

Radio spectrum management review: a consultation paper

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Foreword

In March 2001, I was appointed by the Chancellor of the Exchequer and the Secretary of State for Trade and Industry to conduct an independent review of spectrum management in the United Kingdom, with the purpose of promoting UK competitiveness. The attached discussion document sets out some of the issues which my team and I have identified as being crucial to the future conduct of spectrum management, and invites responses on these and other matters. The premises on which I am operating are that:

- the spectrum is an asset of large and growing importance, crucial to the success of many industries, such as the communications industry, which have a major bearing on our future prosperity and in which the U.K. can excel;
- understandably, a régime for allocating spectrum has grown up which relies largely on administrative measures and is not always necessarily calculated to ensure that best use is made of the spectrum;
- at the same time, it is vital to ensure that adequate spectrum is available in the public sector to ensure the delivery of essential services such as defence and the emergency services.

Paradoxically, the fact that the starting conditions are non-optimal creates unusual opportunities for implementing policies through which almost all participants and stakeholders – existing private firms, new private firms, existing public organisations and consumers - can benefit. We should therefore be able to put forward proposals which are palatable to as many as possible of the interested parties.

In my opinion, the objective of enhancing efficiency can best be achieved by developing a régime for spectrum management which gives all spectrum users an incentive to take into account the opportunity cost of the spectrum they are using. In the case of private sector users, such as mobile telephony companies, this can readily be achieved by developing a free market in spectrum or licences associated with spectrum, both by auctioning them when they first become available and by introducing secondary trading. The impact of this system will be enhanced by loosening the restrictions placed on the uses to which particular blocks of spectrum can be put. This should help to ensure that spectrum is deployed in the most effective way by encouraging firms to develop new technologies. Ideally, full substitution across alternative spectrum uses should result in a situation in which as much as possible of it is utilised, while prices are kept low.

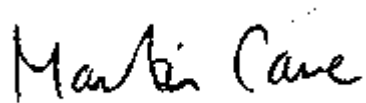
In the public sector, ways must be found to give spectrum users an incentive to consider a range of possible technologies which may economise on valuable spectrum. This may involve, for example, trade-offs between spectrum use and the bringing forward of equipment renewal, or between spectrum use and 'wired' alternatives such as fibre-optic cable.

Many people have commented on the power of *constraints* upon the implementation of any new policy, resulting from the need for the UK to comply with international obligations. I fully acknowledge the existence of these constraints, but am currently inclined to recommend policies which seek progressively to minimise them through unilateral and international action, and to focus upon the *opportunities* which better

spectrum management can create. The likely relaxation of the EU's prohibition on spectrum trading is a major and essential step in this direction. But the constraints do draw attention to the inevitable long-term nature of introducing major changes in spectrum management.

For this reason, it is likely that my proposals will seek to identify long-term means of reaching the objective. Some of the steps towards this end, though, may well require implementation over a shorter period, as a necessary precursor to enabling moves towards spectrum efficiency over the longer term.

I look forward to receiving responses to the accompanying document by August 17th, and to speaking in person with the major parties with an interest in spectrum use.

A handwritten signature in black ink that reads "Martin Cave". The signature is written in a cursive, slightly slanted style.

Martin Cave

June 2001

Responding to the review

The review welcomes responses to this consultation paper from all quarters. The consultation paper is particularly addressed at:

- trade associations and major individual companies with an interest in spectrum use,
- Government departments and regulatory bodies involved in spectrum management activities, in the UK and overseas,
- public interest groups representing consumers' use of radio services, and
- academics and economic policy consultants and other individuals with an interest in regulatory and communications issues.

A summary of the issues for discussion raised by the review is at **Annex A**.

Responses should be addressed to the secretary to the review, Daniel Storey, at the following address:

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Wyndham House
189 Marsh Wall
London E14 9SX

e-mail: spectrum.review@ra.gsi.gov.uk
telephone: 020 7211 0662

This document, and others relating to the review, can be found at the review's website:

www.spectrumreview.radio.gov.uk

and at the websites of the Radiocommunications Agency (www.radio.gov.uk) and Her Majesty's Treasury (www.hm-treasury.gov.uk).

