not used for broadcasting for use by technologies that are able to detect local TV transmissions and avoid transmission on those frequencies. A technical standard to deliver this capability (IEEE 802.22) is currently under development.

multiplexes will use a 64 QAM transmission mode and we would expect the commercial multiplexes to follow suit after switchover.<sup>54</sup>

There might also be the opportunity to switch from 2k to 8k transmission for DTT to allow the implementation of single rather than multiple frequency networks, which in turn could allow some release of spectrum. The extent of the gain will be constrained by the reduced capacity of SFN multiplexes (due to increased guard intervals). This will only be feasible if 1) the international agreement reached at RRC 2006 allows it; 2) all multiplex operators are prepared to change their spectrum use; 3) requirements for regional programming are not breached by the use of an SFN and 4) a significant number of consumers change their roof top aerials. Furthermore, the use of the spectrum 'released' might need to be heavily constrained to protect Continental broadcasters. These factors present a major obstacle to the implementation of SFNs.

#### **4.3.3 Allocated use**

As long as the UK complies with the interference limits implied by international agreements, it can in principle use the spectrum for any of the primary or secondary allocations given in the ITU Radio Regulations (RR) for the bands in question. The spectrum could even be used for other services subject to compliance with Article 4.4 of the RR (essentially meaning operation on a non-protected, non-interference basis).

Strict controls on the use of the broadcasting bands derive from the requirements to provide TV broadcasting services given in the Broadcasting Acts 1990 and 1996, the BBC's Royal Charter and Agreement, and the Communications Act 2003. Relaxation of these constraints could require a significant change to broadcasting policy.

A further control on the use of spectrum by digital services is also given by limits contained in multiplex operator licences on the amount of multiplex capacity that may be used to transmit non-programme related data services.<sup>55</sup>

#### **4.3.4 Type of programme service**

Spectrum is reserved for BBC and commercial PSB TV services to be supplied on a national and regional basis. Removing these constraints but still requiring broadcasting use of the spectrum could allow spectrum to be reassigned between different services to achieve a more market-based set of assignments. This would imply a departure from current broadcasting policy.

#### **4.3.5 Digital TV switchover plans**

The digital switchover plan provides for regional switchover from analogue to digital transmission over the period 2008-2012.<sup>56</sup> The plan prescribes transmission powers, locations and the transmission mode. All broadcasters must switch at the same time in each

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<sup>54</sup> "Planning Options for Digital Switchover", Statement, Ofcom, June 2005

<sup>55</sup> The limit is 10% for TV.

<sup>56</sup> "Tessa Jowell Confirms Digital Switchover Timetable and Support for the Most Vulnerable", Press release 116/05, 15 September, 2005





region. We understand that the plan is demanding in terms of the time available to undertake the necessary engineering work, suggesting there is little, if any, scope to advance the timing of switchover.

Delays to switchover would be possible in principle though broadcasters would then be in breach of their Broadcasting Act licence obligations. While removal of broadcasters' licences may be difficult to implement in practice, the UK could be in breach of international agreements if it were to allow analogue broadcasting after certain dates.

#### 4.3.6 Conclusions

Table 4.2 summarises our conclusions concerning broadcasters' short term flexibility in responding to AIP. As can be seen, in the short term broadcasters/multiplex operators have limited flexibility to change their spectrum use because of the constraints imposed by their licence obligations. However, as we have argued in previous chapters pricing has an important role in providing appropriate incentives over the longer term to change spectrum use, to change policy constraints and to introduce new technologies. For example, broadcasters should face the opportunity cost of spectrum when making decisions about transmitting in HDTV format or not.

**Table 4.2: Conclusions on broadcasters' short term flexibility to change spectrum use**

Service	Scope for change under current constraints
Analogue TV	Limited pre-switchover,
Digital TV	Commercial multiplex operators may choose more/less coverage, subject to minimum coverage requirements All operators have choice over whether to improve picture quality or otherwise enhance their service above minimum standards

#### 4.4 Implications for spectrum pricing

In summary, our analysis suggests there is likely to be excess demand for UHF spectrum as a result of demand from existing and alternative uses over the next 5-10 years. This suggests that AIP should be applied to this spectrum. In doing this we need to be mindful of the role AIP can play in rationing demand for new spectrum uses (e.g. HDTV, mobile TV) as well as providing incentives for efficient use of spectrum by existing applications (e.g. analogue TV and DTT).

The UHF band is used by analogue TV services which have no scope to change their use of spectrum pre-switchover, largely because of policy requirements for service coverage and international planning constraints. There is therefore little merit in pricing the spectrum pre-switchover.

However, pricing should be applied after switchover i.e. after 2012. Investment in the transmission infrastructure required to enable digital switchover is likely to be promoted by anticipated spectrum charges, provided that such charges apply irrespective of whether analogue or digital broadcasting is in operation since digital technology requires less spectrum and therefore lower spectrum charges to deliver the same output. For this reason, it is important that spectrum pricing applies to both analogue and digital TV use of spectrum post switchover.





The date from which pricing would apply is also in part determined by government policy that spectrum pricing for digital terrestrial TV will not be applied before the end of the first licence period for each of the DTT multiplexes. This is 2010 for the multiplexes assigned to S4C, Digital 3 and 4 and the first BBC multiplex (the PSB multiplexes), and 2014 for the other three multiplexes (the commercial multiplexes). Hence pricing could apply from 2014 on to all multiplexes.



## 5 Radio - Demand and Constraints

This Chapter considers the current and future demand for frequencies in the medium wave and VHF bands for radio broadcasting, and examines the technical and regulatory constraints on the use of spectrum in these bands. The results of these analyses are used to draw conclusions about whether to apply pricing to spectrum used by broadcasters and how this might be done in principle.

### 5.1 Demand

Radio services are now available in analogue and digital formats via terrestrial transmission and digitally over a number of new platforms including the internet, 3G services,<sup>57</sup> and digital TV platforms.<sup>58</sup> Despite the growth in listening over these new platforms, we anticipate that the majority of listening will continue to be to off-air radio services for the next 10 years. The remainder of this section discusses demand for spectrum from analogue and digital radio services in the bands currently allocated to these services.

#### 5.1.1 Medium and Long Wave

##### 5.1.1.1 Current Situation

The medium wave (522 – 1602 kHz) and long wave (150 – 279 kHz) bands, also referred to as medium frequency (MF) and low frequency (LF) respectively, are ideally suited to long range transmission of low bandwidth signals. Unlike the VHF and UHF bands, transmissions can extend well beyond the visible horizon and are relatively unaffected by obstructions such as buildings or undulating terrain.

Currently both bands are planned internationally for AM broadcast services, using a 9 kHz channel spacing. Channels are defined under an ITU plan<sup>59</sup> and are internationally assigned to countries with maximum power levels specified in the plan.

The current broadcast band plan for medium wave in Europe has 120 potential 9 kHz radio channels but to avoid interference not all channels can be used in each country. In the UK about 76 of the channels are currently used (see Figure 5.1). Five medium wave frequencies and one long wave frequency are currently used nationally across the UK and a further five frequencies are used to provide high power services to specific regions (notably London, Wales, Scotland and Northern Ireland). The remaining channels are used in various parts of the country for low power local services, including relays to support coverage of national AM stations. In the recent consultation document “Radio – preparing for the future”, Ofcom stated that a further ten medium wave frequencies had been identified which have development potential for new community or local services. We understand that these frequencies are of low commercial value because of their limited coverage but there is still interest in frequencies

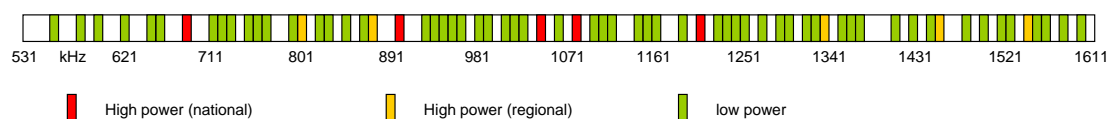
<sup>57</sup> Virgin Radio has announced that it will be the first radio station in the world to offer radio via 3G mobiles. <http://news.bbc.co.uk/2/hi/technology/4324875.stm>, 7 March, 2005.

<sup>58</sup> The Radio Advertising Bureau reports RAJAR survey data for quarter 1, 2005 that shows 17% of adults have listened to the radio via the Internet, 32% via the TV and 6% via a mobile phone.

<sup>59</sup> GE75, the plan for Medium Frequency broadcasting in regions 1 & 3 and low frequency broadcasting in Region 1, Geneva 1975



for national or large regional AM services. For example, we note that in 2003 the UK based company Radlon Media bought an AM frequency in the Dutch auction for the express purpose of broadcasting to the UK.



**Figure 5.1: Current use of Medium wave band in UK**

Although the level of interest in new AM local stations is low compared to FM (reflecting the relatively poor audio quality), of the two national AM stations, one has been the subject of a takeover during 2005.<sup>60</sup> Furthermore, we note that the two national AM stations each pay the government an annual fixed amount of £0.5-1m plus a percentage of their revenues for their licences, part of which reflects the opportunity cost of the spectrum.

#### **5.1.1.2 Alternative uses**

Although in principle the LF and MF bands could be used for non-broadcast services, such as time signals or navigation beacons<sup>61</sup>, in practice the demand for such services in adjacent bands has declined significantly over recent years as alternative platforms such as GPS have become more commonplace. Given the unique characteristics of these bands in terms of coverage and propagation, it seems certain that broadcasting will remain the principal use for the foreseeable future.

Development of a digital radio standard for operation in these bands (along with the HF bands between 2 and 30 MHz) has been underway for several years. Digital Radio Mondiale (DRM) is an open, non-proprietary standard intended to provide a digital alternative to existing AM transmissions that will fit into the existing 9 kHz (European) or 10 kHz (American) channels. DRM is claimed to deliver audio quality approaching that of existing FM services (15 kHz audio bandwidth) and can also deliver limited multimedia content, such as station names and formats or the transmission of HTML pages.

DRM uses coded orthogonal frequency division multiplexing (COFDM), which is also used for DVB-T and DAB. The following table compares the main technical characteristics of these three digital standards:

<sup>60</sup> Although this is not the only part of the bid, as 16 local commercial FM stations were also part of the deal.

<sup>61</sup> The national long wave frequency 198 kHz already transmits such a service which is used to control multi-tariff electricity meters as an overlay to the Radio 4 service.



Standard	Frequency Band	Channel width	No of carriers	Carrier spacing
DVB-T (2k)	UHF	8 MHz	1,705	4.464 kHz
DAB	VHF / L-band	1.5 MHz	1,536	1 kHz
DRM (mode A)	MW / LW	9 kHz	204	41.66 Hz

Using COFDM allows a Single Frequency Network (SFN) to be created where many transmitters can operate on the same frequency without suffering mutual interference. The potential benefits of this approach for national services could be significant. For example, the UK's two national commercial AM stations (TalkSport and Virgin) currently use nine frequencies in total to cover the country and still experience poor reception in many areas. DRM by comparison could deliver these services nationally, with audio quality approaching that of FM, with just two 9 kHz channels. DRM also provides the option of using a "double channel", i.e. an 18 kHz channel comprising two adjacent AM channels, which would provide further enhanced audio quality and scope for additional data capacity, but may be problematic in terms of international co-ordination.

Whilst there is a clear attraction in using DRM for national services, in practice such demand may be limited as national coverage is also readily available using DAB, with superior audio quality and a significant head start in terms of receiver availability. Joint DRM/DAB receivers may be in the market by the end of 2005 as DRM services are expected to be launched on the Continent later this year. DRM may also prove more attractive for localised services which are less suited to incorporation into a DAB multiplex (due to the inability to tailor the multiplex coverage for individual stations), though issues of receiver availability and price will remain.<sup>62</sup> Although such local services can also be provided using FM in VHF Band II, the use of much of this band for national services means there is a shortage of frequencies in many areas.

Unlike DAB, which operates in its own dedicated spectrum, adoption of DRM will require migration of existing AM stations to release capacity in the MW band for new DRM services. It has been suggested that the use of frequencies immediately above the European MW broadcast band (1611 – 1710 kHz), which is currently used for broadcasting in North America but until recently was allocated to analogue cordless telephones in the UK could provide an interim solution to the introduction of DRM in Europe. In response to a recent consultation, Ofcom confirmed its intention to phase out the use of analogue cordless phones in this band to facilitate the introduction of innovative technologies. The use of HF frequencies around 26 MHz has also been proposed, and the DRM standard is currently being extended to cover frequencies up to 120 MHz, thus including the FM broadcast Band (Band II).

### 5.1.2 FM Radio - VHF Band II

VHF Band II is allocated globally for broadcast services and is used universally for FM transmissions. Any commercially available FM receiver is therefore capable of receiving local FM broadcasts in any country in the world. In the UK the band is partitioned between national and local/regional services (see Figure 5.2). Since its inception Ofcom has commenced a rolling programme of issuing FM Radio Licences. Eleven licences have already been issued

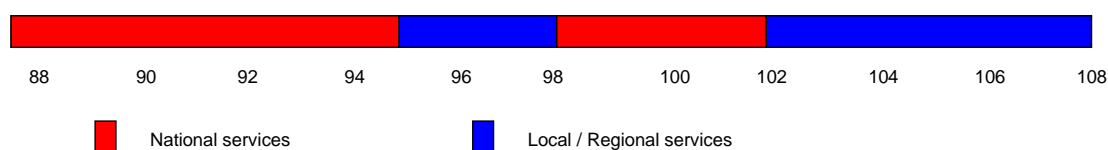
<sup>62</sup> We understand that there are now DRM radios on the market.



and there are nineteen left on the current timetable, with the potential for more to be added until all the spectrum has been assigned. For the eleven that have been issued so far there was strong commercial interest.

Although the band was used until a decade or so ago for PMR services, the relatively large antennas and propensity to periodic interference from high power Continental broadcast stations makes it unattractive for such use today. It is therefore hard to disagree with Ofcom's stated view (from "Radio - preparing for the future") that there are no significant profitable uses foreseen for released AM or FM spectrum other than more broadcasting. The question arises therefore as to which type of broadcast service the band is most suited for, as this may give an indication of possible future demand for the band. The ubiquitous availability of low cost FM receivers and the suitability of this mode for localised transmissions carrying a single broadcast service suggests there would be little merit in adopting an alternative transmission mode for some time. In the long term migration to digital transmission can be expected – to DAB and/or DRM and possibly also DVB-H - but this might not be for at least ten years.

If DAB coverage and penetration eventually reaches levels comparable to today's analogue services then it might be possible to migrate national FM services to DAB (and/or to single frequency DRM), enabling the released spectrum to be released for local services. This could potentially double the amount of spectrum available for local, regional or community services.



**Figure 5.2: Current allocation of the FM band to national and local/regional services**

### 5.1.3 VHF Band III

A study commissioned by Ofcom<sup>63</sup> in 2004 concluded that Band III could potentially be used for private mobile radio (PMR), public access mobile radio (PAMR), public safety / national security applications or DAB. Based on cost-benefit analyses, the report recommended that the band is made available on a technology neutral basis in a manner compatible with use by DAB services. We anticipate that demand from PMR and PAMR will be weak given the higher cost and limited availability of equipment for Band III as compared with Band II<sup>64</sup>, and the availability of spectrum in Band II.

Responses to an Ofcom consultation following publication of the above report indicate that there is interest in further national and regional commercial DAB multiplexes and, given the increasing take-up of DAB receivers in the UK, this may prove the most economically attractive use, at least in the short to medium term. Another option is the deployment of digital multimedia broadcasting (DMB), which adds MPEG4 video capability and a more efficient audio coding method to T-DAB. DMB is being deployed in the Far East for mobile TV transmission and trials of this application are also underway in Europe, however the relatively large antenna requirement at Band III is a disadvantage for reception by small mobile

<sup>63</sup> Assessment of options for allocating available spectrum within VHF Band III and L-band, November 2004

<sup>64</sup> This is because Band III is used for broadcasting elsewhere in Europe.



terminals. L-band or the deployment of DVB-H in the UHF bands, subject to spectrum being available are likely to be more attractive for this application. The adoption of DMB as an “upgrade” to DAB for conventional sound broadcasting is being considered by a number of European countries and may be a more likely evolutionary route in Band III, especially if DVB-H frequencies become available in the shorter term.

In principle, the band could also be used to provide an additional TV channel, although this would be unlikely to be attractive for mainstream broadcasting as few TV receivers in the UK can receive VHF transmissions. The band could provide an opportunity for specialist transmissions however, such as HDTV transmission to pubs or cinemas.

Finally the band could be used to support programme making and special events (PMSE) applications. Parts of the (non-broadcast) Band III spectrum are currently quite intensively used for PMSE applications, including radio cars and radio microphones. Ofcom has proposed that the spectrum in Band III used for these applications (i.e. sub-band 3) be re-farmed for T-DAB use and so there is little sense in considering the use of the spectrum currently allocated to T-DAB for PMSE use.<sup>65</sup>

#### 5.1.4 Conclusions

Table 5.1 summarises our current views on the likely level of demand over the next five to ten years for existing and alternative applications in each of the bands considered. Our view is that there is likely to be excess demand from commercial applications for broadcasting spectrum in all bands for frequencies other than those that offer highly localised services (say with a coverage radius of less than 5km). This suggests that AIP should be applied in the bands currently allocated to radio services, except in the case of frequencies offering only a highly localised service<sup>66</sup>.

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<sup>65</sup> Radio - preparing for the future", Consultation Document, Ofcom, December 2004

<sup>66</sup> There is demand for these frequencies from community radio operators but only on the presumption that the spectrum is made available at a low cost.

**Table 5.1 Conclusions on spectrum demand**

<b>Band</b>	<b>Application</b>	<b>Likely demand</b>
LW/MW	AM broadcasting	Continued demand for national and regional licences. Over the longer term gradual decline for most services, especially where alternative platform available (e.g. DAB or FM), though demand for AM may continue to support reception in areas unserved by FM / DAB simulcasts, especially offshore, and to maintain current data service on 198 kHz
	Digital Broadcasting (DRM)	Could prove attractive for national SFNs and/or local, community stations, especially in areas where FM band is congested. This will depend on receiver availability / prices and whether alternative spectrum (e.g. above 1611 kHz) is made available for digital migration.
Band II	FM broadcasting	Demand likely to remain high for the foreseeable future, due to prevalence of low cost FM receivers. No obvious demand from any alternative applications in the next 5-10 years though migration to digital reception is possible beyond this timeframe.
Band III	DAB	Appears to be demand for further commercial multiplexes, particularly at national and regional level.
	T-DMB	Could be demand for delivering mobile multimedia, especially if switchover timetable hinders DVB-H deployment. L-band and DVB-H are likely to be more popular in longer term.
	TV	Unlikely to be attractive as current UK TV sets / STBs not VHF compatible but could be used for specialist transmissions, e.g. HDTV to public places (though even here satellite is likely to be more cost-effective).
	PMR	Demand is likely to be weak because of the cost and limited availability of equipment.
	PAMR	Little demand for additional spectrum.
	PMSE	Demand arises from the fact that PMSE is being removed from other parts of Band II to make way for T-DAB

## 5.2 Constraints on use

### 5.2.1 Introduction

Radio broadcasters' flexibility to use spectrum is constrained by

- international controls to avoid harmful interference
- technical transmission parameters which in turn impact on coverage and sound quality
- controls on the allocated use of spectrum
- within the allocated use, controls on the type of programme service.

Environmental planning regulations and procedures comprise a further category of constraint on the location of masts and so transmission sites. We assume that these regulations and

public attitudes to the location of masts mean that the location of high powered transmission sites cannot be changed.

