A Guide to the Spectrum Framework Review

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Ofcom
OFFICE OF COMMUNICATIONS

The role of this guide

Ofcom's strategy for managing the UK's radio spectrum was set out in some detail in our Spectrum Framework Review (SFR) Statement. Published in June 2005, it was necessarily quite technical; the primary target audience of the Statement was those who are already familiar with the regulation of radio spectrum.

The aim of this guide is to explain our thinking to a wider audience, including people making investment decisions in companies that use, or might use, radio spectrum. So while the Statement remains the definitive policy document[1], we hope this guide will prove useful in introducing some of the issues.

1 The Statement is considered by Ofcom as the definitive publication of our strategy. This document is intended for guidance only.

An introduction to radio spectrum

Every day, we take it for granted that wireless communications will be there to serve us. From mobile phone calls and broadband connections, to the radio and television programmes we flick on without a thought, to radio taxis and Wi-Fi enabled laptops – our need for wireless communication never stops and, indeed, is growing as new technology creates new demands. Wireless communications are also the backbone of safety-critical operations such air traffic control and the railways, and the rapid response of the emergency services.

Wireless services work by sending signals to each other through the air. The radio waves that carry these signals form part of what is known as spectrum (or, more properly, 'electromagnetic spectrum').

A key property of wireless transmissions is the frequency of the signal being transmitted. In the same way that sound can be at a low frequency (for example, a drum beat) or a higher frequency (such as a whistle), so wireless transmissions have different frequencies. These vary according to the electrical signal used to generate them.

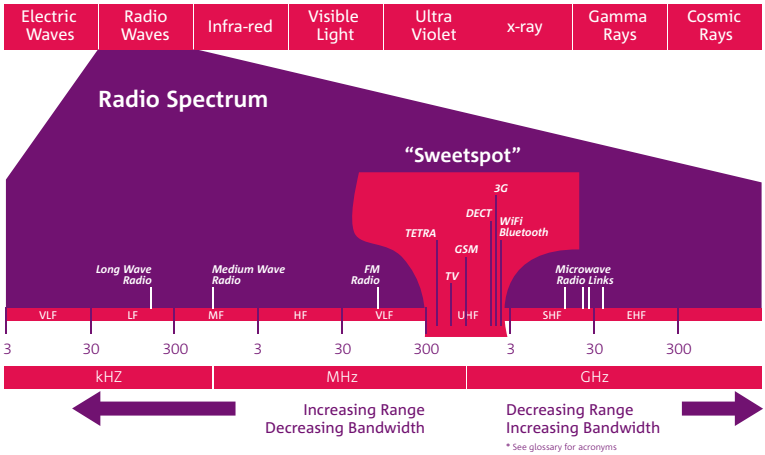
Usefully, different frequencies do not interfere with each other, even if they're transmitted in the same place. That's also why you can hear many different FM radio stations, simply by changing the frequency on your dial. So by licensing different broadcasters and users on different frequencies we can avoid one interfering with another.

However, not all frequencies are the same. At lower frequencies, signals travel a long way, but they have limited room for information or different services. At high frequencies, signals may only travel tens of metres from the transmitter – but can carry massive amounts of information.

Figure 1 sets out the spectrum or range of frequencies, and where some of the key services reside. Its most useful area is UHF; this mid-region 'sweet-spot' offers the best of both worlds, where signals travel a reasonable distance but also have a good capacity for carrying information.

Given radio spectrum's importance to enterprise, safety and society as a whole, Ofcom has been considering carefully how to manage this vital resource. In November 2004, we published a consultation document

Figure 1:



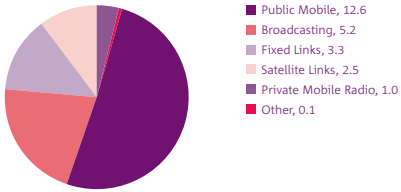
on the Spectrum Framework Review. The responses this generated were taken into account before publishing our Spectrum Framework Review Statement in June 2005. This publication is a concise guide to that Statement, summarising its main conclusions.