Responses are requested by **Friday 17 August 2001**. In the interests of openness, the review intends to publish (via its website) the responses received, along with the identity of authors, unless confidentiality is requested.

Introduction

1. The radio spectrum is an essential raw material for many of the UK's most promising industries of the future. It is also a key input into many vital public services, affecting the quality and safety of life of all UK citizens. It contributes to a diverse array of cultural, social and scientific activities. But the amount of spectrum available is finite and ensuring that it is used efficiently is essential if the demands of growing industries and high quality public services are to be accommodated.
2. The next decade will see significant continued growth and innovation in wireless communications. The UK has, on the whole, been successful in making spectrum available for new services. The Government has taken steps in recent years to improve the UK's spectrum management regime to provide that spectrum users face greater incentives to use it efficiently. It has introduced administrative pricing and auctions as spectrum management tools. But it is essential that the framework for spectrum management keep up with the pace of change if the UK is to remain at the forefront of the information revolution.
3. The Government therefore commissioned this independent review of spectrum management, to report to the Chancellor and to the Secretary of State for Trade and Industry. (A copy of the H M Treasury press notice of 30 March 2001 which sets out the review's remit is at **Annex B**). The review will advise Government on the principles which should govern spectrum management and what more needs to be done to ensure that all users, commercial and non-commercial users, are focused on using spectrum in the most efficient way possible. In doing so, it will consider the use of spectrum management mechanisms such as spectrum valuation, pricing and trading.
4. The review will report to Ministers by the end of this year with recommendations.
5. The purpose of this consultation paper is:
 - to set out the approach of the review to tackling its remit;
 - to provide a preliminary exposition of the potential benefits from, and constraints on, applying economic principles more comprehensively to spectrum management in the UK;
 - to identify some of the key questions which the review will aim to address; and
 - to solicit views from all interested parties on the current practice of spectrum management and the scope to make further improvements to this in the interests of the UK economy as a whole.
6. The review's objectives are focused very firmly on seeking principles which can be turned into regulatory practice, which will help deliver a more economically efficient use of radio spectrum across the UK economy as a whole. This is a broad remit, encompassing both public and private sectors. It is broad also in the application of the concept of economic efficiency, which can encompass both sectors, as well as both marketed and non-marketed

goods. The review will seek solutions in which use of spectrum for public policy objectives and the delivery of certain services to UK citizens (e.g. defence, 'safety of life' emergency and transport services, public service broadcasting) can be weighed against the opportunity cost of achieving these policy outputs. Ultimately, the breadth and quality of these services to the UK populace, and the manner in which they are delivered, is a matter of public choice via the political process. But this choice may be better made if informed by the cost of spectrum usage associated with different means of achieving the same policy outcomes.

7. The review's focus on maximising economic efficiency in spectrum use across all sectors of the UK economy does not equate to a focus on maximising proceeds to the Exchequer from ongoing spectrum usage fees or one-off auction proceeds. In certain circumstances, there may well be a coincidence between spectrum efficiency concerns and revenue generation, for example in the design of an auction for commercial use of certain spectrum bands. In other cases, achieving economic efficiency in spectrum usage and delivering public policy outcomes may preclude or over-ride any revenue generation objectives. In other words, the review's starting point is that charges on spectrum use should be applied where necessary to guide spectrum to its most efficient uses. Charging is not an end in itself.

