Spectrum Liberalisation

A consultation on proposals to reduce or remove certain restrictions on spectrum use

Consultation document

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Contents

Section 1

Executive summary

Spectrum liberalisation is the reduction or removal of restrictions on the use that can be made of spectrum

1.1 Traditionally, wireless telegraphy licences have specified, often in considerable detail, the use to which spectrum can be put and the means by which that spectrum can be exploited – including for example details of the service that can be offered and the technology that can be deployed. Spectrum liberalisation involves the reduction or removal of these restrictions.

Ofcom believes that spectrum liberalisation will be of significant benefit to UK citizen-consumers

1.2 Ofcom expects that spectrum liberalisation and trading will make it easier for entrepreneurs and innovators to enter the market, deploy new technologies and applications, and compete with existing players; they will make it easier for spectrum to migrate from relatively low value uses to higher value ones. Although spectrum trading and liberalisation are distinct developments, they are complementary. A recent report for the European Commission[1] estimated the benefits of spectrum trading with liberalisation to be some €9bn per year across the EU, predominantly arising from the earlier adoption of new technologies and applications that trading and liberalisation would allow. The benefits of spectrum trading alone, without liberalisation, were estimated to be about one tenth of this.

But spectrum liberalisation is not without risk

1.3 Some restrictions on the use of spectrum are essential, in order to prevent unacceptable interference between neighbouring spectrum users. Certain restrictions may also be necessary in order to comply with international obligations and to promote certain other public policy goals. The challenge is to maintain sufficient control over the use of spectrum to ensure that interference is kept under control (and other obligations and objectives are met), while allowing as much flexibility of use within those constraints as possible, thereby maximising the potential value that can be derived from the use of spectrum for the benefit of UK citizen-consumers.

Two mechanisms are available to Ofcom to implement spectrum liberalisation

1.4 The first involves requests from licensees for changes to licences to reduce or remove restrictions. This document presents specific variations, for a number of licence classes that are considered to be intrinsically unproblematic on spectrum management grounds and to which Ofcom would therefore normally expect to be able to agree. Ofcom would welcome requests for other types of variation although there would be greater *a priori* uncertainty about whether or not Ofcom would be able to agree to those without more detailed assessment. To facilitate this process, Ofcom will give guidance about the considerations it

1 http://europa.eu.int/information_society/topics/radio_spectrum/useful_info/studies/secondtrad_study/index_en.htm

would apply when considering licence variation requests.

1.5 The second mechanism involves Ofcom changing existing licences generically to make them less usage and technology specific. This would allow licensees to make certain types of change to their use of spectrum without needing the prior consent of Ofcom. Changes outside those permitted by the liberalised licence would still require Ofcom's consent.

1.6 Of these two mechanisms, the first allows Ofcom to exercise control over interference (and other issues) on a case-by-case basis and to minimise the risk of unacceptable interference. However, licensees (and the industry more generally) will not have certainty about what will be permitted until Ofcom has given its consent to a specific change. This mechanism is also administratively burdensome.

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1.7 The second mechanism is superior to the first in that it provides more certainty and is less burdensome administratively. However, implementation is more challenging as spectrum usage rights need to be defined generically in a way that is more technology and usage neutral while maintaining the necessary degree of control over interference.

1.8 Ofcom plans to use both mechanisms when liberalisation is introduced later this year. But for practical reasons we propose to rely more on the first approach initially. The second approach should be introduced for certain types of licence in 2005, when a new assignment tool is available. More radical changes to licences to make them more technology neutral will be discussed in Ofcom's forthcoming Spectrum Framework Review published later this year.

Protection for neighbouring users

1.9 This document sets out a number of protections for existing spectrum users. One proposal is that we should publish guidance for licensees about the levels of interference that Ofcom expects could be encountered from other services. It will be used by Ofcom as a key criterion in deciding whether to allow changes to licence terms, such as those relating to transmission power or geographical coverage, and will serve as a reference for Ofcom in resolving interference complaints. This guidance will be based on the existing criteria used when deciding whether or not to make new assignments.

1.10 Ofcom would not expect to agree to the removal of a restriction where the change would result in the lowering of spectrum quality of neighbouring licensees below the benchmark level. There will be no guarantee for users that interference will fall within these levels in practice, but Ofcom will continue to investigate and resolve interference complaints.

Scope and responses

1.11 This document discusses our general approach to liberalisation, and how it might be applied in detail in three licensing sectors in 2004 and 2005: business radio, fixed wireless access, and terrestrial point-to-point fixed links. 2G and 3G services are not discussed as Ofcom expects to publish a further document relevant to these classes before the end of 2004. However, the general issues discussed here are relevant to all spectrum users.

1.12 Your comments are invited by 12 November 2004.

Section 2

Background

Ofcom's approach to management of the radio spectrum

2.1 This document forms one of a series setting out Ofcom's new approach to management of the radio spectrum, which is intended to promote innovation and competition in the provision of wireless services across the UK. Radio spectrum is a key raw material for the communications sector. Consumers, equipment manufacturers and network operators all stand to benefit from spectrum being managed in a way that can respond more quickly to technological and market change.

2.2 Ofcom's overall approach to spectrum management will be set out in the Spectrum Framework Review, one of Ofcom's three major reviews, due to be published in the fourth quarter of this year. This will describe Ofcom's intended balance between 'command and control', market forces and licence exemption, as well as the ways in which Ofcom's overall framework for managing spectrum will affect specific spectrum policies. Spectrum trading and liberalisation fit within the Framework Review as the key mechanisms in the implementation of a more market-oriented approach to spectrum management.

2.3 Since the Cave report in 2002, substantial progress has been made to this end, most notably through the development of proposals to implement spectrum trading and liberalisation. Ofcom is committed to continue the implementation of this approach. Ofcom is taking forward its reform programme through three inter-related projects. These are:

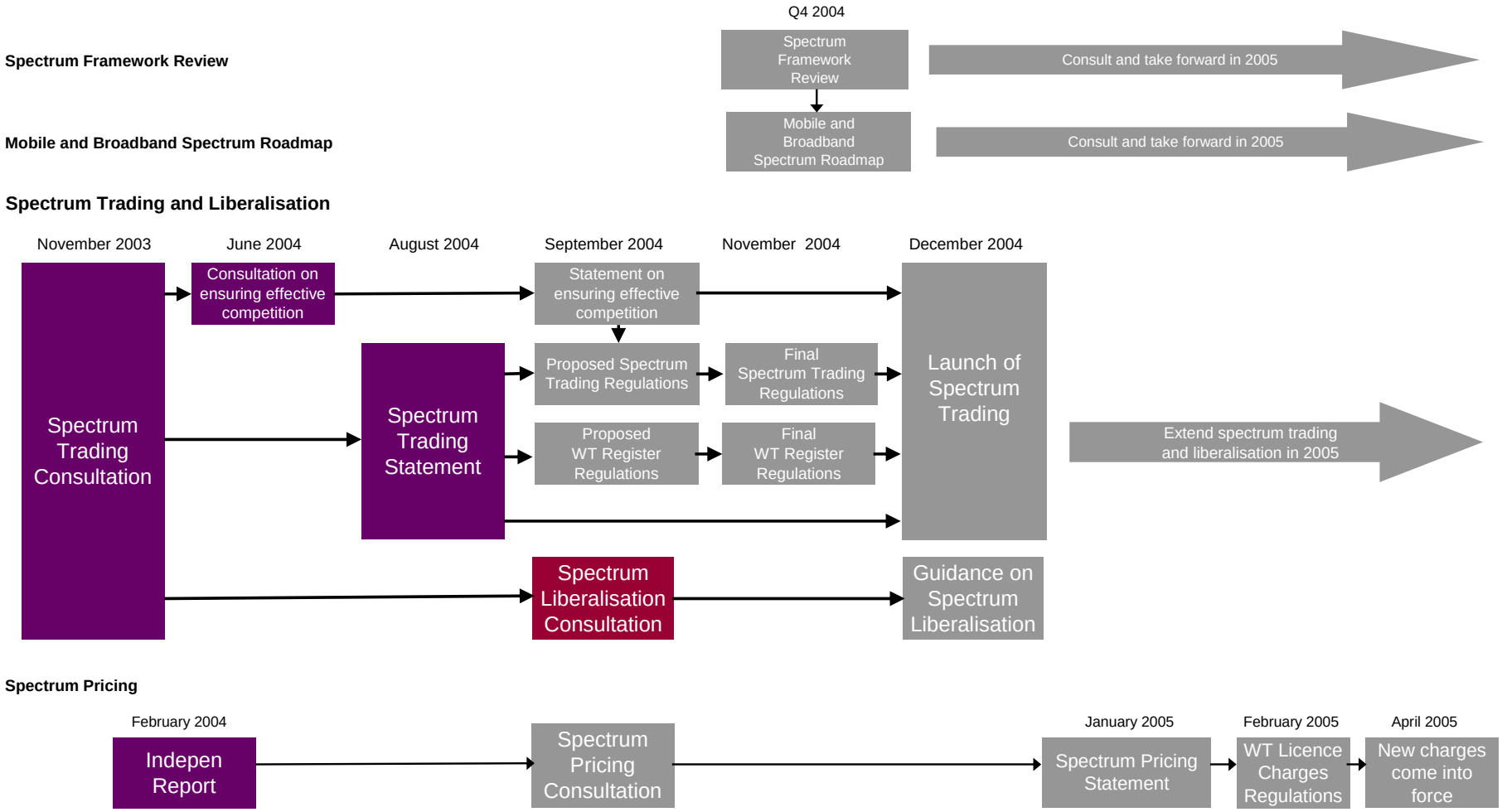
- spectrum trading – mechanisms for allowing spectrum to change hands;
- spectrum liberalisation – relaxation of constraints on the use of spectrum;
- spectrum pricing – updating of annual fees for spectrum not acquired through auction.

2.4 Alongside these we will also be publishing a "Mobile and Broadband Spectrum Roadmap" – a joined-up approach to some short and medium term issues in the mobile and broadband wireless areas.

2.5 This document sets out Ofcom's detailed proposals on spectrum liberalisation, following the earlier consultation on spectrum trading in November of 2003. Other documents are currently scheduled for publication according to the timetable illustrated below.

2.6 It is important that the proposals in this consultation are read in conjunction with Ofcom's statement on *Spectrum Trading: Implementation in 2004 and Beyond* published on 6 August 2004. That statement sets out Ofcom's policy on a number of important and related issues, including licence terms and periods of notice.

Spectrum Strategy : Ofcom Roadmap of Activities



Section 3

Why liberalise spectrum?

3.1 This section explains the background to Ofcom's liberalisation proposals and our general approach. The proposals provide for significant and early progress over the next two years focusing on three key licence sectors: Business Radio, Fixed Wireless Access and Fixed Links.

3.2 The radio spectrum is a finite resource of considerable economic and social value. Spectrum is essential for modern communications and broadcasting, for the effective operation of the armed forces and emergency services and for safe and efficient transport systems. It also has many scientific, social and educational applications. There is increasing demand for spectrum, particularly in frequency bands that are suitable for mobile and wireless communication. Timely access to spectrum free from unnecessary restrictions is essential if entrepreneurs are to have maximum scope to innovate and business creativity is to flourish.

3.3 Spectrum use has to be planned and managed to prevent radio signals from interfering with each other. Historically, this has involved a 'command and control' approach with the regulator dictating in detail how spectrum is used by imposing restrictions on the services provided and technologies used. Existing licences issued under section 1 of the Wireless Telegraphy Act 1949 to authorise transmissions (and, without which transmission would be a criminal offence) impose a variety of restrictions, depending on the service. These include:

- the application to which the spectrum is to be put, eg mobile, point-to-point terrestrial links and type of business;
- use to be made of the spectrum;
- technology to be employed;
- transmitter power and location and antenna height;
- frequency and bandwidth.

3.4 This makes the licences relatively inflexible as, in order to change use or any other characteristics beyond the terms of the licence, it is necessary to vary the licence. Ofcom's aim is to remove restrictions that are no longer proportionate or necessary and to empower users to introduce a wider range of services and technologies. This marks a significant policy shift towards market-based mechanisms that allow users, rather than the regulator, to decide which parts of the spectrum should be allocated to particular services and technologies.

Reasons for liberalisation

3.5 Ofcom has statutory duties under the Communications Act 2003 to further the interests of citizen-consumers in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by

promoting competition, and to secure optimal use of the radio spectrum[2]. In exercising its spectrum functions, Ofcom must have regard to the availability of spectrum to meet current and future demand from all users and to the desirability of promoting efficient management and use, economic and other benefits, innovation and competition[3].

Optimal spectrum use

3.6 Liberalisation will improve the efficiency of spectrum management and use. Markets are in general considered to be better than regulators at allocating finite resources such as spectrum to achieve optimal use. Those directly engaged in the market have better information about the value of alternative applications and have a commercial incentive to make decisions that will generate benefits for themselves and their customers.

3.7 Markets can respond to changing circumstances more dynamically than regulation. Combined with the -incentives provided by spectrum trading and pricing, liberalisation provides the means to empower spectrum users to adopt new services and technology and to have stronger commercial incentives to utilise spectrum rights as efficiently as possible and release spectrum for higher value applications.