The value of spectrum to society

It is hard to put a price on something that sits at the very heart of how we live, work, travel and relax. Without radio spectrum, journeys by trains, boats and planes would be chaotic, and considerably more risky. 999 assistance would be slower and less effective. TV would be the preserve of city dwellers who could plug into cable, and there would be no radio at all. You could forget about your mobile phone, and a host of devices such as central locking car key-fobs, garage door openers and cordless phones.

Studies in the past have conservatively estimated that the use of radio spectrum adds around £24bn each year to the UK economy and that this value grows significantly year-on-year. Figure 2 shows how this value is divided across the main users of the radio spectrum.

Figure 2:
Value of radio spectrum to the UK economy in £bn, estimated in 2002



Why spectrum is regulated, and Ofcom's duties

Clearly, radio spectrum is a vital resource for the nation, demanding careful management. In practical terms, this raises two regulatory priorities: to make sure that its current use is protected from disruption, and to extract the maximum value from spectrum for the benefit of our society.

Preventing disruption

The orderly use of spectrum can be disrupted by interference. This is caused if two users in close proximity transmit on the same frequency at the same time. The result can so degrade a radio signal that it becomes indecipherable. To prevent interference, Ofcom usually grants the right to transmit on a particular frequency over a particular geographical area. By making sure that anyone else using the same frequency is sufficiently far away, most forms of interference can be avoided.

The right to transmit is sometimes referred to as 'access to the spectrum', and users will sometimes refer to having bought 'spectrum at auction'. Of course, radio signals do not stop at borders, so the issue of interference has an international dimension as well.

Maximising value

Rather like land, there is only so much radio spectrum to go around. It is a finite resource, with many potential applications vying for the most valuable frequency bands. It's in everyone's interests that spectrum is allocated in a way that realises the very best value from the resource available. However, with many thousands of possible uses, and spectrum spanning a wide range of frequencies, this is a hugely complex task. Much of what follows in this guide focuses on our strategy for maximising the value of spectrum.

Ofcom's duties

Ofcom is responsible for managing spectrum in the UK for civil use. The Communications Act 2003 requires that Ofcom encourages the optimum

use of spectrum and maximises the economic benefits. As well as fulfilling these duties Ofcom has a wider ambition to make the UK a leader for wireless investment and innovation.

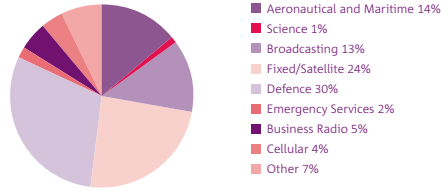
How spectrum has been managed and why this should be changed

Almost as soon as spectrum started to be used, it needed to be managed. So, around 100 years ago, spectrum management was introduced in the UK, with the initial focus on preventing interference. It is only in recent times that the thinking has been widened to include maximising the value of spectrum as well.

Worldwide, there has been a general pattern of spectrum managers deciding, often in line with an agreed international framework, how a particular band should be used, and who should be able to use it.

This approach was appropriate while there were relatively few uses and users. The spectrum manager could have as good an understanding of the best use of spectrum as the market itself, and sensibly control all aspects of spectrum usage. The distribution of spectrum that has emerged in the UK under this approach is shown in Figure 3.

Figure 3:



Generally speaking, this style of spectrum management has worked well in terms of avoiding interference. Less clear, however, is whether it has maximised the value of spectrum.

Broadly, it seems unlikely that it would – pinpointing a set of uses that would produce the maximum value is an almost insurmountable task. The vast quantity of data needed to assess the business case of every possible mix would require enormous resources, well beyond the capability of any regulator.

But in any case, is a regulator a better arbiter than the market itself? Many economists argue that companies are inherently experts in their own business cases and that natural competition will lead to scarce spectrum resources being distributed in the optimum manner. This is nothing new: market forces are

used in many aspects of our lives and are now addressing issues such as pollution rights and fishing quotas. In the same way, the argument goes, the market – not the regulator – is better placed to maximise the value of spectrum.

It is virtually impossible to prove this either way. If the market approach were better, it would allow new and changed uses of the spectrum to emerge more rapidly. There is some evidence of this in market-led countries such as the US, where a wider range of technologies is deployed, although it is hard to decouple this from other influencing factors such as the ready availability of venture capital there.

Weighing these arguments, it seems reasonable to suggest that the wider market is more attuned to the values of different applications than the regulator. It follows that a well functioning market would probably generate a greater value from the spectrum than a centrally managed system.