The value of spectrum

8. The value of spectrum has, at its heart, a very human basis: the enjoyment and utility which individuals and society place on communication. Radio spectrum enables communication across many different media, for many different purposes, individual and collective, commercial and non-commercial. The phenomenal growth in the use of the internet, mobile telephones, and multi-channel television broadcasting is a manifestation of the attraction of communication in all its electronic forms to very broad sections of society. People like to talk and listen, to watch and learn, to be informed and entertained: radio spectrum enables this.
9. At the same time, individuals and society enjoy a wide range of publicly provided benefits from spectrum use. We all value the security and protection of the emergency services, where radio is an integral input into their activities. Likewise, UK society places a value on the defence of the country and its interests via the UK's military capabilities, which in turn rely on a range of spectrum uses. Advances in scientific understanding, for example through radio astronomy and radio telemetry earth observations, provide international benefits.
10. Shifts in technology constantly open up new possibilities for spectrum use, paving the way for consumers, businesses and governments to discover newly valuable uses of radio services. Technological advances have both increased the productivity of existing usable frequencies and opened up new frequency bands, thereby increasing supply. At the same time consumer and public sector demands for radio services have leapt forward, spurred on by network effects in an increasingly information intensive economy. Enabling

changes in spectrum use which reflect changes in these relative values should increase the benefit which society as a whole derives from this resource.

11. So maximising the economic efficiency with which spectrum is used (the focus of the review's deliberations) should manifest itself in very tangible and human ways, such as:
 - Higher quality lower cost personal communications
 - Richer delivery of information and entertainment to the home and to business
 - Better quality public services delivered with greater value for money
12. This increased value, enjoyment and utility from spectrum use thus presents a real opportunity for the UK economy. But to realise this gain for all will require a rigorous approach to spectrum management, which enables society to respond, through public policy, regulation and the market, to the new opportunities from and changing demands for radio services.

Economic gains from efficient use of spectrum

13. Radio spectrum is a finite resource with scarcity value in many frequencies and geographical areas. This creates the potential for economically wasteful congestion and interference. Balancing spectrum supply and demand to avoid this inefficient outcome has been the rationale for regulating access to spectrum at both a national level, under the Wireless Telegraphy Acts, and internationally, under the auspices of the International Telecommunication Union and the European Conference of Post and Telecommunications Administrations. This regulatory approach has successfully provided an evolving framework for a diverse range of users (commercial and public sector, civil and military) to access the spectrum they currently need. It has also enabled users to input into the regulatory process forecasts of their prospective demands, in order to influence future determination of spectrum use.
14. What has changed, though, in recent years has been the speed of technological advance and the growth in services reliant upon radio spectrum as a vital input¹. In other words, spectrum management is becoming more difficult and more important. Speed of change makes it much harder for a purely regulatory approach to ensure that spectrum is used as efficiently as possible on a continuing basis. Growth in spectrum-reliant services makes efficient use increasingly important to the health of the UK economy as a whole. Misallocation and inefficient use of spectrum can have major adverse impacts on consumers, businesses and users of public services. Conversely, spectrum management which incentivises efficient use and re-use over time

¹ for example, the number of cellular mobile phone subscribers grew from 1 million to 10 million between 1992 and 1998, and then leapt to 35 million by 2000 (source: Oftel); the number of local commercial radio stations rose from 130 in 1991 to 248 in 2000 (source: Radio Authority)

can be an important enabler of the diffusion of new technology, which in turn contributes to economic growth.

15. Recent economic events and studies illustrate the scale of the challenge faced by spectrum management policy. Last year's auctions and comparative selections ('beauty contests') by most European governments of licences to operate so called 3rd Generation mobile phones raised some €130 billion², or around €350 per head of population. Operators may face at least comparable costs for the deployment of new networks and for the marketing of new 3G services. The total amount raised through licence fees (whether through auction or 'beauty contest') represents a lower bound on the telecoms companies' estimate (at the time of the sales) of the net surplus they might create through their 3G services. In the UK, the total amount paid for licences (£22.5 billion) equates to some £1.8 billion per year over the 20 year life of the licences (assuming a 6 per cent real interest rate), or some £21 million per MHz.
16. Few other spectrum users in the UK have been subject to such direct market valuations of their spectrum use. Recent economic studies undertaken for the Radiocommunications Agency, though, have shed light on the estimated benefits to producers and consumers of radio industry services³.

