



postnote

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RADIO SPECTRUM MANAGEMENT

The radio spectrum supports services from air traffic control to wireless Internet. Demand for it is increasing with the rise in wireless and mobile services. This POSTnote discusses the UK move towards more liberalised spectrum use. It also outlines debate over the “Digital Dividend”: the forthcoming release of radio spectrum as a result of the switchover from analogue to digital television.¹

Radio waves

Radio waves (10kHz to ~100GHz) are a form of electromagnetic radiation, just like visible light or infra-red.² Unlike visible light, they can penetrate walls and non-metallic objects and can be transmitted and received using antennae, making them useful for communications, navigation and broadcasting. They have many different properties, depending on the frequency and power of transmission (Figure 1). For example long wave radio has a cross-continental range, while Bluetooth signals (used in phones and other devices) travel only up to 10m.

Radio spectrum management

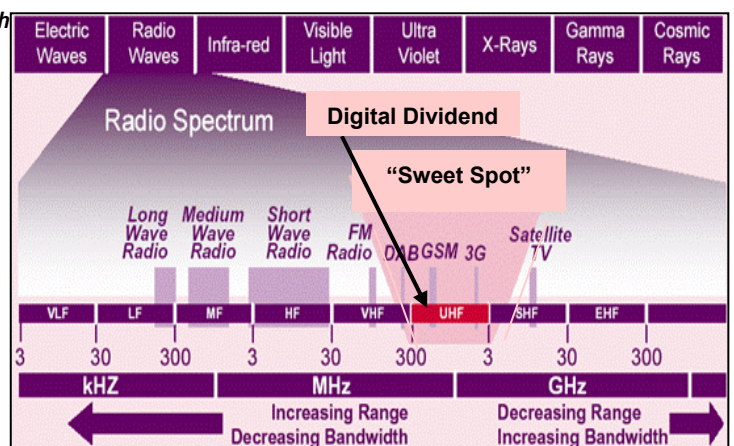
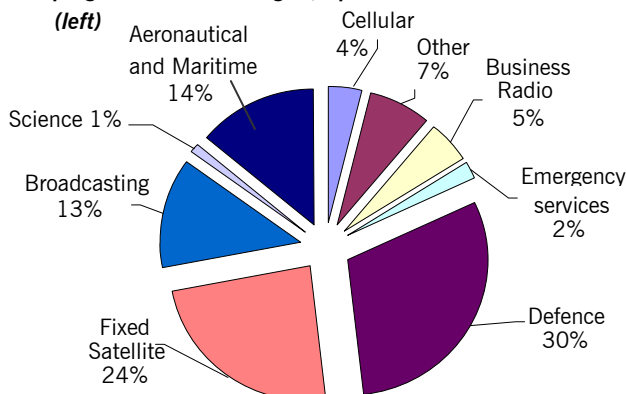
There are many competing uses and users of the spectrum. Regulation aims to secure the best use for society, and to minimise interference between signals.

The regulator Ofcom manages civil radio spectrum in the UK (Box 1) and grants spectrum licences, giving users the right to operate over a set locality at a selected range of frequencies. Before the 1998 Wireless Telegraphy (WT) Act, licences were awarded for a specific technology and use. Fees were set to cover administrative costs only. Prospective businesses would submit proposals to the regulator, who would pick the proposal it deemed economically and socially beneficial. Such “beauty contests” were manageable when there were fewer demands for licences. As demand increased other models have been introduced.

Auctions

The 1998 WT Act enabled the use of auctions to grant licences, where appropriate. For some services, such as emergency services, auctions are not suitable. Some devices (such as Wifi and Bluetooth), are licence-exempt because they emit at low power. They account for over 6% of UK radio spectrum. The first UK spectrum auction was in 2000 for 3G mobile phone licences, and raised £22 billion. Two main constraints were imposed: licences could be used only for 3G mobile phone technology, and licensees had to provide reception for at least 80% of the UK population by the end of 2007.

Figure 1: Radio Spectrum. Source: Ofcom Technology Research programme 2004/5 (right); Spectrum Framework Review 2004 (left)



Box 1 Spectrum regulators

UK level

The 2003 Communications Act formed **Ofcom** from 5 existing regulatory bodies. Its responsibilities are to:

- negotiate and adhere to international agreements;
- ensure the spectrum is used in the interests of citizens and consumers;³
- employ market mechanisms, where appropriate, to secure optimal use of spectrum resources.

Public sector bodies (such as the **Ministry of Defence** and the **Civil Aviation Authority**) manage spectrum for defence, aviation, shipping, science and public safety. Spectrum assignment often follows strict international standards.