How spectrum might be managed

With the dual goals of minimising interference and maximising value, Ofcom sees three possible approaches to spectrum management.

1. **More of the same.** Ofcom manages the radio spectrum in a similar fashion to the way it has been managed for the last 100 years. This is often known as 'command & control' and, until recently, has been used for around 95 per cent of the spectrum.
2. **Market mechanisms**. The market manages the radio spectrum within the terms of the licences set by Ofcom. This route was strongly recommended in the Review of Radio Spectrum Management (the Cave Report). It is currently being introduced in the UK thorough the implementation of spectrum trading and liberalisation.
3. **Licence-exempt usage**. In this approach, no one has control over who uses the spectrum, but power constraints or other mechanisms restrict usage to reduce the probability of interference. This is known as licence-exempt use (or sometimes 'spectrum commons'). Around five per cent of the spectrum in the UK is currently set aside for licence-exempt use.

Let's look at the latter two approaches in a little more detail.

Market mechanisms: trading and liberalisation

If spectrum is to realise its full value, the market must make sure that spectrum can be bought by users who are able to maximise their investment, and who can use it in the way they want. This will require two key market mechanisms:

1. Trading of spectrum between users so that they can buy, sell, aggregate or unbundle spectrum holdings; and
2. Liberalisation of spectrum use, so that users can change technologies, or the type of use, applied to their spectrum.

Our proposals for trading are now well advanced. We implemented trading in some licence classes at the end of 2004, and plan to extend it progressively to almost all suitable licence classes by the end of 2007.

Rather more complex is the issue of spectrum liberalisation. Spectrum users have been packed in tightly by spectrum managers over the years, with many users sharing spectrum. Handled wrongly, liberalisation could therefore lead to intolerable interference. Ofcom has published a statement on liberalisation, making it clear that some restrictions will be essential. There are two ways in which we will implement liberalisation:

- Licence holders can ask Ofcom to alter the terms of their licence, allowing them to use the spectrum for a different application. Ofcom will consider whether the request can be granted without it resulting in unacceptable interference to other users; and
- Ofcom will alter existing licences, making them less specific regarding usage and technology. This will free licence holders to make certain types of change to their use of spectrum without needing the prior consent of Ofcom. We are currently investigating whether this can be achieved using a concept we have termed 'spectrum usage rights'.

This new era of liberalisation will mean no, or only limited, constraints on technology and usage. Historically, licence holders have been restricted to particular uses, such as mobile, and often to particular technologies, such as GSM. In time, liberalisation should largely sweep these restrictions away.

Using spectrum to achieve policy objectives

In the past, certain obligations have been attached to spectrum in order to achieve policy goals, or outcomes judged to be socially desirable. A good example was the coverage obligation that accompanied 3G licences. But the upside of, for example, a more inclusive service may come with the downside of a less attractive licence.

Going forward, Ofcom does not believe that obligations should be attached to spectrum for policy ends. We believe that a subsidy (usually through taxation) is a more efficient, and less distorting, way of meeting costs raised by policy goals. In the case of cellular, for example, if the Government wished to achieve a certain coverage in the future there could be a subsidy for operators to provide coverage in specific areas.

There will be cases when our statutory duties or other circumstances require us to manage the radio spectrum to further certain policy objectives. We believe these will be rare, but when they occur we will justify why we have departed from our general preference for market mechanisms.

Licence-exempt usage

Every day, most of us use radio devices that do not need a licence. These 'licence–exempt' devices range from wireless headsets, cordless phones and car key-fobs to baby monitors, garage door openers and WiFi systems.

Licence-exempt devices are also widely used in industry, including anti-theft systems in shops, identity cards that activate doors, and in some cases for data links to remote base stations.

Although these are uses that do not generally result in large financial activity, consumers often find them highly valuable and hence they help Ofcom achieve its objective of maximising the value of the spectrum.

To make a device exempt from licensing, Ofcom normally identifies the technology or standard that can be used in a "licence-exemption regulation" (although it would be possible to include generic classes of devices). A key issue is to limit a

device's transmitting power: radio signals from high-powered devices travel further, increasing the chances of interference with others using the same frequencies. If this occurs, the frequencies will become of limited use – the so-called 'tragedy of the commons'.

