Market prices boost efficiency

Allowing regulators to calculate a market price for spectrum rather than simply recover their admin costs cuts down on wasted frequencies argues consultant Chris Doyle.

Regulating radio spectrum use is costly. In practice costs are recovered through licence fees paid by radio spectrum users. In most countries spectrum charges reflect the administrative costs associated with policing interference matters. For example, in the United States the FCC applies two types of fees – application fees and regulatory fees to cover administrative costs.

In recent years some policy makers have started to ask the question: is cost recovery the best way to set prices for radio spectrum use? If not, is there an alternative to charges based upon the recovery of administrative costs? I shall argue that setting charges based on cost recovery are not the best way to set spectrum charges and show a superior method for setting charges exists and is working well in the UK.

Do cost prices reflect the true value?

To many the setting of prices for spectrum such that the administrative costs of managing the spectrum are recovered would appear to make sense. Indeed, if there were no shortage of radio spectrum this would be the best way to set prices. However, spectrum is not always abundant and in many countries there are more users seeking spectrum in the 450MHz-3GHz range than there are frequencies available. If a spectrum agency relies on charges that recover administrative costs, there is a risk prices will be too low for certain bands. Whilst the buyers of such spectrum may not complain about this, from society's perspective the resource would not be effectively managed.

For example, for many years television and radio broadcasting have been allocated large swathes of spectrum below 1GHz. With the spectacular rise in mobile radio applications (notably mobile telephony), this spectrum commands high value today. But where charges are based on factors which are independent of demand conditions for radio spectrum, then broadcasters will continue to make use of large amounts of spectrum as it is relatively cheap. This is despite the fact that mobile telephone companies may be willing to pay much more the spectrum.

The main problem with setting spectrum charges based upon the recovery of administrative costs is the inability to send desirable signals to users of the radio spectrum. If certain frequency bands become more attractive to users, then ordinarily the price for those bands should increase. In this regard spectrum should be subject to prices which are no different to those for private land. It could be argued that rather than have centralized administration of radio spectrum; prices should be determined, like private land, through market transactions. The introduction of spectrum trading, however, is difficult and requires a transition process whereby prices for spectrum are determined as if there were a market but instead are calculated by the radio administrator.

About the author
Chris Doyle is an independent telecoms consultant and on the faculty at the Centre for Management under Regulation, Warwick Business School, University of Warwick , UK
chris.doyle@cdoyle.com

Calculating a price

In recent years some spectrum agencies, such the Radiocomunications Agency in the UK (now Ofcom) have shifted from setting charges based on cost recovery to prices based on the underlying market value. The prices are known as Administrative Incentive Prices (AIP) – prices set by the radio administrator with incentive properties like those which would be found in a private

➲p11

1. Calculating AIP for fixed links

Link speed and less efficient scheme	More efficient option	Spectrum utilisation		Equipment costs (£)		Value per 2x1 MHz (£)	Annualised value (£ per 2x1 MHz)*
		Less efficient	More efficient	Less efficient	More efficient		
8Mbps/QSPK	16QAM	7 MHz	5.25 MHz	6,500	10,400	= £3,900/1.75 = £2,228	266

Notes:

** This is the value equivalent to the payment of a loan based on constant payments over a 15 year period for a constant interest rate (the discount rate) of 10%.*

Figures extracted from a consultants study for Ofcom for fixed link operating at 8Mbps.

➲p10

market. In the UK, the regulator Ofcom calculates AIP based on opportunity cost principles. Opportunity cost is a fundamental concept in economics and is the value of an asset or resource in the best alternative that is foregone by virtue of its actual use.

How is the principle of opportunity cost applied to radio spectrum? To see this consider a quantum of radio spectrum, this is the asset or resource which can be used for many different purposes: mobile communications, radar, astronomy, etc. Suppose some radio spectrum is used for astronomy purposes. This spectrum could be used for some other purpose – such as in fixed telecommunications or broadcasting. Applying the principle of opportunity cost requires that we determine the value of the spectrum in these alternative uses, and then choose that alternative that yields the highest value.

But what is the value of the spectrum were it applied in these alternative uses? This may not be so straightforward to compute in practice but in principle it is calculated by looking at how the spectrum in the alternative use would affect costs. For example, if the alternative use is fixed telecommunications and this resulted in lower overall costs in supplying fixed telephony services (because the spectrum allows operators to more efficiently construct networks), then the lower costs comprise the value. If the current astronomy user were not willing to pay this sum, then this indicates that society would be better off if the spectrum were used in fixed telecommunications instead.

Applying AIP to fixed links

It is helpful to provide a concrete example of AIP use and I shall look at fixed link services in the UK. Fixed link services are point-to-point radio communication services used in the UK primarily for infrastructure links by or on behalf of mobile telecommunications networks. Each fixed link is separately licensed by Ofcom and there are over 40,000 links in operation. Popular frequency bands in use are 7.5GHz, 13GHz, 23GHz and 38GHz. There is also increasing interest in the 55, 58 and 65GHz bands for very short fixed infrastructure and access links.

Many of the bands used for fixed link communications do not have high demand from other users, which is particularly true for the higher frequency bands. Although there are often no other users, within a fixed link band there exist competing fixed link users. From an efficiency perspective therefore it is important that the fixed link users providing highest value supply service. AIP can be calculated to ensure this happens.