International level

- The **International Telecommunications Union** (ITU) is a United Nations body allocating broad category uses for frequency “bands” (ranges of frequencies) for activities such as mobile systems, satellite communications, broadcasting and radio navigation. Treaties signed are part of UK law.
- The **European Union** (EU) also legislates on spectrum use. Decisions are binding for the UK.
- The **CEPT**⁴ is a body of regulators of 48 European countries that develops spectrum management recommendations for Europe and coordinates European proposals to the ITU. It advises the EU Commission on spectrum decisions.

The UK is one of the first EU member states to begin liberalising spectrum. Many others are continuing with traditional styles of regulation.

Liberalisation

After the 2003 Communications Act and Ofcom's 2004 Spectrum Framework Review, the UK moved towards a more liberalised approach, removing auction and licence constraints where possible. There are three components:

- **Technology and service neutrality:** businesses may use the spectrum for any compatible purpose or technology and may change this as they see fit;
- **Spectrum trading and leasing:** licences may be traded, so users that are short of spectrum can lease or buy spectrum from others;
- **Administered Incentive Pricing (AIP):** introduced in the 1998 Wireless Telegraphy Act, AIP aims to encourage more efficient use of spectrum (p3).⁵

One aim of liberalisation is for spectrum use to be largely governed by market forces. Ofcom says businesses are better placed than it, to decide how spectrum should be used and for what, although some technical constraints to prevent interference are unavoidable. It says liberalisation should help emerging technologies and businesses to gain spectrum access, so stimulating innovation. There is broad support for these policies, although industry and broadcasters agree that there is still a significant role for regulation.⁶

Appropriateness of auctions

One of Ofcom's key arguments for auction is that competing demands for spectrum can be tested in an open and transparent process. However, some are concerned that in an auction, the optimum uses of spectrum (in terms of social value) may not always

Box 2 Digital Dividend (DD)¹

This is spectrum released in the range 470-862MHz as analogue TV is switched over to digital TV. This frequency range is attractive as it combines a high data rate (Figure 1) with a large coverage area. This makes national coverage feasible. Mobile services, local TV, wireless broadband, standard and high definition TV are all competing applications.

The frequency range is divided into “channels”, historically numbered 21 to 69. Of these, 32 channels will be reserved for digital terrestrial television (DTT), or “Freeview”. Sixteen channels may be released through an auction, as proposed in Ofcom's Digital Dividend Review (DDR). As switchover takes place on a region by region basis from 2008 to 2012, channels will become available. Digital switchover is happening in many countries but plans to reuse the spectrum vary. For example, France is reserving most of the freed up TV spectrum for High Definition Television.

draw the most financial backing. Nevertheless many commentators from industry and broadcasting accept that while auctions may not always guarantee optimum spectrum use, they are generally the fairest way to deliver it to users. The auction of the Digital Dividend or DD (Box 2) was the subject of an Ofcom consultation earlier this year that attracted some 750 responses.

Issues

European harmonisation

In the past, harmonisation (using certain frequency bands exclusively for particular technologies) has occurred at EU level. Advocates say benefits include:

- enabling consumers to roam across borders and still have functioning devices (as is the case for mobile phones following the “GSM” standard – Box 3) ;
- cheaper manufacturing costs, as devices can be sold across the EU.

Although technology and service neutrality brings many benefits, it may lead to the same frequencies being used for different purposes in different countries. This could hinder harmonisation. Many manufacturers fear that the benefits of large scale production for an EU-wide market may not be realised without harmonisation. Mobile handset and other device costs could increase significantly. Some industry analysts say that a “hands-off” policy is not suitable: Ofcom's market-based approach should be balanced with some regulation.

However, others argue that picking specific technologies could hinder competition and that harmonisation should be achieved through market forces. One way of achieving the benefits of harmonisation, while avoiding inflexibility, is through ‘zoning’ – where the EU requires specific channels (Box 3) to be made available for certain technologies, but not to be exclusively reserved for them. For example, a CEPT task group may recommend that channels 60 to 69 within the Digital Dividend be available for mobile services. This could help manufacturers plan ahead. Harmonisation is also debated at wider international level (Box 3).