Users need to be aware that there are no guarantees that the spectrum will be free of interference. Some may even invest in licence-exempt equipment, only to discover there is too much interference for it to work in their vicinity. However, by managing the power level rules, the regulator can keep the probability of interference low. Ofcom is also now investigating whether requiring other approaches, such as 'politeness protocols', would increase the value gained from licence-exempt usage.

How we select between the different options

It is the task of the regulator, and not the market, to strike the best balance between these different types of spectrum management. The market alone cannot decide, for example, how much spectrum should be licence-exempt, because its users are typically individuals. It would be difficult to co-ordinate their actions to acquire spectrum through a market mechanism.

We have selected the balance between the different options by:

- assessing how much spectrum we believe should be licence-exempt;
- using market mechanisms to manage as much of the remaining spectrum as possible; and lastly
- managing any remaining spectrum using command & control.

What follows is how we carried out each of these steps.

Assessing the need for licence-exempt spectrum

There is no rule of thumb or industry standard for determining the optimum amount of licence-exempt spectrum. For the reasons expressed above, it is the regulator, and not the market, who must decide and we have developed a new methodology to help us.

The economics of spectrum management show that where congestion is expected, a licensed approach should be followed. In general, longer-range communications

rapidly increase the probability for interference and, therefore, congestion. The exceptions to this are rural areas and relatively under-utilised bands.

While we can determine the relative probability for interference given a maximum range and likely user-density, we cannot be certain that congestion will never occur. We therefore need to work on a balance of probability and with an action plan to ease congestion should it arise. In the 2.4GHz band we are now seeing early reports of interference, mainly between WiFi nodes.

Typically, these have a maximum range of around 200m and, therefore, this should be the general upper limit for licence-exempt devices in urban areas. With such a range, the applications for licence-exempt spectrum are restricted to short-range uses such as home and office networks.

By restricting the applications in this way we can estimate the total data rates likely to be needed by users. Although opinions may differ, the consensus is that 100Mbits/s per person should be sufficient for the applications that can be foreseen over the next five to ten years. By understanding the re-use factors needed in urban environments, a ceiling of 800MHz on the amount of spectrum needed for licence-exempt use can be reached.

Ofcom has already made 535MHz available in the 2.4GHz and 5GHz bands (excluding band C which is subject to light-touch licensing). As a maximum, then, an additional 250MHz or so of spectrum might be needed for licence-exempt use. While this may seem like a small increment, a very large amount of spectrum has been recently reserved for licence-exempt use in the lightly used 5GHz band.

While this puts a ceiling on the likely need for licence-exempt spectrum, it doesn't tell us whether this allocation would maximise the value of the spectrum. To do this, Ofcom would need to compare the relative economic benefits of licensed, and licence-exempt, usage. This is difficult as it requires forward-looking assessments of the best use of the spectrum.

However, since there have been few takers for the existing part of the 5GHz band set aside for licence-exempt use, it seems unlikely that providing additional spectrum now would be economically sensible. Therefore, Ofcom will instead monitor the usage of the 5GHz band in order to predict when demand in the band might exceed capacity. As and when this looks likely, we will conduct an economic study to assess whether more spectrum should be made available for licence-exempt use, and act accordingly.

Determining which spectrum cannot be managed by market mechanisms

While we prefer to use market mechanisms to manage spectrum, there are some areas of allocation decision-making where they cannot be fully applied. These are:

- spectrum where there are unavoidable, important or valuable international issues. For example, spectrum assigned to satellite operation may be covered by international obligations and there may be valid economic reasons why the UK would like to see these continue;
- spectrum which relates to a broader social objective. As a rule, Ofcom is not in favour of policy goals being attached to the allocation of spectrum. However, there are some current licences where policy conditions are attached and it will not be possible to remove them. This applies to broadcasting spectrum and to some of the emergency services; and
- spectrum where it is important to maintain international harmonisation for operational reasons. This includes aeronautical and maritime uses, where common frequencies worldwide are essential.