For most fixed link applications, there is more than one technology option, in terms of modulation scheme. In general, higher level modulation schemes result in a lower spectrum utilisation per unit of data conveyed by the link. If a unit of spectrum were taken away from a fixed link user, to maintain service provision a higher modulation scheme would need to be deployed. The value of the marginal unit of spectrum to the fixed link user can therefore be measured as

2. AIP revenue raised by sector in the UK (in £000)

	Sector	2004/2005	2005/2006
1	Aeronautical	818	931
2	Amateur and Citizen's band	1,030	883
3	Broadcasting	2,454	4,001
4	Business Radio	15,187	11,838
5	Fixed Links	18,203	20,895
6	Maritime	1,723	2,031
7	Programme Making and Special Events	1,145	1,412
8	Public Wireless Networks	63,868	63,011
9	Science and technology	112	745
10	Satellite	928	974
11	Ministry of Defence	24,314	55,398
Total		**132,168**	**164,094**

ADMINISTERED INCENTIVE PRICING

Market prices boost efficiency

➲*p11*

the cost difference between different modulation schemes. (See table 1) As the equipment for fixed link use is supplied on competitive markets, this cost factor constitutes the opportunity cost.

In the UK AIP for fixed link use have been calculated by identifying the capital costs for the different technologies which can perform the necessary data conveyance. In the UK the costs of three different modulation schemes (QPSK, 16QAM and 128QAM) for six different data rates ranging from 2Mbps up to 155Mbps were used. It was assumed that a spectrally more efficient modulation scheme utilises 75% of the spectrum utilised by the next best less efficient alternative. It was also assumed that over 15 years of the lifetime of the equipment, a discount rate of 10% applied and that the maintenance costs of more efficient equipment was identical to that of less efficient equipment.

The value of spectrum is calculated by supposing that there is a marginal decrease in spectrum. For the operator to maintain data conveyance at 8Mbps, a more efficient modulation scheme at 16QAM would be the next best alternative and this would entail slightly less bandwidth (1.75MHz). On the other hand the 16QAM technology is more costly, £10,400 versus £6,500. Hence, the value of 2x1MHz is estimated by taking the additional costs associated with the more efficient technology and dividing this by the spectrum saved. Finally this figure is adjusted to obtain an annualised sum of £266.

The computation above shows that the estimated opportunity cost is sensitive to a number of variables: capital cost estimates, the perceived next best alternative, judgments about spectral efficiency gains, the discount rate (or cost of capital), and the lifetime of the equipment.

AIP has been in use since 1998 in the UK and the system of prices has evolved and generally become more sophisticated. The amount of revenue that was collected through these charges in 2002 is shown below. Initially the scope of AIP was limited to some major commercial uses, but over time it has been extended to cover spectrum used by the emergency services and the military.

Does it work?

There is some evidence of the success of the AIP policy in the UK. In the last two years significant amounts of spectrum have been returned to Ofcom for re-assignment, as a more or less direct result of AIP. 28MHz of the more valuable spectrum below 3GHz has been released by public and private sector users in response to AIP, as has 160MHz of the second-tier spectrum in the range 3-10GHz.

AIP, if calculated accurately, are very effective for ensuring that spectrum is used so society achieves the maximum benefits from the radio spectrum asset. But, AIP will only be as good as the administrators calculating the prices. Inaccurate AIP could be very costly and do more damage than relying on traditional command and control methods.

The setting of AIP is something radio administrators should seek to do in an effort to improve more efficient use of radio spectrum. One of the biggest challenges facing a spectrum management agency in setting AIP is calculating the prices. This requires detailed analysis of the various markets and uses to which radio spectrum is put, and considerable judgment. The evidence gathered in the UK suggests that AIP does work and it is improving the way in which spectrum is utilised. •

IMT-2000/WiMAX

Circular letter smooths path for WiMAX

ITU confirms WiMAX IMT-2000 submission and urges stakeholders to monitor new webpage.

By Michael Newlands

The efforts by the IEEE and the WiMAX forum to get WiMAX recognised as an IMT-2000 technology by the ITU in time for WRC-07 in October appear to be going smoothly despite some road bumps at the 21 st meeting of ITU-R Working Party 8F In Cameroon last month. (See *PolicyTracker* February 2007)

The director of the ITU Radiocommunication Bureau, Valery Timofeev, has issued a circular letter (8/LCEE/152) confirming the submission of IP-OFDMA for consideration as the sixth terrestrial radio interface, and highlighting the setting up of a new web page. Interested parties are requested to monitor the site because ''evaluation information … will continue to be added to the web site as it becomes available''.

The pro-WiMAX lobby is pleased the letter has been issued as it makes it much more difficult for opponents to try and adopt delaying strategies at the next WP-8F meeting in Kyoto this May where they hope the submission will be accepted for formal ratification in June

Peter Gibson of Intel, who attended the Cameroon meeting, said: "There was no obligation for this circular letter to be issued, but the letter together with the website make the whole process transparent and give plenty of time for submissions and evaluations before Kyoto. There will be no excuse to try and hold things up".

The next important meeting will be the IP-OFDMA Evaluation Group Coordination Meeting, which will be part of the IEEE 802.16 Working Group meeting in Orlando, Florida on March 13 to 14. •