Harmful interference

In the past, regulators knew the kind of equipment likely to be transmitting at a given frequency, or in a geographical area. Interference was managed by specifying technical restrictions on equipment as part of licence conditions. The current changes will make it harder to predict what devices will be operating, where, and at what frequencies. This could make interference harder to manage, so Ofcom is introducing Spectrum Usage Rights. These would impose generic restrictions on the power of transmissions that a licensee may transmit in adjacent frequency bands or locations - regardless of the type of radio transmitter operated - be it a broadcast transmitter, taxi radio or mobile phone base station. Some say legal responsibility for limiting interference, and meeting any associated costs if it occurs, should be established before spectrum is licensed.

Difficulties with auctions

Different technologies have different spectrum needs. Some devices, (like mobile phones), require separate frequencies to transmit and receive while others, (like broadcasting equipment), only transmit. Therefore the way that spectrum is "packaged" when it is auctioned can bias an auction towards certain technologies. Some measures are being proposed to address this issue in the impending 2.6GHz auction (Box 3). The timing of an auction is also critical. Industry says it needs reliable information on auction dates as far in advance as possible to plan ahead and to reduce risk.

Administered Incentive Pricing (AIP)

AIP involves giving certain spectrum users who do not currently have to compete for spectrum, incentives to use it more efficiently. This often requires Ofcom to increase the licence price. Any spectrum freed up by licensees (for example by investing in more spectrally efficient equipment) can be leased or traded by the organisation, so raising revenue. There is broad support for AIP, although there is considerable debate about how licence prices are set. Ofcom sets these according to a calculation of market value ("opportunity cost"). Some economists believe this is not an accurately measurable quantity. Others say a balance between what is affordable, and what will motivate better use, should be applied. AIP is applied to both the public and private sector.

Ministry of Defence (MoD)

The MoD manages 30% of the UK radio spectrum (Fig 1) and pays £55 million per year for this. This price will rise significantly after an independent government review (the Cave Audit).⁵ This also recommended a full audit of MOD spectrum usage, (which the MOD have begun) to identify potentially surplus spectrum. AIP is already applied to some MoD spectrum holdings; the MoD say it will be extended to others as appropriate. The MoD is acting on various recommendations of the Cave Audit, such as facilitating opportunities for secondary spectrum markets, through leasing and trading freed frequency bands.

Box 3 Technology neutrality & international policy

Debates are emerging over how to harmonise international, EU and UK practice.

Expansion of mobile networks in India and China

Many new standards have been set for mobile technologies in India and China, where markets are expanding rapidly - leading to debate over the importance of EU harmonisation, to allow the EU to compete with other markets.

2.6GHz spectrum: The band of spectrum at 2.6GHz (which is outside the DD) has been identified by the ITU for 3G mobile use. However, Ofcom plans to auction this in the UK as technology and service neutral, rather than restricting the auction to 3G uses only. This band is of interest to WiMax (a form of wireless broadband) as well as to mobile operators. To allow both uses to compete, Ofcom propose to split the band into sub-bands.

GSM liberalisation: Mobile network operators operate in three frequency bands. Two are for GSM mobile phone licences, issued for indefinite periods. GSM is a common 2nd generation (2G) mobile phone technology. The third is for 3G licences, issued in the 2000 auction. These last for 20 years only and were more expensive. Ofcom is considering whether to allow 3G services to be provided, at lower cost to operators, using GSM frequencies. This move is soon to be permitted by the EU, but in the UK, the debate over how to implement the move has not been resolved.

Civil Aviation Authority (CAA)

The CAA is an independent regulator (similar to Ofcom); it plans assignments of spectrum for all UK aeronautical use. AIP has not yet been applied to the aviation sector; Ofcom plans to consult on this. The CAA broadly welcomes AIP as a tool to encourage efficiency, as licence fees would be lower for more efficient users. However it would be opposed to aviation licensees being allowed to trade unused frequencies, rather than returning them to the pool for aeronautical use. The CAA also stresses that international obligations should not be compromised and that it would approve leasing of freed spectrum only if there were guarantees to prevent interference. Ofcom is consulting on whether aviation licensees should be allowed to trade or to lease spectrum for other applications, recognising that international obligations and interference issues may limit flexibility.

Broadcasters

Ofcom and the UK government believe AIP should be applied to the Public Service Broadcasters or PSBs (BBC, ITV, Channel 4 and 5). All PSBs could face substantial increases in the amount they pay for spectrum, and oppose this, arguing that:

- AIP is not needed as an incentive to make efficient use of the spectrum;
- programme quality and coverage could suffer as money is diverted to cover spectrum costs.