Summary

By using the mechanisms set out above we are able, firstly, to set aside some spectrum for licence-exempt use and, secondly, to apply market mechanisms in all but those areas where command & control management is required. The relative amounts of spectrum managed under these three different approaches, and how they will change as a result of these strategies, is shown in the tables below.[2]

Change in values for spectrum below 3GHz

	Command & Control	The Market	Licence-exempt
2000	95.8%	0.0%	4.2%
2005	68.8%	27.1%	4.2%
2010	22.1%	73.7%	4.2%

Change in values for spectrum between 3GHz and 60GHz

	Command & Control	The Market	Licence-exempt
2000	95.3%	0.0%	4.7%
2005	30.6%	61.3%	8.2%
2010	21.1%	69.3%	9.6%

The figures show a major shift away from command & control in favour of market forces between 2000 and 2010, with a smaller increase in licence-exempt spectrum in the bands above 3GHz.

2 These figures exclude defence spectrum and are percentages of amounts of spectrum relative to the band centre frequency, rather than absolute amounts. Assumptions and approximations are needed in compiling these figures which should therefore be taken as illustrative.

Spectrum usage rights

When buyers acquire licences to use spectrum, perhaps through auction, they expect that they have bought certain rights. These rights are often expressed as both a right to transmit within certain guidelines, and a right to expect only low levels of interference from others. While the right to transmit is normally clearly defined, the expected level of interference is less so. Often, a licence states that the user can expect the spectrum to be free of 'harmful interference'.

As part of the liberalisation process we would like to see clearer definitions of usage rights. This will not only allow licence holders to change their technology or usage, but also give greater clarity on levels of interference. We are currently developing proposals for this complex area.

International issues and harmonisation

Historically, there have been two key international objectives in managing spectrum. These are:

- working with neighbouring administrations when licensing uses of spectrum which may cause interfering signals to extend across national borders, or where services are inherently multi-national (such as satellite systems); and
- helping to reach international agreement on frequency bands for particular applications in order to promote economies of scale and international roaming (often called 'harmonisation').

A number of international bodies work to achieve these aims.

At the global level the International Telecommunications Union (ITU) sets out guidelines for usage, although these are non-binding. At a regional level, the European Commission (EC) has powers to deliver binding directives and

decisions across European countries. It is supported by the European Confederation of Postal and Telecommunications regulators (CEPT), which provides technical expertise and may also deliver non-binding recommendations on frequency harmonisation across Europe. Other bodies, such as NATO, have been delegated international control of spectrum in particular frequency bands such as those used for Defence purposes. Decisions taken by these bodies restrict national freedom on the use of spectrum.

We are not proposing any change to achieve the first of the two international objectives set out above – namely the control of interfering signals and multi-national usage. For bands where there are international interference concerns or multi-national services, the command & control approach to spectrum management needs to continue.

However, we are proposing changes to the way that the second objective – harmonisation – is delivered. Before explaining our policies in this area, we use the following definitions:

- Standardisation: The development of an open standard for a particular type of equipment allowing multiple manufacturers to make equipment which can interoperate. Standards are normally developed by bodies such as ETSI and the IEEE;
- Harmonisation: The identification of common frequency bands throughout a region (e.g. Europe) for a particular application and, in some cases, a specific standard; and
- Exclusive access: The exclusive provision of frequency bands for a specific application or standard.

Ofcom believes that standardisation and harmonisation can bring significant benefits, such as reduced interference; lower cost equipment through economies of scale; increased certainty for manufacturers; and international roaming. GSM is often heralded as a prime example of harmonisation at its best.

However, Ofcom does not generally support exclusive access. Recently, we commissioned a study that showed cases where exclusive access has provided little benefit, or has actually reduced the value of the spectrum by reserving it for a technology that did

not develop commercially. By adopting harmonisation, but without exclusive access, it would still be possible to reap the benefits of a GSM, while avoiding the loss of value from cases such as ERMES.

Ofcom also believes that, in the long-term, the market will be able to bring about standardisation and harmonisation, rather than the regulator. Imagine a group of interested manufacturers and operators, working within a body such as ETSI, proposing a frequency band for their new standard. Ofcom and other regulators could then – subject to interference studies – create sufficiently flexible licensing terms for the spectrum to be used for their new application, without requiring that this is how the spectrum must be used.

Users of spectrum would then be free to acquire the newly harmonised spectrum through trading, and change its use. This approach would ensure that, in the event of an inappropriate standard being harmonised, spectrum would not remain unused. This is because, in such a case, it is likely that the spectrum will not be acquired by new users, but left with the existing users.