Economic benefits

3.8 Liberalisation will deliver substantial economic benefits, especially when combined with spectrum trading. Businesses will have greater scope to use spectrum for higher value applications or to sell it in the market to those that can use it better. Increased innovation and competition will drive benefits for consumers (see below) and make the UK communications market more competitive and dynamic. A recent report produced for the European Commission[4] estimates that the annual benefits to the European Union of introducing liberalisation and trading would amount to around €9bn whereas the benefits from trading alone would be just 10% of that amount. The study also estimates that the additional costs of liberalisation, for example in terms of additional interference coordination, would amount to less than €100m a year across the EU and so would be small relative to the potential benefits.

Innovation and competition

3.9 Free from unnecessary restrictions, entrepreneurs will have increased scope to use spectrum in different ways to introduce innovative services and technologies.

3.10 Shortage of spectrum can act as a significant barrier to entry to the wireless communication market as it can take a considerable time to gain access to spectrum for innovative services or technologies. Liberalisation combined with trading will reduce this barrier. As explained above, entrepreneurs will gain easier and faster access to spectrum. This should accelerate innovation and promote competition between companies, services and technologies; and consumers will benefit from new services and lower prices.

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[2] Section 3, Communications Act 2003
[3] Section 154, Communications Act 2003
[4] *Study on conditions and options in introducing secondary trading of radio spectrum in the European Community,* May 2004, Analysys, DotEcon and Hogan & Hartson, available electronically at http://europa.eu.int/information_society/topics/radio_spectrum/highlights/what_new/index_en.htm.

Light-touch regulation

3.11 Liberalisation will progressively remove restrictions that in Ofcom's view have become unnecessary or disproportionate. Ofcom's approach to spectrum liberalisation reflects its view that the very prescriptive regime historically imposed by spectrum managers is no longer appropriate, given the benefits of market-based tools such as trading. Ofcom also considers that the removal or reduction of unnecessary restrictions is consistent with its wider duty to keep regulatory burdens to a minimum.

There will be safeguards against interference

3.12 However, liberalisation is not without risk. Spectrum use has to be managed and planned to prevent radio signals from interfering with each other. As we move away from a situation in which the regulator reserves specified blocks of spectrum for particular services and technologies, spectrum use will become more mixed and changeable. Existing assumptions on which spectrum planning is based will cease to apply with the same certainty and there will be an increased risk of interference. This could be exacerbated by incentives to work spectrum more intensively and reduce separation between neighbouring users.

3.13 In order to offset this risk, liberalisation will be implemented within a framework of effective and proportionate regulation designed to prevent harmful interference. Ofcom believes that the proposals described in this document will overcome the risk of increased interference and Ofcom will continue to play an active role in the investigation and resolution of interference. Ofcom reaffirms that it will not allow liberalisation to develop into an interference free-for-all. This is implicit in Ofcom's duty to ensure optimal use of the spectrum.

3.14 The regulatory impact assessment at Annex 4 analyses the risks of liberalisation and how these will be managed.

Response to the trading consultation

3.15 The trading consultation in November 2003 proposed a process for liberalisation involving variations of licences on a case-by-case basis in accordance with Ofcom guidance. Responses on this question are summarised at Annex 5. They broadly supported liberalisation and Ofcom's approach. However, several expressed reservations that the proposals went too far or should not apply in specific sectors, such as broadcasting, satellite services, aviation and safety-of-life, or that further research is needed on how to define emission rights and quality. Ofcom has taken account of these points in the proposals that follow by suggesting that licence conditions and spectrum quality should initially be based on current assignment criteria and by proposing a phased approach incorporating effective safeguards against interference.

Liberalisation mechanisms

3.16 Two main liberalisation mechanisms are envisaged.

3.17 The first is *individual licence variation*. A licensee wishing to change use, technology or technical parameters outside the terms of the current licence will have to seek a variation from Ofcom. Licence variation may be a precursor to a transfer of rights by trading or could be requested by an incumbent wishing to retain the licence but with different terms and conditions. Ofcom will give guidance to applicants about the considerations it will apply in considering requests, which will include a technical assessment of the impact of the change

on the spectrum quality of other spectrum users.

3.18 The second is *generic licence change* to make licences intrinsically more flexible through removal of certain restrictions on technology and application. This embeds liberalisation in the licence itself and allows users to change use or technology without *ex-ante* clearance by Ofcom.

3.19 This principle applies also to new licence products. When granting these, whether by auction or otherwise, Ofcom will consider the extent to which it is possible, given its legal duties and international obligations, to avoid imposing restrictions that are prescriptive of technology, service or use.

Constraints on liberalisation

3.20 Ofcom has a statutory duty to ensure that licence conditions are objectively justified in relation to networks and services to which they relate, non-discriminatory, proportionate and transparent[5]. These obligations are ongoing and must be assessed against market circumstances and the state of technology development at the time.

3.21 The November 2003 trading consultation noted that Ofcom would need to take a number of considerations into account in issuing guidance on liberalisation and in assessing proposals for change of use and configuration.

3.22 Ofcom has broad discretion under section 1(4) of the Wireless Telegraphy Act 1949 to agree to vary licences but legal rules operate to limit that discretion. These legal rules include the following, in summary.

- UK obligations under European law or international agreements where use of spectrum has been harmonised: Ofcom will not agree to remove restrictions from licences or other changes that would conflict with the UK's obligations under international law. This includes changes in use or technology that would contravene binding Community measures, such as directives or harmonisation measures adopted under the Radio Spectrum Decision (676/2002/EC) and ITU Radio Regulations.
- Ofcom must comply with any direction from the Secretary of State under sections 5 or 156 of the Communications Act 2003.
- Ofcom must act in accordance with its statutory duties, including the duty to ensure optimal use of the spectrum, and obligations under the European Authorisation Directive (2002/20/EC).
- General legal principles, which include the duties to act reasonably and rationally when making decisions and to take account of legitimate expectations.

3.23 The management of interference is discussed in section 6 of this document. Ofcom would not normally expect to grant a request to vary a licence if the change would reduce the estimated spectrum quality of neighbouring[6]

[5] Section 1D(9) of the Wireless Telegraphy Act 1949 and the EC Authorisation Directive 2002/20/EC
[6] The licensees affected by the change might extend beyond those immediately adjacent depending on how fast the emission levels fell off over distance and frequency separation. For this reason, this document uses the term "neighbouring" rather than "adjacent" to denote that licences not immediately bordering an assignment have to be considered.

assignments below the benchmark level.

3.24 Ofcom will also consider carefully whether there are domestic policy objectives that justify delayed introduction of trading or liberalisation in some types of spectrum use or that justify restricting the extent of liberalisation permitted in some areas. In general, Ofcom considers that constraints due to policy considerations should be the exception rather than the norm. Such constraints are also in general likely to be transitional.

3.25 Ofcom would not, for example, allow a change of use or configuration of the spectrum used by the emergency services if this would undermine their ability to operate effectively.

3.26 Ofcom considers that in general spectrum liberalisation should be highly beneficial to competition, by removing unnecessary constraints on the competitive process. However, there may also be circumstances in which liberalisation could lead to a distortion of competition. This could arise, for example, as a result of the circumstances under which the spectrum used in a particular economic market was originally acquired, or the specific licence conditions imposed. Ofcom would consider such matters before making or agreeing to licence variations.

3.27 The November 2003 consultation proposed that, given the scale and uncertainty of the investment involved in 3G mobile services, Ofcom would not expect to allow bands not currently designated for 3G to change their use to offer 3G services before 2007. Ofcom recognises that, in practice, a range of issues needs to be addressed in relation to spectrum that could be used for 2G or 3G services. This includes identifying plans for a number of bands available for release into the market for fixed or mobile use over the next few years. Ofcom proposes to publish a consultation paper on these issues by the end of 2004.

Ofcom's approach to liberalisation in 2004 and 2005

3.28 Ofcom proposes to introduce a rolling programme to liberalise spectrum use, beginning with licence classes in the first phase of spectrum trading. In 2004 and 2005, liberalisation will be extended to at least the following licensing sectors:

- Business Radio – previously often referred to as land mobile radio (including national paging, data networks, common base stations, public access mobile radio and private business radio);
- Fixed Wireless Access; and
- Fixed Links.

3.29 Further details of Ofcom's proposals for specific licence sectors and classes are given in section 5. Initially, Ofcom proposes to liberalise initially through individual licence variation. This will enable Ofcom to exercise control over each change of use. However, Ofcom aims to move quickly towards making some licences more intrinsically flexible. Current assignment tools limit the liberalisation that will be possible in 2004 but further progress in the business radio sector should be possible when Ofcom's new mobile assignment tool, MASTS, becomes operational, which is expected to be in 2005. This will enable

the number of separate licence classes to be reduced from about two dozen to just a handful, which will considerably enhance flexibility.

3.30 In addition, some types of change of geographical and frequency boundaries do not involve significant risk of interference and will be allowed through spectrum trading as a *partial transfer.* This will be a more streamlined process than licence variation. A preliminary draft of the Trading Regulations, published with Ofcom's statement *Spectrum Trading: Implementation in 2004 and Beyond* in August 2004 and available from www.ofcom.org.uk, proposes that certain partial transfers should be permitted of the rights and obligations relating to certain frequencies or a certain geographical area specified in a licence. The trading statement and draft regulations detail the partial transfers that Ofcom proposes to permit and how the partial transfer process will work. Partial transfer is therefore not considered in detail in this document.

After 2005

3.31 Ofcom expects to see two developments after 2005. First, liberalisation will be extended where possible to all other licence classes. Second, there should be further progress towards making licences more intrinsically flexible. Further work on the scope for radical changes to licences to make them more technology neutral will be taken forward in Ofcom's Spectrum Framework Review, to be launched later this year. Ofcom may also explore the scope for innovative use of other spectrum management tools, such as overlay licences.

3.32 Different approaches may be appropriate for different licence classes, and some restrictions are likely to continue to be necessary to control interference, comply with national and international obligations that mandate specific technologies and services and promote certain broader public policies. However, within these constraints, Ofcom's general approach will be to remove restrictions wherever possible. This will provide greater certainty to businesses and be less burdensome administratively. If licences can be made intrinsically more technology and application neutral, licensees will enjoy wider scope to change the use of spectrum without having to apply to Ofcom for individual licence variations.

3.33 Exhibit 1 below shows how Ofcom proposes to implement liberalisation progressively across the radio spectrum in 2004 and 2005. Note that the table is indicative. Some detail of spectrum allocation has been omitted to enhance clarity.

Exhibit 1: proposed roll-out of spectrum liberalisation by frequency band

Business Radio Bands

Band	*Licence classes liberalised in 2004*	*Additional licence classes liberalised in 2005*
55.75 – 87 MHz	National and regional PBR, CBS	Wide area PBR
137 – 154 MHz	National and regional PBR, national paging	Wide area PBR
154 – 157 MHz	National and regional PBR	Wide area PBR
157 – 173 MHz	National and regional PBR, CBS	Wide area PBR
173 – 177 MHz	National and regional PBR, data networks	
177 – 192 MHz	National and regional PBR, analogue PAMR, CBS, Data networks	Wide area PBR
192 – 208 MHz	National and regional PBR, analogue PAMR, data networks	Wide area PBR
410 – 430 MHz		Digital PAMR
450 – 470 MHz	National and regional PBR, national paging, scanning telemetry	Digital PAMR, Wide area PBR

Fixed Bands (fixed links and FWA)

Band	*Licence classes liberalised in 2004*	*Additional licence classes liberalised in 2005*
1.35 – 1.517 GHz	Point to Point Fixed Links	
3.48 – 3.5 GHz 3.58 – 3.6 GHz	FWA	
3.605 – 3.689 GHz 3.925 – 4.009 GHz	FWA	
3.6 – 4.2 GHz	Point to point fixed links	
5.925 – 6.425 GHz	Point to point fixed links	
6.425 – 7.125 GHz	Point to point fixed links	
7.425 – 7.9 GHz	Point to point fixed links	
10.125 – 10.225 GHz 10.475 – 10.575 GHz		To be assigned
12.75 – 13.25 GHz	Point to point fixed links	
14.5 – 15.35 GHz	Point to point fixed links	
17.7 – 19.7 GHz	Point to point fixed links	
22.0 – 23.6 GHz	Point to point fixed links	
24.5 – 26.5 GHz	Point to point fixed links	
28.0525 – 28.4445 GHz 29.0605 – 29.4525 GHz	FWA	
31.815 – 32.319 GHz 32.627 – 33.131 GHz		To be assigned
32.319 – 32.571 GHz 33.131 – 33.383 GHz	Point to point fixed Links	
37.0 – 39.5 GHz	Point to point fixed links	
40.5 – 43.5 GHz		To be assigned
51.4 – 52.6 GHz	Point to point fixed links	
55.78 – 57.0 GHz	Point to point fixed links	

Question 1:
What are your views on Ofcom's general approach to introducing greater flexibility and, in particular, on the timing and phasing?

Section 4

Spectrum rights and quality

4.1 Ofcom agrees with respondents to the November 2003 trading consultation that it is important for spectrum emission rights and spectrum quality for reception to be more clearly defined. This section discusses some general considerations concerning spectrum rights and quality and proposes that where these need to be made explicit they should be based initially on existing licence formulations and assignment criteria.