Economic impact of radio: selected sectors³			
	Value (producer plus consumer benefits) (£m)	Licence fees (£m)	Benefits/fees
Total radio industry	20,300	512	40
Mobile telephony services	8,200	44	186
Broadcasting	7,400	435	17
Satellite links	1,800		600
Fixed links	1,600	3	
Private mobile radio	1,100	18	89
Maritime	1	8	138
Aviation	16	2	0.5
Amateur/citizens radio	5	1	16
Others	200	1	5
		-	-

Notes on licence fees:
 Broadcasting: spectrum access fees proxied as the sum of Wireless Telegraphy Act licence fees (£4.9m) plus Broadcasting Act payments for independent TV (£419m) and independent radio (£11m); source: ITC and Radio Authority annual reports, 2000
 All other categories: annual accrued W T Act licence fees received by RA for 2000-01
 Satellite links: fees do not apply to mobile satellite stations

² as of 20 March 2001 (source: European Commission Communication COM(2001)141, *The Introduction of Third Generation Mobile Communications in the European Union: State of Play and the Way Forward*)

³ *The Economic Impact of Radio, A Study Produced by The Radiocommunications Agency, February 2001*

17. These data present some striking results:
- The total economic value of the radio industry surveyed is some £20 billion at 2000 prices (excluding civil aviation, defence and other public sector use of radio, and consumer benefits of some licence-exempt services)
 - Broadcasting and public mobile radio together account for around three-quarters of the estimated benefits
 - Consumer benefits account for 83 per cent of the total value from the radio services surveyed. Producer benefits were 15 per cent, while licence fees (a benefit to the public sector) were some 2.5 per cent
 - The ratio of total benefits to consumers and producers versus licence fees for spectrum usage is estimated around 40:1. There is an extraordinarily wide range in this ratio, though, across different spectrum users: for example, from 600:1 for satellite services, 186:1 for public mobile radio, 17:1 for broadcasting, down to less than 1 for maritime services.
18. One can compare these estimates of the value of radio services to the UK economy with the current use of spectrum. Usage currently ranges widely across spectrum from 9 KHz (Very Low Frequency) up to 300 GHz (Extremely High Frequency), but 'prime spectrum'⁴ is generally considered at present to lie within the range 300-3,000 MHz (Ultra High Frequency band). Use of this spectrum range, and the explicit or implicit licence fee charge for spectrum usage in these prime bands, is currently split as follows:

⁴ so termed because of the physical properties of these radio waves which enable significant amounts of data to be transmitted across economically useful distances, and also allow mobile applications

Prime spectrum allocation in UK (300-3,000 MHz)		
	percentage	licence fee/MHz (£k/pa)
aeronautical	25	1
defence and emergency services	28	20
broadcasting radio	1	112
broadcasting TV	16	2,000
fixed links	5	35
maritime	5	15
private business radio	4	100
2G mobile	8	300
3G mobile	7	21,000
other mobile	1	257
	100	

Source: Radiocommunications Agency

Notes:

Spectrum percentages are approximations which depend in part upon assumptions made about attribution of shared spectrum

Broadcasting: spectrum access fees proxied as the sum of W T Act licence fees (£4.9m) plus Broadcasting Act payments for independent TV (£419m) and independent radio (£11m); source: ITC and Radio Authority annual reports, 2000

All other categories: annual accrued W T Act licence fees received by RA for 2000-01

Satellite links: fees do not apply to mobile satellite stations

3G fees derived from annualising the net present value of the £22.5 billion auction receipts, assuming a 6 per cent real interest rate

Defence spectrum: no fee levied on NATO-managed bands and radar usage, other bands charged at similar rates to public mobile

19. These economic data suggest strongly that there are potentially serious mismatches between:
- the value which UK society places on services using radio spectrum as an input
 - the amount of spectrum allocated to such services, and
 - the fees charged to users of such spectrum to provide direct incentives for the economical use of spectrum.
- At the very least, these data raise questions about the transparency of demands for spectrum use across the economy and the scale of charges for such use.
20. Some of these mismatches are starting to be tackled by the gradual implementation of spectrum pricing via auctions and administratively set prices. But the review has concerns about the ability of the current regulatory regime to deliver significantly better alignment, on a comprehensive and timely basis, between the benefits of spectrum use and the allocation and assignment of specific spectrum access. Indeed, this concern underlies the remit of the review, set by H M Treasury and the DTI. Furthermore, these figures are just a snap-shot, and do not capture the further potential gains from adjusting spectrum use over time to reflect changes in technology and society's demands for radio services.