To appreciate the implications of some of these constraints the following technical aspects of spectrum use need to be borne in mind.

- AM and FM radio services have the potential to cause interference over relatively large distances. For example, the coverage of a small FM relay in West Dorset is constrained by interference from a main transmitter in Kent. In the case of AM services, the interference potential is on a continental scale. This means that if a station changes its use of spectrum in area A, then this could have knock-on effects in numerous other areas. To release any spectrum that might be made available by reducing the power of transmissions in a given area, the frequencies used by many other broadcasters would need to be changed
- DAB is planned by allotment, and not by specific assignments. DAB multiplex operators therefore have the opportunity to substitute a high powered station with many lower powered ones in an SFN and thus reduce exported interference, though transmission costs would increase.

### 5.2.2 International constraints

Our starting point is to assume that the Geneva 75 and 84 Plans for analogue radio and the plan to be agreed at the Regional Radio Conference (RRC) 2006 for DAB and bilateral agreements between the UK and other countries concerning spectrum use cannot be breached. The plans and agreements specify the location, power and frequencies used by certain (high powered) broadcast transmitters. We assume that as a result of international agreements the location of the main analogue radio transmission sites and the frequencies used at these sites cannot be changed in a manner that would impact on interference to other countries. In practice this means that transmissions at these sites cannot be changed.

There will be greater flexibility, in principle, built into the plans for digital services that will be negotiated at RRC 2006, in that planning will be based on an allotment of frequencies to areas, rather than the assignment of specific parameters to specific transmitter sites.<sup>67</sup> Hence changes that do not cause agreed interference limits to be exceeded need not be co-ordinated. It is, however, likely to be very difficult to change the pattern of use greatly, without updating the plan. This could take many years to negotiate.

### 5.2.3 Coverage obligations

The broadcasters' coverage obligations vary. The BBC has rather loosely specified obligations, that derive from the Charter and the Agreement, to provide national and regional radio services and local radio in localities with a reasonable size population.

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<sup>67</sup> Although the existing assignments at the main sites will be 'embedded' within the allotment plan.



National commercial analogue radio licensees must reach over 70% of the population, while the national commercial multiplex operator (and the BBC's national multiplex) are expected to achieve more than 85% coverage.

Local radio services have a maximum coverage areas written into their licences. These obligations tightly constrain the location and coverage of services and reflect public policy objectives in respect of the provision of local radio services. It is expected that if these constraints were removed stations would seek to amalgamate on a national or regional basis with stations focussed on the main population areas.<sup>68</sup> This is because there are considerable fixed costs associated with running a radio service and so stations are more profitable if they cover a large population base.<sup>69</sup>

#### **5.2.4 Sound quality**

For analogue radio, quality regulation could be relaxed by removing requirements for stations to broadcast in stereo. A switch to mono transmission would reduce the power required for a given coverage area and hence the interference exported, though many stations may choose not to do this because of the impact on their audience. As an indirect consequence of this, stations would lose the capacity to transmit Radio Data System (RDS) data (e.g. station name and links to traffic information) with the programme service. The display of the station name is now standard on in-car radios<sup>70</sup> (and increasingly on portables) and is an important mechanism for attracting or retaining listeners. In addition, the RDS traffic data service carried by the Classic FM network is separately licensed by Ofcom as a datacast service. Numerous broadcasters would have to switch and replanning of the overall network would be necessary to realise the potential gain of such changes.

Ofcom is considering relaxing the minimum bit rate on DAB services and replacing it with a co-regulatory system to maintain quality based on a number of variables. This would give commercial multiplex operators more flexibility to respond to choose the mix of quality and number of services that would maximise profits. We note there are already concerns from listeners that audio quality on some DAB stations is below that of alternative platforms even with existing bit rates, due to the relative inefficiency of the DAB codec.

#### **5.2.5 Allocated use**

As long as the UK complies with the interference limits implied by international agreements, it can in principle use the spectrum for any of the primary or secondary allocations given in the ITU Radio Regulations (RR) for the bands in question. The spectrum could even be used for other services subject to compliance with Article 4.4 of the RR (essentially meaning operation on a non-protected, non-interference basis). The allocated use of the spectrum may however be limited by the UK frequency table.

Strict controls on the use of the broadcasting bands derive from the requirements to provide radio broadcasting services given in the Broadcasting Acts 1990 and 1996, the BBC's Charter

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<sup>68</sup> See "Economic study of commercial radio licensing", Spectrum for Ofcom, December 2003

<sup>69</sup> Evidence supporting this view is given in Figure 12, "Radio - Preparing for the future", Phase 1: developing a new framework, Ofcom, 15 December 2005.

<sup>70</sup> In car listening comprises about a third of total listening.



and Agreement, and the Communications Act 2003. A further control on the use of spectrum by digital services is also given by limits contained in multiplex operator licences on the amount of multiplex capacity that may be used to transmit non-programme related data services. The current limit is 20% for radio.

### 5.2.6 Type of programme service

Spectrum is reserved for BBC services, national, regional and local commercial radio services, and for community radio services. Removing these constraints but still requiring broadcasting use of the spectrum could in principle allow spectrum to be reassigned between different services to achieve a more market-based set of assignments. This would imply a significant departure from current broadcasting policy.

### 5.2.7 Conclusions

Radio broadcasters' spectrum flexibility under current constraints is summarised in Table 5.2. This suggests that there is some, albeit limited, scope for analogue broadcasters to change their spectrum use in the short term. In the longer term, changes might be possible through replanning the FM band and/or migration to digital technology. DAB broadcasters have more scope to change their spectrum use through the use of low powered SFNs. Whether it is economic for broadcasters to make these changes will depend in part on the cost of spectrum access.

**Table 5.2: Conclusions on flexibility in spectrum use**

Service	Scope for change under current constraints
Analogue radio	Limited to flexibility within current coverage obligations Change of ownership of radio licence, subject to ownership controls In the longer term migration to digital technology (DRM or DAB) or changes in the geographic distribution of use through replanning the FM band
Digital radio	Possible through use of more lower powered transmitter sites

#### 5.2.7.1 Analogue radio

In the case of analogue radio, it is difficult for licensees to change their transmission parameters (e.g. to use a lower power, or a less elevated site) so that they reduce the level of exported interference. This is because there needs to be a mechanism by which the band might be re-planned after any such modification, to exploit the lower interference levels. The example shown in Box 5.1 shows the extent of replanning could be considerable and so is unlikely to happen unless the stations concerned are all under common ownership.

**Box 5.1: Case of replanning radio services around London to increase the value of spectrum use<sup>71</sup>**

Consider the case of the local radio services at Guildford and Southend, which are often said to be 'blocking' a channel in London. This is, to a large extent, correct, but the complexity of the situation becomes clear when the detail is examined.

The Guildford transmitter operates on 96.3 MHz, that at Southend on 96.4 MHz. If neither of these transmitters were used, it would be possible to make use of one of the two channels to cover the London area. However, while these two stations are the dominant interferers, there is also a station at St. Albans on 96.6 MHz and in North-West Kent on 96.7 MHz. Both of these stations would suffer unacceptable interference if a new London service were to be introduced, and they would also be likely to generate significant interference within parts of the London service area due to their greater proximity of the services.

A further complication is that it is not only by virtue of outgoing interference power that an existing service constrains the use of a channel in a given area, but by also by requiring protection from interference. The interference to, and from, continental stations might also need to be considered.

If Guildford (for example) were to close, to avoid AIP, the Southend transmissions would continue to block a London service, and overall spectrum efficiency would have worsened. Co-operation between Southend and Guildford is required to offer any possibility of an improvement in spectrum efficiency. However, while it might appear that Guildford and Southend could co-operate to close the existing local services, and to provide a joint Guildford-London-Southend service, this would require additional power to be radiated that would be likely to cause interference further afield.

Radio station operators would need to weigh the disruption caused (e.g. by frequency and coverage area changes) against the gains in spectrum capacity that would be likely to arise. We imagine many stations would not wish to change their broadcast frequency or coverage areas unless the benefits from doing so were considerable (i.e. AIP was high) given the station frequency is often part of the station brand or identity.<sup>72</sup> There are cases however, where some benefits might be realised from applying AIP. An example is given in Box 5.2.

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<sup>71</sup> Note in this example we abstract from any public policy issues that might be associated with replanning the spectrum.

<sup>72</sup> Broadcasting policy could also limit the scope for making these changes.



### **Box 5. 2: Example of incentives that might arise from applying AIP**

As a case study, we consider a hypothetical scenario involving the national commercial FM service, Classic FM. This service uses a network of some 40 high and medium power transmitters to provide a service that covers more than 80% of the population. Were AIP to be applied, Classic FM might make the decision to cut back this network to provide an FM service only in the major urban areas. Coverage elsewhere would continue to be available via DAB. Such a decision might leave an FM service provided by some 6-10 transmitters. Such a reduction in the transmitter network might then allow the re-planning of frequencies within the Classic FM sub-band (~100-102 MHz) to accommodate a further tier of urban radio stations.

At first sight, it might be thought that the savings in AIP from these actions would be small, as the transmitters switched off would be located in areas of relatively low population density. However, it must be remembered that AIP is typically determined on the basis of the population within the *interfering* field strength contour. For a rural transmitter, such as Ridge Hill (Herefordshire) this is likely to encompass at least one dense urban area, such as Birmingham. The AIP savings would thus be considerable.

This example illustrates the opportunity cost associated with the coverage requirements imposed on Classic FM and that AIP might be used to encourage migration to digital where this is economic. To achieve the potential gains in spectrum efficiency there may need to be a change in broadcasting policy.

In the longer term, AIP could provide an incentive for digital migration. DRM in particular offers the potential for gains in spectrum efficiency for national services by enabling single frequency networks to be deployed.

#### **5.2.7.2 Digital radio**

Different considerations apply in the case of DAB. Regional DAB services, unlike FM stations, have the scope to tailor their networks so that exported interference is minimised. This is because one frequency can be used in an SFN, whereas in the FM case new frequencies would have to be found for each low power transmitter. A single, high power, high elevation transmitter (as is traditionally used for FM services) will at best provide only an approximation to the target service area and is likely to sterilise an area several times the coverage area. A network of lower power DAB transmitters using directional aerials located around the edge of the target service area and pointing inwards will provide a significant reduction in exported interference, enabling greater re-use of the spectrum resource. Of course, additional network costs will arise from the multi-site approach. Where spectrum is scarce, AIP could be used to provide an incentive to minimise exported interference.

### **5.3 Implications for spectrum pricing**

There is likely to be excess demand for spectrum in analogue and digital radio bands from organisations wishing to operate national and regional radio services, and possibly also DMB services in VHF Band III, over the next 5-10 years. This suggests that AIP should be applied to this spectrum.



When determining the approach to estimating the opportunity cost of spectrum for analogue radio services we will take account of the possibility of moving to digital operation and the “rent” earned by existing licence holders. For VHF Band III, we will consider opportunity costs based on the substitution of more transmitters for spectrum and the potential value of the spectrum for providing DMB services. The detailed approach and estimates are given in Chapters 6 and 7, respectively.

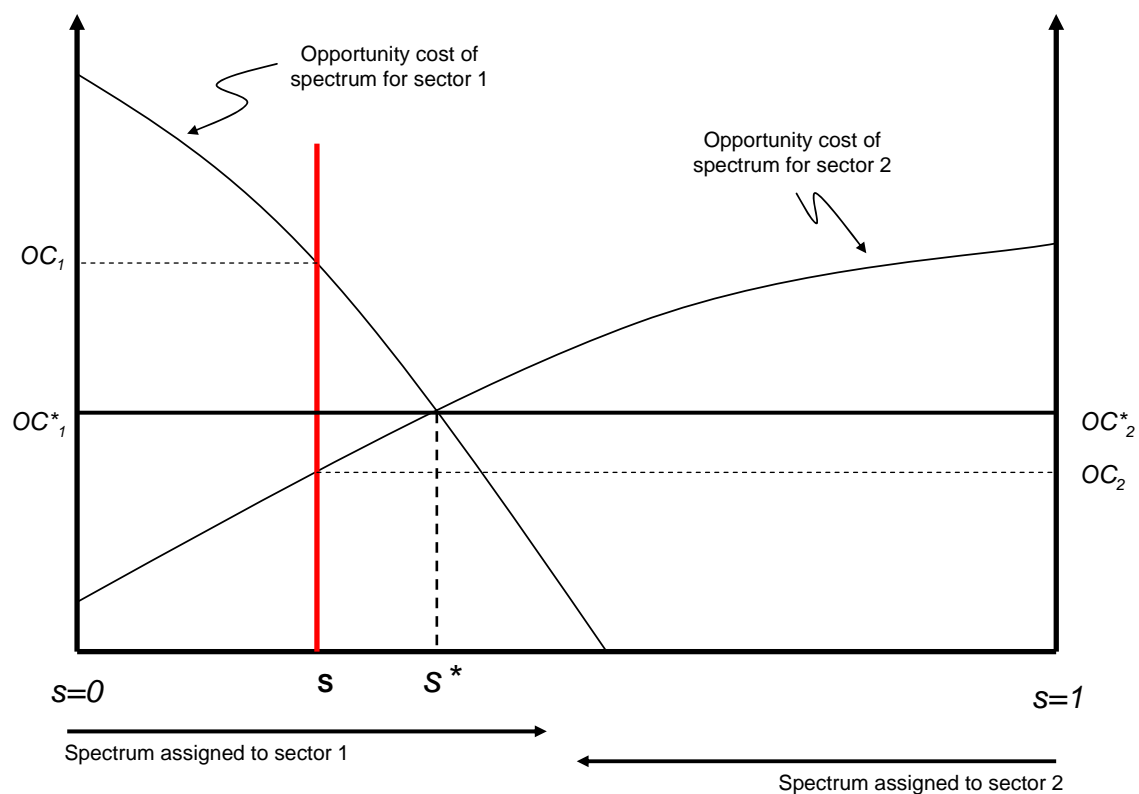


## 6 Methodology

### 6.1 Introduction

The issue addressed in this Chapter is how, in principle, spectrum prices should be set to give broadcasters incentives to promote efficient spectrum use. As a general matter, efficient use of spectrum is promoted if users pay a price equal to the opportunity cost of the spectrum<sup>73</sup> i.e. the marginal value of output forgone when spectrum is used by a particular use or user rather than the next best alternative. The task is to estimate the opportunity cost (i.e. marginal value) of spectrum for current and potential alternative uses. Opportunity costs of spectrum for the simple case where there are two possible uses of a block of spectrum are shown in Figure 6.1, where the current allocation between the two uses is shown by the vertical red line.

**Figure 6.1 Opportunity cost functions for a given set of final outputs**



The efficient allocation of spectrum is at  $S^*$  where the opportunity cost for each of the two uses is equalised, that is where  $OC^*_1 = OC^*_2$ . The price should be set at this level to achieve the efficient allocation. In practice, we do not know the shape of the opportunity cost curves but can estimate  $OC_1$  and  $OC_2$ , the opportunity costs of spectrum to user 1 and 2 respectively, at the current spectrum allocation and we know the price should lie between these two values.

<sup>73</sup> In Chapter 2 we show that prices of inputs should be set at the conditions necessary for productive efficiency i.e. at their opportunity cost.



In this Chapter, we describe the current approach used to estimate the opportunity cost of spectrum for a particular use and then discuss aspects of the way spectrum is used for broadcasting (and potentially other services) that could mean this approach needs to be extended. A possible extension is discussed and the role of market information from trading and auctions in informing spectrum prices is also considered. Finally, we set out how opportunity cost estimates could be used to set prices.

## 6.2 Current approach

Opportunity cost estimates for spectrum used by mobile and fixed users have been calculated as the change in input costs that would occur if an average user was given access to a small amount less (more) spectrum. The additional cost (cost saving) depends on the application and is calculated as the estimated minimum cost of the alternative actions facing the user. These alternatives may include

- investing in more/less network infrastructure to achieve the same quantity and quality of output with less/more spectrum
- adopting narrower bandwidth equipment
- switching to an alternative band
- switching to an alternative service (e.g. a public service rather than private communications)
- switching to an alternative technology (e.g. fibre or leased line rather than fixed radio link).

To calculate estimates using this approach assumptions are required concerning

- The change in the amount of spectrum to which a user has access.
- The nature of a “representative” user for which opportunity costs are estimated .
- The maturity of existing networks, level of service demand and a variety of cost factors, including equipment and operating costs, and discount rates and the discount period used to convert one-off costs into annualised values.

Demand and cost issues are always problematic because many estimates are forward looking, but applying the method to broadcasting poses no more challenges than other services. This is not the case for the other two sets of assumptions and below we discuss issues that arise in their application to broadcasting.

### 6.2.1 Change in amount of spectrum

The current approach assumes that the output produced by a user is the same before and after the change in spectrum use and changes in spectrum use are small (i.e. marginal). If the only feasible changes in spectrum use are large, say because of indivisibilities in the amount of spectrum that can be used to provide the service, then the assumption of constant output could significantly bias the opportunity cost estimate. The optimal action for the user may be to make changes in the level of output as well as, or instead of, increasing the amount of non-spectrum inputs or using an alternative technology or platform when denied spectrum access. This situation may apply in the case of broadcasting use of spectrum for the following reasons

- broadcasting networks are relatively sparse (in terms of the number of transmitters) so that many changes in spectrum use are not marginal
- the technology, in particular analogue technology, may not allow capital/spectrum substitutions at the margin because it is often not possible to expand the transmitter infrastructure without requiring further frequency resources. Thus, while a DAB network may be able to reduce exported interference through the use of a larger number of lower-powered transmitters, additional transmitters in an analogue network would require new frequencies.
- there are severe constraints on changing spectrum use because of the impact on interference to other services in the UK and elsewhere in Europe. This makes capital/spectrum substitutions at the margin difficult to achieve.

We illustrate these points with two examples – FM radio and digital TV.

For the case of FM radio, assume the broadcaster is denied access the spectrum it uses. The broadcaster could either go out of business, in which case there may be a loss of producer surplus (i.e. super-normal profits)<sup>74</sup>, or seek to deliver the service over alternative platforms such as satellite, DTT, 3G networks and the internet. If alternative delivery platforms are used then there will be a reduction in the number of listeners, given that it would be uneconomic to supply listeners with free replacement receivers for these alternative media and some media do not offer portable reception. The cost to the broadcaster would comprise the change in profitability of the service when moving from FM transmission to an alternative platform. If the less drastic option of reduced access for part of the existing coverage area was permitted by the regulator, then the broadcaster would lose the revenues and so profits associated with the lost audience. Any changes in transmission costs are likely to be small unless the area is served by several transmitters.

For the case of digital TV, assume a multiplex operator is denied access to an 8 MHz frequency channel at all transmission sites. This would result in a loss of coverage i.e. reduced output. Output could be restored by enabling households that can no longer receive the service to receive it via cable or satellite. However, this will only be worthwhile if the additional cost (i.e. the cost of household conversion less the cost of DTT transmission) is less than the net revenues earned from the households who receive the service via cable or satellite. If maintaining the level of output is not worthwhile, then the broadcaster may choose instead to reduce service coverage (i.e. not fund household conversion).

This suggests that we need to add a further step to the approach to estimating opportunity costs for a particular service, namely a check on whether the “least cost alternative” approach is more or less profitable than reducing output and thereby forgoing some surplus.

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<sup>74</sup> Note we are not concerned with consumer surplus from the spectrum using service as this does not affect the producer's valuation, as consumer surplus is that benefit which the producer is not able to capture. See the discussion in Chapter 2, Section 2.1.