4.2 Beyond 2005, there may be more fundamental changes to make greater use of boundary conditions and spectrum masks. Their application raises complex technical issues that require further study. Consideration will be given to this in the context of the Spectrum Framework Review and any changes will be subject to consultation.

Emission rights

4.3 Spectrum licences issued under the Wireless Telegraphy Act 1949 give the holder permission to transmit radio signals subject to compliance with specified terms, conditions and limitations. Most terms are imposed in the interests of minimising interference and ensuring compliance with international obligations.

4.4 Most emission rights are defined in terms of the right to send signals from particular transmitters. This makes them relatively inflexible as opportunities for change of use are limited. It also makes it difficult to aggregate or disaggregate assignments. For some licence classes (e.g. maritime coastal stations and aeronautical ground stations), there are important safety reasons why there should be certainty about the characteristics of an individual transmitter. For other classes, the primary reason for defining emission rights in such a relatively inflexible way has been to ease the process of planning adjacent services. With the advent of more powerful planning tools, and the move towards a more technology and usage neutral approach to spectrum management, a more flexible approach to the specification of emission rights would seem desirable.

Boundary conditions

4.5 In principle, emission rights could be defined in licences in terms either of the locations of transmitters and their technical specifications or more generically in terms of the levels of power allowed at some geographical boundary combined with a spectrum mask that limits the power levels allowed at different frequencies. The consultation on spectrum trading proposed that Ofcom should adopt the latter approach, which is more usage and technology neutral.

4.6 Ofcom recognises that the boundary conditions approach may not be suitable for all licence classes, for example where there are large numbers of licences, each covering small amounts of spectrum or small geographical areas and sharing spectrum on a carefully planned basis to maximise spectrum efficiency. In such cases, the benefits of the new approach may be outweighed by the cost and complexity of dealing with many small assignments, especially if the licensees do not have the resource to manage an increasingly complex electromagnetic environment.

4.7 Where, on the other hand, assignments are for exclusive national or regional spectrum and licensees are more likely to have the necessary expertise, licensees can be given greater freedom to plan the location of transmitters themselves, subject to informing Ofcom and compliance with any international coordination requirements, with few, if any, restrictions on the services they provide.

4.8 It is also the case that boundary conditions and spectrum masks may not completely define spectrum quality in all situations. Levels of interference can be affected by how transmitters on adjacent channels are deployed within the coverage area. A comprehensive definition of spectrum quality would need to take account of this.

International aspects

4.9 Radio waves do not respect national boundaries and emission rights will need to be compatible with rules and agreements covering cross-border interference and frequency use, where applicable. A range of international agreements and treaties defines the field strengths of radio transmissions allowed at borders before international agreement must be sought through international coordination. Ofcom will continue to protect UK assignments and act in the interests of UK operators in addressing international coordination and policy issues in international bodies and bilateral contacts with other administrations.

4.10 Spectrum allocation is also subject to the ITU Radio Regulations at the international level. Spectrum allocations at this level are defined very broadly. Departure from them is permissible but, where this happens the UK service operates on a non-interference, non-protected basis under Radio Regulation 4.4. The service cannot claim protection under international rules from interference and operations would be curtailed where they interfered with a higher priority service, now or in the future, in another country. In these circumstances, it would be necessary for the operator to make a judgment concerning the implications of these constraints for the commercial viability of the service.

Spectrum quality

4.11 Emission rights are explicitly set out in licences. Spectrum quality for reception is less clearly defined and has tended to be implicit in assignment criteria. Licensees are generally required to avoid causing “harmful interference” but this is not defined quantitatively unless international standards or other quantitative requirements are incorporated by reference[7].

4.12 Spectrum quality may be measured in different ways. A key concept is the ability to communicate without experiencing a level of interference that unacceptably impairs or prevents communication. This may be quantified in terms of the sum of the emissions at the receiver location from neighbours’ transmissions, which will effectively be defined by the neighbours’ emission rights, although emissions from licence-exempt and non-radio equipment will also have to be taken into account. Section 5 and Annex 6 discuss spectrum quality in more detail.

[7] Section 183 of the Communications Act 2003: interference is harmful if it “degrades, obstructs or repeatedly interrupts” lawful broadcasts or transmissions.

4.13 The term "benchmark spectrum quality" is used in this document to denote the level of spectrum quality on which Ofcom's technical planning and coordination processes and criteria are based. These will be published in the form of Technical Frequency Assignment Criteria (TFAC) documents or, for some licence classes, Coordination Guidelines. It is possible from these to deduce the effect on spectrum quality of emissions from other licensed sources.

How Ofcom will use benchmark spectrum quality

4.14 Benchmark spectrum quality will provide guidance for licensees about the levels of interference that Ofcom expects are likely to be encountered from other licensed services. It will be used by Ofcom as a key criterion in deciding whether to allow changes to licence terms, such as those relating to transmission power or geographical coverage, and will serve as a reference for Ofcom in resolving interference complaints as described more fully in section 6 below.

4.15 While Ofcom appreciates the importance of certainty about spectrum quality, it is not practicable to offer any guarantee about levels of interference. The spectrum quality experienced in practice might be different from the benchmark spectrum quality. Benchmark spectrum quality should be interpreted with caution subject to five important caveats.

4.16 *First*, TFAC are based on engineering calculations. While every effort is made to make these as accurate as possible, the effects of a given level of emission may be different in practice from those predicted by theory and it is not possible to guarantee that a particular standard of spectrum quality will invariably be met.

4.17 *Second*, the total noise floor in an assignment, and hence spectrum quality, will also be affected by emissions from licence-exempt and non-radio devices, such as computers, microwave ovens or fluorescent lights, that emit radio frequency energy and, in some bands or locations, signals from transmitters in other countries. These sources are not licensed by Ofcom and Ofcom has no control over how they are deployed. It would ultimately be for a prospective purchaser to carry out due diligence on the actual and prospective electromagnetic environment at the location in question to check on noise levels. Ofcom can provide a certain amount of information from its monitoring programme about actual levels of emissions from licensed sources and the level of the overall noise floor but this may not be sufficiently detailed to relate to individual sites and may vary according to time of day, day of the week or seasonally.

4.18 *Third,* if a band is not currently full, spectrum quality might temporarily be above the benchmark level but reduce to that level as new assignments are made in accordance with the published criteria.

4.19 *Fourth,* interference may be caused by unauthorised transmissions or equipment malfunction. Ofcom can act against the perpetrator but enforcement is, by its nature, usually reactive rather than preventative.

4.20 *Finally,* spectrum quality guidelines should not be regarded as fettering the discretion that Ofcom has to exercise as discussed in section 3. The effect on spectrum quality of a proposed change is a relevant consideration for Ofcom to take into account but is not the only factor.

4.21 Information from Ofcom's unattended monitoring systems would show actual levels of spectrum usage and signal strengths of emissions from licensed sources but could not cover every site in the UK as Ofcom's monitoring resources are limited. Raw monitoring data could track daily, weekly, seasonal or longer term variations in recorded occupancy and signal levels but might need further analysis for spectrum users' purposes. Ofcom would be willing to publish information from its monitoring, including from targeted audits, and would welcome views on how the data could most usefully be supplied and presented.

Users will be able to negotiate

4.22 Ofom does not propose to vary existing emission rights and spectrum quality as a precursor to trading and liberalisation in 2004 since to do so could increase uncertainty and delay their introduction. However, users may be able to negotiate amongst themselves to adjust the technical parameters of licences if it is in their mutual interests to do so. Changes that are negotiated in that way and that cannot be effected through spectrum trading or coordination agreements will have to be submitted to Ofcom to be dealt with as licence variations in accordance with the procedure discussed in section 6. Ofcom would not normally expect to grant a variation in these circumstances if the change in question would reduce the estimated spectrum quality of other licensees below their benchmark level, unless they had agreed to the change.

Receiver characteristics

4.23 The effect of interference on radio communications is a function of both the level of the interference and the ability of the receiver to withstand interference. Ofcom does not intend to impose standards of receiver performance beyond the requirements of The Radio Equipment and Telecommunications Terminal Equipment Regulations 2000 for radio equipment to be constructed to use spectrum effectively and avoid harmful interference. It will be for users to decide whether to invest in more robust receivers that provide better performance or whether to use cheaper receivers that may be more prone to the effects of interference and so offer lesser quality of service.

4.24 However, Ofcom intends to assume a certain level of receiver performance, reflecting international standards, in deciding whether a given level of interference is excessive or may reasonably be expected to be tolerated. Ofcom will keep these assumptions about the appropriate level of receiver performance under review. In planning point-to-point terrestrial links, Ofcom already considers receiver characteristics as documented in the relevant TFAC. Ofcom intends to publish its assumptions on receiver performance more generally, usually as part of the relevant Radio Interface Requirement.

Advanced wireless technologies

4.25 Advanced wireless technologies raise specific issues in relation to spectrum rights and quality. Faster and cheaper processing power will make radios more intelligent and able to use spectrum more intensively without impinging on other users. Proponents claim that such technologies can operate in licensed spectrum without interfering with the licensed use. For example, ultra wideband (UWB) technology transmits data at very high speed over a wide range of frequencies but at very low power levels that are claimed to be below the

background noise floor. Software defined (or cognitive) radio (SDR) hops to an unused frequency if it senses a licensed user trying to gain access.

4.26 These technologies challenge traditional notions of radio spectrum management. In theory, they may allow spectrum access to be shared without affecting spectrum quality in the bands in question. This raises the question of how and on what terms spectrum might be made available for the new generation of radio technology.

4.27 The question of whether to allow UWB in licensed spectrum and, if so, the technical limitations that should apply, is under consideration in the CEPT. Ofcom intends to consult further on UWB and other advanced radio technologies.

Question 2:
(a) What are your views on Ofcom's proposals to base initial spectrum emission rights and quality indicators on existing licence conditions and assignment criteria?

(b) Is there an alternative approach you would suggest and why?

Question 3:
Would you find it useful for Ofcom to publish monitoring data and what format and content would you find most helpful?

Section 5

Proposals for individual licence classes

5.1 This section discusses detailed proposals to allow changes of characteristics by licence variation and definition of emission and interference parameters for licence classes in the first phase of spectrum trading in 2004 and beyond. Annex 6 provides supporting technical information.

5.2 The procedures that Ofcom proposes to follow in dealing with requests for licence variations and interference resolution are discussed in section 6.

Overview

5.3 The extent and timing of liberalisation will differ from licence class to licence class, depending on practical considerations, such as the degree of sharing, the complexity of band planning and coordination, the availability of suitable assignment tools and users' ability to devote resource to managing interference themselves.

5.4 Service-specific regulation, in which particular applications or technologies are mandated by the regulator, will over time be replaced by a system-based approach, in which restrictions are based more on the ability of different technologies and applications to co-exist without causing or suffering interference.

5.5 Ofcom proposes a progressive roll-out of new facilities and flexibilities by which spectrum users can be given greater freedom to trade, adopt new technology or offer new services. Liberalisation will begin in those licence classes summarised at exhibit 2. The reasons underlying the proposals are explained in the paragraphs following the exhibit.

5.6 Ofcom will consider all requests for licence variations within the constraints on its discretion as summarised in section 3. Ofcom would normally expect to be able to agree to changes of the sorts listed in exhibit 2 as these are not in themselves considered to be intrinsically problematic on spectrum management or competition grounds. However, they will still need to be considered individually on a case-by-case basis.

5.7 Requests outside the parameters in exhibit 2 are also welcome and will be considered on a case-by-case basis in accordance with Ofcom's legal powers and remit. They are more likely to raise complex interference or other issues that require more extensive analysis, so there is greater uncertainty about whether Ofcom will be able to agree them. Nevertheless, Ofcom wishes to encourage such requests, especially where they concern new services and technologies that do not fall within the scope of existing licence products. These may highlight areas where it would be beneficial for Ofcom to reassess existing restrictions in the light of changing facts and market circumstances and so promote innovation, competition and optimal use of the radio spectrum.

Exhibit 2: programme of liberalisation in 2004 and beyond[8]

2004	*Business Radio* ▪ Change of licence class by licence variation between the analogue PAMR, data networks, national paging, national and regional PBR licence classes ▪ A single interface requirement will facilitate change of technology. ▪ Change of frequency bandwidth in multiples of 12.5 kHz by partial transfer ▪ Removal of minimum subscriber requirement from CBS *FWA* ▪ Continuing flexibility on application and technology. ▪ Flexible changes of frequency bandwidth or geographical coverage by: - partial transfer through trading in the 3.4 and 28 GHz bands - licence variation in the 3.6 GHz band *Fixed links* *Point-to-point fixed links* ▪ Transfer of individual links by partial transfer through trading ▪ Change of bandwidth due to the use of different modulation type and/or data rate by licence variation ▪ Change of technical characteristics by licence variation ▪ Deployment of new antennas by licence variation *32GHz* ▪ Ofcom is considering the appropriate award process for the vacant band *Scanning telemetry* ▪ Transfer of individual channels by partial transfer through trading ▪ Technical change by licence variation
2005	*Business Radio* ▪ With introduction of new mobile assignment tool (MASTS), liberalisation will be extended for wide-area PBR and CBS ▪ Introduction of more explicit measures of spectrum quality ▪ Licences will be streamlined into fewer and broader classes giving users wider flexibility to change use within licence classes without reference to Ofcom ▪ More flexible frequency and geographic segmentation will be considered *FWA* ▪ Flexibility in the 10 GHz and 40 GHz bands when they are assigned is expected to be similar to that at 3.4 and 28 GHz
Beyond 2005	▪ Liberalisation will be extended to other licence classes. Ofcom will consult on the scope for flexibility and the procedure for licence variation ▪ Scope for further liberalisation will be kept under review. The scope for options such as overlay licences will be considered.