However, this approach is only likely to work when spectrum markets are liberalised in more countries. We will promote this outcome by putting forward our views to international bodies. In the interim, we will continue to be active participants in harmonisation activities internationally.

In summary, then, our long-term objective is to see non-binding harmonisation brought about mainly by the market, with minimal regulatory intervention. However, a critical mass of support will be needed. Meanwhile, Ofcom will remain active in international harmonisation activities, while seeking to avoid exclusive access.

Mixed modes of usage

There is not always a neat dividing line between spectrum that is licensed to a particular user – whether under command & control or market forces – and licence-exempt spectrum. There are a number of instances where it might be possible for licence-exempt users to transmit in licensed spectrum.

The entitlement to transmit in spectrum that is actually licensed to others has existed for some time. For example, everyday electrical equipment such as hairdryers transmit unwanted interference into a wide range of frequency bands. In practice, this is rarely an issue because the power levels they transmit are normally so small.

More recently, a number of researchers have started to look at whether deliberate emissions such as these might be a valid way of getting even more use from the spectrum. Discussions have centred around two possibilities:

- Entitlements in time. Users hop onto a temporarily unused frequency, transmit briefly and then leave it before the licensee needs to use it; and
- Entitlements in power. Low-powered technologies transmit across multiple bands licensed to others, but at such low power levels there is no significant degradation in performance.

These entitlements can act across a wide range of spectrum bands, whether licensed, or set aside for licence-exempt use. In general, we are less concerned where the spectrum is set aside for licence-exempt use. In this case, if the transmission is low-powered it would typically be allowed already. However, if it is a higher power transmission, it would need to remain within the overall power limits for the licence-exempt equipment. The discussion that follows is focused on entitlements in licensed spectrum.

Entitlements in time ('cognitive radio')

There are now radios (known as 'cognitive radios') that can scan multiple frequency bands, spot an unused band, transmit on it and then move to a different band. Even so, problems with the technology mean that you can never be totally sure that a band is unused; the only way to be certain is through central management by the owner of the band. It therefore becomes the spectrum owner's choice whether they wish to allow this kind of access and, if so, under what conditions. Ofcom will allow licence holders to enable cognitive access if they wish to do so, as part of the general trading regime.

Entitlements in power

Ultra-wideband (UWB) is a technology that spreads a data signal across a broad bandwidth. By harnessing this increased bandwidth, even very low-powered transmissions levels can be used to reliably transmit information. To achieve this, the signal needs to be spread across broad swathes of spectrum, where there may be hundreds of licence holders. UWB might have a wide range of uses including in-home networks, car radars and board-to-board communications within racks of equipment. Clearly, it isn't practical for someone wishing to transmit using UWB to seek permission from hundreds of licence holders; it is an issue for the regulator to resolve. We have carried out consultations on UWB and our policy now is to work with Europe to enable its deployment under carefully crafted conditions.

UWB is an 'underlay' technology: in terms of output power, it lies underneath the other users of the band. It is possible that other underlay technologies will emerge and, in considering their impact, Ofcom must strike a balance. On one hand, we want to define stable spectrum usage rights and, on the other, to recognise our duty to enhance the efficient use of spectrum and bring innovative products to the fore. We can't give chapter and verse on regulating technologies that don't yet exist. However, in general, Ofcom would prefer not to mandate an underlay technology unless:

- there were overriding directives legally requiring Ofcom to do so; or
- the technology or service would bring significant net benefits to the UK.

In the latter case, we would prefer users of underlay technologies to negotiate directly with licence holders they may affect for access using, for example, trading principles. But as mentioned above, this poses considerable challenges in the case of technologies such as UWB. In these cases, it may be appropriate for Ofcom to intervene.

Why this framework will bring benefits

We began this document by noting that the primary reasons for managing spectrum were to maximise value and avoid interference. We also set out a number of aspirations for Ofcom's management of the spectrum.

We believe that the proposals contained in the full Statement of the Spectrum Framework Review (and which we summarise here) will lead to the UK realising greater value from its radio spectrum resource. With users able to trade spectrum and change its use, the market should allow higher value uses to emerge with the resulting increase in value to the country. We also expect the proposals to be a catalyst for innovation and investment; people with exciting new ideas will have simple and rapid access to spectrum, and find there are relatively few constraints on how they use it.