### 6.2.2 Nature of a “representative” user

As discussed in Indepen et al (2004) when opportunity costs are calculated an “average” firm is taken as a representative of all firms in a use area.<sup>75</sup> In practice, some firms in a use will find the AIP price too high, and other firms will find the price lying below their opportunity cost values. For AIP to work well, the selection of the representative firm has to be undertaken carefully.

In the case of TV and radio broadcasting different users have different licence obligations, in terms of coverage, output and various technical requirements, and these could affect the estimated opportunity cost value. A single measure of the opportunity cost may be calculated however by taking an average value or a weighted average value, where the weights to use could be the amounts of frequency in the different sub-uses.

## 6.3 Non-marginal spectrum changes

In principle, opportunity cost estimates could be derived by seeking to mimic the process a user goes through when deciding how much to pay for spectrum in a market, say through trading or auctioning the spectrum. In market transactions the user would be prepared to pay up to the net present value of the producer surplus or cost savings that accrue from buying an additional block of spectrum. This sum could be calculated by projecting and discounting the revenues and costs associated with having additional spectrum (or being denied access to spectrum). The lump sum value would need to be converted to an annual stream by applying the discount rate that the hypothetical spectrum user would use when calculating the amount it would pay in a market. This approach is similar to that used by Ofcom when determining the annual licence payments made by Channels 3 and 5 and national commercial radio licensees.<sup>76</sup>

An approach to estimating opportunity cost based on notional auction or traded values is not fundamentally different from the least cost alternative approach described above. This can be seen by noting that the producer surplus from additional spectrum is derived from

1. The reduced cost of supplying the service, as compared with the cost of supplying the service using less spectrum, a less desired frequency band or a wired alternative, (assuming such alternatives exist and are economically viable)
2. The additional surplus (i.e. above normal profits) from output produced using additional spectrum. This surplus is made possible by the exploitation of market power (which in turn derives from the reduced competition caused by spectrum scarcity).

Both these elements allow the spectrum user to earn producer surplus as compared with an organisation supplying the same service but with access to less spectrum. The second element is not relevant when output is assumed to be constant.

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<sup>75</sup> See Chapters 4 and 6.

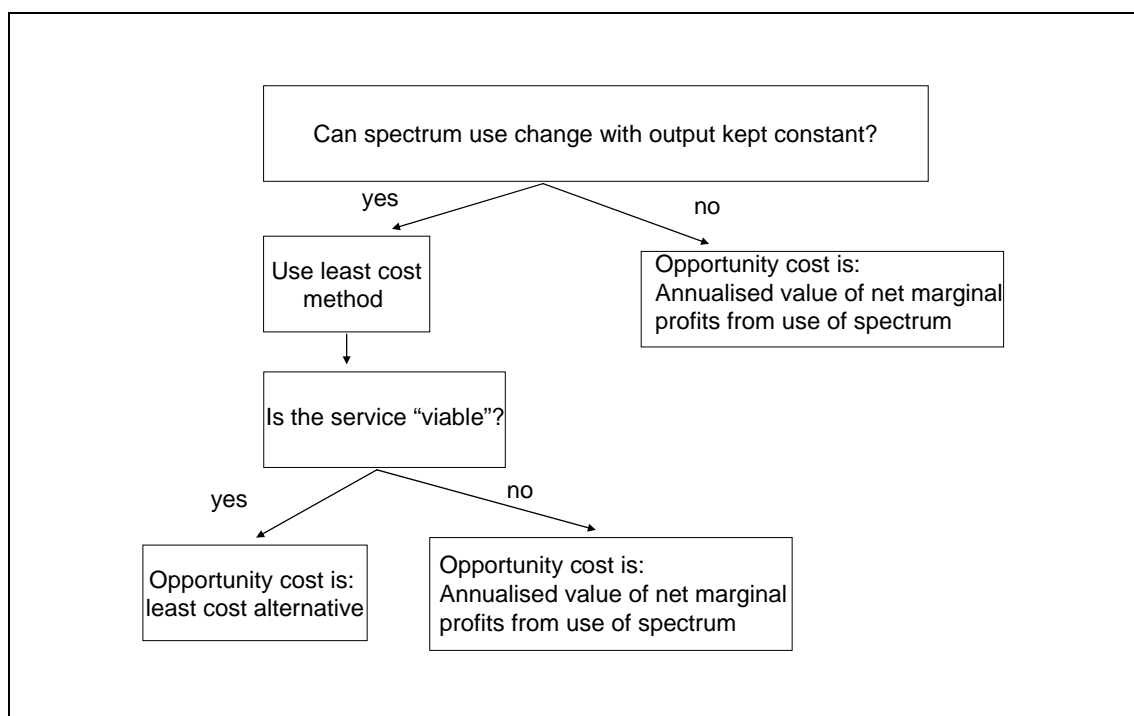
<sup>76</sup> “Methodology for reviews of financial terms for Channel 3, Channel 5 and Public Teletext licences”, Ofcom 13 October 2004



The need to take account of service profitability in calculating the opportunity cost of spectrum is informationally much more demanding than an approach based solely on costs of alternative ways of supplying the service. This is because revenues as well as costs need to be taken into account, the profit maximising level of output needs to be determined and calculations may need to take account of total revenues and costs and demand elasticities rather than just marginal costs. In addition, the profitability of existing broadcasters is importantly determined by their output and coverage obligations. We therefore favour use of the least cost alternative approach where this can be applied practically.

Figure 6.2 summarises a hierarchy of tests we propose to apply when calculating opportunity cost. The “viability” test is required after working out the opportunity cost for the least cost alternative because the alternative may be so expensive as to put an efficient broadcaster out of business.<sup>77</sup> If this is the case, we fall back to an approach based on broadcasters’ profitability.

**Figure 6.2 Approach to estimating opportunity cost for a particular service**



## 6.4 Use of market information

There are potentially several sources of information about the opportunity cost of spectrum that are revealed by market transactions. Service licences and the associated spectrum are occasionally traded and/or sold at auction, and there is a market in radio/TV multiplex capacity, where a fraction of the traded price of this capacity will reflect the value of spectrum

<sup>77</sup> Increased costs may not be able to be passed on to consumers in the case of advertising funded services, as the price of advertising is determined largely by competition in the advertising market and not the cost of the advertising medium.

when used for radio/TV. In time the spectrum itself may be tradable.<sup>78</sup> The question we consider is whether market price information could be used to estimate the opportunity cost of broadcasting spectrum.

#### 6.4.1 Traded licences

There is no planned date for the introduction of trading of spectrum licences in radio and TV bands. However, change of ownership of Broadcasting Act licences effectively involves a trade of assets that include the associated access to spectrum. The value of these trades reflects amongst other things the opportunity cost of the spectrum traded. The value of other assets (including the station brand) would need to be deducted from the traded value to give a value for the spectrum. Consideration then needs to be given to whether the trade was of a “representative” or average licence and so could be used to derive an estimate of opportunity cost for all broadcasting use of the band in question.

If AIP was linked to observed trading prices this could discourage trade (or at least discourage transparent trades). Linking AIP to observed traded prices could also discourage innovations that raise the value of existing spectrum. To minimise these disincentives to innovate one option would be to commit only to using information from trading with a lag in setting administered prices – this may result in any case from the necessary administrative lag in resetting AIP.

We note that as changes in the ownership of broadcasters do not happen frequently it is possible that values will fluctuate according to the specific circumstances of the deal (e.g. degree of bargaining power of the parties to the bid) potentially making the outcome an unreliable indicator of opportunity cost.

#### 6.4.2 Auctioned licences

There is provision in the Communications Act for auctioning general DAB multiplexes and the prices could provide information concerning the opportunity cost of DAB spectrum. It is also expected that the fourteen channels released by digital switchover will be auctioned on a technology and service neutral basis. The auction prices price could be used to set an AIP for continued analogue TV use of the spectrum, given that analogue use will block release of the 14 channels.<sup>79</sup> However, for the channels reserved for DTT services the auction price is likely to exceed the opportunity cost of the spectrum because

- The market clearing price could be determined by the value to a non-DTT user and users of the reserved channels would not be permitted to change their spectrum use
- If the reserved DTT spectrum was also released onto the market a lower market clearing price would be expected in the first instance.

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<sup>78</sup> Ofcom has suggested that spectrum used by broadcasters may be tradable after 2007, though this is under review. A Statement on Spectrum Trading, Statement, Ofcom, August 2004.

<sup>79</sup> This assumes the auction is held in advance of the official switchover date.



The latter point applies generally to prices yielded by auctions of alternative spectrum. One way of dealing with this might be to set prices based on the bids of bidders that did not win licences in the auction.

We also note that that if large blocks of spectrum are auctioned then the auction prices may also overstate the marginal value or opportunity cost of the spectrum.<sup>80</sup> They would only be relevant if the broadcaster faced an all or nothing choice about its use of spectrum.

#### **6.4.3 Multiplex capacity charges**

If multiplex operation is profitable, then multiplex capacity charges will need to cover the costs of distributing, multiplexing and transmitting services and a return for the multiplex operator<sup>81</sup>, in addition to the value of spectrum. Hence an estimate of the value of the spectrum could be obtained by subtracting the multiplex operator's costs and an estimated return from market determined multiplex charges.

There is market information concerning DTT and DAB multiplex charges and this could be used to estimate the opportunity cost of the spectrum, assuming the spectrum is used for broadcasting. We note that current charges for capacity on DTT multiplexes could be a poor guide to values post switchover, as after switchover much more capacity will be available (from the 14 release channels). However, over time as the switchover plans become clearer we would expect the potential release of additional spectrum and changes in demand to be anticipated and reflected in the price of multiplex capacity.

#### **6.4.4 Conclusion**

Market information could provide a useful indicator of the opportunity cost of spectrum. In using this information, it will be important to

- Check that the market values arise from a situation comparable to that for which opportunity costs are required, and if not to understand any biases in the values
- Take account of the value of payments for resources other than spectrum

### **6.5 Setting prices using opportunity cost**

A generalised approach to setting AIP using opportunity cost was presented in Indepen et al (2004) and we propose to use this when determining AIPs. It involves an iterative approach to setting prices which can be summarised as follows

- For a given frequency band identify the current and other potential uses of the band.

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<sup>80</sup> Basing AIP on auction prices for licences captures the super-normal profits for all of the spectrum used by an operator, not just the marginal amount. These values are likely to exceed the efficient price.

<sup>81</sup> Returns to the multiplex operator could be above normal levels if the multiplex operator has market power.

- Calculate the marginal opportunity cost of spectrum for the current use of the band and other uses until a use is found which has a higher marginal opportunity cost than the current use.
- If there is a use with a marginal opportunity cost higher than the current use of the band then set the AIP between the two values, but towards the bottom end of the range of values in the first instance.
- If there is no use with an opportunity cost higher than the current use of the band then set the AIP at the value for the current use.

Figure 6.1 above illustrates the rationale for this iterative approach.

This approach assumes that it is possible to reallocate spectrum from the current use of the band in question to other potential uses. The feasibility of achieving this over users' time horizons for making both short and long term spectrum use decisions needs to be considered. If it is not likely to be feasible to reallocate the spectrum in these timescales, then only the opportunity cost for the current use should be used to determine AIP. These tests will need to be applied when prices are set taking account of broadcasting policy constraints e.g. whether certain spectrum is reserved for broadcasting rather than other applications.

## 6.6 Conclusions

In summary, we propose an extension to the least cost alternative approach to estimating marginal opportunity cost to address the particular features of broadcasting use of spectrum. This involves estimation of values based on what a user would pay for the spectrum in an auction (i.e. annualised values of the producer surplus from the use of the spectrum) in circumstances where the least cost alternative approach is not appropriate because the assumption of constant output is not feasible. In doing this care will need to be taken to ensure values are estimated for a representative or average user.

We also suggest that market information obtained through licence trading, auctions or secondary markets (e.g. the market for multiplex capacity) could be used to derive opportunity cost values, so long as care is taken to make any adjustments necessary to give a "like for like" comparison with the situation for which opportunity cost estimates are required. If AIP is linked to observed trading prices, then to minimise disincentives to innovate one option would be to commit only to using information from trading with a lag in setting AIP. Alternatively traded prices from one area might be used to inform prices in another.

Finally, opportunity costs should be estimated for all potential uses of the band and then prices set in the range between the opportunity cost for the current use and the highest value alternative use. If there is no higher value use of the band then the price should be based on the opportunity cost for the current use.



## **7 Estimating Opportunity Costs and Setting AIP**

### **7.1 Introduction**

In this Chapter we derive opportunity cost estimates for the broadcasting bands to illustrate the methodology described in Chapter 6 and consider how these estimates might be used to set AIP. In developing our estimates we have taken account of the potential uses of the spectrum and constraints on its use discussed in Chapters 4 and 5. In addition, our recommendations concerning the use of opportunity cost estimates to set AIP assume that the mechanisms for focusing any subsidies on broadcasting outputs discussed in Chapter 3 are implemented. If this is not possible for practical and/or political reasons then there is still a strong case for using the opportunity cost estimates in any appraisal of spectrum allocation decisions and applying the estimate to the relevant government agencies.

There are numerous uncertainties concerning the opportunity cost estimates we have produced, not least those concerning the likely future market, business models and implementation of new technologies for delivering mobile multi-media content. These technologies could potentially use a number of frequency bands, including the broadcast bands we are considering. We do not make any judgement as to which (if any) of the bands will eventually be used. Mobile TV services in Band III, UHF and L Band are all considered possible, however, in practice not all of these are likely to occur. AIP may not be introduced for a number of years and in the intervening time, markets will evolve in ways we have not anticipated and the costs of providing services will differ from those we have assumed. More reliable estimates, possibly based on market transactions, should be produced nearer the time AIP is introduced.

### **7.2 UHF TV spectrum**

After the completion of switchover it is expected that some of the spectrum will be reserved for DTT, excluding the interleaved spectrum. It is also expected that the 14 cleared channels will be auctioned. If analogue TV services continue transmission beyond the prescribed regional switchover date, then they will block the provision of these services and so they should face a price that reflects the opportunity cost of spectrum for mobile TV and additional DTT services.

The opportunity cost of spectrum reserved for DTT services will need to take account of the regulatory limitations placed on the use of the spectrum and the availability of the release channels. These limitations are not known with certainty, however, for the purposes of this report we assume that the band will be used primarily for the transmission of DTT services, where these may be in standard or HDTV format. We also assume that

- Three multiplexes are designated as PSB multiplexes
- PSB multiplexes must meet a “universal” (i.e. 98.5%) coverage obligation
- PSB licensed programme services must continue to be broadcast on the same regional basis as currently applies



- Commercial multiplexes must achieve at least 73% coverage.

The only real choice facing PSB multiplexes is to move to an alternative transmission platform (e.g. satellite or cable) while maintaining coverage, while commercial multiplexes also face a choice of extending coverage using DTT or an alternative platform.

Table 7.1 lists the opportunity cost values that need to be estimated and our proposed method for estimating these values.

**Table 7.1: Approach to estimating opportunity costs for UHF spectrum**

Service	Method
Mobile broadcasting (DVB-H)	Cost of denying access to new DVB-H services so that either <ul style="list-style-type: none"> <li>• traffic must be carried on a conventional 3G mobile network<sup>82</sup></li> <li>• L-band must be used rather than UHF spectrum</li> </ul>
Analogue TV	Cost to broadcasters of being denied access to UHF spectrum estimated by <ul style="list-style-type: none"> <li>• The cost of migrating viewers to DTT or satellite reception. (Note cable is always more expensive than satellite so is not considered.<sup>83</sup>)</li> </ul>
DTT	Cost to broadcasters of being denied access to UHF spectrum estimated by <ul style="list-style-type: none"> <li>• Cost of migrating viewers to satellite reception</li> <li>• Value of spectrum implied by multiplex charges</li> </ul>

## 7.2.1 DVB-H

### 7.2.1.1 DVB-H as an alternative to additional UMTS capacity

The recent launch of 3G mobile services, providing on-demand audio and video content that is tailored for mobile terminals, has stimulated interest in the delivery of broadcast content to these devices. A variant of the DVB standard has been developed, known as DVB-H (Handheld) that is optimised for reception by mobile devices. DVB-H has the potential to deliver up to around 40 TV channels or video streams per radio frequency (RF) channel at a highly compressed bit rate (typically 256 kbit/s) that is suitable for viewing on small handheld devices.

The principal benefit that DVB-H offers is that it avoids the need to deliver audiovisual content to each subscriber independently, as is the case with a conventional mobile network. Delivering content individually to large audiences places a high demand on network resources, requiring investment in additional infrastructure to support the extra capacity. Hence the cost of delivering broadcast or streamed content over a conventional mobile network increases broadly in line with the size of the audience, whereas for DVB-H the cost is independent of audience size within a given coverage area. Hence for low audiences the conventional mobile network will be the most cost-effective solution and for high audiences DVB-H will be cheaper.

<sup>82</sup> Such a service is currently being offered by Orange in the UK and other operators elsewhere. See [www.mobitv.com](http://www.mobitv.com)

<sup>83</sup> The cable companies offer a basic service of £180/month (Telewest) or £120/month plus telephone rental (ntl). By comparison, the costs of satellite installation amortised over 5 years are in the range of £30-40/year. We do not expect the relative costs of the two services to change greatly over the next 5-10 years.





By considering the cost savings that might accrue to a mobile operator by using DVB-H for delivery of broadcast content rather than UMTS, it is possible to estimate the opportunity cost arising from the denial of spectrum for DVB-H. In doing so, it is important to consider the marginal costs for each platform, i.e. the cost of providing additional capacity in a UMTS network versus the cost of providing additional capacity in a DVB-H network. For the UMTS network, this additional capacity could be provided either by the use of additional frequencies at existing transmission sites (assuming these are available, e.g. in expansion bands) or by installing additional base stations. The latter will be more expensive due to the additional site acquisition and rental costs, however in an effective spectrum market these costs should be factored into the price paid for additional spectrum, hence we have chosen this approach for our valuation.

For the DVB-H network, we have considered the costs associated with the following three scenarios:

- i) rolling out a single DVB-H multiplex from scratch
- ii) adding a second DVB-H multiplex to an existing network
- iii) adding a third DVB-H multiplex to an existing network

The extent of the cost saving that DVB-H will provide relative to additional mobile network infrastructure will depend on various factors, most of which are highly uncertain given the currently undeveloped state of the mobile multimedia market. The factors include:

- Audience size: as noted above the value of DVB-H depends on there being a large audience for “real time” multimedia content such as television or streamed audio / video material. This in turn depends on factors such as the market penetration of video-enabled terminals and consumer preference for live broadcasts vs on-demand content. We have assumed a total mobile TV audience at the busiest time of 3 million
- Audience concentration: current “fixed” TV viewing is concentrated on a relatively small number of programme channels, comprising the five free-to-air analogue services, premium sports channels and a handful of the more popular digital-only channels. If mobile TV viewing patterns were to be similar to those of fixed TV and the first DVB-H multiplex were to include all the most popular channels, the value of that multiplex in terms of the saving in additional UMTS capacity would be far greater than subsequent multiplexes, since these would be catering for much smaller audiences. Recent viewing figures for multi-channel homes reported by BARB suggest that the forty most popular channels account for around 83% of the audience, the next most popular forty 8% and the third most popular forty 4%. Since a DVB-H multiplex can accommodate up to forty channels, we have used these three viewing shares to determine the audience for the first, second and third multiplexes in our calculations.
- DVB-H costs: these will be dependent on coverage and on whether one or more competing networks exist (assuming all mobile networks wish to provide the most popular broadcast content, there will be considerable cost savings in doing this over a single DVB-H network as with current TV services, rather than each network installing its own DVB-H infrastructure).