[8] This table omits consideration of the form and timing of liberalisation of 2G and 3G services for the reasons identified in paragraph 3.27.

5.8 Ofcom believes that its proposals strike the right balance between increased freedom for spectrum users and concerns about interference. They combine sizeable and early gains in flexibility with effective safeguards against harmful interference. Taken together, they will liberalise over 50,000 assignments in 2004, increasing to around 80,000 in 2005 when MASTS is introduced. They extend across a wide range of spectrum and types of radio use and provide a sound foundation for further reform.

5.9 The following paragraphs summarise Ofcom's proposals in detail for individual licence sectors and classes for 2004 and beyond. Further technical detail may be found in Annex 6. To clarify the terminology, licence *class* refers to a use or group of uses that a particular licence type allows. Licence *sector* refers to a group of licence classes that share some common characteristic.

Business radio

5.10 In the business radio sector, it is proposed to remove the distinction between Public Mobile Operator (PMO) and Private Business Radio (PBR), which comprise similar services. Both include transmission between mobile radios in which a base station, or network of base stations, provides local, regional or national coverage and is used to send and receive voice messages or data. The business radio sector covers a wide range of services and users from High Street taxis and couriers to large businesses (such as oil companies, utilities, transport companies and supermarket chains) and the emergency services.

5.11 The sector previously known as PMO comprises radio networks operated by service providers offering radio services to third-party consumer or business customers. The licence classes from this sector included in the 2004 trading implementation and covered by the proposals in this document are:

- analogue public access mobile radio (PAMR) – national or regional network system provided by operators for customers on a commercial basis;
- common base stations (CBS) – a single channel base station shared by several users and controlled by an operator on a commercial basis to provide coverage in a localised geographical area;
- national paging;
- data networks – intended for transmitting data as opposed to voice and used, for example, in logistics and transport.

5.12 The sector previously known as PBR encompasses radio systems that are generally licensed for closed or 'private' user groups, which distinguishes it from PMO. National and regional PBR licences will be tradable in 2004. Wide-area PBR, typically used by taxis and couriers, is planned to be made tradable in 2005, when MASTS is introduced, and liberalised at the same time.

5.13 Ofcom proposes for 2004 to remove the restriction that CBS operators should have at least 3 subscribers. The purpose of this requirement is to ensure that spectrum is used efficiently but the introduction of trading will make it unnecessary as trading will provide a market mechanism and incentive for operators to transfer licences to those that can attract more business. After MASTS is operational in 2005, it will be possible for Ofcom to consider extending the range of flexibilities available in this licence class.

Business radio: 2004

5.14 PMO and PBR are considered together as they use similar technology. The distinction between private and public services is increasingly becoming blurred and is likely to erode further. This is partly in response to market developments and the growing desire of operators of self-provided systems to use surplus capacity to offer services to others. It also has the effect of increasing competition, which is a further reason for removing the distinction.

5.15 Ofcom therefore considers that the distinction between public and private mobile is no longer justifiable or proportionate and our liberalisation proposals will make it easier to switch between the two sectors as well as between individual licence classes. However, Ofcom does not propose to remove the public/private distinction from licences immediately since to do so would divert resource from, and delay, the introduction of MASTS. Instead, Ofcom proposes to progress change of use through individual licence variation as an interim measure until MASTS is operational.

5.16 Ofcom proposes to introduce a range of new flexibilities that will allow change of use between licence classes in the business radio sector by licence variation. These will include change of use between PMO and PBR (i.e. from private to public use) as well as between classes in the same sector (e.g. from national paging to national PAMR). They will also encompass change to permitted technology (e.g. analogue to digital), frequency segmentation within existing rasters and frequency amalgamation within the Radio Interface Requirement (IR).

5.17 This will be supported and enabled by the introduction of a single IR, which will establish a single set of technical parameters across the relevant licence classes. In practical terms, licensees changing use between the classes in question will be able to do so without necessarily having to change equipment, as long as it complies with the new IR.

Business radio: 2005

5.18 The introduction of MASTS, which is expected to enter operational service in 2005, will expand opportunities for trading and liberalisation, especially in non-exclusive spectrum, by enabling the interference effects of change of use or technology to be assessed more accurately. It will support the extension of trading to wide-area business radio, increase flexibility in all mobile business radio licence classes, enable spectrum quality to be better defined and potentially enable on-line licence variation. MASTS will enable a reduction in the number of licence classes from over 20 separate licence classes to just a handful, within which users will have considerably enhanced flexibility. The licensing distinction between public and private use will then disappear.

Possible longer term developments

5.19 MASTS has the potential significantly to increase spectrum flexibility. However, alternative management tools such as overlay licences might also be considered. Overlay licences have been used with some success in other countries and Ofcom intends to keep the possibility of using them under review in the light of experience of trading and liberalisation. There would be a full and detailed consultation before overlay licences were introduced.

Fixed wireless access

5.20 Fixed wireless access (FWA) systems at 3.4 GHz, 3.6 GHz, 10 GHz, 28 GHz and 40 GHz employ microwave radio links as a means of making 'last-mile' connections between users' premises and a telecommunications network or to provide transmission capacity for telecommunications infrastructure. FWA can deliver data rates in excess of 2 Mbit/s, depending on such factors as available radio bandwidth, capacity requirements and data contention constraints, and has the potential to transport a wide range of electronic traffic, including telephony, high-speed data, television and multimedia services.

3.4 GHz, 3.6 GHz and 28 GHz FWA

5.21 Licences for FWA in the 3.4 GHz, 3.6 and 28 GHz bands authorise the provision of fixed services between end-user premises and/or between telecommunications networks. They are already relatively neutral on technology and usage and impose no modulation, technology or antenna characteristics.

5.22 Ofcom proposes to allow transfers of rights of spectrum use or geographical coverage by way of partial transfer under the Trading Regulations for the 3.4 and 28 GHz bands without limit on divisibility, provided that original licences conditions on deployment continue to be met. However, use of the 3.6 GHz band for FWA is subject to coordination with fixed satellite and point-to-point fixed links. Consequently, any request for segmentation of licences by frequency or geographical coverage in the 3.6 GHz band will be considered by Ofcom under the licence variation process so that interference considerations can be addressed on a case-by-case basis.

Spectrum quality: FWA

5.23 FWA licences define geographical boundaries of regions of the country where base stations can be deployed and their technical characteristics. Interference between assignments is managed through coordination procedures. These specify pfd levels and spatial separations that trigger coordination but do not dictate the form of the coordination agreement. Ofcom does not propose to change these arrangements, which give licensees flexibility to agree boundary conditions that meet their requirements. However, Ofcom proposes to introduce a transmitter registration facility to facilitate the procedure.

5.24 Existing spectrum blocks for FWA at 28 GHz currently have a 28 MHz guard band between each block as, otherwise, under certain deployment scenarios, interference could occur. Ofcom does not propose to alter current arrangements in respect of these guard bands, further details of which may be found in the 'Related Items' area accessed via the spectrum liberalisation consultation page of the Ofcom website www.ofcom.org.uk.

5.25 Ofcom does not propose to enforce a guard band requirement within existing assignment blocks when an assignment is partitioned. Responsibility for managing interference between the parts of the original block will rest with the parties. This will be subject to a requirement to ensure that nothing done within the assignment excessively impacts neighbouring licensees, except with their agreement.

Fixed links

5.26 Fixed links are used for communications between two fixed points. They are used, typically, to provide communications infrastructure, for example in

backbone telecommunications infrastructure and carry a wide range of traffic from data to broadcast transmissions. Users demand an extremely high level of availability from their links with typical availability values of around 99.99% in order to achieve their required quality and reliability of service.

5.27 In order to provide this, the assignment and spectrum management process must be based on detailed performance and interference prediction. The interference management function requires calculation of all wanted and interfering signal powers incident to a radio receiver and evaluation of 'wanted to unwanted' ratios. These calculations require an accurate appreciation of the appropriate parameters and currently necessitate a high level of centralised management. As a result, changes in technical characteristics will be considered by Ofcom under the licence variation request process to enable the necessary technical checks to be made to maintain spectrum quality.

Point-to-point fixed links: 2004

5.28 Ofcom proposes to permit transfer of rights by trading under the Trading Regulations for point-to-point fixed link licences in 2004. Partial transfers of individual links will also be permitted and it will be possible to change the technical characteristics of links by licence variation, including bandwidth if a licensee wishes to dispose of part of the link.

5.29 In addition, Ofcom proposes to provide a range of flexibilities for fixed point-to-point link licence holders in bands other than those currently closed to new fixed link applications. These will include changes to:

- equipment used, which may operate in a different bandwidth or use a different modulation scheme;
- antennas, including gain and off-axis performance;
- antenna positioning at both ends of the link ;
- signal polarisation.

Spectrum quality: point-to-point fixed links

5.30 Spectrum management considerations make it necessary to retain a degree of central planning in this sector. In order to avoid interference, it is proposed that all changes of characteristics will need to be facilitated through the use of Ofcom's assignment process using its FiLSM frequency assignment/co-ordination tool to check whether the proposed change is compatible with existing links using current assignment criteria.

Beyond 2004

5.31 Ofcom is considering an appropriate award process for the remaining vacant two-thirds of the spectrum in the 32 GHz band. Ofcom envisages that this band will be tradable from award and will also endeavour to ensure that maximum flexibility is available to licensees.

5.32 Ofcom also intends to extend tradability to the 31 GHz security CCTV services band used by local authorities. This will need to be done in a way that does not compromise local authorities' ability to fulfil their statutory duties and Ofcom will review spectrum use in this band before developing plans for trading and liberalisation.

5.33 Ofcom will assess the feasibility of making its assignment tool available online so that licensees can carry out technical evaluation themselves

Scanning telemetry

5.34 Scanning telemetry is used in the main by the gas, electricity and water industries, typically for remote measurement and control functions. 72 channels are used by these utilities. Other users, requiring similar functionality, have access to 8 channels. Links between scanning telemetry hubs and outstations are planned to a high level of availability, in general approaching 99.9%.

5.35 Ofcom proposes to permit transfer of rights by trading for national and regional scanning telemetry licences at 457 – 464 MHz, technical changes by licence variation and partial transfers of individual channels.

5.36 Ofcom will consider liberalising current technology and service restrictions imposed on scanning telemetry licences in 2005. In the longer term, Ofcom plans to examine if this spectrum might alternatively be managed through the MASTS assignment tool in a similar way as business radio.

***Question* 4:**
(a) What are your views on Ofcom's specific proposals for liberalisation in the licence classes discussed in this document and listed below?

- *PAMR*
- *national paging*
- *data networks*
- *common base stations*
- *PBR*
- *FWA*
- *point-to-point fixed links*
- *scanning telemetry*

Do you agree that these proposals are unlikely to be problematic from a spectrum management perspective? Do you see any other reasons why Ofcom should not proceed with these proposals?

It would be helpful if you would comment specifically on the proposed approach to defining technical criteria for spectrum quality and on whether they are likely to be sufficiently clear and robust.

Section 6

Licence variation application process and interference resolution

6.1 Section 5 of this document sets out liberalisation proposals for a range of licence classes. This section describes the processes that Ofcom proposes to apply in handling requests for changes to licence characteristics and in resolving any interference issues that may arise.

Overview

6.2 Ofcom intends its procedures to be as straightforward and as light-touch as possible but recognises that allowing trading and liberalisation to take place without appropriate controls has the potential to lead to increases in harmful interference. For this reason, and in order to comply with its statutory duties, Ofcom proposes a phased approach involving an initial stage of licence variation with *ex-ante* checks to be made in relation to requests to vary the permitted use or technology beyond the terms of existing licences and for certain changes in technical parameters.

6.3 It should be noted that the licence variation process is likely to be a less streamlined process for licensees than a partial transfer under the Trading Regulations because of the additional technical and other checks involved. Licensees will have to apply to Ofcom for a licence variation if they wish to alter the terms of their licences, including a partition of their rights and obligations in a way not allowed as a partial transfer. Requests for a variation will be considered in accordance with section 1E of the Wireless Telegraphy Act 1949 using a process based upon existing procedures for licence variation but amended to accommodate the new flexibilities proposed in this document.

6.4 In the light of the responses to this consultation, Ofcom intends to issue, for each licence class, guidance to spectrum users on the extent of change that Ofcom expects to permit by licence variation. A key element of this guidance will be Ofcom's Technical Frequency Assignment Criteria (TFAC). The TFAC, from which benchmarks of spectrum quality will be derived, are the technical criteria Ofcom will take into account as part of its assessment of whether to agree to a particular request for licence variation.