Regarding the second priority of avoiding interference, we believe these proposals will be neutral. The previous management approach was generally effective and we see no reason to alter it.

The changes proposed by the Statement represent a significant progression in the way radio spectrum is managed. They will open up new opportunities for users, particularly in fixed and mobile systems. Equally, this will be a significant change for those already using spectrum and appropriate transitional arrangements need to be put in place to recognise existing investments.

No one can predict with any precision the net effect of these changes, but we can envisage developments such as:

- an operator acquiring some spectrum previously used for fixed applications and deploying a WiMax mobile data service, providing multi Mbits/s mobile laptop coverage across major parts of the country;
- cellular operators gaining more spectrum, enabling a raft of new applications such as interactive gaming and personal broadcast services at low cost;
- emergency services gaining temporary access to spectrum when they need it, enabling, for example, video from the helmet of fire-fighters and emergency medical workers; and
- consolidation in the private mobile radio market, resulting in a low-cost but higher capacity service, reducing operating costs for taxi companies, despatch riders and many others.

What actually happens may, of course, be very different; the important thing is that it is real market need, rather than

the regulator's assumptions, which dictate the nature of change.

These are the most wide-ranging changes to spectrum management since the first act of Parliament regulating radio spectrum in 1904. We expect them to bring major benefits to investors, manufacturers, operators, spectrum users, citizens and consumers.

How to buy and sell spectrum

We describe as 'spectrum trading' any transaction that involves the transfer of rights to use radio spectrum, granted by a Wireless Telegraphy Act licence, from one organisation to another.

These deals could involve the outright sale, leasing or swapping of rights. They could be for the entirety of the rights granted under a licence, or just a part; for example, the rights in only one part of the country, or for a subset of the licensed frequencies. A transaction could be concerned almost entirely with the transfer of spectrum usage rights, or be part of a much larger deal – for example, the transfer of an entire network – for which the transfer of usage rights is a peripheral, but none the less necessary, part.

Spectrum trading became legal in the UK, for certain classes of WT Act licence, in December 2004. Ofcom intends to expand the range of licences that can be traded, with the majority of licences tradable well before the end of the decade.

The regulatory process for completing a Spectrum Trade is very straight forward because Ofcom's main concern is to be clear who holds which spectrum usage rights – not the commercial details of the transaction.

We have not laid down any rules on commercial arrangements between trading parties, nor set up any sort of 'trading floor' or system for usage rights transactions. We anticipate the industry developing a variety of different types of Spectrum Trade to meet its disparate needs, with various types of agent and intermediary helping parties to identify and complete transactions efficiently.

The regulatory process for completing a Spectrum Trade is as follows:

- the parties to the trade agree the terms of the deal;
- the parties jointly complete and submit a simple form to Ofcom, setting out who they are; the details of the spectrum usage rights that are to be transferred; and a statement by each party consenting to the transfer;
- Ofcom reviews the details of the proposed transfer, confirms that it is permitted under the regulations and that we are willing to give our consent; and
- with everything in place, the transfer is made by surrendering the old licence, and Ofcom issuing a new licence (or licences).

Basic details of Spectrum Trades, either in progress and completed, are published in the Transfer Notification Register on Ofcom's website. Ofcom also publishes basic details of all tradable licences on its website, in the Wireless Telegraphy Act Register. Both registers can be accessed through Ofcom's Spectrum Licensing Portal:

http://www.ofcom.org.uk/radiocomms/isu/ukpfa/intro

Further details and guidance on Spectrum Trading can be found in the Trading Guidance Notes published on Ofcom's website:

http://www.ofcom.org.uk/radiocomms/ifi/trading/tradingguide/tradindguidencenotes.pdf

The Vision

In this guide, we have set out how we believe that the markets are more likely to maximise the value of spectrum than central control from the regulator. We have shown how we will allow market mechanisms to be used for the majority of spectrum, after setting aside an appropriate amount for licence-exempt usage and excluding spectrum where central management is still needed. We have shown how this reduces the need for the regulator to be involved in international harmonisation activities.