- 3G mobile costs: The costs incurred to provide additional capacity will include site acquisition, rental and equipment costs. We have aggregated these into a single annualised cost per base station, for which a range of values has been assumed.
- The number of channels that are required to provide national coverage. A national DVB-H network could be provided by means of either a single frequency network (SFN) or multi-frequency network (MFN). In the case of a single frequency network, the size of the individual coverage areas is constrained by the need to avoid interference between coverage areas, to a radius of around 30 km.<sup>84</sup> Hence it would not be possible to provide contiguous coverage on a national basis, but in practice this would not be necessary with DVB-H, since the coverage gaps could be filled by conventional mobile delivery (streaming over UMTS). By locating the coverage areas in the centres of greatest population it should still be possible to cover the majority of the population using a single frequency, assuming this was unconstrained by international co-ordination requirements.

It will be necessary to deploy an MFN where the available frequencies are not available nationally (due to international co-ordination requirements) or where coverage beyond what can be provided with an SFN is required. A theoretical minimum of three and an estimated practical minimum of four frequencies would be needed to provide contiguous national coverage in a DVB-H network.<sup>85</sup>

An SFN that concentrated on serving the most populated areas could serve the majority of the population, so the per-MHz value of the frequencies used in an MFN would inevitably be lower than the per-MHz value of the frequencies used in an SFN. We have therefore derived opportunity cost estimates for DVB-H on the basis of an SFN configuration, as this represents the maximum potential value. The values are based on 100% coverage and should be regarded as an upper bound on the value. This allows for potential technology developments that might overcome the coverage limitation that currently would apply to a single frequency DVB-H network.<sup>86</sup>

In order to assure a consistent approach to the various estimates in this section and for radio, the following common assumptions have been made:

- i. Assumed depreciation period and discount rate: we have assumed that network infrastructure has a 10-year depreciation period and is subject to an annual discount rate of 10%. These figures reflect those used for telecommunications networks in the previous Ofcom study on AIP.

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<sup>84</sup> The separation distance required is estimated to be around 40 km. These figures are based on discussions with Nokia.

<sup>85</sup> Although these frequencies could in principle be used for other applications in the areas where they are not used for DVB-H, in practice this utility would be limited due to the relatively high levels of interference generated by the DVB-H network (e.g. it is unlikely that the frequencies could be used to deliver any high power services (such as DVB-T) in any populated area since there would be insufficient separation from nearby DVB-T transmitters. The residual value of these frequencies (i.e. beyond the value accruing from their use as part of the DVB-H MFN) would therefore be limited and in practice the value of the additional channels would arise mainly from the additional population that could be served with the MFN as opposed to an SFN configuration.

<sup>86</sup> For example, the proponents of the proprietary MediaFlo<sup>®</sup> technology claim that this could provide substantially national coverage using a single frequency network.



- ii. Maintenance cost: we have assumed that all infrastructure has an associated annual maintenance cost equivalent to 12% of capital costs.
- iii. Site costs: we have used the figures from the previous AIP study, i.e. a site acquisition cost of £25,000 (depreciated at 10% over 10 years) and a site rental cost of £6,000 per site per annum.

Based on these assumptions, we have arrived at the estimates for the value of DVB-H spectrum shown in Table 7.2 below, based on an SFN configurations assuming that all the frequencies used provide national population coverage. Detailed calculations are presented in Appendix 2.

**Table 7.2: Estimates of the opportunity cost of spectrum for DVB-H multiplexes (assuming a total maximum audience across all multiplexes of 3m and national coverage)**

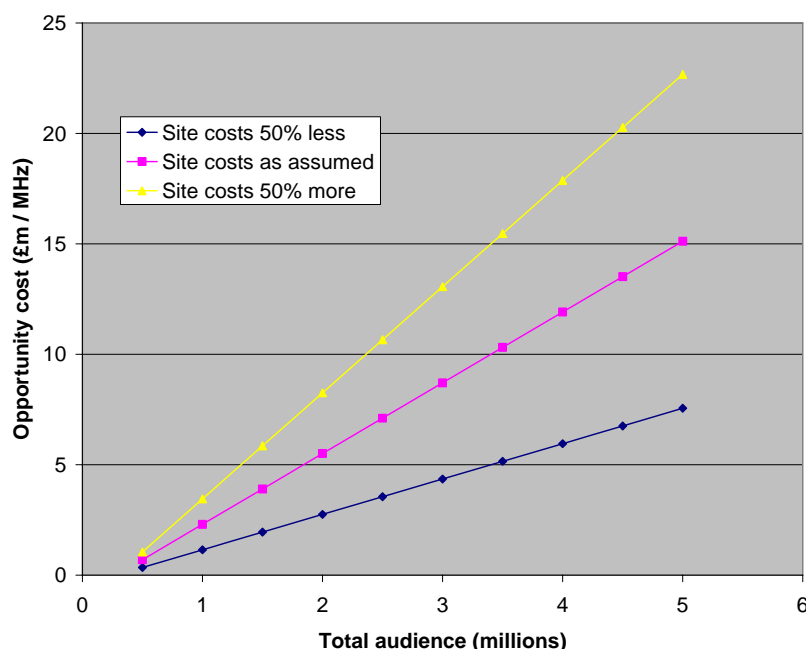
	<b>Opportunity cost – SFN (£m/MHz)</b>
First multiplex	84
Second multiplex	8.6
Third multiplex	4

These estimates show that the value of spectrum falls rapidly as the amount of spectrum assigned to a DVB-H operator increases. One implication of this finding is that the value of spectrum revealed through the auction of ,say, Channel 36 for DVB-H is likely to give a poor indicator of the opportunity cost of other UHF spectrum. More generally, AIP for the UHF spectrum should not be set based on the opportunity cost values derived for the first DVB-H multiplex.

Figure 7.1 shows the sensitivity to the estimate to the site cost and audience assumptions. Similar graphs for the first and third multiplex are given in Appendix 2.



**Figure 7.1: Opportunity cost of spectrum for a second DVB-H multiplex using an SFN by the number service users**



### 7.2.1.2 DVB-H in UHF (Band IV) rather than L-band

Based on discussion with industry experts, we understand the number of transmitters required at L-band to provide a national DVB-H network with around 80% population coverage would be around 4,200, compared with around 2,700 at UHF and the cost would increase by around 60% from £500m to £800m, i.e. the use of UHF would represent a cost saving of around £300m. Applying this cost saving to a national single frequency network operating in 8 MHz of spectrum would indicate a value of £37.5m per MHz for the UHF spectrum, equivalent to an annual value of £10m per MHz, assuming a 10% discount rate and 12% maintenance costs on the additional infrastructure at L-band. Note however that this ignores the cost that would be incurred in obtaining the L-band spectrum at auction.

## 7.2.2 Analogue TV

International interference constraints and regulatory coverage requirements mean that the only options for conserving on spectrum use and maintaining current levels of output for analogue TV broadcasters involve moving to alternative platforms, namely satellite or DTT, and paying the transmission<sup>87</sup> and household conversion costs for these platforms. The value derived from the costs of moving to satellite provides an upper bound on the opportunity cost, for if the value were higher DTT providers would not be using terrestrial transmission.

<sup>87</sup> Note that in the case of DTT transmission costs should include the opportunity cost of spectrum used for this service.

Table 7.3 summarises our calculations of the costs of moving all viewers to either satellite or DTT platforms at the date of switchover in each region. Details of the calculations are provided in Appendix 2. For the move to DTT we assume hypothetically that all five analogue channels are moved to a single multiplex that can be provided using 43MHz of spectrum (i.e. five to six 8 MHz channels) and that this spectrum has an opportunity cost of around £1m/MHz (i.e. around the middle of the range reported below).

Prices for analogue TV are intended to incentivise broadcasters not to delay switchover beyond Ofcom's proposed switchover date for each region. As switchover is being rolled out on a regional basis, switchover in given region at time T can only proceed if switchover has been achieved in other regions scheduled to have switched at time T-1. In Table 7.3, we present an average opportunity cost across all regions.

**Table 7.3 Estimates of average opportunity cost for analogue TV at switchover**

	Move to Satellite Platform	Move to DTT Platform
<b>Household conversion cost<sup>88</sup></b>	£960m	£398m
<b>Plus opportunity cost of additional spectrum</b>	0	£43m
<b>Less saving in annual transmission costs</b>	£96m	£76m
<b>Total cost</b>	£864m	£365m
<b>Spectrum released</b>	368 MHz (46x8 MHz)	325 MHz (assuming on average 43 MHz are required for a multiplex <sup>89</sup> )
<b>Value/MHz</b>	£2.35m	£1.12m

### 7.2.3 Digital TV

We have assessed values using two different approaches:

- i) The cost of moving to satellite. This provides an upper bound on the opportunity cost, for if the value were higher DTT providers would not be using terrestrial transmission.
- ii) The value of spectrum revealed through recent trades of multiplex capacity

We also considered whether it would be possible to derive estimates of opportunity cost based on the additional costs imposed on broadcasters wishing to transmit HDTV services. Operators wishing to offer existing services in HDTV will either have to

- displace 3-4 standard DTT services
- use an alternative platform or

<sup>88</sup> This is the annualised cost of household conversion, assuming costs are spread over 5 years for conversion to DTT and seven years for conversion to satellite (reflecting differences in equipment life) and a discount rate of 8%. At switchover 35.6m TV sets are estimated to require conversion.

<sup>89</sup> The six DTT multiplexes deny use to other users of 256 MHz (i.e. 32 8 MHz channels) after switchover.

- offer a more limited download service. This might involve using DTT multiplex capacity to “trickle” to service to PVRs.

Current estimates of the cost of the first option can be obtained from market data on the value of multiplex capacity, as is described further below. The second and third options are more difficult to quantify because they both require estimates of the, at present, unknown additional revenues that might be earned from HDTV as compared with standard TV services. Given these uncertainties we have not sought to provide estimates for this case.

### 7.2.3.1 Costs of moving to satellite

The frequency plan agreed at RRC06 will determine the number, location and transmission characteristics at the main DTT sites. PSB multiplexes have 98.5% coverage obligations and commercial multiplexes must transmit from the 80 main sites at specified powers etc. and must achieve a minimum of 73% coverage. In both cases, the only way spectrum use can be reduced below these thresholds is by moving to satellite transmission. We calculate a cost assuming all six multiplexes move and the cost of funding the conversion of households to satellite reception is borne equally by each multiplex operator. The results are summarised in Table 7.4.

**Table 7.4 Estimates of opportunity costs for DTT in 2012**

	<b>Cost of moving to satellite for all multiplexes</b>
<b>Cost of household conversion<sup>90</sup></b>	£917m
<b>Less saving in DTT Tx and distribution costs</b>	£159m
<b>Total</b>	£758m
<b>Spectrum released<sup>91</sup></b>	256 MHz <sup>92</sup>
<b>Value/MHz</b>	£2.96m

### 7.2.3.2 Value implied by the traded value of multiplex capacity

The difference between the market price for commercial multiplex capacity and the transmission costs of providing that capacity provides a ceiling on the opportunity cost of the spectrum. Values based on current data can be derived as follows.

Contracts for capacity for a single channel on each of the two Crown Castle multiplexes C and D is reported to have traded for prices of around £5m p.a.<sup>93</sup>, though we understand this estimate is on the low side. Pro-rating this up to a whole multiplex gives a value of around

<sup>90</sup> This is the annualised cost of household conversion, assuming costs are spread over seven years for conversion to satellite and a discount rate of 8%. In 2012 34.6m TV sets are estimated to require conversion.

<sup>91</sup> PSB multiplex operators make more intensive use of the spectrum than the commercial multiplex operators in the sense that re-use is higher, however, the use denied to others is roughly the same. There may be the possibility to re-use some of the frequencies used by commercial multiplex operators in areas with low population (perhaps by PMSE) and some adjustment for this could be made.

<sup>92</sup> This is derived assuming there are 14 release channels which leaves 32 8 MHz channels for DTT i.e. 256 MHz.

<sup>93</sup> See [www.digitalspy.co.uk/article/ds20326](http://www.digitalspy.co.uk/article/ds20326).



£40m p.a., assuming 8 TV services carried on a multiplex.<sup>94</sup> The annualised cost of providing this capacity and distribution of programmes is about £20m including a 10% margin on the annualised cost, and we allow £1m administrative costs of running the multiplex. This then gives the average net annual value of the spectrum for a single multiplex is £19m. Assuming 43MHz is used per multiplex, this gives a spectrum value of £0.44m/MHz.

#### 7.2.4 Implications for setting AIP

Table 7.5 summarises the opportunity cost estimates we have calculated for the UHF spectrum. The values for analogue TV are upper bounds on the value to existing analogue broadcasters, for if they were applied the broadcasters would move to another platform. Similarly the cost of migrating DTT viewers to satellite provides an upper bound on the opportunity cost for digital TV. The bottom end of the range for DTT is derived from what we understand to be a low estimate of actual market transactions and so may underestimate the opportunity cost. None of these estimates include the value of spectrum in those parts of the country that are not sterilised by TV broadcasts. In other words, the values underestimate the value of having a clear block of spectrum on a national basis.

**Table 7.5: Opportunity cost estimates for the UHF spectrum**

Service	Estimates
Mobile broadcasting (DVB-H)	Use of UMTS network: Values depend on assumed demand for mobile TV. With 3m subscribers, the estimated opportunity cost ranges from £4m/MHz for the third DVB-H mux to £84m/MHz for the first mux. (assuming SFN operation) Use of L-Band: £10m/MHz plus the cost of L-Band spectrum.
Analogue TV	Cost of migrating viewers to <ul style="list-style-type: none"> <li>• DTT implies a value of £1.12m/MHz</li> <li>• satellite implies a value of £2.35m/MHz</li> </ul>
DTT	Cost of migrating viewers to satellite reception implies a value of £2.96m/MHz Value of spectrum implied by traded value of multiplex capacity is £0.44m/MHz

We next consider the following questions

- to whom should AIP be applied?
- when AIP should be applied?
- how should opportunity cost estimates be used to set AIP?

##### 7.2.4.1 To whom should AIP be applied?

AIP should be applied to all users of the UHF spectrum except those who obtain access to the spectrum through auction. The reasons for this conclusion are elaborated in Chapters 2 and 3. For the purposes of this report we focus on use by analogue TV broadcasters and digital multiplex operators, as we anticipate that other potential users will obtain spectrum access through auction.

<sup>94</sup> The multiplexes operate at 16 QAM but at switchover will be able to switch to 64QAM operation and will therefore be able to support more channels. They also carry a number of data and radio services.



#### **7.2.4.2 When should AIP be applied?**

As discussed in Chapter 4, AIP should be applied to the UHF spectrum after switchover. The government has made commitments that mean that AIP cannot be applied to digital multiplex operators until their licences are renewed, variously in 2010 and 2014.

We consider that once switchover has been completed in 2012 AIP should be applied to UHF spectrum that is not auctioned, for the following reasons

- If the release channels are auctioned, then AIP provides for a degree of competitive neutrality between those broadcasters using the release channels and those using the spectrum reserved for DTT
- If the release channels are not auctioned, then AIP provides appropriate economic signals for those deciding the use of the spectrum (be they multiplex operators or government officials). Otherwise, there is a risk the spectrum might be used for low value applications.

We recognise that in the short term AIP could be delayed for political reasons. If this is the case, we note that the beneficial long term impacts of AIP on investment, technology and spectrum use decisions can be retained by early announcement of the ultimate policy goal of charging all users of the UHF spectrum

#### **7.2.4.3 How prices should be determined?**

Figure 7.2 show the opportunity cost estimates we have derived for each of the potential future uses of the UHF spectrum for the cases where DVB-H is distribution by an SFN. As can be seen from Figure 7.2 the three estimates for DVB-H are not relevant for setting AIP, because if they were applied most of the spectrum would remain idle – terrestrial broadcasters would find it more cost effective to move to satellite transmission. Rather we suggest that AIP should be set based on the opportunity cost of spectrum for DTT. As the estimates for analogue TV provide an upper bound on the opportunity cost and for reasons of consistency and administrative simplicity, we suggest that the AIP for analogue TV is set at the value for DTT.<sup>95</sup>

This suggests that AIP should be set initially towards the lower end of the range found for DTT i.e. around £0.5m/MHz. This implies a fee per national DTT multiplex of around £22m.<sup>96</sup> These estimates do not include the value of spectrum in those parts of the country that are not sterilised by TV broadcasts. To obtain a reference value for a national channel the value of use (e.g. for programme making and special events) outside the areas sterilised by TV services needs to be added. We suggest that population within the area sterilised (defined by field strength contours) by the particular application coverage is used to scale values, as population is the main driver of value.

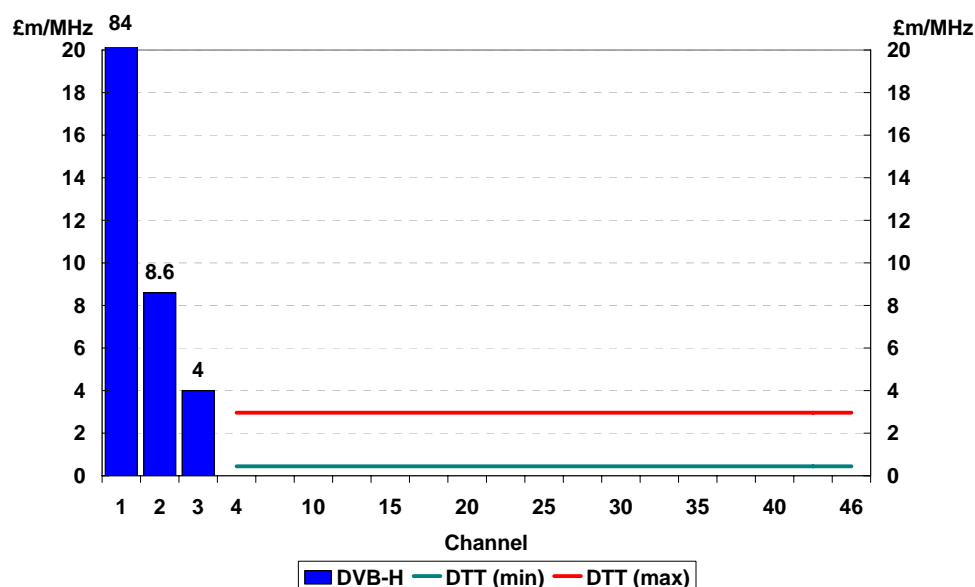
It is important to note that the estimates given in Figure 7.2 are only relevant for a snapshot in time. Values will change over time as service demand changes. If demand grows, for

<sup>95</sup> The value should be discounted back to the date of application. A suitable discount rate could be the rate (12%) used in the Channel 3 licence valuations.

<sup>96</sup> This assumes 43 MHz is required per multiplex, as 256MHz is used to deliver the existing 6 multiplexes.

example, as a result of the success of consumer adoption of HDTV or demand for greater interactivity, then values could increase. By contrast, if spectrum availability increases after switchover or demand for terrestrial broadcast TV services declines, say, because of the growth of IPTV then values could fall.

**Figure 7.2 Opportunity cost estimates for DTT and DVB-H**



## 7.3 Radio

### 7.3.1 AM and FM bands

In general AM and FM radio broadcasters cannot reduce the amount of spectrum they use to deliver a given service coverage by investing in additional infrastructure, because national and international constraints on frequency use define the specific location and nature of transmissions. This means we need to consider whether spectrum use could be changed by moving to an alternative transmission platform. Possible options are: DAB, DRM, satellite, 3G, the internet and DTT. In all cases, the broadcasters' output will be diminished in the sense that fewer listeners will be able to receive the service and in the case of DTT, the internet and satellite, mobile radio reception will be reduced or lost. Maintaining output at current levels would be prohibitively expensive, as this would require most radio receivers to be replaced by alternative receivers, such as DAB sets or 3G phones. In this regard, we note that it is estimated that each household has around 6 AM/FM radios.