6.5 A key factor for Ofcom in its consideration of whether to consent to a particular request for licence variation will be whether there is a risk of interference that will reduce the spectrum quality of other users below their benchmark value. Ofcom would not expect to agree to a request for licence variation where the outcome of that change would result in the lowering of spectrum quality of neighbouring licensees below the benchmark level derived from the relevant TFAC. Ofcom will normally refuse a request that is not consistent with the TFAC unless the licensee or licensees potentially affected have consented. It will be the responsibility of the party requesting the variation to obtain the agreement of any affected licensees.

Ofcom's discretion

6.6 Ofcom aims to operate in a way that is predictable and transparent in order to promote market confidence and reduce uncertainty. However, it must be

emphasised that the use of TFAC or spectrum quality indicators should not be construed as fettering Ofcom's discretion to decide whether or not to accept a particular request to vary a licence. The factors Ofcom will take into account are discussed in section 3 of this document.

Licence variation process.

6.7 Ofcom intends to publish a set of revised Licensing Procedure Manuals which will contain a clear description of the new licence variation processes as applied to each licence class. These will be available from Ofcom's website in November 2004.

6.8 The licensee should first seek confirmation from Ofcom as to whether or not the proposed change requires an amendment to the existing terms of the current licence.

6.9 Where a licence variation is required, the licensee should submit a request for a licence variation to Ofcom. Ofcom intends to publish a request for variation form (usually as part of our standard application form for that class) which will also specify the information that a licensee will at a minimum need to provide in order for Ofcom to evaluate if the proposed variation is acceptable. The nature of information required may vary according to the licence class and type of change requested. For example, if the change is simply to introduce a new technology operating within Ofcom's published spectrum mask for a band, a simple declaration that this is the case might suffice. Ofcom may also require the applicant to produce a technical assessment to satisfy it that the spectrum quality of other licensees will not be reduced below their benchmark level.

6.10 Ofcom will then assess the application for licence variation in accordance with its statutory duties and other legal requirements and against its published criteria relating to the licence class and will consider the evidence provided by the licensee. In particular:

- Ofcom will need to be satisfied that the proposed change will not reduce third parties' spectrum quality below its benchmark level, or if it will, that they have consented to the change;
- Ofcom may notify neighbouring licensees (co-channel users, adjacent channel users or co-located users), and in some cases other parties who may be affected by the proposed change, who will have an opportunity to make representations to Ofcom (see paragraphs 6.14 and 6.15 below);
- Ofcom will ensure that the proposed change conforms to national site clearance requirements and to international co-ordination agreements and treaty obligations;
- there may be occasions where Ofcom refuses a request for variation on public policy grounds or to comply with a direction from the Secretary of State;
- where necessary, Ofcom may request further modelling, field monitoring or propagation studies to provide evidence to support its decision-making process.

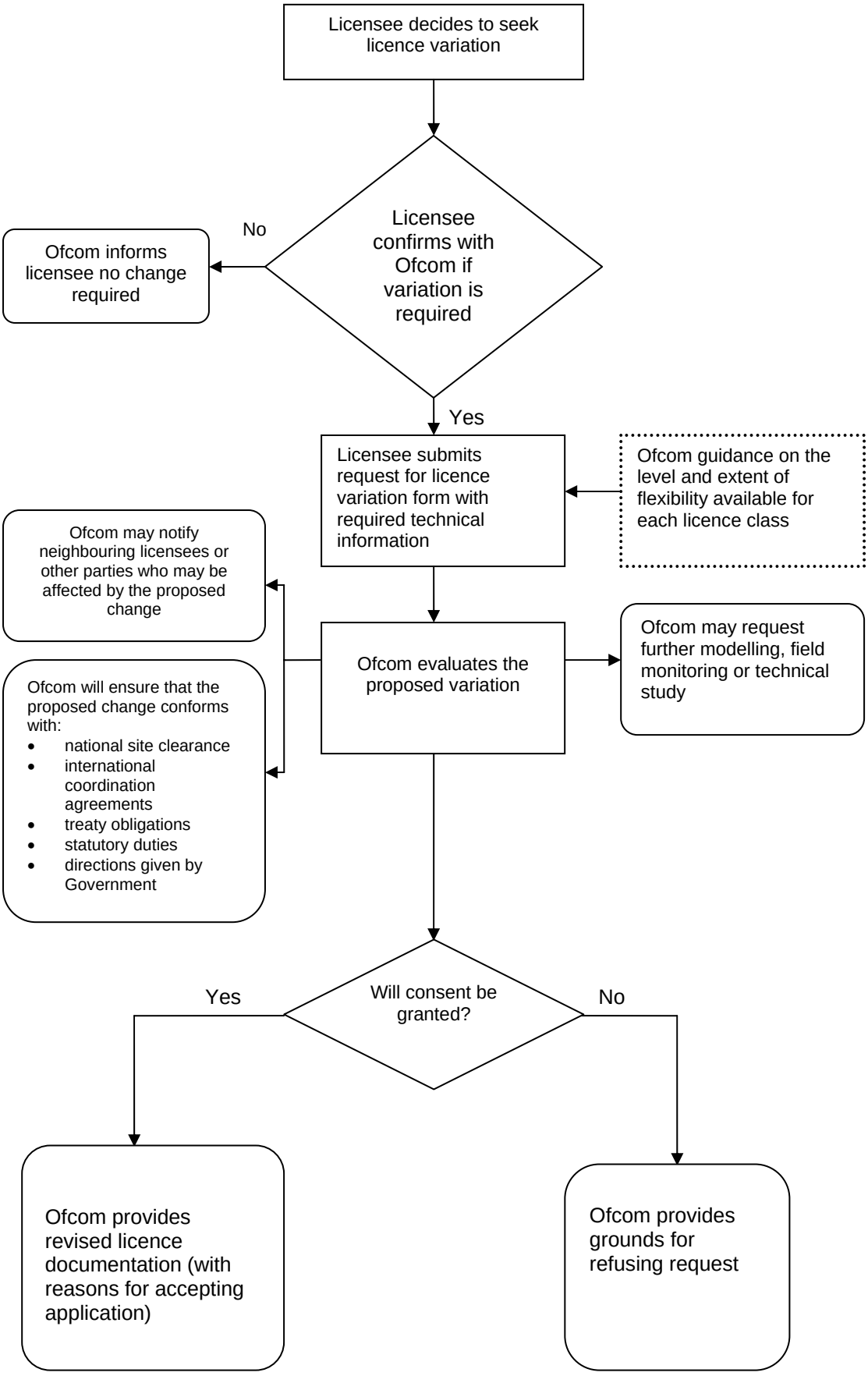
6.11 Ofcom will then give its decision in writing to the licensee. Where consent is not granted, Ofcom will make clear the grounds on which it has withheld permission, so that the licensee has the opportunity to modify its plans and make an alternative application or appeal to the Competition Appeal Tribunal. In

addition, it is proposed that licence holders will have an opportunity to make representations to Ofcom regarding its decision to withhold consent.

6.12 Where Ofcom grants consent, it will make the licence variation and then update the public register of licensing information, the UK plan for frequency authorisation, and (if appropriate) the international registry of frequency assignments. On completion of this process, Ofcom will provide revised licence documentation to the licensee.

6.13 The variation process is illustrated in exhibit 3.

Exhibit 3: licence variation process



Notifying requests for variation to other parties

6.14 In considering requests for licence variations, there will be occasions when it is appropriate to notify neighbouring licensees (co-channel users, adjacent channel users or co-located users), and other parties, including businesses and consumers, who may be affected by the proposed licence variation. They will then be given the opportunity to make representations to Ofcom. In such circumstances Ofcom will allow a minimum of one month for representations to be made and considered.

6.15 Ofcom wishes to ensure that licence variation is supported in the most administratively streamlined manner, and that changes can be applied by licensees as rapidly as possible. In view of the extra administrative burden and processing delays introduced by notification, Ofcom would only intend to notify third parties of licence variations when the proposed change is judged significant enough to make this necessary.

On-line service

6.16 As well as extending the range of liberalisation options, Ofcom intends to improve the processes and procedures by which such changes can be effected.

6.17 Ofcom is examining ways in which it can make licence application and variation available on-line. This may also involve on-line access to Ofcom's planning and coordination tools. This would provide a means by which spectrum users could perform their own assessment of the viability of a particular change of characteristic prior to seeking Ofcom's approval. MASTS is planned to be available on-line in 2005 for licence classes in the private business radio and public mobile operators sectors. Ofcom is currently exploring if, along with support for on-line application, this kind of 'what-if' analysis could be introduced. Ofcom also continues to explore if other of its planning tools, including FiLSM for point-to-point terrestrial fixed links, could be made directly available to spectrum users.

6.18 The proposals in this document will involve licensees and potential purchasers of licences assuming greater responsibility for planning the use of spectrum. This is the other side of the coin of being relieved of some of the existing restrictions on their use of spectrum. To assist them, Ofcom will make available information about licences and assignments as proposed in paragraphs 7.36 to 7.63 of the trading statement. This will enable licensees and others contemplating applying for licence variations to test different scenarios to assess the impact on other spectrum users and to compare this with Ofcom's TFAC, which will also be published.

Charges

6.19 As stated in the trading statement, Ofcom has decided that, in order to minimise administrative burdens and encourage trading, no fee will be raised during the first year of operation for transacting and facilitating spectrum trading. Ofcom intends to extend this approach to variation applications but will keep the position under review in future years in the light of the resource demands on Ofcom. Any proposal to introduce fees will be subject to further consultation and based on cost-recovery principles.

Interference resolution

6.20 Ofcom envisages that it will continue for the foreseeable future to play an active role in investigating and resolving interference problems, including any that arise following spectrum trading or a licence variation. In so doing, it will largely follow existing practices and procedures.

6.21 In accordance with its usual interference investigation and enforcement procedures, Ofcom will investigate to establish the source of the interference and, in the case of a licensed transmitter in the UK, whether the source is operating within the terms and conditions of the licence. Ofcom aims to respond to complaints from safety-of-life services within 24 hours and to complaints from business radio users within 5 working days, although it may not always be possible to resolve the problem in that time as the root cause of interference can be difficult to trace. Where the source is located in another country, Ofcom will invoke the international machinery for resolving cross-border interference. Further details of Ofcom's current procedures for dealing with interference to business services may be found in the 'Related Items' area accessed via the liberalisation consultation page of the Ofcom website www.ofcom.org.uk.

6.22 As a general rule, where the source of the interference is authorised, Ofcom will not usually intervene unless the affected user's spectrum quality is reduced below the benchmark value.

6.23 Interference, whether as a result of trading or licence variation or otherwise, might arise for various reasons, including the following.

- A licensee may be transmitting in excess of the specified emission rights.
- The victim system might be insufficiently robust against interference, for example because of poor receiver quality.
- Intermodulation may arise – receiver generated, which is the responsibility of the licensee, or transmitter generated, which may be a site engineering matter.
- Co-channel interference, which may be inherent in the service, e.g. a standing issue in shared spectrum that the user should possibly have been aware of or the result of a periodic and unpredictable change in atmospheric conditions.
- There may be an incompatibility between emission rights and benchmark spectrum quality. Licence conditions and spectrum quality indicators will be based on predictive spectrum modelling, which can never be completely accurate.

6.24 It is not possible to anticipate all the possible circumstances in which interference may arise. However, the following paragraphs are intended to provide some examples of possible interference scenarios and explain how Ofcom would generally expect to deal with each. The list of examples, which are intended to be illustrative, is by no means exhaustive.

6.25 *If a licensee is in breach of licence conditions*, Ofcom will take appropriate action. This will depend on what is proportionate and necessary in the circumstances. For example, a transmitter fault resulting in spurious emissions, possibly unknown to the user, could be solved by negotiation and agreement on a voluntary basis if the user cooperates. If the breach was not due to

transmitter fault and was deliberate, on the other hand, Ofcom would probably consider issuing a Conformity Notice in accordance with sections 172 to 174 of the Communications Act 2003. This process gives time for remedial action or representations to be made before a criminal prosecution was brought. An immediate interim close-down would be possible, especially if there was a threat to public safety or serious operational or economic problems were caused to other users. The sanction of varying or revoking a licence is separate to the legal enforcement process and in practice would be triggered by the need for strong enforcement action following prosecution or repeated breaches of licence conditions.

6.26 *If the fault lies in the victim installation*, Ofcom will not generally take any action as remedial action is the user's own responsibility in such a case but may, for a fee charged at commercial rates, advise the operator on remedial action.

6.27 *If the originator of the interference is operating within the licence terms and conditions and acted in good faith but interference nonetheless results from a discrepancy between the predicted and actual effects of the transmission*, Ofcom will consider the facts of the case, representations by the parties and any other relevant considerations and decide what, if any, action to take. If the victim had previously agreed to the change that caused the interference, Ofcom will generally expect the parties to resolve the situation themselves in line with the terms of their agreement. If they cannot, or if the victim was not party to such an agreement, Ofcom will consider appropriate intervention action and will generally intervene if the victim's spectrum quality is reduced below its benchmark level. In those circumstances, Ofcom may, for example, decide that it is appropriate to enforce a solution by requiring the interferer to take remedial action and to achieve this by giving formal notice of a proposal to vary the interferer's licence.