Ofcom has decided that AIP should apply to digital TV broadcasting from 2014; decisions on pricing will be taken nearer the time. Concerns have also been voiced over the impact of AIP on the commercial radio industry.⁷

Digital dividend issues

High Definition Television (HDTV)

HDTV has a higher picture quality than standard definition (SD) TV. Sales of HDTV “ready” sets are increasing. Sky, BBC and ITV have all invested in HD programme making, as many overseas markets require this format. HDTV requires much more spectrum than SDTV. Terrestrial broadcasters do not have enough spectrum to offer it, so it is currently only available on satellite and cable channels. After switchover, Ofcom estimates there will be sufficient capacity (Box 2) for four national terrestrial HD channels. However, many commercial broadcasters and PSBs do not think there will be enough spare capacity to cater for terrestrial HD demand. PSBs argue that there are significant legal and economic difficulties in securing the spare spectrum for HD. To receive terrestrial HD if it were offered, some viewers would need to invest in a new set top box as well as an HD “ready” TV.⁸

Ofcom says the PSBs could secure extra spectrum for HDTV at an auction, but PSBs say they would be unable to fund a competitive bid against commercial operators. The HDforAll campaign backed by HD manufacturers, retailers and broadcasters, says some dividend spectrum should be ring-fenced or loaned for terrestrial HD.

Programme Making and Special Events (PMSE)

Some frequencies within the Analogue TV spectrum have been used to support wireless microphones and cameras, in-ear monitors and talkback systems, by a wide range of groups. These range from 24 hour news stations to West End theatres. The Joint Frequency Management Group (JFMG) manages spectrum for PMSE. Ofcom’s Digital Dividend Review suggested auctioning PMSE frequencies within the analogue TV spectrum. However, responses stressed the social value of PMSE, and the problems PMSE users would face in forming a bid at an auction.

In response, Ofcom has launched a further consultation. It proposes continued PMSE access to this spectrum until 2018, and favours the emergence of a “band manager”, acting on users’ behalf, either at beauty contest or at auction. However, access will be reduced from its current form. For example PMSE users will lose access to frequencies near 2.6GHz as this auction proceeds (Box 3). Some users say this could impact on future events, and claim that the UK would not have had enough spectrum for the London Tour de France TV coverage if the 2.6GHz band had been unavailable.

Channel 36

Channel 36 falls within the Digital Dividend (DD), but an airport radar facility has historically used it. The licence will be revoked in 2008/9, making it available nationally before the region-by-region release of the rest of the DD, for other uses. There is debate over when to release it. Businesses are interested in using it to deliver mobile TV. Many say an early auction would give a developer time to build a mobile TV network and launch at switch-off, rather than leaving spectrum unused. However with developments in the EU to “zone” some of the DD (p2)

some businesses argue against early release. Ofcom has not yet decided whether to award it in advance of the rest of the DD.

Local TV

Local TV is a possible user of the digital dividend. Many say it delivers some societal benefits that national TV does not. Concerns have been raised that local TV channels will not be competitive in an auction process.

2012 London Olympic Games and Paralympic Games

As part of the Olympic bid the UK government committed to ensuring that enough spectrum would be available for worldwide media coverage. Even in its current form, the PMSE system would require extra spectrum, as it is already at capacity. JFMG says coverage of major events has depended on loan of spectrum from other sectors, but it is not clear whether this will be practical in future. Ofcom will publish a discussion document on spectrum planning for the Olympics in autumn 2007.

Overview

- The UK is moving towards a more liberalised approach to managing radio spectrum. Ofcom aims to optimise spectrum usage to secure the best use for society.
- Issues arising include how to strike a balance between flexibility and international harmonisation, to avoid harmful interference and how to ensure efficient spectrum use by public bodies.
- Industry says that provision of advance information on auction dates is crucial for planning ahead.

Endnotes

- 1 Analogue to Digital Switchover, Postnote 264, Parliamentary Office Of Science and Technology, June 2006
- 2 Frequency is described in Hertz (Hz) ; 1kHz = 1000Hz, 1MHz = 1 million Hz, 1GHz = 1 billion Hz.
- 3 Note that this POSTnote often refers collectively to “society” rather than distinguish between citizens and consumers.
- 4 CEPT stands for *Conference Europeenne des Administrations de Postes et des Telecommunications*
- 5 *Independent Audit of Spectrum Holdings: Government Response and Action Plan*, Cabinet Office Committee on UK Spectrum Strategy, March 2006
- 6 *Digital Dividend Review*, Ofcom, December 2006
- 7 *Response to Ofcom’s Consultation on Administered Incentive Pricing*, The RadioCentre, October 2006
- 8 Digital Television, Postnote 233, Parliamentary Office Of Science and Technology, December 2004

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