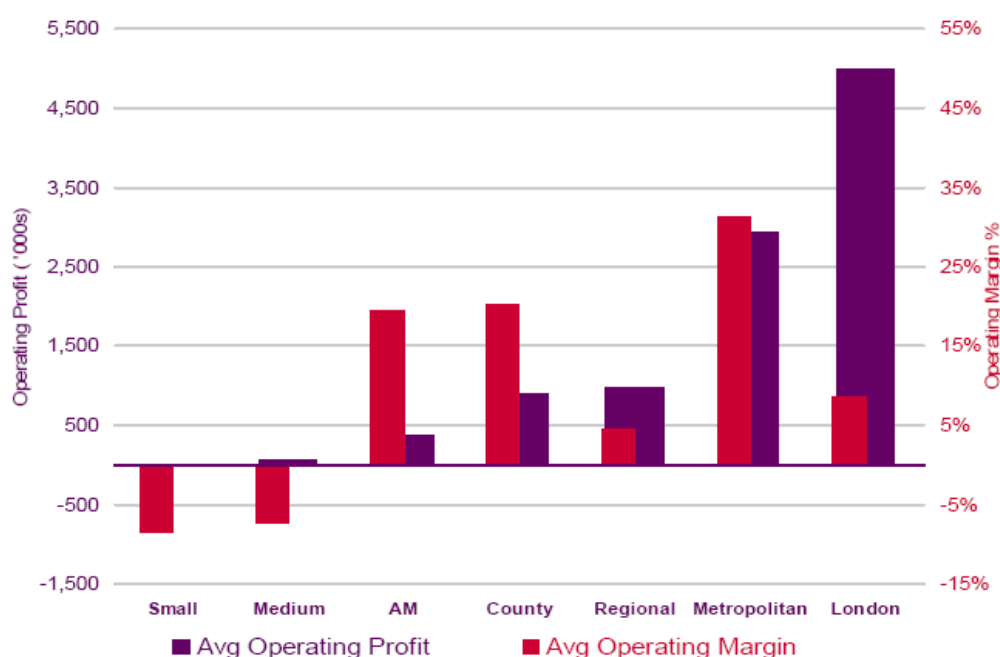
As we showed by example in Chapter 5, if coverage constraints were relaxed and one radio broadcaster was to reduce their use of spectrum (e.g. by reducing power), this would have an impact on several other users in the geographic area surrounding that station, and users of adjacent frequencies (who may be some distance away geographically). Therefore, many broadcasters would have to change their transmissions, in a co-ordinated manner, to "release" spectrum. We doubt this could be achieved economically other than by central direction.





The opportunity cost of the spectrum used by AM/FM broadcasters in a given location is therefore given by the amount a broadcaster would be willing to pay for an AM/FM licence. This could be estimated from projections of station revenues and costs, where costs should include an allowance for the station to make a “normal” return on capital. As discussed in Chapter 6, these calculations should be done for a representative or average radio station, however, identifying such a station is not straightforward as radio stations vary considerably in terms of format and coverage areas. In particular, speech-based stations are typically less profitable than music stations, mainstream heritage stations<sup>97</sup> tend to be more profitable than other music stations and stations with large coverage areas tend to be more profitable than those with small coverage areas (see Figure 7.4).<sup>98</sup> We propose determining opportunity cost based on average station profitability for an average population served.

**Figure 7.4: Relationship between station profit and operating margin and area served**



Source: Data provided to Ofcom by licensees. Average operating margins are simple averages.

**Source: Radio Review, Ofcom, 2004.**

We do not have the data required to estimate the relevant opportunity values but suggest they are calculated for an average commercial FM and AM station separately and ideally using data for a number of years to take account of cyclical fluctuations as follows<sup>99</sup>

- Estimate average station profitability (pre-tax) for all stations using the band (from returns to Ofcom), as the ratio total industry profitability/number of stations
- Estimate average population covered for all stations using the band (from licence data)

<sup>97</sup> Broad music-based licences aimed at a 15-50 year old mass market that have been operating since before 1990.

<sup>98</sup> Station format and the size of audience are both important determinants of profitability. See Chapter 7, “Economic Study of Commercial Radio Licensing”, Spectrum Strategy for Ofcom, December 2003.

<sup>99</sup> This may require an attribution of costs and revenues to each band where stations are simulcast.

- Estimate average capital employed for all stations using the band
- Estimate average return on capital employed for all stations using the band
- Estimate a normal return for the radio industry<sup>100</sup> – we note in this regard Ofcom has proposed a normal pre-tax return of 12% for Channel 3 in the evaluation of Channel 3 licence payments.
- Take the difference between the average and the normal return, multiply by the average capital employed to give an estimate of the value an average station would be willing to pay for its licence, which we refer to as the average station surplus
- Calculate the spectrum used and population within the area sterilised by the average station to give a value per MHz x population. As is discussed below, doing these calculations is not straightforward.

We note that by using actual station data the estimates could be biased downwards as radio stations' broadcasting licence obligations will depress their profitability as compared with the situation in an unconstrained market.

An alternative approach would be to take the annual payments by the national commercial radio stations as an indicator of the "surplus" earned from the spectrum and use the values for AM and FM separately to give an estimate of the opportunity cost of spectrum for each band. The implied opportunity cost values using 2004 licence payments are as follows

- For Classic FM, the payment totalled £3.9m for access to 2.2MHz of spectrum on a national basis, implying a value of £1.8 m/MHz
- For Talksport and Virgin on AM, average payments were £1.6m each and each service uses two 9 kHz channels implying an average value of about £0.09m/kHz (or about £90m/MHz).

### 7.3.2 VHF Band III

Table 7.6 lists the opportunity cost values that need to be estimated and our proposed method for estimating these values.

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<sup>100</sup> This is usually done using the capital asset pricing model.

**Table 7.6 Approach to estimating opportunity costs**

Service	Method
DMB	Cost of denying access to DMB so that traffic must be carried on a 3G network Cost of using L-band rather than Band 3 Market value implied by cost of DAB multiplex capacity (scaled for DMB coding efficiency) less the annualised capital and operating costs
DAB	Cost of re-engineering network to reduce exported interference Market value implied by cost of multiplex capacity less the annualised capital and operating costs Cost of using L-band rather than Band 3

### **7.3.2.1 DMB – based on deployment for mobile TV delivery**

This example compares the cost of delivering a mobile broadcast service using DMB technology over a national single frequency network in Band III. It is assumed that there are 1,350 DMB transmitters providing national coverage.<sup>101</sup> The estimated marginal value for a third DMB multiplex added to an existing network<sup>102</sup>, based on 4.6% of the total mobile TV audience watching content from the marginal multiplex, is around £27.6m per MHz per annum (see Appendix 2). Corresponding values for the first and second DMB multiplexes would be much higher, reflecting the bigger audiences for the more popular channels. These values are estimated to be £297m / MHz and £84m / MHz respectively.

There are two main reasons why the DMB values are so high, namely:

- the small amount of spectrum (1.5 MHz compared with 8 MHz for DVB-H)
- the low cost of rolling out a network in Band III (half the number of transmitters compared to DVB-H).

It is perhaps helpful to compare this value with the annual revenue that might be generated from the assumed 3 million mobile TV subscribers, assuming each paid £10 per month which is the amount Orange is currently charging for its (UMTS-delivered) service. This would amount to £360m, per annum suggesting that the potential economic return to mobile operators from access to that spectrum currently used by broadcasting could be significant.

DMB could also be provided using L-band frequencies, but many more transmitters would be needed. We estimate that approximately three times the number of transmitters would be required to match the coverage at Band III. Assuming that all the extra transmitters would require new sites at an estimated cost of £12,400 p.a., a total extra cost of £12.4m would be incurred. This would imply a value of £8.3m per MHz per annum for the Band III spectrum, but this does not take account of the price that might be paid for the L-band spectrum at auction.

<sup>101</sup> This is half the number assumed for DVB-H, reflecting the lower frequency band.

<sup>102</sup> We have used the third multiplex rather than the second used for DVB-H as the capacity of a DMB multiplex is only a tenth of that of a DVB-H multiplex. We understand there is unlikely to be scope for more than three new DAB/DMB multiplexes in Band III

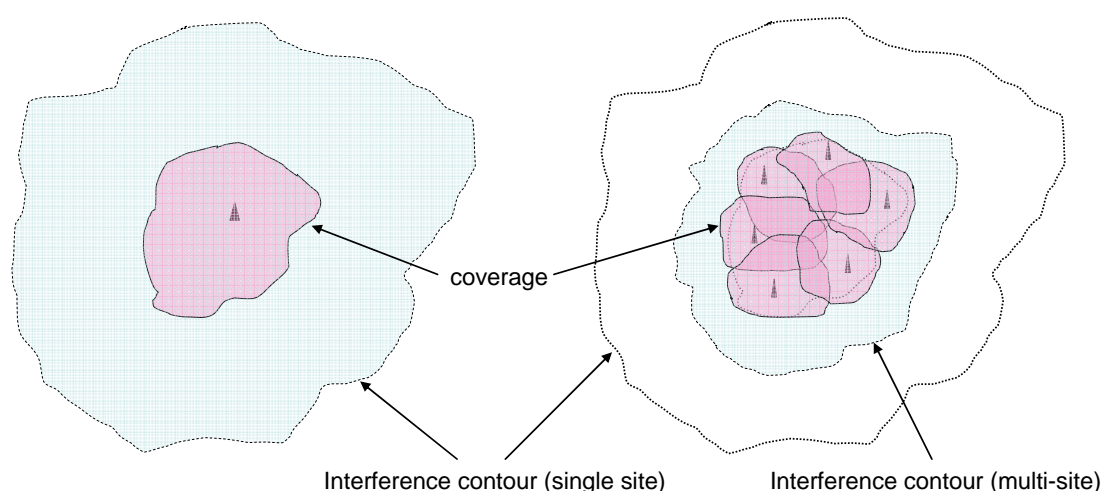


### 7.3.2.2 DMB – based on deployment for digital audio broadcasting with similar parameters to current DAB networks

It is by no means certain that DMB will be adopted for mobile TV transmission in the UK, especially if an alternative such as DVB-H is available. If DMB is instead deployed merely to improve the efficiency of DAB transmissions, the value will be much lower. DMB is claimed to offer an 82% improvement in capacity assuming the same audio quality is maintained, equivalent to increasing the number of stereo audio channels from 22 to 40<sup>103</sup>. The value of the spectrum could therefore be based on the cost saving of not needing an extra DAB mux to deliver the same content. Assuming around 100 transmitters (equivalent of current Digital One network) and £10k per transmitter, this equates to around £1m saving in capex, or £258k per annum. This yields a value of £172k per MHz for national channels - very much lower than the mobile TV value but reflecting the relatively low cost of adding a further DAB multiplex to an existing network. Note that this value does not make any allowance for the cost of replacing existing DAB receivers DMB receivers which could negate the saving in transmission infrastructure many times over.

### 7.3.2.3 DAB

The opportunity cost value derived in the previous section relates to a national 1.5 MHz channel, as used currently for DAB services. In the case of regional channels, these are re-used at multiple locations around the country. The geographic separation that is necessary between co-channel assignments depends on how far interference extends beyond the designated coverage area. This can be influenced by network design, in that one or two centrally located, omni-directional transmitters will export more interference than a larger number of directional transmitters located near the edge of the coverage area (see figure below). Application of AIP to regional DAB networks based on the opportunity cost of the area sterilised by interference could provide an incentive for broadcasters to optimise their network design from an exported interference perspective.



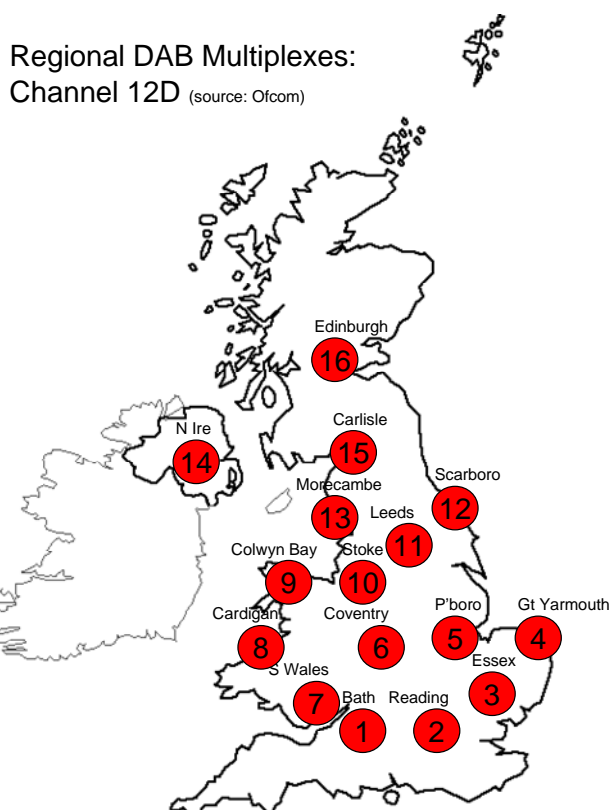
One way to determine the opportunity cost corresponding to the extra interference generated by a sub-optimally engineered network would be to consider the potential cost of the additional infrastructure that would be needed to reduce the interference by a given amount.

<sup>103</sup> source: [www.digitalradiotech.co.uk/dab\\_vs\\_dvb-h\\_vs\\_dmb.htm](http://www.digitalradiotech.co.uk/dab_vs_dvb-h_vs_dmb.htm)



For example, if an existing network comprising three transmitters (typical of current regional multiplexes) were to be replaced with one comprising eight transmitters, this might typically result in a reduction in the sterilised area of around 20% (in practice, the reduction will vary according to the local topography and availability of transmitter sites, but a typical value of 20% would appear reasonable). An analysis of current regional DAB assignments reveals that there are 16 regional multiplexes accommodated on channel 12D (the most intensively used), implying a national re-use factor of 16 (see figure). In principle, reducing the sterilised area by 20% would improve the re-use factor to 20, i.e. a 25% increase in capacity nationally. Therefore applying this reduction in sterilised area to four DAB regional multiplex frequencies would result in additional capacity equivalent to one additional frequency (since 80 regional multiplexes could then be accommodated on four frequencies rather than five).

**Figure 7-2: Current Regional DAB assignments (channel 12D)**



We estimate that the total annual cost of releasing this additional capacity, based on an average five additional transmitters per multiplex would be £5.35m. On this basis, the national value of a regional DAB multiplex frequency would be £3.6m per MHz and the fee for an individual multiplex could be set pro-rata to the population in the sterilised area.

#### **7.3.2.4 Opportunity cost of DAB spectrum derived from multiplex charges**

Ofcom has supplied us with some examples of current annual multiplex charges. Several examples are given for the Sussex Coast multiplex and so we have used that to illustrate the calculations. Two stations pay annual charges of £70,000 and £90,000 p.a. and there are seven stations on the multiplex, suggesting total annual revenue of around £560k.



The costs of providing this capacity comprise the capital costs of the five transmitters and aerials plus operating and distribution costs. We assume the costs of DAB transmitters are similar to those of DTT transmitters though have double the transmitter power because of the lower frequency band used. We estimate the capital costs are around £350k, annual operating costs are around £80k per annum and distribution costs are about £50k p.a. Spreading the capital costs over 10 years and assuming a 10% margin (on total costs) for the transmission provider gives a total annualised cost of about £180k p.a., implying a surplus of about £380k p.a. for the use of 1.5 MHz of spectrum (covering an area of about 1000 sq km). To give a national figure we need to make an estimate of the number of times the frequency can be used to serve significant population areas. Assuming the same re-use factor as derived in the previous section i.e. 16 this gives a value of around £4m/MHz on a national basis. This value should be regarded as an upper bound on the likely value of spectrum as it is not clear that broadcasters will be willing to pay multiplex charges at current levels on a long term basis, as digital radio services are unlikely to be profitable for some time yet.

### 7.3.3 Implications for setting AIP

Table 7.7 lists the opportunity cost estimates we have calculated. For the AM/FM bands, we do not have the data to estimate values though we would expect that it is held by Ofcom. These estimates do not include the value of spectrum in those parts of the country that are not sterilised by radio broadcasts. In other words, the values underestimate the value of having a clear block of spectrum on a national basis.

**Table 7.7: Opportunity cost estimates for radio bands**

Band	Estimates of opportunity cost on a national basis
AM and FM bands	<p>Estimate based on producer surplus: we do not have the data required to produce estimates but values could be calculated from station financial data. Average station values could be calculated on per MHz basis and then factored up an average re-use factor to give opportunity cost values on a national basis</p> <p>FM based on national commercial station: £1.8m/MHz</p> <p>AM based on average for national commercial stations: £0.09m/kHz</p>
DAB band (VHF Band III)	<p>Cost of denying access to DMB: £27.6m/MHz for a third DMB multiplex</p> <p>Cost of using additional infrastructure: £3.6m/MHz</p> <p>Multiplex charges: At most £4m/MHz</p>

It is important to note that the estimates given in Table 7.7 are only relevant for a snapshot in time. Values will change over time as service demand changes. If demand grows, for example, as a result of the success of consumer adoption of DAB, then values could increase. By contrast, if spectrum availability increases say through the auction of Band III spectrum then values could fall.

We next consider the following questions

- to whom should AIP be applied?
- when AIP should be applied?
- how should opportunity cost estimates be used to set AIP?



### **7.3.3.1 To whom should AIP be applied?**

In Chapters 2, 3 and 5, we argued that AIP should be applied to all radio broadcasters in the AM, FM and DAB bands, except for those that offer highly localised services (e.g. with a coverage radius of 5km or less). AIP would apply to broadcasters who in future obtain access to spectrum through auction.

### **7.3.3.2 When should AIP be applied?**

AIP could in principle be applied once all the practical issues around determining the appropriate level of AIP and any other funding arrangements have been ironed out (see below).

In the case of spectrum used by DAB services, AIP should be applied by the time any additional spectrum in VHF Band III is released either for auction or on an administrative basis. If the spectrum is auctioned, AIP provides for a degree of competitive neutrality between the different DAB bands. In this case, AIP should be set with reference to the market clearing price at auction.

If the spectrum is released on an administrative basis (first come first served or a beauty contest) the AIP provides appropriate economic signals for those deciding the use of the spectrum (be they multiplex operators or government officials).

### **7.3.3.3 How should opportunity cost estimates be used to set AIP?**

#### **AM and FM bands**

As the current use of these bands is the highest value use AIP should be set based on estimated opportunity cost values for radio broadcasting. As discussed above, further information is required to derive average values per station.

At first sight, it appears attractive to relate opportunity AIP levels to the area or population 'sterilised' by the use of a particular transmission network, as this represents the spectrum use denied to others. However, population served and population sterilised differ considerably. Thus, if the existence of a service in town A, precludes the use of a particular frequency in towns B and C, the AIP costs would be related to the population of towns A and B.

The application of such a methodology is, however, complicated by the realities of practical frequency planning. It is instructive to examine the case of FM radio, where these complications are probably greatest. Two technical points are particularly relevant here. Firstly, the interference from a typical local FM transmitter of around 1kW will extend over an area many times greater than the coverage. This is exacerbated by the need to protect other services even for the 5% - 1% of time when high pressure conditions mean that signal levels at long distances are greatly enhanced.