Interference arising as a result of segmentation

6.28 Assignment segmentation raises particular issues. Spectrum quality within an existing assignment may be affected if it is partitioned geographically or by frequency. For example, if an assignment is split, whether by partial transfer or licence variation, interference between the resulting segments may arise unless adequate guard bands are allowed by the parties to the transaction.

6.29 Trading and liberalisation will give users additional flexibility. However, the corollary is that they accept greater responsibility for defining spectrum quality parameters and managing interference issues within the blocks of spectrum that they trade. This is subject to the condition that nothing is done within an assignment to cause spectrum quality in neighbouring assignments to be reduced below its benchmark value, except with the agreement of those affected.

6.30 In Ofcom's view, it should be up to the licensee who wishes to partition rights of use under a licence to ensure that the boundary condition between the proposed segments offers a spectrum quality that meets present and future requirements and to resolve any interference issues that arise with the purchaser of the segment that is sold. Ofcom would not normally expect to become involved in such disputes.

6.31

Question 5:
(a) What are your views on the proposals for dealing with requests for licence variations and for dealing with interference?
(b) Do you consider that they are reasonable, proportionate and will be effective in preventing harmful interference?

Question 6:
Do you agree that, in the case of segmentation, the parties themselves should be responsible for resolving interference issues between them (i.e. that do not affect third parties)?

Section 7

Next steps

7.1 This section explains how the liberalisation process will be taken forward following this consultation.

7.2 Ofcom intends to publish a series of documents and other information to provide the technical detail required to support the first phase of trading and liberalisation in late 2004. This includes the following.

- Publication of draft spectrum trading regulations, details of the proposed Ofcom Spectrum Registry and statement on Ofcom's approach to ensuring effective competition in the spectrum market (September 2004)
- Single Interface Requirement for mobile radio in tradable licence classes (September 2004 as a draft)
- TFAC for PMO and PBR licences to be liberalised in 2004 (September 2004)
- Assumptions on receiver performance (usually appearing in the IR) (September 2004)
- Details of transmitter registration facility for FWA (September-October (autumn) 2004)
- Request for variation form specifying information to be provided to support request for variation (November 2004)
- Revised Licensing Procedure Manuals (November 2004)
- Statement giving guidance on liberalisation taking account of response to this consultation (November-December 2004)
- Spectrum Framework Review will consider longer term reforms to licences and licensing processes (November 2004)
- Publication of draft roadmap on approach to mobile and wireless broadband services (December 2004)
- Review of limitations order under section 164 of the Communications Act 2003 (late this year)

7.3 In addition, Ofcom plans to publish the following in 2005 as liberalisation is progressed.

- Details of how scanning telemetry and on-site PBR licensing will be managed in the future
- Revised TFAC for business radio and technical criteria to be applied in assessing requests for variations when MASTS is operational and spectrum quality indicators for mobile communications

Section 8

Responding to this consultation

How to respond

Ofcom invites written views and comments on the issues raised in this document, to be made by **5pm on 12 November 2004**.

Ofcom strongly prefers to receive responses as e-mail attachments, in Microsoft Word format, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 2), among other things to indicate whether or not there are confidentiality issues. The cover sheet can be downloaded from the 'Consultations' section of our website.

Please can you send your response to spectrumlib@ofcom.org.uk.

Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Laurence Green
Competition & Markets
4th Floor
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Fax: 020 7783 4103

Note that we do not need a hard copy in addition to an electronic version. Also note that Ofcom will not routinely acknowledge receipt of responses.

It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 3. It would also help if you can explain why you hold your views, and how Ofcom's proposals would impact on you.

Further information

If you have any want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Laurence Green on 020 7783 4289.

Confidentiality

Ofcom thinks it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt (when respondents confirm on their response cover sheer that this is acceptable).

All comments will be treated as non-confidential unless respondents specify that part or all of the response is confidential and should not be disclosed. Please place any

confidential parts of a response in a separate annex, so that non-confidential parts may be published along with the respondent's identity.

Ofcom reserves its power to disclose certain confidential information where this is necessary to fulfil its functions, although in practice it would do so only in limited circumstances.

Please also note that copyright and all other intellectual property in responses will be assumed to be assigned to Ofcom unless specifically retained.

Next steps

Following the end of the consultation period, Ofcom intends to publish a statement giving guidance on liberalisation around the beginning of December 2004.

Please note that you can register to get automatic notifications of when Ofcom documents are published, at http://www.ofcom.org.uk/static/subscribe/select_list.htm.

Ofcom's consultation processes

Ofcom is keen to make responding to consultations easy, and has published some consultation principles (see Annex 1) which it seeks to follow, including on the length of consultations.

This consultation is shorter than Ofcom's standard 10 week period because, following the November 2003 document, it represents a second consultation on this issue so that respondents have already had an opportunity to provide comments. It is also desirable to complete the consultation in time for liberalisation to be introduced at the same time as spectrum trading.

If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk. We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, whose views are less likely to be obtained in a formal consultation.

If you would like to discuss these issues, or Ofcom's consultation processes more generally, you can alternatively contact Philip Rutnam, Partner, Competition and Strategic Resources, who is Ofcom's consultation champion:

Philip Rutnam
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA
Tel: 020 7981 3585
Fax: 020 7981 3333
E-mail: philip.rutnam@ofcom.org.uk

Annex 1

Ofcom's consultation principles

Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

1. Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

2. We will be clear about who we are consulting, why, on what questions and for how long.

3. We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened version for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

4. We will normally allow ten weeks for responses, other than on dispute resolution.

5. There will be a person within Ofcom who will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. This individual (who we call the consultation champion) will also be the main person to contact with views on the way we run our consultations.

6. If we are not able to follow one of these principles, we will explain why. This may be because a particular issue is urgent. If we need to reduce the amount of time we have set aside for a consultation, we will let those concerned know beforehand that this is a 'red flag consultation' which needs their urgent attention.

After the consultation

7. We will look at each response carefully and with an open mind. We will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 2

Consultation response cover sheet

A2.1 In the interests of transparency, we will publish all consultation responses in full on our website, www.ofcom.org.uk, unless a respondent specifies that all or part of their response is confidential. We will also refer to the contents of a response when explaining our decision, unless we are asked not to.

A2.2 We have produced a cover sheet for responses (see below) and would be very grateful if you could send one with your response. This will speed up our processing of responses, and help to maintain confidentiality by allowing you to state very clearly what you don't want to be published. We will keep your completed cover sheets confidential.

A2.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to confirm on the response cover sheet that Ofcom can publish their responses upon receipt.

A2.4 We strongly prefer to receive responses in the form of a Microsoft Word attachment to an email. Our website therefore includes an electronic copy of this cover sheet, which you can download from the 'Consultations' section of our website.

A2.5 Please put any confidential parts of your response in a separate annex to your response, so that they are clearly identified. This can include information such as your personal background and experience. If you want your name, contact details, or job title to remain confidential, please provide them in your cover sheet only so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

What do you want Ofcom to keep confidential?

Nothing	☐	Name/contact details/ job title	☐
Whole response	☐	Organisation	☐
Part of the response	☐	If there is no separate annex, which parts?	

If you want part of your response, your name or your organisation to be confidential, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

Yes	☐	No	☐

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response. It can be published in full on Ofcom's website, unless otherwise specified on this cover sheet, and all intellectual property rights in the response vest with Ofcom. If I have sent my response by email, Ofcom can disregard any standard email text about not disclosing email contents and attachments.

Ofcom can publish my response: on receipt ☐ once the consultation ends ☐

Name Signed (if hard copy)

Annex 3

Consultation questions

Question 1:
What are your views on Ofcom's general approach to introducing greater flexibility and, in particular, on the timing and phasing?

Question 2:
(a) What are your views on Ofcom's proposals to base initial spectrum emission rights and quality benchmarks on existing licence conditions and assignment criteria?

(b) Is there an alternative approach you would suggest and why?

Question 3:
Would you find it useful for Ofcom to publish monitoring data and what format and content would you find most helpful?

Question 4:
(a) What are your views on Ofcom's specific proposals for liberalisation in the licence classes discussed in this document and listed below?

- *PAMR*
- *national paging*
- *data networks*
- *common base stations*
- *PBR*
- *FWA*
- *point-to-point fixed links*
- *scanning telemetry*

Do you agree that these proposals are unlikely to be problematic from a spectrum management perspective? Do you see any other reasons why Ofcom should not proceed with these proposals?

It would be helpful if you would comment specifically on the proposed approach to defining technical criteria for spectrum quality and on whether they are likely to be sufficiently clear and robust.

Question 5:
(a) What are your views on the proposals for dealing with requests for licence variations and for dealing with interference?
(b) Do you consider that they are reasonable, proportionate and will be effective in preventing harmful interference?

Question 6:
Do you agree that, in the case of segmentation, the parties themselves should be responsible for resolving interference issues between them (i.e. that do not affect third parties)?

Annex 4

Regulatory Impact Assessment

A4.1 The analysis presented in this section, when read in conjunction with the rest of this document, represents a Regulatory Impact Assessment (RIA), as defined by section 7 of the Communications Act 2003. You should send any comments on this RIA to us by the closing date for this consultation. We will consider all comments before deciding whether to implement our proposals.

A4.2 RIAs provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making and are commonly used by other regulators. This is reflected in section 7 of the Act, which means that generally we have to carry out RIAs where our proposals would be likely to have a significant effect on businesses or the general public, or when there is a major change in Ofcom's activities. In accordance with section 7 of the Act, in producing the RIA in this document Ofcom has had regard to such general guidance as it considers appropriate, including related Cabinet Office guidance.

Proposal, purpose and intended effect

A4.3 Ofcom is proposing to:

(a) *liberalise spectrum use:*

(b) define *emission rights to be more flexible;*

(c) define *spectrum quality benchmarks.*

A4.4 The intended effect is to give licensees greater flexibility to aggregate and partition assignments and introduce new services and technology. This will complement spectrum trading and increase opportunities for entrepreneurs to access spectrum for new services and technology.

Benefits and costs

A4.5 The November consultation on spectrum trading included a comprehensive regulatory impact assessment (RIA) that covered proposals to allow Wireless Telegraphy licence conditions to be changed.

A4.6 This estimated that change of use through trading would generate benefits in excess of £27m a year and impose costs of £1.8m. The net present value of trading was estimated to be in the range of £164m to £228m depending on the extent of change of use, with the higher figure corresponding to more extensive change of use. This illustrates the synergy between trading and liberalisation and the added contribution that liberalisation can make.

A4.7 These figures are likely to underestimate the benefits. They were conservatively estimated and they do not take into account additional benefits from any changes of use that might result from existing licensees taking advantage of liberalisation to offer new services themselves without transfer of rights by

trading. Economic impact studies on the use of spectrum carried out for the Radiocommunications Agency by National Economic Research Associates and Smith System Engineering Ltd indicate that earlier introduction of a completely new service, which liberalisation could be instrumental in facilitating, could generate substantial consumer benefits. For example, the October 1995 study estimated that early introduction of new cellular services generated economic benefits of over £2bn a year.

A4.8 This conclusion is reinforced by a report produced by Analysys, DotEcon and Hogan & Hartson for the European Commission on conditions and options in introducing secondary trading of radio spectrum in the European Community[9]. This concluded that there are powerful synergies between trading and liberalisation and estimated that benefits from both are over 9 times the benefits from trading alone. The study also estimated that the costs, mainly from additional interference management, amount to less than 1% of the benefits relative to the status quo. Overall benefits for the EU as a whole were estimated at €9bn a year.

A4.9 These estimates relate to the EU as a whole but the ratio between costs and benefits is likely to be broadly similar for the UK.

A4.10 Ofcom's statement on spectrum trading, published in August 2004, undertook that Ofcom will take comments received on the trading RIA into account in revising it for the Trading Regulations and the Register Regulations to be published later in the year. This RIA for liberalisation may need to be revised if the trading RIA is altered. However, any changes are unlikely to affect the conclusion that liberalisation can be expected to add substantially to the benefits of trading alone.

Options considered

A4.11 The proposals in this document are based on a phased approach. Initially, licensees wishing to change their spectrum usage beyond the terms of their existing licences would need to apply to Ofcom for a licence variation, except in cases in which the risk of interference was judged to be sufficiently low. The introduction of an advanced assignment tool for mobile radio will allow flexibility to be increased in that sector. In the light of experience of the regime proposed in this document and the outcome of the forthcoming strategic Spectrum Framework Review, Ofcom will consider reducing further the restrictions in licences on services and technologies.

A4.12 Other options considered were to:

- maintain current restrictions;
- move direct to the second phase of liberalisation, ie removing usage restrictions from licences to make them more flexible and allow change of use without the need for prior approval.

9 http://europa.eu.int/information_society/topics/radio_spectrum/useful_info/studies/secondtrad_study/index_en.htm

Risk assessment

A4.13 The risk of doing nothing is that opportunities would be lost to introduce new services and technologies. Innovation and competition would be held back. Potentially sizable consumer benefits (see paragraph A4.7 above), would be foregone. Wider policies, such as rolling out broadband, could be hampered.