21. The review will examine further the economic data generated by the Radiocommunications Agency and others on the values which producers and consumers of radio services attach to spectrum use. These data will form the empirical context for the review's recommendations and could provide compelling evidence of the need for change in spectrum management policy and practice.

Issues for discussion

- i. How best can Government assess the economic gains from enabling more efficient use to be made of spectrum?
- ii. How could information from market transactions and economic impact studies best help inform the design of spectrum management policies?

Economic principles of spectrum management

22. The Radiocommunications Agency operates to an ambitious corporate plan with stretching aim and objectives:

“Aim

To be the best spectrum manager in the world, managing the radio spectrum effectively in support of the Government's aim of building a successful and competitive knowledge economy that is the best in the world for electronic trading while providing high quality service in line with the 'Modernising Government' programme.

Objectives 2000/01 to 2004/05

For the Plan period these include:

To support Departmental objectives by:

- managing spectrum in accordance with a clear strategic plan, which:
 - promotes enterprise, innovation and competitiveness;
 - makes full and appropriate use of all available spectrum management tools to promote the best social and economic use of the radio spectrum; and
 - carries forward innovative and progressive approaches to spectrum management.”

23. These aims and objectives are firmly focused on the economic benefits of effective spectrum management to the UK as a whole. They also require the Agency to make trade-offs on behalf of Government and society as a whole between competing social and economic uses of spectrum. But the process of making such trade-offs, and the factors and weightings to be given to competing private and public sector spectrum users, are not clearly articulated.

24. The review's over-arching principle is that all spectrum users should face some form of price reflecting the opportunity cost of their spectrum use, thus providing incentives over the long term towards efficient use. The review will consider how this principle might be translated into regulatory objectives and

practice. It will examine the case for strengthening the Agency's economic efficiency objectives. It will also explore the scope for articulating more clearly in organisational objectives the wider social objectives of managing spectrum access for the provision of non-marketed services.

Issues for discussion

- iii. How far can the over-arching principle, that spectrum users should bear the opportunity cost of their usage, be applied in practice?
- iv. How can the trade-offs between competing economic and social uses of spectrum be more clearly articulated in the principles governing spectrum management?

Legislative basis for spectrum management

Statutory functions and duties of a unified regulator

- 25. The proposed creation of a new unified regulatory body for the communications and media industries – an Office of Communications (Ofcom)⁵ – will include the current spectrum management functions of the Radiocommunications Agency. The Communications Bill to be introduced to implement these plans presents an opportunity to refine the statutory functions, duties, aims and objectives of Ofcom with regard to spectrum management. There is scope to embed in the statute a framework to help ensure that the new regulator faces clear incentives to deliver effective spectrum management to the long term benefit of the UK economy.
- 26. Spectrum management will be only one of a number of high-level functions to be carried out by Ofcom. In one sense, this spectrum function is central and pivotal to all of the services and networks which Ofcom will regulate, as it provides one of the key inputs to both telecommunications and broadcasting. At the same time, spectrum management also has important constituencies outside the converging worlds of communications and broadcasting, notably defence, transport and emergency services. Ofcom should face enduring incentives to take due account of spectrum efficiency for the good of the economy and society as a whole, which could act as a counterweight to Ofcom's internal telecoms and broadcasting constituencies.
- 27. To achieve this, it may be helpful to make ensuring efficient spectrum use one of the primary duties of Ofcom, to rank alongside its duties towards delivering consumer choice and value in telecoms and its public service broadcasting goals. Spectrum efficiency should be measured by the impact on the UK economy as a whole, given wider political choices about the balance between marketed and non-marketed goods, and the scale of the latter.