Secondly, while FM stations are assigned on the basis of a 100kHz channel raster, the transmitted power and the receiver response are not confined to a 100 kHz channel. Thus the frequency planner has to take into account a sliding scale of protection requirements for channels at different frequency separations. This is shown below:





Separation (kHz)	Protection requirement (dB)
0	45
100	33
200	7
300	-7

Combined with a knowledge of the fall off in field strength<sup>104</sup>, and a service area coverage limit of 54dBµV/m, a table of required separation distances can be calculated (it should be noted that these calculations are simplified, but representative).

Separation (kHz)	Required separation (km)
0	275
100	160
200	34
300	16

This table illustrates the scale of the problem, if an attempt is made to attribute the opportunity cost associated with the 'blocking' of spectrum in any area with specific licences. Given a particular town, constraints will be imposed on new services by existing co-channel transmitters at a great distance and by relatively local transmitters at larger frequency spacings.

Given this background, we may examine the case of the local radio services at Guildford and Southend, which may be said to be 'blocking' a channel in London. This is, to a large extent, correct, but the complexity of the situation becomes clear when the detail is examined.

The Guildford transmitter operates on 96.3 MHz, that at Southend on 96.4 MHz. If neither of these transmitters were used, it would be possible to make use of the channel to cover the London area. However, while these two stations are the dominant interferers, there is also a station at St. Albans on 96.6 MHz and in North-West Kent on 96.7 MHz. Both of these stations would suffer unacceptable interference if a new London service were to be introduced, and they would also be likely generate significant interference within parts of the London service area.

A further complication is that it is not only by virtue of outgoing interference power that an existing service constrains the use of a channel in a given area, but by also by requiring protection from interference. The interference to, and from, continental stations might also need to be considered.

If it is desired to link AIP charges to the 'sterilising' impact of a given service, some of this complexity must be confronted, even if a decision is then taken to make simplifying assumptions. The fact that a large number of individual services will constrain the change of use of any particular channel, and to different extents, would seem to suggest that AIP should be calculated for each in isolation.

<sup>104</sup> assumed to be given by the curves of ITU-R P.370<sup>104</sup>, for 5% time and a 1kW transmitter at 75m above mean terrain height. P.370 has been replaced by P.1546. The old Recommendation is used here simply for ease of reference, as the 5% values are derived by interpolation in the new Recommendation



One option might be to define a (somewhat arbitrary) level of field strength, which would define the 'interference contour' of a transmitter. This contour would *have* to be arbitrary, as, to some extent, all major FM transmitters will have an impact across the UK, and beyond. The population falling within this contour would then be counted, and the AIP would be set proportional to this figure. One disadvantage of this method would be that, if Guildford (for example) were to close, to avoid AIP, the Southend transmissions would continue to block a London service, and overall spectrum efficiency would have worsened.

An alternative option might be to attempt some form of apportionment of the AIP between those transmissions responsible for 'blocking' a frequency in an area. Thus, in the case of 96.3 MHz / 96.4 MHz in London, a value representing the opportunity cost of denying a city-wide service would be derived, and apportioned equally<sup>105</sup> between Guildford and Southend. Logically, such an approach would require that, if, for instance, Guildford were to close down, the entire opportunity cost would fall on Southend. This consideration would give an incentive for joint action by existing broadcasters to free spectrum for other uses. In practice, the difficulty of calculating a fair apportionment would seem to outweigh any theoretical advantages of this approach.

We suggest that on practical grounds the first of these two options is adopted, namely that AIP is set proportional to the population falling within a defined field strength contour. A decision will be required as to whether this is the contour at which harmful interference no longer occurs for either co-channel or adjacent or third channel interference.

### VHF Band III

Opportunity cost estimates range from £3.6m/MHz to over £27m/MHz. We suggest setting values towards the bottom of this range on the grounds that demand for spectrum from DMB could well be met by the release of spectrum in this band. The value is calculated assuming exclusive use of spectrum on a national basis. We suggest the value is scaled by the share of the national population within the area sterilised by the service to give a per service value.

As has been discussed, it is difficult to define the 'area sterilised' by an analogue FM transmitter, largely because the problem involves the dimensions of both geographical and frequency separation. The problem is far more tractable for the case of digital transmitters (e.g. T-DAB). Here, the interfering effect of a transmitter is confined<sup>106</sup> to its own channel. Furthermore, it is assumed for planning purposes that receiver aerials are non-directional. Consequently, it is only necessary to define a required wanted/interference ratio for a given service, and this will define a field strength to allow an 'interference contour' to be drawn for any transmitter.

## 7.4 Conclusion

In this chapter, we have presented estimates of opportunity cost using values derived from potential substitution opportunities and market transactions. The former involve numerous assumptions about how services might be configured and the costs of their deployment using

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<sup>105</sup> Ignoring the second order effects in Kent and St Albans

<sup>106</sup> This is to a first order. In practice, care must be exercised to avoid overload problems from adjacent-channel transmitters.



different frequency bands and technologies. Values based on market transactions are, however, more certain given they reflect current costs but can be expected to change in future as market conditions change. However, at a point in time market based estimates would seem likely to provide a more reliable basis for setting AIP than estimates based solely on hypothetical substitution opportunities.

Our estimates suggest a value of at least £0.5m/MHz for UHF TV spectrum and higher values for spectrum used by radio broadcasting, in part reflecting the higher spectral efficiency of radio as compared with TV broadcasting. It should also be recognised that the estimates for radio are generally upper bounds on values. In the case of AM and FM services they have been derived from the value of spectrum to national services and values to local services could differ from this. In the case of DAB, it is not clear whether current market rates for multiplex capacity will be sustainable in future.



## **Appendix 1: Measuring the Social Value of Broadcasting**

### **1. Introduction**

There is broad policy consensus on the need for valuation of public service broadcasting (PSB) beyond individual utility because of market failure/ externality and public policy concerns peculiar to broadcasting. There is however little consensus on how to measure the 'social' value of broadcasting and a significant body of expert opinion is of the view that it is unquantifiable. This Annex is a survey of recent methods for measuring the social value of broadcasting, drawing both on academic approaches and on particular solutions and proposals within regulatory policy (at Ofcom for instance). We examine government decisions, both in terms of the wider policy context for PSB (e.g. in the recent Green Paper on the BBC) and in terms of approvals of new BBC services. Independent, Government commissioned reviews of new BBC services (which are to be replaced with a 'Public Value Test') offer some tools for measuring the social value of broadcasting. We also review the recent contributions of the BBC through its submissions to the Government on Charter Review, and other contributions to public debate in the context of Charter Review.

We argue overall that whilst a definitive measure capable for example of determining spectrum subsidies is not possible, a basket of available measures could be useful in the context of spectrum policy decisions. To illustrate: this review of a basket of potential measures of social value of broadcasting confirms that measures of consumer value alone do not capture the total value of broadcasting. It shows that contingent valuation methods have been proposed for calculating social value, but the key policy decisions in broadcasting are not based on calculated quantifiable cash values for social value. Rather, they are based on policy objectives and benchmarks of the public purposes of broadcasting. Because of this, and because of the fact that it would be extremely difficult to measure the 'opportunity cost social value' of proposed spectrum uses, policymakers would find it difficult to propose applying AIP to broadcasting spectrum. More research on these measures of value would be necessary before they could reliably be used in key regulatory decisions.

### **2. Measurement of Social Value in Policy Context**

'Social value' is an umbrella term which is contrasted to 'private value'. Due to the market failures and the externalities associated with broadcasting, and optimal level of social value would not be delivered to viewers and listeners through the aggregation of their individual choices in a market situation. In policy discussions on broadcasting, a range of terms have been used under the general umbrella of social value, including citizen and public value.



Private Value	Social Value
Consumer value	Citizen value
	Public Value
	Externalities
	'Economic Impact' (e.g. negative impact on market, positive multiplier effects).
Method	
Revealed preference	Stated Preference

### Reviews of BBC News 24, BBC Digital Radio, BBC Online and BBC Digital Television Services

Most measurement of social value in the context of regulatory decisions is measurement against stated public policy objectives, for example against terms of permission of BBC to provide a service. (e.g. BBC service independent reviews and permissions). These reviews have come under increasing criticism, even by those attempting to chair them such as Philip Graf in his review of BBC Online. There is implicit, soft cost-benefit analysis, but in the context of these reviews, no serious attempt is made to quantify social value of broadcasting.

A partial exception is the Barwise review of BBC Digital Television services, published in 2004. Barwise establishes a conceptual framework for determining what he calls 'net public value': 'By public value, we mean the benefit of the services to the UK public. This includes both short- and long-term benefits, both direct and indirect benefits, and both consumer and citizenship benefits. Assessing these benefits is inherently subjective. The direct consumer benefits (range, quality, value for money) can be partly assessed using objective measures such as ratings or shares, audience appreciation, the cost per viewer hour, and viewers' estimated or claimed willingness to pay. Indirect and/or citizenship benefits (eg from the BBC's investment in UK/regional production and training or in educational initiatives, or its social, cultural, or political contributions to the British quality of life) are generally even harder to evaluate. Ofcom's extensive research for its public service broadcasting review aims to develop practical metrics to help such evaluation without trying to quantify the unquantifiable.' (Barwise 2004 19) Barwise concludes that 'CBeebies, CBBC, BBC3 and BBC4 are all creating net public value, that is, they have all largely met their remits and their market impact is limited relative to their public value'. Barwise does not in the context of this report offer a means of balancing value (by remit) against quantified impact on the market and therefore remains within the 'broader pragmatic' frame of reference.<sup>107</sup>

<sup>107</sup> Graf Report on BBC Online; Lambert Review of BBC News 24 2002; Gardham Review of BBC Digital Radio Services 2004; Barwise Review of BBC Digital Television Services 2004



## BBC Building Public Value

The BBC has adopted a public value approach to their services, drawing on the experience of the large number of new service reviews in recent years. Their approach has been to set out various categories of 'public value' reflecting the externalities and merit goods associated with broadcasting, and outline key benchmarks and measures for measuring broadcasters performance against these. Public value for the BBC has five components<sup>108</sup>: Democratic Value; Cultural and Creative Value; Educational Value; Social and Community Value; and Global Value.

Under proposals on the future governance and regulation of the BBC, now largely supported by Government, the Public Value test – which seeks to measure contributions of the BBC against those objectives - will be applied to all BBC services periodically and also to all proposed new services.

### The BBC Public Value Test: a 3 part process<sup>109</sup>

**1 INDIVIDUAL VALUE:** the benefit that people derive as individuals from a BBC service, compared with the costs of providing it. Measures will include:

- Willingness to pay analysis
- Consumer demand assessment
- Conjoint analysis

**2 CITIZEN VALUE:** the benefit that people derive from a BBC service as citizens, such as its contribution to a better-informed democracy, higher educational standards or a more inclusive society. These are complex, judgemental issues and assigning a monetary value is likely to be difficult and sometimes impossible. Indicative measures will include:

- Investment needed by another public body to achieve the same outcome
- Value to society as estimated by audiences through willingness to pay analysis
- Expert panels
- Evidence-based impact tracking (for instance, measurement of the number of people pursuing further education as a result of BBC programmes)
- International comparisons

**3 NET ECONOMIC VALUE:** the net benefit that the wider media economy may derive from the BBC's services. It will have a positive dimension, such as the impact of the BBC on the profitability of the creative economy, training and market development. In some cases, the BBC may reduce commercial profitability if it is providing a service that takes away audiences from a commercial service. A net calculation will be made. Measures will include:

- Market impact analysis
- Industry modelling

Box 2 and to an extent also box 3 represent the social value.

Clearly, there are immense challenges of measurement of social value and the new public value test will take some time to develop. To take the example of democratic value; measures

<sup>108</sup> BBC: Building Public Value 1.2 p30.

<sup>109</sup> Boxes from BBC (2004) 'Building Public Value' p84-5.

might include` indirect effects (e.g. take-up of courses, volunteering; and opinion polls on value of broadcasting services) and more direct effects e.g. quantifying the expenditure that another public body would have to make in order to get across a similar public service message. Holtz-Bacha and Norris have made a survey of the statistical evidence of a correlation between exposure to public television and the degree of political and civic awareness of populations in Europe<sup>110</sup>. This research drew a distinction between commercial television and public service television, addressing the question of whether the increasing commercialisation of television in Europe is resulting in a decline in levels of informed democratic citizenship. The key question of the study is 'what is the relationship between regularly watching public sector television and awareness of politics and international affairs'. (Holtz-Bacha, 1999, 7) They found some evidence of a strong correlation that suggests that the exposure to public television directly influences the level of civic knowledge. If, as the Ofcom, DCMS, and BBC policy position on the 'value' of civic information is accepted, then this is significant as it indicates that there are public/democratic externalities associated with broadcasting.

There is of course a danger of a christmas tree effect when 'social value' is measured on the basis of a 'broader pragmatic approach' as there is no limit to the public purposes that could be invoked. Different policymakers will add different purposes to the list of purposes that broadcasting is supposed to deliver (witness the recent Ofcom, BBC and DCMS consultations on public broadcasting-discussed in the next sections). Other seriously considered 'Social Values' associated with broadcasting include the notion of 'social capital'<sup>111</sup>. Mass, universally available broadcasting is seen as an important source of social cohesion in fragmenting multicultural societies. Whilst this term is more appealing than the notion of social glue, it is no easier to measure.

### **Ofcom Position in PSBTR/ Radio Review**

In the context of its reviews of radio, and of public service television, Ofcom, like the BBC has explored the measurement of social value. In the case both of radio and television, a variety of methods are explored, including the use of survey data on social value e.g. 'value to society as a whole' based on subjective measures. (Phase I p49; Phase III p43).

Ofcom presents four purposes for public broadcasting (merit goods) that it argues would be underserved by market supply of programming. (See list at note 2). These are echoed by the Government in their outline of new purposes for the BBC in the recent green paper.

Therefore, Ofcom has used a basket of indicators, and poll data to confirm the overall thesis that social or public value of broadcasting exceeds the private value. Ofcom does not however identify any individual or combined measure that would be able to quantify the social value of broadcasting.

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<sup>110</sup> The research used multiple regression models to measure the strength of the relationships between viewing habits and civic knowledge of various types measured by a quiz. Direction of causality is of course difficult to confirm, but the sample was controlled for level of education and social background factors. Several countries in Europe showed particularly strong correlation between knowledge and preference for public channels, with beta coefficients above 10.

<sup>111</sup> Watching Alone. The BBC and Social Capital. The Work Foundation 2004.



In the case of Radio, Ofcom has acknowledged that Radio broadcasting has externalities, and merit goods features (Ofcom 2005: 48). The 'public purposes' of radio, which are shared with television. Ofcom accepts that the features of radio may mean that the balance of these objectives may be different in the case of radio, and a consultation on the public purposes of radio is ongoing. According to the review document 'the purposes that emerge may be similar to those for television, although the emphases and the way in which the purposes are delivered will almost certainly be different'.

### **Government position in BBC Green Paper**

The Government outlined the public purposes of the BBC in the recent BBC Green Paper: they are the following:

- •sustaining citizenship and civil society
- •promoting education and learning
- •stimulating creativity and cultural excellence
- •representing the UK, its Nations, regions and communities
- •bringing the UK to the world and the world to the UK

In the same document, the Government endorsed the BBC's proposals in Building Public Value for new governance arrangements including new arrangements for assessing Social Value. (5.42). According to the Green Paper:

#### **DCMS Green Paper on BBC Charter Renewal 2005.**

'Whenever a proposal is put together for a new service, or the extension of an existing one, it should be submitted to the (new BBC) Trust for a rigorous test of its public value. Part of the test should be a market impact assessment, to be conducted according to a standard formula agreed between Ofcom and the BBC Trust, and to be conducted by Ofcom itself in the case of a new service. Only if the Public Value added by the service outweighs any negative market impact should the proposal be given any further consideration'.

The Green Paper offers few details on how to develop measures of Public Value, indeed it calls for future debate on the issue. (5.43).

### **3. Conceptual Frameworks for Measuring Social Value of Broadcasting**

The claim is often made that broadcasting, and particularly public broadcasting, generates social benefits that justify subsidies of many kinds, including cheap spectrum. Defenders of public broadcasting argue in general that broadcasting should not be operated on a market basis. They do so on the basis of a variety of arguments, many of which are relevant to the notion of the 'social value' of broadcasting.





## Market Failure and Externalities

Because of the externalities associated with broadcasting, both positive and negative, and because of the public good features of broadcasting, individual choices in the market will fail to provide the optimal level of social welfare. In the field of spectrum use, it is claimed that in a fully marketised spectrum management regime, less spectrum will be used for public broadcasting than is optimal for social welfare, because it requires a positive policy decision to take into account these externalities to ensure that the spectrum used provides the optimal social benefit. Approaches that seek to correct for market failures can be divided into 'narrow economic' approaches that seek to measure value of broadcasting to consumers (e.g. the work of Gavyn Davies) and 'broader-pragmatic' approaches such as Ofcom's and the Green Paper, which sets out objectives and social welfare targets, against which market provision/failure may be judged.

### 'Public Value'. A New Policy Settlement.

The BBC has recently developed a 'public value' approach which attempts to operationalise the measurement of the social value of broadcasting services. In regulatory terms they are suggesting that new BBC services, should be subject to a 'public value test' to ensure that their social value outweighs their disbenefits for example their impact on the market. This approach has met with government approval, for example in the BBC Green Paper, though it has been criticised by some experts (e.g. Peacock 2004). Whilst much remains to be clarified in the operation of the PV test, the method draws upon a broader approach in public management that is based on a critique of policy attempts to reduce value of institutions to individual utility based on a simple cash value and revealed preferences (consumer choices). It seems likely that some version of the Public Value test will replace or be integrated into the current system of review of proposed new services as a means of measuring the public benefit against cost of proposed new BBC services.

The Public Value approach is best summed up in a Strategy Unit paper by Kelly, Mulgan and Muers (2002). They give one example of the 'Public Value' of school dinners not being captured in the traditional cost-benefit approach to contracting them out (see box below). The following key issues for policy makers are identified <sup>112</sup>

- Identifying whose preferences should count: current users, those who might need a service (even if they are not aware of it), future users, those who will never use it but whose political support needs to be maintained, those who have views about who else deserves a service?
- Identifying the issues on which the public will want to be involved, to obtain citizen views where important but not to be over-demanding. There is clear evidence that on some issues there is a strong desire among affected citizens to make their views known, especially those with a direct personal impact. In other areas this will not be the case.
- Providing forums in which citizens/groups can learn about issues, express views, explore scenarios and seek to reach accommodations that can inform policy.

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<sup>112</sup> [http://www.strategy.gov.uk/downloads/files/public\\_value2.pdf](http://www.strategy.gov.uk/downloads/files/public_value2.pdf)



- Recognising the limits of 'revealed preferences' and exploring the potential of 'stated preference' approaches that focus on policy trade-offs and don't rely on cash as the only unit of comparison.

### **Recognising different forms of value - contracting school meals**

Studies of competitive tendering have suggested that some schools saved around 10% of their total spend on school meals by switching from in-house to out-of-house provision. It is often claimed that part of the reason for the lower cost was a decline in quality/nutritional standards but assume for the sake of this hypothetical example that quality remains constant. Conventional reasoning would maintain that contracting out increased technical efficiency and with it public value (citizens benefit through better use of public resources). However, when consideration is given to some of the hidden benefits of in-house provision then the calculus may become less clear. For instance it may have been the case that in-house provision led to a higher ratio of pupils' parents and other local members of the local community being employed by the school. This could have created benefits in the form of increased:

- supervision of children;
- attention to learning to sit and eat meals;
- recognition by local adult members of the community of school pupils.