A4.14 Faster liberalisation might deliver the benefits sooner. However, this would not be risk-free. Liberalisation carries a risk of increased harmful interference from other services in the UK and from services in neighbouring countries if innovation in this country runs ahead of international spectrum planning. The risk of interference is especially great in bands that are currently subject to a high degree of planning and coordination in making assignments, such as private business radio and terrestrial point-to-point fixed links.

A4.15 There is also a risk that liberalisation could lead to greater fragmentation of spectrum, which could impair overall spectrum efficiency. Doing nothing would avoid these risks and their consequences and the costs of managing them. However, Ofcom believes that the risks can be managed through the phased approach as summarised in exhibit 4 below.

Exhibit 4: risk analysis and mitigation

Area of risk	*Possible effects*	*Mitigation*
Interference to or from internationally harmonised services in other countries	◦ UK services operate without protection from interference from such services ◦ UK services may not interfere with such services	◦ Ofcom will refuse request for licence where incompatible with mandatory harmonisation ◦ Operator may mitigate effects by network design or tailoring coverage area
Interference between different services in the UK	◦ Greater inhomogeneity of service and intensity of spectrum use increases risk of interference ◦ Technology-neutral licence conditions may not be sufficient to prevent harmful interference ◦ Users' expectations about freedom from interference are unclear	◦ Ofcom will consider interference against quality indicators in considering requests for change ◦ If interference arises, Ofcom will investigate and take appropriate action ◦ Users can come to arrangements to mitigate interference either by agreement or through market ◦ Ofcom's prior approval will be required for change of use beyond existing licence conditions ◦ Technology neutral emission rights will not be widely introduced until additional experience has been gained ◦ Benchmarks for spectrum quality will be developed and published ◦ In mobile licence classes, full liberalisation will await introduction of advanced assignment tools

Area of risk	*Possible effects*	*Mitigation*
Inefficient use of spectrum	◦ Fragmentation if assignments are split with transaction costs preventing assembly of contiguous assignments into blocks large enough for new services ◦ Greater inter-user separation in form of guard bands between dissimilar applications	◦ Ofcom believes the market is better than 'command and control' regulation at delivering efficient use of finite resource ◦ Users can come to agreement to adjust guardbands where this meets their purposes ◦ Ultimately, aim is to secure most beneficial use of spectrum, not to maximise intensity of use ◦ Possible use of tools such as overlay licences
Disruption to consumers	◦ Change of use may leave consumers deprived of service and with redundant equipment ◦ Change of assignment characteristics may be profitable for manufacturers but require consumers to retune or replace equipment	◦ Ofcom's approval will be required for change of use and, where necessary, Ofcom will require licensees to consult consumers before approving request

Conclusions

A4.16 Quantification of costs and benefits inevitably involves a degree of uncertainty but previous estimates and the recent study for the European Commission indicate that spectrum liberalisation can deliver substantial net benefits and powerfully augment the gains from trading. Doing nothing on liberalisation would forego substantial benefits for consumers, equipment manufacturers and service providers.

A4.17 In some licence classes, the risks, including those of increased harmful interference, are too great to move immediately to technology-neutral licences without any service restrictions.

A4.18 The risks can be mitigated and managed to an acceptable level by requiring Ofcom's prior approval for certain changes of use outside existing licence restrictions. This will enable experience to be gained and the interference management regime to be fine-tuned before increasing users' flexibility further.

A4.19 The phased approach offers a way to achieve early and substantial progress without excessive risk and should be adopted.

Annex 5

Response to the trading consultation

A5.1 The November consultation document proposed that Ofcom would provide an indication of the level of interference that a licensee might reasonably expect to experience. This would be set to be consistent with permitted emissions from other licensees, possibly with reference to geographical location and the duration of the interference as well as its absolute level. Interference above this level, which would be adjusted in line with any variations in emission levels that the parties had agreed, could trigger an interference complaint that Ofcom would become involved in resolving. Questions 7, 8, 17 and 18 (see box below) were relevant to these issues.

Questions from trading consultation

Question 7

(a) Do you anticipate problems in defining the right to transmit in terms of transmitted power or equivalent isotropically radiated power (eirp) and a 'spectrum mask and, if so, what?

(b) What alternative approaches (such as standardised frequency trading units) would you prefer?

Question 8

(a) How important is it to provide guidelines on levels of interference for each licence class?

(b) Do you anticipate any problems in this and, if so, what?

(c) *What alternative approaches might Ofcom adopt?*

Question 17

(a) Do you think liberalisation of spectrum use as proposed should be pursued as well as trading?

(b) Do you agree with the constraints on liberalisation outlined [in the consultation document]?

Question 18

(a) Do you agree with the proposed process for approval of licence reconfigurations or change of use?

(b) Are there other factors which Ofcom should take into account in whether or not to approve an application for change of use?

(c) Should Ofcom make commitments to performance targets for assessing applications for change of use?

A5.2 These questions attracted a significant number of responses, which may be may be read in full on Ofcom's website www.ofcom.org.uk .

A5.3 There was broad support for the basic approach suggested by Ofcom. Respondents recognised the importance of defining emission rights clearly and effectively to avoid interference problems and engender market confidence while avoiding inefficient use of spectrum. However, several responses made detailed suggestions for elaborating on the proposed approach as they do not consider that eirp and a spectrum mask will be sufficient by themselves. There was concern that Ofcom should not relax restrictions in a way that causes the

interference environment to worsen or results in incumbents suffering more interference. Several suggested caution, urging Ofcom to carry out further research and consultation on this topic. A common theme was that change of use is likely to change the interference environment and complicates the task of definition. Several responses referred to the technical challenge this poses. Standardised spectrum trading units received little support as they were felt to be relatively inflexible and to offer no clear advantage.

A5.4 Respondents generally agreed that defining levels of interference is fundamental as radio systems are increasingly operating under interference-limited conditions and that it will also be technically challenging. Some respondents expressed concern about the feasibility of controlling interference in a spectrum market and recommended that Ofcom carries out further analysis of interference controls before proceeding to full-blown liberalisation.

A5.5 Ofcom has taken all of these responses into consideration in formulating the proposals contained in this document.

Annex 6

Summary of proposals and supplementary technical information

A6.1 Exhibit 5 summarises the liberalisation proposals in this document. The changes of use referred to are illustrative and Ofcom will welcome applications for change of use beyond these although they may require more extensive analysis and consideration.

Exhibit 5: summary of liberalisation proposals for 2004 and 2005

Licence sector	*Licence Class*	*Changes to be permitted: licensee, frequency, coverage, illustrative technology and use*
Business radio (previously known as Public Mobile Operator (PMO))	Analogue PAMR	2004 • Liberalised technology through new single Interface Requirement • Change of licence class and type of use within and between PMO and PBR sectors by licence variation (see exhibit 6) 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning • On-line application for change of licence characteristic
	Digital PAMR	2005 • Completion of realignment exercise with MoD will enable introduction of trading and liberalisation
	National Paging *420-450 MHz band excluded from proposals because of sharing requirements* *The ERMES paging bands (169 MHz paired with 870 MHz) excluded as all licences have been returned to Ofcom. Use of band currently under review within Europe.*	2004 • Liberalised technology through new single Interface Requirement • Change of licence class and type of use within and between PMO and PBR sectors by licence variation (see exhibit 6) 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning • On-line application for change of licence characteristic
	Data Networks (174-208 MHz) *420-450 MHz band excluded because of sharing requirements* *866-868 MHz band*	2004 • Liberalised technology through new single Interface requirement • Change of licence class and type of use within sector by licence variation (see exhibit 6) 2005 • Licence classes and licences simplified to offer greater flexibility on use

Licence sector	*Licence Class*	*Changes to be permitted: licensee, frequency, coverage, illustrative technology and use*
	excluded pending consultation on deregulation *Transfer of rights only for single narrowband licence for asset-tracking at 133 and 146 kHz.*	• Geographical partitioning and more flexible frequency partitioning • On-line application for change of licence characteristic
	Common Base Stations *420-450 MHz band excluded from proposals because of sharing requirements*	2004 • Liberalised technology through new single Interface Requirement • Removal of minimum subscriber requirement 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning • On-line application for change of licence characteristic
Business radio (previously known as Private Business Radio (PBR))	National & Regional Private Business Radio *420-450 MHz band excluded from proposals because of sharing requirements* *Licences in this class held by the emergency services will not be subject to trading before 2006*	2004 • Liberalised technology through new single Interface Requirement • Change of licence class and type of use within and between PMO and PBR sectors by licence variation (see exhibit 6) 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning • On-line application for change of licence characteristic
	Wide-area PBR	2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning • On-line application for change of licence characteristic
	On-Site PBR	2005 • Liberalised technology through new single Interface Requirement • Licence classes and licences more usage-neutral
Fixed Wireless Access	3.4 GHz	2004 • Liberalised technology and use • Flexible frequency and geographical partitioning through partial transfer
	3.6 GHz	2004 • Liberalised technology and use • Flexible frequency and geographical

Licence sector	*Licence Class*	*Changes to be permitted: licensee, frequency, coverage, illustrative technology and use*
		partitioning through licence variation
	10 GHz *Future use of band under consideration*	2005 and beyond • Expect to be tradable on issue with change of use, change of technology, frequency partitioning and geographical partitioning
	28 GHz	2004 • Liberalised technology and use • Flexible frequency and geographical partitioning by partial transfer
	40 GHz *Currently vacant*	2005 and beyond • Expect to be tradable on issue with change of use, change of technology, frequency partitioning and geographical partitioning
Fixed links	Scanning Telemetry	2004 • Technical change by licence variation 2005 • Consider liberalisation of technology • Review arrangements for managing the spectrum, including self-management
	Point–to–point fixed links	2004 • Change of bandwidth (resulting from use of different modulation type and/or data rate) by licence variation • Technical changes by licence variation • Change of antenna by licence variation 2005 • Examine on-line application for change of licence characteristic
	32 GHz	2004 • One-third of 32 GHz band currently used for point-to-point fixed links will be liberalised to the same extent as other terrestrial fixed link spectrum 2005 and beyond • Two-thirds of 32 GHz band is currently vacant and Ofcom is considering appropriate award process for this spectrum

Business radio

A6.2 Exhibit 6 shows an illustrative list of the licence classes to which change is likely to be more straightforward. This is not an exclusive list, and licensees are encouraged to bring forward more far-reaching proposals.

Exhibit 6: change of licence class in 2004 within business radio sector

Channel spacing	*Current licence class*	*Illustrative change of use – more straightforward examples*
12.5 kHz	Analogue PAMR	Public mobile data National and regional PBR National paging
	Public mobile data	National and regional PBR National paging Analogue PAMR
	National & Regional PBR	Public mobile data National paging Analogue PAMR
25 kHz	National paging	Public mobile data National and regional PBR Analogue PAMR

A6.3 These new flexibilities will be enabled by introducing a *single Interface* Requirement for a wide range of licences in the public mobile and private business sector as illustrated by exhibit 7. This will contain technology-neutral emission limits for services that operate in 12.5 kHz and 25 kHz channels. The emission limits will be based around ETSI Land Mobile standards EN 300 086 and EN 300 113 and is designed to ensure spectrum users in adjacent spectrum are not unduly affected by differing technology choices. The new digital mobile radio standard under consideration within ETSI is expected to be based on the same emission limits.

A6.4 *Frequency segmentation* of current 25 kHz channels into 12.5 kHz within existing rasters will be allowed by partial transfer Ofcom is currently exploring whether greater degrees of partition could be supported (eg 6.25 kHz) and hopes to introduce such facilities progressively over the next few years.

A6.5 *Frequency amalgamation of adjacent channels* will allow use of wider bandwidth equipment. Ofcom will require the performance at the edge of any group of channels to meet the emission limits published in its Interface Requirement.

Exhibit 7: current interface requirement (IR) for licence classes

Licence Class	*Current IRs*	*Single IR*
Analogue PAMR	2013	12.5 kHz and 25 kHz channels spacing for business radio sector, covering CBS, analogue PAMR, national paging, national data networks, national and regional PBR authorisations
National paging	2010	
Public mobile Data	2012	

National and regional PBR	2001	
CBS	2018	

How MASTS will support liberalisation

A6.6 The current method of assignment and interference management for mobile business radio relies heavily on engineering expertise and local knowledge. MASTS will replace the current arrangements for the assignment of mobile radio licences with a computer-based system that takes into account complex radio propagation phenomena, terrain information and radio usage characteristics to manage the available spectrum more efficiently.

A6.7 MASTS will enable assignments to be more precisely and accurately planned in the business radio sector and facilitate technical evaluation of potential spectrum trades or changes to licence characteristics. It is anticipated that MASTS will enter into service in 2005 following installation and operational testing in the second half of 2004.

A6.8 MASTS will provide a basis for indicators of spectrum quality to be introduced in the business radio sector. MASTS has the capability to define a user's *designated service area* (DSA) in terms of the level of interference from other licensed services and the degree of sharing to be expected. It is envisaged that licensees will be offered various options for available channels and transmission powers so they can select the combination that best meets their requirements. Ofcom envisages that the DSA will be defined in terms of:

- a geographical boundary defined in terms of a specified field strength;
- a percentage time that the user will experience field strength from other users above this level (embedded in the TFAC);
- a percentage exclusivity or activity factor, which measures the degree of sharing of the channel, eg 100% for an exclusive channel, 20% for a channel shared equally between five users.