The Ofcom Spectrum Vision where market forces can be applied can be summarised as follows:

The Ofcom Spectrum Vision

1. Spectrum should be free of technology and usage constraints as far as possible. Policy constraints should only be used where they can be justified.
2. It should be simple and transparent for licence holders to change the ownership and use of spectrum.
3. Rights of spectrum users should be clearly defined, and users should feel comfortable that they will not be changed without good cause.

We will achieve this by:

- providing spectrum for licence-exempt use as needed, although we estimate that little additional spectrum will be required in the foreseeable future, growing only to seven per cent of the total spectrum;
- allowing market forces to prevail through the implementation, where possible, of trading and liberalisation. We will fully implement these policies in around 72 per cent of the spectrum; and
- continuing to manage the remaining 21 per cent of the spectrum using current approaches.

Inevitably, there will be circumstances when we cannot fully achieve this vision. In these cases, we will explicitly explain why we have departed from it.

Glossary

3G	The third generation cellular phone system, currently being deployed, which offers higher data rates than previous systems allowing services such as videophones.
AIP	Administrative incentive pricing. A fee charged to users of the spectrum to encourage them to make economically efficient use of their spectrum.
Auction	The use of a standard bidding process to award spectrum licences to those prepared to pay the most for them.
Beauty contest	An approach to deciding who should have a spectrum licence where those who want the licence make a case as to why they should have it and the regulator decides which case is most convincing.
BlueTooth	A standard for short range communications between devices such as cellphones and headsets.
BWFA	Broadband fixed wireless access. A means of connecting to homes and offices using wireless, as opposed to copper or fibre optics.
CEPT	The European Conference of Postal and Telecommunications administrations. A Europe-wide organisation whose aims include harmonised use of the spectrum.
Cognitive radio	A radio which can sense when a piece of spectrum is not being used, adapt itself to fit the spectrum, transmit briefly and then move onto the next free piece of spectrum.
Command & control	A way of managing the radio spectrum where the regulator takes all the key decisions including what spectrum is to be used for and who can use it.

DAB	Digital Audio Broadcasting. A standard for digital radio.
DECT	The Digital European Cordless Telephone. A cordless phone standard widely deployed in homes and offices.
De-regulation	Removing the need to have a licence in order to make a transmission in some specific areas.
EMC	Electro-magnetic compatibility. Regulations that ensure that non-radio devices do not generate interference and are reasonably immune to radio frequency interference.
ERMES	The European radio messaging system, a standard for paging. It was not widely deployed.
GSM	The Global System for Mobile Communications. The existing cellular technology widely deployed around the world.
Interference	Two or more signals on the same frequency resulting in the receiver not being able to distinguish one clearly.
ITU	The International Telecommunication Union. A body that seeks to harmonise telecommunication activities around the world, including access to spectrum.
Liberalisation	Allowing licence holders to change the use to which they put their spectrum, within constraints to prevent interference.
Licence-exempt	Allowing anyone to use the spectrum for any application under certain specified restrictions, but typically with maximum power levels.
Market mechanisms	An approach to managing spectrum where key decisions are made by the licence holders acting to buy and sell spectrum, rather than by the regulator.

Power	The strength of the wireless transmission. The stronger the signal the further it will travel, but this in turn will increase the chances of interference.
Regulation	The management of the radio spectrum.
SDR	Software defined radio. A radio whose characteristics are set by software, not hardware, which as a result can change itself considerably to adapt to situations.
Spectrum	The set of radio frequencies from around 9kHz to 300GHz.
TETRA	The Terrestrial Trunked Radio system. A standard for the type of radios used by emergency services and some business users.
TFTS	Terrestrial flight telephone system. A standard developed to allow phone calls from planes direct to the ground. It was never deployed - current systems use satellites to relay signals.
Trading	The ability of users to buy and sell spectrum licences without prior approval from the regulator.
UWB	Ultra-wideband. A technology that transmits at high data rates over short distances by using low power signals spread across many different parts of the spectrum.
WiFi	Another name for wireless LANs. The technology used to connect computers wirelessly in homes, offices and increasingly in "hotspot" areas such as airports. Also sometimes known as IEEE 802.11.
WiMax	A developing standard for delivering broadband mobile data services within urban areas.

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