The proper use of cost-benefit analysis could have captured some of these components of value resulting from in-house provision (i.e. by asking parents how much they value having local members of the community providing school meals). However, some of the wider benefits to community cohesion are unlikely to be picked up through a contingent valuation exercise.<sup>55</sup>

According to Kelly et al, '*Understanding public preferences is key at the early stages of the policy process (setting objectives and analysing options). At the broadest level, conventional democratic processes provide an opportunity for expressing collective views about policy priorities. This is however, a very blunt mechanism for signalling complex preferences across a broad range of policy issues. Making use of the concept of public value requires the use of techniques that are effective at probing public preferences in some depth.*' This has broad implications for methodologies: '*Establishing underlying public preferences about what is valued, and to what degree, will involve reasoned and deliberative processes as well as snapshot opinion polling/voting. As well as traditional representative channels (parties, MPs and so on) and the media, public bodies need to (and often do) employ a range of filtering devices in order to decipher these preferences (media, polling, focus groups, user groups/panels) as well as directly elected user representatives (school governing boards, NDCs etc).*'

### **Consumer benefits versus citizen benefits (Ofcom)**

Partly in recognition of the nature of social values in communications Markets,<sup>113</sup> Ofcom has been given two general tasks in the Communications Act 2003:

" 3(1) *It shall be the principal duty of Ofcom, in carrying out their functions;*  
(a) *to further the interests of citizens in relation to communications matters; and*

<sup>113</sup> See the Report to the Joint Committee on the Draft Communications Bill Volume 1. Ch2 (1) 26. 2002.



*(b) to further the interests of consumers in relevant markets, where appropriate by promoting competition"*

There is thus a clear recognition that citizen interests cannot be reduced to individual utilities and that there is a duty on the regulator to seek ways of furthering the unique citizen interest. This, along with the specific duties to strengthen and maintain public service television, has guided the PSBTV review provided by Ofcom, which develops specific measures of social value (see below).

Ofcom, in line with recent regulatory policy supplements a narrow market failure approach as the key justification of intervention in broadcasting markets with an approach that isolates key policy objectives in broadcasting<sup>114</sup> and examines the ability of the market to provide these benefits through surveys, peer review and content analysis. These were widely criticised as difficult to measure in the consultation on the PSBTR.

### **Broader economic impact**

The broader economic impact is another aspect of social value, and one that is often neglected in broadcasting. Studies of the economic impact of theatre and other arts sectors<sup>115</sup> attempt to analyse the knock-on/ multiplier effect on spending, employment and attendance at performance on the level of economic activity and employment in given regions. Recent research has also focused on the role of arts spending in regional regeneration. However, one has to be very careful as to how these data are interpreted. The economic impacts that are measured do not measure the economic activity that would be lost if the activity in question was discontinued. Rather if the activity was discontinued then the resources used would be deployed elsewhere in the economy where they may generate more or less economic output. In the broadcasting sector, broader economic impact has also included the question of the impact of launching new subsidised services (e.g. at the BBC) on competition.

## **4. Methodologies: Summary**

### **Consumer Surplus/ Willingness to pay**

The public good features of broadcasting have led to a tradition of using contingent valuation/ willingness to pay surveys to estimate value. In the absence of a market measurement and with the assumption that viewing does not measure all aspects of value, researchers have presented respondents with a counterfactual scenario whereby a broadcasting service is

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<sup>114</sup> According to the Ofcom PSBTR phase III these are to:

- To inform ourselves and others and to increase our understanding of the world through news, information and analysis of current events and ideas.
- To stimulate our interest in and knowledge of arts, science, history and other topics through content that is accessible and can encourage informal learning.
- To reflect and strengthen our cultural identity through original programming at UK, national and regional level, on occasion bringing audiences together for shared experiences.
- To make us aware of different cultures and alternative viewpoints, through programmes that reflect the lives of other people and other communities both in the UK and elsewhere.

Ofcom is currently consulting on the public purposes of Radio.

<sup>115</sup> The Economic Importance of the Arts in Britain. J. Myerscough, Policy Studies Institute, London 1988; Economic Impact Study of UK Theatre. Dominic Shellard Arts Council of England April 2004.

threatened with closure or encryption and they are asked how much they would be willing to pay to keep it open or to continue to receive it.

There have been a wide range of willingness to pay (WTP) methods applied in academic and policy literature on broadcasting. They have also been used to generate consumer surplus models. For example the BBC's own research shows about 17m UK households value the BBC services at more than the current license fee and about 6m UK households value the services at less than the current license fee. If you subtract the latter from the former you get the figure of a £2bn consumer surplus. (Davies, 2005: 138).<sup>116</sup>

Contingent Valuation Studies are used widely in cultural policy for evaluating the provision of amenities where values and outputs are difficult to measure, such as art galleries. (Sunstein 2000). Here the sample is asked what they would pay to keep an amenity from closing. This elicits a response that would presumably combine a respondent's view on the value of the amenity to them personally ('consumer value') with a subjective view on the value to society as a whole ('public', 'citizen' or 'social' value). Whether WTP studies can be considered a measure of social value rather than merely private value depends on the survey question. Several studies for example of the BBC have been directly concerned with the potential for shifting BBC services to a subscription model. These ask what viewers would be willing to pay for BBC services, and is known as the BBC Gabor-Granger Method. The Gabor-Granger Method asks respondents to say whether or not they would buy a product at a particular price-point and reveals levels of demand at different prices, the price elasticity and therefore the optimum price point. It is good for researching what people would be *willing* to pay for a consumer product but is less appropriate for researching what people think a public service is *worth*.

In contrast, a contingent valuation or willingness to pay method can be used to measure *social value* by employing what is referred to as a National Voting Question, whereby voters are addressed as citizens voting in a referendum. Respondents are asked to *vote* between the total closure of the BBC or its continuation at a particular price point. In work undertaken by Human Capital for the BBC respondents were asked questions using both the Gabor-Granger method and the National Voting question.<sup>117</sup> The results are shown (respectively) in the two graphs below.

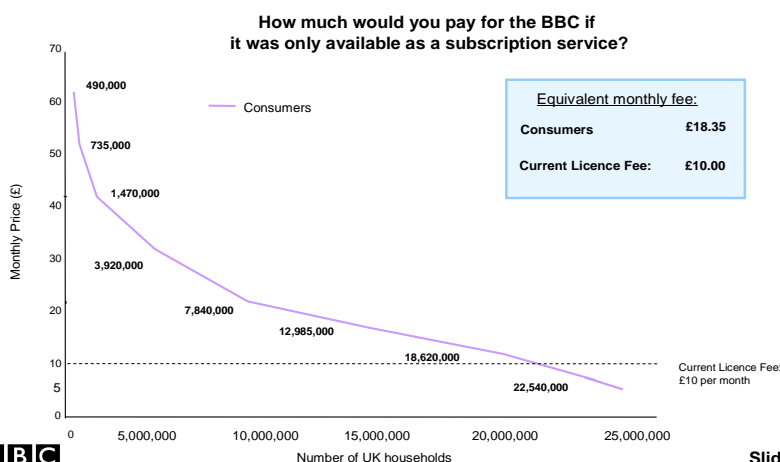
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<sup>116</sup> See also Ofcom and DCMS research on willingness to pay, and Valuing the Canadian Broadcasting Corporation Finn et al 2003., and Ofcom Phase II report p49-50

<sup>117</sup> Human Capital Report to the BBC 2004, reported in background supporting information to Delivering Public Value: BBC Licence Fee, <http://www.bbc.co.uk/thefuture/related.shtml>



## How much would people pay for the BBC?

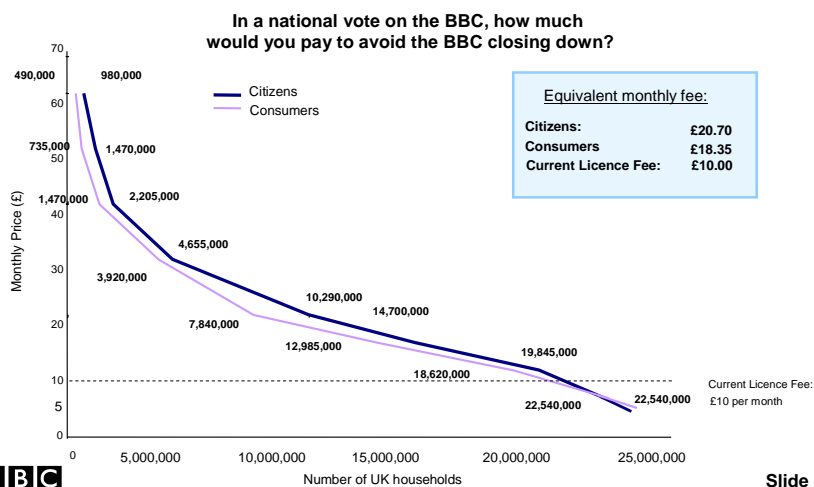


**BBC**

Slide 23

Source: Measuring Success at the BBC. James Thickett. BBC 21 June 2004, Demonstrating Value: Conference held by the British Library

## How much would people pay for the BBC?



**BBC**

Slide 25

Source: Measuring Success at the BBC. James Thickett. BBC 21 June 2004, Demonstrating Value: Conference held by the British Library

In the graph above, the difference between the two lines represents citizen or social value. Attempts have been made to address the methodological problems of isolated WTP surveys by making 'conjoint analysis' of relative value of BBC services but these have been viewed as unsuccessful.

The central problem with this type of methodology is that when confronted with the national voting question the respondent is presented with a choice between monetary values rather than a vote, so the question remains somewhat artificial. Further, whereas the private

marginal benefit of services is relatively easy to calculate, there is, as we have seen, no accepted means to attach a single value to social benefits, and different question wording can introduce variation and error.

### **Other methods**

Contingent valuation methods are not the only methods that are used in measuring social value. Value is measured against specific agreed targets and benchmarks in pragmatic approaches. And in addition, Public Value Tests and other measures of social value generally draw on multiple methods including: content analysis, appreciation indexes, output by genre measures and subjective indicators such as, awards won and various forms of peer review. One interesting model is the 'Audit' of the commercial radio sector's public sector output carried out by the Commercial Radio Companies Association in June 2000. This used a variety of tools, mainly content analysis of channel output by identified genres, outlining the number of minutes spent 'giving information on events' (1.54 million minutes per year) or on 'social issues and charities' (an average of 1.25 hours per station per week). These measures, whilst interesting, are extremely vague as measures of value or impact, because they do not take into account the size of the audience, the quality of the material or the subjective values attached to them by viewers.

The Ofcom public service broadcasting review also made innovative use of qualitative methodologies, combined with willingness to pay. Qualitative methods offered the chance to vary the information provided before asking willingness to pay, and look at the impact of different question structures on the response. The research found that participants in the deliberative groups generally supported general levels of explicit subsidy of PSB.<sup>118</sup> The respondents were not asked to consider 'hidden' subsidies such as may be provided by non-market pricing of spectrum.

### **Discussion of measurement methods**

There is a large literature on the potential pitfalls of contingent valuation studies. Some of these relate to the methodological difficulties of controlling for respondent error, e.g. certain groups being more inclined to claim higher willingness to spend across the board. Respondents may tend to hide poverty or meanness in an interview situation and therefore inflate willingness to pay. Others outline the errors that are introduced by various ways of presenting questions to respondents, such as the effect of grouping different categories of amenities (health vs cultural, for example) which quite dramatically alters the average values given by respondents. (Sunstein 2000). When asked to value something in isolation, respondents give very different responses. The obvious solution: altering methods of WTP studies to make sure that people are not asked their WTP for broadcasters in isolation from other uses of their money may be difficult to perform in methodological terms as it makes survey questions unwieldy and counterintuitive.

On balance, it is probably fair to say that many WTP studies tend to inflate values of cultural products. They are often commissioned by the operators of the amenities (galleries,

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<sup>118</sup> Ofcom PSBTVR, 4.35-4.39.

museums, theatres) themselves and only a rigorously independent and relative ranking approach should be used in any attempt to measure value of broadcasting.

In the context of AIP/ opportunity cost methods for measuring the social value of spectrum based services, we can in theory imagine applying a social value methodology based on WTP. If we assume that it is possible to ask respondents to what extent they value and are willing to pay for broadcasting services, it should in theory at least be possible to simply add questions to WTP surveys which would attach a social value to both existing and proposed services and a comparison could be made. (For example we could measure both the private demand and the social value of a new mobile service or an enhanced TV standard.)

We would effectively be asking respondents to attach comparative values to services that they are extremely familiar with (such as BBC, Channel Four, ITV or local broadcasting services) with services that by definition do not yet exist, and are unknown to consumers. The validity of valuations derived from contingent valuation or stated preference experiments has been questioned by numerous authors, largely because of the hypothetical nature of the choices facing respondents. Techniques have been developed that seek to overcome these criticisms by offering choices which are more realistic to consumers and proponents of the approach argue that choice experiments<sup>119</sup>

- provide an efficient method of valuing individual attributes within a scenario;
- can provide more easily generalised results as they can better measure marginal values of changes in the characteristic of the goods or service; they are also easier to pool with other choice and pricing models;
- can deal with multi-collinearity as the designs are based around a series of hypothetical situations in which the variables are independent of each other; this also allows the examination of non-existent alternatives.

Nevertheless it is likely that WTP/CV estimates would be contested and therefore may be difficult to apply as part of a pricing methodology. This does not deny there is a social value on broadcasting but rather that more work is required to find a reliable approach to measuring it. It is also possible that new services, even non-broadcast services might generate greater social value than existing broadcasting services, or it may be that an existing public body or consortium (take the Ordinance Survey and the DFES for example) may develop a spectrum – based service that would generate new levels of social value. Equally it is surely possible that commercial services might generate externalities and social value.

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<sup>119</sup> Cave M, Burningham D, Buxton M, Hanney S, Pollit C, Scanlan M and Shurmer M (1993). (The valuation of changes in quality in the public services. HMSO, London) recommended the use of such an approach to valuation of changes in quality of public services generally. A recent publication for the Department for Transport concurred with this view. Bateman, I., Carson, R.T., Day, B., Hanemann, W.M., Hanley, N., Hett, T., Jones, A., Loomes, G., Mourato, S., Ozdemiroglu, E., Pearce, D.W., Sugden, R., Swanson, J (2002). The Summary Guide to Economic Valuation with Stated Preference Techniques, Edward Elgar, Cheltenham (produced for the UK Department for Transport (see [www.dft.gov.uk](http://www.dft.gov.uk))). In the US the Report of the NOAA panel on contingent valuation, Arrow, Solow, Portney, Learner, Radner and Schuman, Federal Register, 58, 1993 recommended the use of these techniques in policy appraisal.



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## Appendix 2: Opportunity cost calculations

### 1. Calculations for UHF TV spectrum: DVB-H used to deliver TV services

The basis of our calculation is that, assuming there is sufficient demand for the delivery of broadcast multimedia content to multimedia devices, it will be more cost effective to deliver this by a marginal increase in the capacity of a DVB-H network rather than a marginal increase in the capacity of a 3G mobile network. In order to compare the costs of the two options, we have made the following assumptions:

#### Network Costs:

- **3G Mobile:**

(based on data used in 2004 Spectrum Pricing study)

- Site acquisition cost: £25,000 = £4,000 per annum (10% discount over 10 years)
- Equipment capital cost: £134,000 per site = £20,000 per annum (based on tri-sectorised sites with 3 transceivers per sector @ £10,000 each (= £90,000) plus further £44,000 for other equipment – figures reflect those used in previous AIP study)
- Equipment maintenance cost (12% of capital): £16,000 per annum per site
- Site rental: £6,000 per annum per site
- Backhaul: we have assumed that mobile TV content would be distributed to the base stations by satellite (a single transponder would be sufficient to cater for up to three DVB-H multiplexes). The additional cost of the satellite receiver is negligible compared to the whole site cost and since the satellite transponder cost would apply to both the UMTS and DVB-H solution this has been ignored.
- **Total annual cost per site = £46,000**

- **DVB-H**

- Specific data for DVB-H is unavailable so we have assumed the cost per DVB-H transmitter will be similar to the cost per 3G mobile transceiver, i.e. £10,000 per transmitter. The annualised cost is therefore £1,480 per transmitter; adding maintenance at 12% of capital brings this to **£2,680 p.a. per transmitter**
- For initial rollout of a single DVB-H multiplex, we have assumed that the estimate of a £500m capital cost for a national network of 2,700 sites provided by NTL would be valid. In order to determine the annual cost, we have attempted to separate out the site and equipment costs, by assuming that the site costs are the same as those for UMTS sites as presented above (i.e. site acquisition cost is £25,000 and site rental £6,000 p.a. .
- Total site acquisition cost for 2,700 sites is thus £67.5m and we assume the balance of the £500m capital cost (i.e. £432.5m) is for equipment. The





annualised equipment capital cost is therefore £64m and the maintenance cost is £52m. The annual site rental is assumed to be the same as for UMTS, i.e. £6,000 per site or £16.2m total.

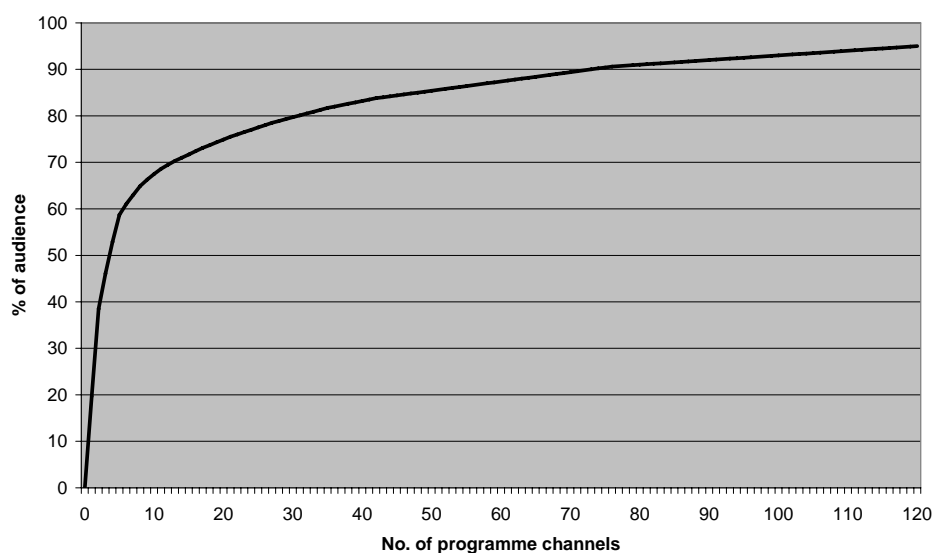
#### Audience Size:

- Market penetration of 3G mobile phones: 50%
- Percentage of users watching live content at busiest time: 10%
- Total audience: 50% x 10% x 60M = 3 million

#### Audience Distribution:

The share of current “fixed” TV viewing is highly skewed towards the mainstream free-to-air channels and a handful of pay-TV services, as the following chart (based on recent BARB data for multi-channel homes) illustrates:

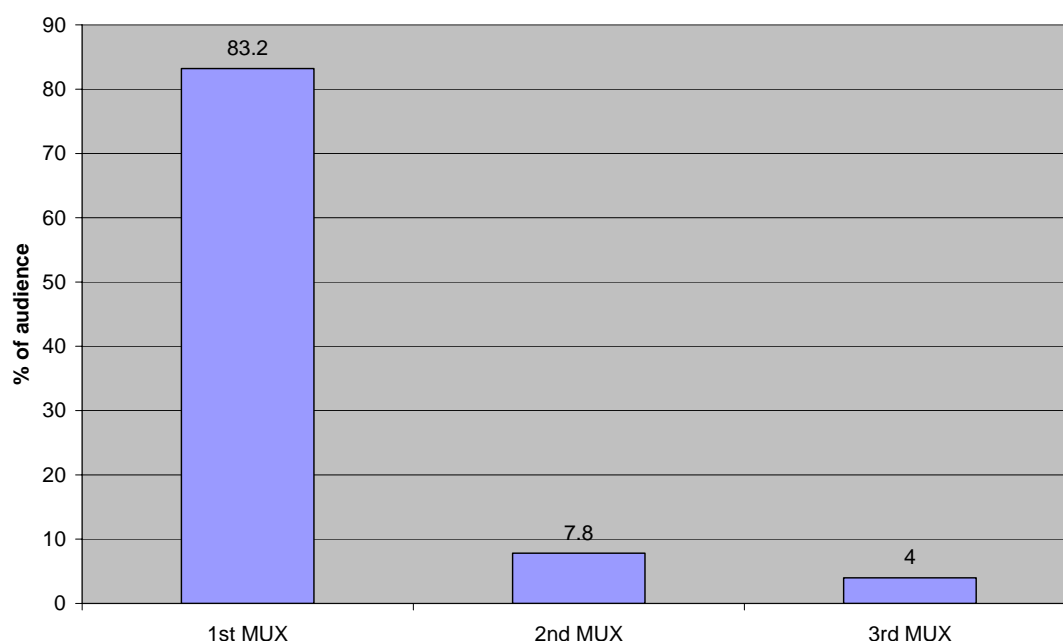
**Cumulative share of viewing of most popular channels in multi-channel homes (based on Feb 2005 BARB data)**



We have assumed for our calculations that mobile TV viewing preferences reflect existing fixed viewing and that typically 40 channels could be accommodated on a single DVB-H multiplex. The following chart shows how the audience would be distributed between three DVB-H multiplexes, assuming that the first multiplex carried the 40 most popular channels, the second carried the next 40 most popular, and so on:



**Proportion of audience accessing each of three DVB-H multiplexes (based on recent BARB data for “fixed” TV viewing)**



It can be seen that whilst 80% of the audience is tuned to the first multiplex, only 8% are tuned to the second, 5% to the third and 3% to the fourth. Since the cost of providing alternative delivery capacity in a UMTS network is broadly proportional to the audience size, the value in terms of cost saving will therefore be much greater for the first multiplex than for subsequent ones, as the following calculations illustrate. These assume that there are 3 million simultaneous viewers for the first DVB-H multiplex and that viewers for the 2<sup>nd</sup> and subsequent multiplexes reflect the proportions in figure 2 above.