A6.9 Once MASTS is operational, Ofcom intends to:

- continue to streamline the range of licences currently available for PBR by removing existing distinctions between types of service or use and making licences more generic. The number of separate licence classes will be reduced from over 20 to a handful. This will considerably enhance licensees' freedom to change use or service without the need to seek licence variations;
- extend spectrum trading with change of use and coverage to wide-area business licences and CBS, subject, where necessary, to satisfying Ofcom that the change will not unduly degrade the quality of spectrum experienced by neighbouring users. The technical criteria that will be applied in assessing proposed changes will be established once MASTS has been tested;
- make spectrum quality more transparent.

A6.10 Ofcom will consult further on the technical details once MASTS has been tested later this year.

Point–to-point fixed links

A6.11 Exhibit 8 summarises the fixed links bands that are to be made tradable in 2004 and the planning criteria that apply in each. Ofcom assigns links using its current planning tool, FiLSM, to co-ordinate with all other links in the same frequency band within a coordination zone around each site. Interference to and from the proposed link is assessed, taking into account the licensee's equipment, path profile between the two stations and other technical parameters. This assessment is made to ensure that all the links within the coordination area have the required level of protection and satisfy the interference protection criteria.

Exhibit 8: tradable frequency bands for point-to-point fixed links and planning criteria

Band	*Frequency range*	*Technical frequency assignment criteria (TFAC)and UK Radio Interface Requirement (IR)*
1.4 GHz	1.350 – 1.375 GHz paired with 1.492 – 1.517 GHz	OF46W / RIR2000
4 GHz	3.6 – 3.875 GHz paired with 3.925 – 4.2 GHz	OF30W / RIR2000
Lower 6 GHz	5.925 – 6.1658 GHz paired with 6.18242 – 6.425 GHz	OF 45W / RIR 2000
Upper 6 GHz	6.425 – 6.760 GHz paired with 6.770 – 7.125 GHz	
7.5 GHz	7.425 – 7.625 GHz paired with 7.673 – 7.9 GHz	OF47W / RIR2000
13 GHz	12.75 – 12.975 GHz paired with 13.031 – 13.250 GHz	OF44W / RIR2000
15 GHz	14.5 – 14.613 GHz paired with 15.229-15.35 GHz	
18 GHz	17.7 – 18.6725 GHz paired with 18.71 – 19.7 GHz	OF 50 W / RIR2000
23 GHz	22 – 22.6 GHz paired with 23 – 23.6 GHz	OF43W / RIR2000
26 GHz	24.5 – 25.445 GHz paired with 25.557 – 26.5 GHz	
32 GHz	32.319 - 32.571 GHz paired with 33.131 – 33.383 GHz	OF42W / RIR2000
38 GHz	37 – 38.178 GHz paired with 38.318 – 39.5 GHz	
52 GHz	51.4 – 51.944 GHz paired with 52.056 – 52.6 GHz	OF32W / RIR2000

55 GHz	55.78 – 56.346 GHz paired with 56.458 – 57 GHz	

TFAC and Interface Requirements

A6.12 Ofcom is in the process of revising its technical documents, such as TFAC and interface requirements to support the liberalisation proposals in this document while continuing to reflect existing planning assumptions about spectrum quality. These are being published in draft at the 'Related Items' area that may be accessed via the liberalisation consultation page of the Ofcom website www.ofcom.org.uk.

References

EN 300 086-1 Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 1: Technical characteristics and methods of measurement.
http://pda.etsi.org/pda/queryform.asp

EN 300 086-2 Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 2: Harmonised EN covering essential requirements under article 3.2 of the R&TTE Directive
http://pda.etsi.org/pda/queryform.asp

EN 300 113-1 Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 1: Technical characteristics and methods of measurement
http://pda.etsi.org/pda/queryform.asp

EN 300 113-2 Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 2: Harmonised EN covering essential requirements under article 3.2 of the R&TTE Directive
http://pda.etsi.org/pda/queryform.asp

Annex 7

Glossary

2G
Second generation of mobile telephony systems using digital encoding. GSM (Global System for Mobile communications) is the 2G technology used in Europe.

3G
Third generation of mobile systems. Provides higher-speed data transmissions to support multimedia applications such as broadcast-quality video.

Allocation
a) The process of identifying specific frequency ranges for specific applications; or
b) a frequency band entered in a table of frequency allocations, for use by a particular category of services.

Antenna
A passive device deigned to radiate and receive electromagnetic energy.

Apparatus
Any equipment designed to radiate and receive electromagnetic energy.

Assignment
Authorisation given by a licensing authority for a radio station to use a specific radio frequency or channel under specified conditions.

Authorisation Directive
Directive 2000/20/EC of the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services, available at:

http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_108/l_10820020424en00210032.pdf

AVL
Automatic Vehicle Location: integration of wireless and communications and location tracking devices into automobiles to allow fleet tracking, roadside assistance, etc.

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

Band III
Former TV broadcast band between 174 and 208 MHz, now used mainly for mobile communications.

Base station
A radio station installed by an operator, usually at a specific location, to provide a communications service, typically used in land mobile telecommunications.

Bluetooth
Wireless standard for short-range radio communications between a variety of devices such as PCs, headsets, printers, mobile phones and PDAs.

CEPT
Conference of European Postal and Telecommunications administrations, comprising over 40 European administrations.

Common Base Stations
a) A single channel base station for PBR shared by users (also known as a community repeater); or

b) a PBR installation giving wide area coverage under the control of one or more operators offering mobile communications on a commercial basis to a number of independent (usually business) users.

Communications Act
Communications Act 2003, which confers powers, duties and functions on Ofcom and came into force in December 2003.

Coordination Agreements
Arrangements between the UK and neighbouring countries designed to avoid harmful interference between users in different countries. Also, arrangements within the UK to limit interference between domestic spectrum users.

Data Networks
A network established and operated for the specific purpose of providing data transmission services for the public.

eirp
Equivalent Isotropically Radiated Power. The product of power supplied to an antenna and the antenna gain in a given direction relative to an isotropic antenna, ie one that radiates equally in all directions.

EMC
Electro-Magnetic Compatibility: the ability of equipment or systems to be used within designated environments without causing or receiving electromagnetic interference.

Emissions
Electromagnetic energy propagated from a source, which may occur anywhere in the spectrum.

ERP
Effective Radiated Power.

ETSI
European Telecommunications Standards Institute.

Ex-ante
Before an event, e.g. a trade, takes place.

Ex-post
After an event.

Field Monitoring
Monitoring spectrum use in real-world situations.

FiLSM
Ofcom's Fixed Links Spectrum Management assignment system

Fixed Links
Communications links between fixed points. Such links may be unidirectional or bidirectional, and may be point-to-point or point-to-multipoint.

Framework Directive
Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services

Frequency Boundaries
The extremities of the radio frequency range of an assignment, specified either in terms of a central frequency with channel width, or a frequency range.

Frequency Re-use
Re-using the same frequencies at different spatial locations, in such a manner that they do not cause undue interference.

Frequency Trading Units
Standard blocks of spectrum defined by frequency, time and geography to act as a common unit for trading.

FWA
Fixed Wireless Access: radio link to the home or the office from a cell site or base station, replacing the traditional local loop.

GHz
Gigahertz, a frequency of one thousand million Hertz (cycles per second).

GSM
Global System for Mobile communications. The international operating standard for the second generation of digital cellular mobile communications.

Guard band
Frequency range between assignments to protect users on either side from out-of-band interference.

Harmonisation
Allocation of frequencies on an international basis, eg within Europe or globally, for particular radio services. Such frequency ranges are known as harmonised bands, or harmonised spectrum.

HF
High Frequency: the portion of the electromagnetic spectrum between 3MHz and 30 MHz. Also known as short-wave.

Interface requirements
In accordance with Articles 4.1 and 7.2 of the R&TTE Directive, UK Radio Interface Requirements (RIRs or IRs) set out the relevant high-level assignment, frequency occupation rules and planning assumptions for licensed equipment. They are referenced in Exemption Regulations and licences.

Interference
The effect of unwanted signals upon the reception of the wanted signal in a radio system, resulting in degradation of performance, misinterpretation or loss of information compared with that which would have been received in the absence of the unwanted signal.

ITU
International Telecommunication Union. The United Nations agency that co-ordinates and manages radio use worldwide through the international Radio Regulations that it promulgates. These have the status of an international treaty and are binding on member states.

Land mobile
A mobile service between base stations and land mobile stations, or between land mobile stations.

Liberalisation
Removal of restriction on use of spectrum (eg technology employed or service provided) including change of geographical coverage, power or frequency bandwidth occupied.

Licence class
Type of licence, for example PAMR or Wide area PBR. Volume classes refer to those licence classes for which there are significant numbers of licensees, for example on site PBR with 26,000 licensees and on-board maritime with 64,500.

Licence exempt
Under regulations made previously by the Secretary of State and now by Ofcom, some types of radio equipment are exempted from the requirement for a licence. The current regulations, the Wireless Telegraphy (Exemption) Regulations 2003 (SI 2003 No. 74), are available at:

http://www.legislation.hmso.gov.uk/si/si2003/20030074.htm

MASTS
Mobile Assignment Technical System, an electronic assignment system currently under development for Ofcom and planned to enter service in 2005.

Ofcom
Office of Communications, responsible for spectrum management in the UK and international representation since 29 December 2003.

Overlay licences
Licences that are encumbered by 'sitting tenants' with defined rights for both the newly licensed users and incumbents. The overlay licensee can negotiate with incumbents to gain increased or exclusive access to the band.

PAMR
Public Access Mobile Radio

PBR
Private Business Radio (previously known as Private Mobile Radio (PMR). A private radio service installed and operated by businesses and public sector organisations to provide mobile communications for their own workforces. A base station is installed by each organisation on a suitable site providing local coverage, and used to send or receive short messages concerning the business of the organisation to, from or between mobile units.

PFD
Power Flux Density; a measure of the intensity of a radio signal at a specific location.

PMR
Private Mobile Radio (PMR), see PBR.

Point-to-multipoint
Fixed link having at one end a multi-directional antenna for communication with multiple users over an area.

Propagation
Transmission of radio waves. Propagation characteristics depend on frequency and are affected by the environmental conditions, such as terrain and atmospheric conditions.

PSD
Power Spectral Density; a measure of the intensity of a radio signal, averaged over a specified frequency range.

RA
The Radiocommunications Agency: an executive agency of the Department of Trade and Industry responsible for the management of most non-military spectrum in the UK and for representing the UK internationally. RA ceased to exist when its functions transferred to Ofcom on 29 December 2003.

Reconfiguration
The redefinition of a right to use spectrum, for example, by separating one licence into two or amalgamating two licences which are adjacent in terms of geography or frequency.

Refarming
Migration from an outgoing to an incoming service on a particular range of spectrum.

Remote meter reading
The reading of meters from a distance using radio.

Roll-out requirements
Specific requirements relating to build or operation of radio networks.

Safety of life services
Services provided by organisations who use radio spectrum to protect the lives of individuals, such as the emergency services.

Scanning Telemetry
Typically used by water, electricity and gas companies for remote measurement and control functions.

Site Clearance
A national process of authorising the use of frequencies at specific sites designed to avoid interference, especially to safety related operations.

SMO
Spectrum Management Organisation: an organisation that undertakes the administrative and technical management of part of the radio spectrum, usually limited to the identification of suitable assignments, record keeping, calculation of interference risks and distribution of licences.

Software Defined Radio
Technology to allow more efficient use of spectrum. Cognitive radio is programmed to select vacant spectrum on which to transmit or reduce power to prevent interference.

Spectrum Mask

The spectrum space within which a device transmits, defined by power levels relative to frequency.

Spectrum tariff unit
An average tariff per MHz of spectrum used per unit area.

Spectrum
A continuous range of frequencies of electromagnetic radiation (eg radio waves).

Telemetry
The transmission of data by radio for remotely indicating or recording measurements.

TFAC
Technical Frequency Assignment Criteria used by Ofcom in planning and granting assignments.

Trading Regulations
Regulations made under section 168 of the Communications Act to introduce and regulate spectrum trading.

Trunked radio
A system in which users share or pool a number of radio channels. Frequencies are distributed by the system according to demand and traffic levels. Trunking can enhance spectrum efficiency in some circumstances.

UMTS
Universal Mobile Telecommunications System – a 3G standard.

Undue interference
Interference with any wireless telegraphy that is harmful, defined by section 183 Communications Act 2003 to include interference that creates dangers or risks to the functioning of any radiocommunications service used for navigation or safety, or that degrades, obstructs or repeatedly interrupts broadcasting or other radiocommunications.

UWB
Ultra wide band. A technology that spreads a low-power signal thinly over a wide range of frequencies.

VHF
Very high frequency; the portion of the electromagnetic spectrum between 30 and 300 MHz.

Wireless LAN
Wireless Local Area Network.

WT Acts
Wireless Telegraphy Acts 1949, 1967 and 1998 as amended by the Communications Act. They regulate use of UK radio spectrum.

WT Act licences
Licences issued under the Wireless Telegraphy Act 1949 (as amended).