	1 <sup>st</sup> mux	2 <sup>nd</sup> mux	3 <sup>rd</sup> mux
No. of subscribers	2.50m	234k	120k
No. of UMTS sites needed (assumes capacity of each site is 36Mbit/s = 140 viewers)	17,850	1,671	857
<b>DVB-H costs (£m p.a.)</b>			
Site acquisition (2700 sites @ £25k)	10.0	0	
Equipment costs	64.0*	4.0*	4.0*
Maintenance costs (12% of capital)	51.9	3.2	3.2
Site rental costs (£6k per site)	16.2	0	0
<b>Total DVB-H costs</b>	<b>142.1</b>	<b>7.2</b>	<b>7.2</b>
<b>UMTS costs (£m p.a.)</b>			
Site acquisition (£25k per site)	66.0	6.2	3.2
Equipment costs (£134k per site)	354.0	33.1	17.0
Maintenance	287.0	26.9	13.8
Site rental (6k per site)	107.1	10.0	5.1
<b>Total UMTS costs</b>	<b>814.1</b>	<b>76.2</b>	<b>39.1</b>
<b>Cost saving using DVB-H</b>	<b>672.0</b>	<b>69.0</b>	<b>31.9</b>
<b>Implied value per MHz</b>	<b>84.0</b>	<b>8.6</b>	<b>4.0</b>

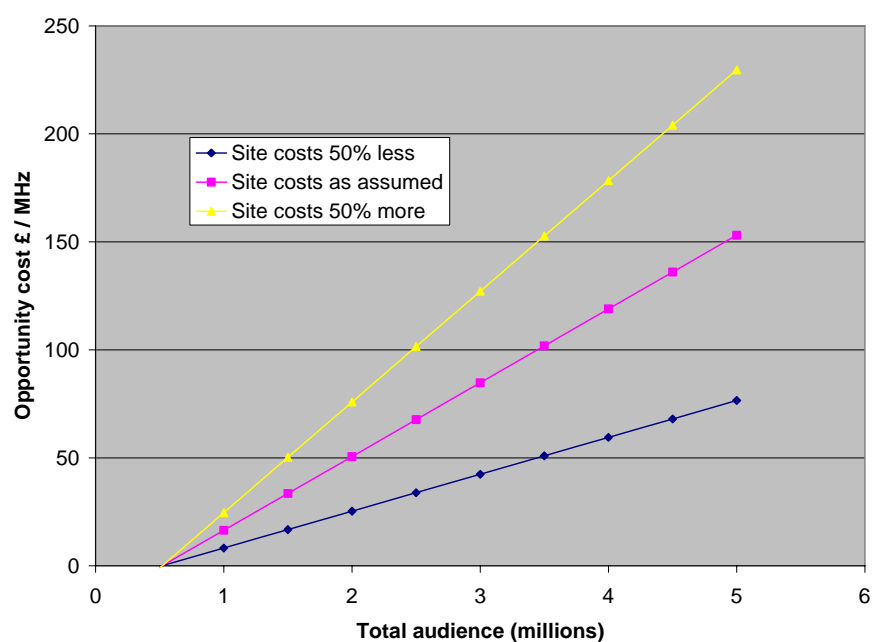
\* based on NTL estimate of £500m total rollout cost, less our estimated site acquisition costs of £67.5m

\*assumes £10,000 per site to add an extra transmitter

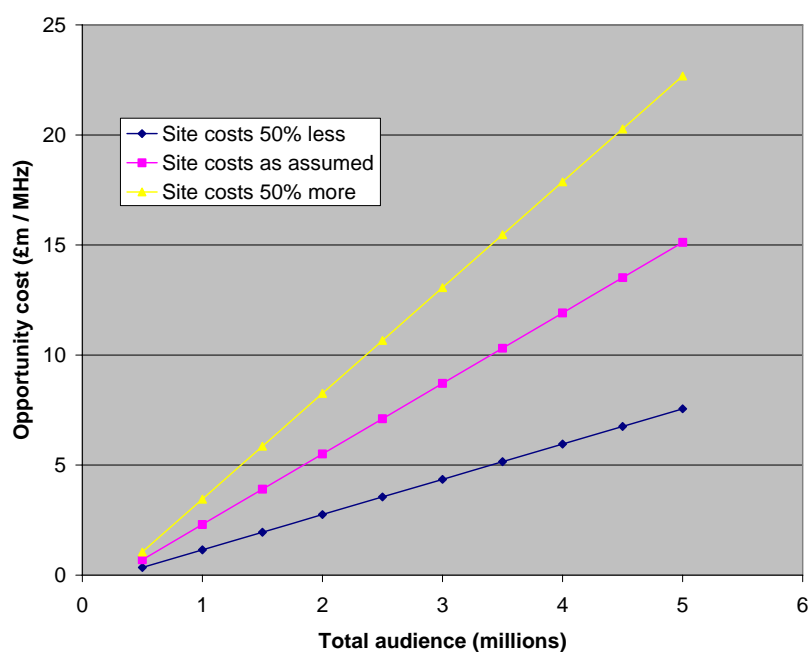
### Sensitivity to assumed audience size and equipment costs

The following graphs show the above spectrum values as a function of audience size and assumed site costs:.

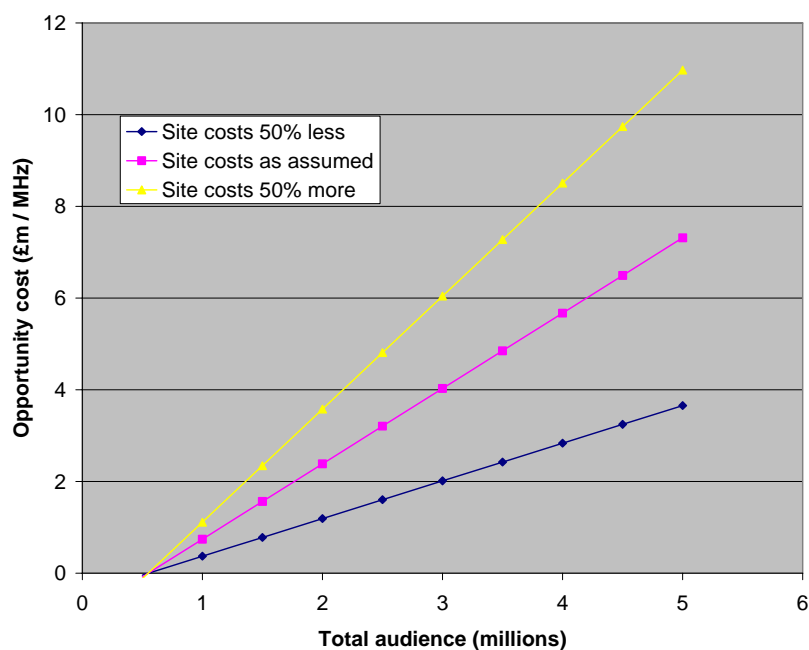
#### *First DVB-H multiplex (includes all site / rollout costs)*



**Second DVB-H multiplex (only cost of additional transmitter equipment considered):**

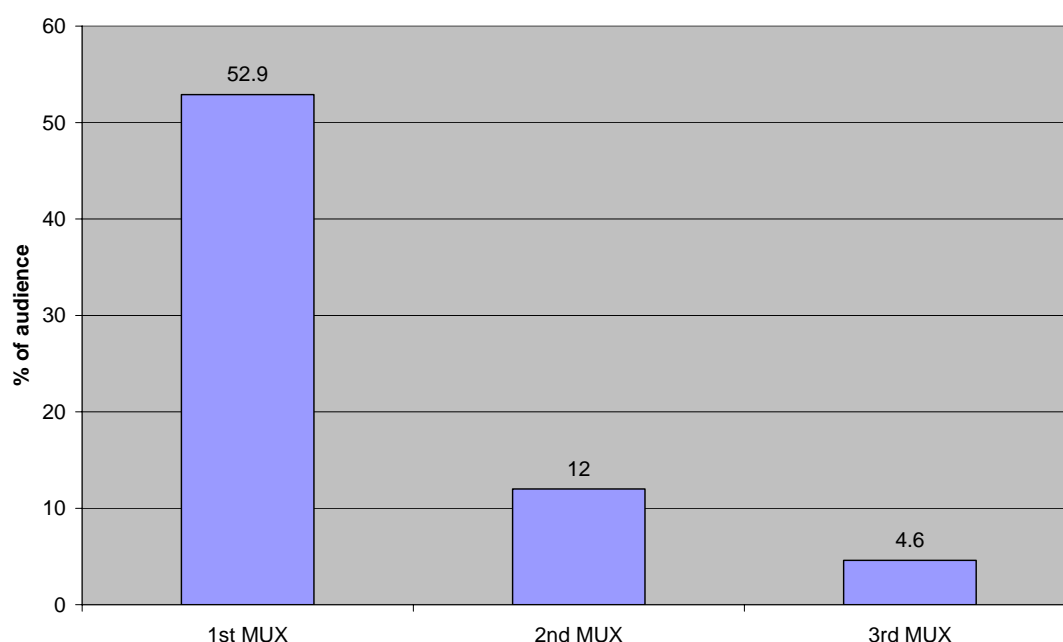


**Third DVB-H multiplex (only cost of additional transmitter equipment considered):**



## 2. Opportunity Cost Band III: DMB used to deliver multi-media content

The basis of our calculation is that, assuming there is sufficient demand for the delivery of broadcast multimedia content to multimedia devices, it will be more cost effective to deliver this by a marginal increase in the capacity of a DMB network rather than a marginal increase in the capacity of a 3G mobile network. As with the DVB-H calculations, we have considered the value based on the first second and third DMB multiplexes. However, since the number of programme channels that can be accommodated on a DMB multiplex is only a tenth of those on a DVB-H multiplex the audience distribution profile is different, as shown in the following graph:



We have assumed the same site and equipment costs for DMB as for DVB-H, and that a DVB-H network in Band III would require half the number of transmitters that a UHF DVB-H network would require, i.e. 1,350 sites. The calculations are as follows:

	1 <sup>st</sup> mux	2 <sup>nd</sup> mux	3 <sup>rd</sup> mux
No. of subscribers	1.59m	360k	138k
No. of UMTS sites needed (assumes capacity of each site is 36Mbit/s = 140 viewers)	11,357	2,571	986
<b>DMB costs (£m p.a.)</b>			
Site acquisition (1350 sites @ £25k)	5.0	0	0
Equipment costs	32.0*	2.0*	2.0*
Maintenance costs (12% of capital)	51.9	1.6	1.6
Site rental costs (£6k per site)	8.1	0	0
<b>Total DMB costs</b>	<b>71.1</b>	<b>3.6</b>	<b>3.6</b>
<b>UMTS costs (£m p.a.)</b>			
Site acquisition (£25k per site)	42.0	9.5	3.8
Equipment costs (£134k per site)	225.2	60.0	19.5
Maintenance	182.6	45.7	15.8
Site rental (6k per site)	68.1	15.4	5.9
<b>Total UMTS costs</b>	<b>517.9</b>	<b>130.6</b>	<b>45.0</b>
<b>Cost saving using DVB-H</b>	<b>446.8</b>	<b>127</b>	<b>41.4</b>
<b>Implied value per MHz</b>	<b>297.9</b>	<b>84.7</b>	<b>27.6</b>

\* based on NTL estimate for DVB-H of £500m total rollout cost, less our estimated site acquisition costs of £67.5m, then halved to reflect lower number of DMB transmitters

\*assumes £10,000 per site to add an extra transmitter

These figures might seem implausibly high, but they should be considered in relation to the annual revenue that might be generated from 3 million mobile TV subscribers, assuming each paid £10 per month which is the amount Orange is currently charging for its service. This would amount to £360m. There are two main reasons for the very high value, namely:

- the small amount of spectrum (1.5 MHz compared with 8 MHz for DVB-H)
- the low cost of rolling out a network in Band III (half the number of transmitter sites compared to DVB-H. because of the lower frequency band).

### 3. Opportunity costs for analogue and digital TV services

The task here is to estimate opportunity cost based on the cost of moving to alternative platforms. This involves estimating

1. The costs of household conversion to the new platform
2. Any change in transmission and distribution costs
3. Any change in the opportunity cost of other spectrum used
4. The spectrum released by the move to another platform

Our assumptions are set out below.

#### Household conversion costs

Household conversion costs depend on

- The number of sets that need to be converted at the date at which the move is assumed to occur. Households have on average 2.6 sets<sup>120</sup> and BARB 2004 data shows that digital households have on average converted 1.4 sets to digital operation. We do not have data showing the numbers converted by platform and have made the simplifying assumption that all sets in a specific household are converted to the same platform. Digital take-up by platform at switchover in each region is based on Ofcom forecasts and these are as shown in Table A2.1
- The costs of conversion. These depend on the platform and whether households live in single or multi-occupancy dwellings. We assume 20% of households live in multi-occupancy dwellings. Satellite and DTT conversion costs are as shown in Table A2.2. For 5% of households we assume new aerials if they switch from analogue TV to DTT at switchover. The DTT costs are annualised over five years as these costs mainly comprise the costs of a set top box, while the satellite costs are annualised over seven

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<sup>120</sup> This is a 2003 value based on survey data report in "The Communications Market 2004 –Television, Appendix: The Public's View Survey Results, Ofcom August 2004.

years as these comprise a mix of set top box and aerial installation costs. An 8% discount rate is used for this calculation.

- At switchover 35.6m sets need to be converted from analogue to either DTT or DSAT and in 2012, 34.6m require conversion to DSAT.

**Table A2.1 Digital households at switchover by region**

Region	Switchover	Satellite	DTT	Cable	Total
Border	2008	53.1%	41.5%	0.5%	95.2%
West Country	2008	39.5%	48.5%	5.2%	93.3%
HTV Wales	2008	50.7%	28.6%	9.5%	88.8%
Granada	2009	37.4%	44.1%	15%	96.5%
HTV West	2009	35.8%	45.8%	14.9%	96.5%
Grampian	2009	33.5%	39%	19%	91.5%
Scottish	2009	32.7%	35.8%	19%	87.4%
Central	2010	36.7%	40.8%	15.5%	93%
Yorkshire	2010	37.3%	44.3%	11.6%	93.1%
Anglia	2010	36.7%	41.5%	11.8%	90.1%
Meridian	2011	38.9%	38.6%	13.3%	93.6%
Carlton LWT	2011	36.3%	39%	17%	92.4%
Tyne Tees	2011	38.4%	44%	13%	95.5%
Ulster	2011	44%	36.2%	7.2%	87.4%
Channel	2012	65.1%	25.9%	5.6%	96.5%

**Source: Ofcom.** Note that Satellite includes Freesat.

**Table A2.2 Summary of Household Conversion Costs**

	One set conversion	Two set conversion
<b>Single occupancy households</b>		
DTT	£40	£89.50
DSat (Sky price)	£150	£300
<b>Multiple occupancy households<sup>121</sup></b>		
DTT	£120	£160
DSat	£174	£428

*Key assumptions are:*

*DTT: £40 per set top box. Average of £9.50 for aerial conversion*

*DTT multi-occupancy households – system upgrade assumed*

*DSAT multi-occupancy – system upgrade and £99 STB assumed*

<sup>121</sup> Data obtained from: Survey of MATV and SMATV systems, Action Plan Task 5.9, Digital Television Project, DTI, December 2003





## **Analogue and digital transmission and distribution costs**

Analogue transmission costs are around £66m p.a. for the four national networks (using 1154 sites) and distribution comprises around a further £16m p.a.<sup>122</sup> The analogous costs for Channel 5 are around £11m p.a. and £3m p.a., respectively.<sup>123</sup>

We estimate DTT transmission costs are around £27m a year per national multiplex plus £5m for distribution.<sup>124</sup> Each 64 QAM multiplex carries around 8 TV programme channels and so we have assumed 5/8 of these costs are required to carry the five analogue channels.<sup>125</sup>

## **Spectrum released**

Forty six 8 MHz channels are required to provide the five analogue TV services, although other services (e.g. PMSE and DTT) can be fitted in and around the analogue services in some locations. Nevertheless, we assume shutting down the analogue TV services will release 368 MHz.

As 14 channels are released by switchover we infer that 256 MHz are required to provide the six existing DTT multiplexes on a widespread basis (98.5% coverage for the PSB multiplexes and 90-93% coverage for the commercial multiplexes), implying 43 MHz per multiplex. Hence if the analogue channels are shutdown and are provided instead on a single multiplex then 325 MHz spectrum is left for other services.

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<sup>122</sup> This is based on the costs reported in "Review of Terrestrial Transmission Costs", G Bensberg, Ofcom Confidential Note, April 2004.

<sup>123</sup> Confidential Channel 5 submission to Ofcom

<sup>124</sup> These costs are based on work we have undertaken for Ofcom. "Costs of digital switchover obligations", Indepen for Ofcom, June 2005.

<sup>125</sup> DTT costs per 8MHz channel are higher than the comparable analogue transmission costs because analogue capital costs are largely written off while the roll-out of DTT involves a number of significant aerial and site related costs in addition to the costs of new transmitters.