⁵ as proposed in the DTI/DCMS White Paper, *A New Future for Communications*, December 2000

Statutory basis of spectrum licensing

28. Spectrum regulation in the UK has relied for nearly a century on the licensing of wireless apparatus, with the use of extensive criminal sanctions to enforce this regime. This regime has been very durable, requiring only three significant Parliamentary Acts during the 20th century, the last of which⁶ maintained the structure of licensing and enforcement while adding new economic tools for spectrum management (see below).
29. The forthcoming Communications Bill provides an opportunity to reassess whether the current regime could be further improved by adding new modes of regulating spectrum. One approach, which has been pioneered by the Australian Communications Authority (ACA), is to augment *apparatus licensing* with regulation of *spectrum usage* directly in certain frequency bands. Spectrum in such bands is divided by geography and frequency into standard trading units which can be aggregated along either of these dimensions. Instead of specifying conditions of apparatus use, spectrum licensing determines the relevant frequencies, the geographic area of authorised use, the maximum emission levels outside the bandwidth of the licence, and the maximum emission levels outside the area of the licence.
30. This emphasis on regulation of spectrum access rather than apparatus is closer to the economic principles which underlie spectrum management, namely avoiding inefficient congestion in electromagnetic signals. One of the potential benefits of this approach could be to provide a means to move progressively towards a more technology-neutral approach to spectrum management, which was indifferent to the type and location of the transmitting apparatus and the type of radio service carried on the spectrum. This could enable UK regulators to deliver more efficient use of radio spectrum within UK territory. For example, it could enable regulation of signals transmitted from outside the UK (such as from satellites) or of radio signals which are incidental by-product emissions from non-wireless apparatus (such as radiation from ADSL lines). This may enable Ofcom to deliver more efficient overall spectrum management by improving its regulatory reach over spectrum use in the UK from all sources.
31. The review's remit invites it to advise, if necessary, on the legislation to implement Ofcom. The review will consider the proposed draft Communications Bill, when published, and will aim to submit any interim report on the aspects of this which affect spectrum management in time to inform preparation of the Bill.

Issues for discussion

- v. To what extent would a separate spectrum management duty for Ofcom be helpful, and how could this best be articulated in a new statutory framework for communications regulation?

⁶ Wireless Telegraphy Act 1998

- vi. What additional statutory alternatives to apparatus licensing could assist Ofcom in meeting its spectrum management objectives?
- vii. How far can new modes of licensing, based upon access to defined spectrum rather than defined wireless apparatus, assist in enabling more efficient use to be made of spectrum?

Regulatory framework for spectrum management

32. Radio transmission signals, from a given system, have a tendency to interfere with the proper reception of those of other systems, unless the respective power levels of each system are properly planned. Also, these signals do not respect national borders. As a result, transmissions from one country can interfere unacceptably with systems utilising the same or similar frequencies in other countries. For these reasons, the field of radio communications has traditionally been a highly regulated industry at both an international and national level.

International dimension

33. The trans-national nature of many radio signals, allied to the global nature of many radio-using services, makes international co-operation in radio frequency planning essential to avoid harmful interference. There are significant global benefits from such co-ordination. As an advanced economy making intensive use of radio spectrum, on the geographical edge of a crowded continent with competing commercial and non-commercial spectrum users, the UK stands to benefit more than many countries from this co-ordination. But there are also costs involved, in terms of constraints on the rate at which spectrum can be made available on an internationally-harmonised basis for new services which place a higher value on spectrum use than incumbents.
34. There are three main rationales for international co-ordination:
 - Planning of radio services involving the global and regional movement of transmitters (e.g. maritime, aviation and increasingly mobile phones)
 - Avoidance of interference by planning of frequencies which propagate significantly across regions (e.g. satellite services, lower frequency broadcasting bands) and across neighbouring countries (most services except for low power and short range)
 - Allocation of bands across regions to particular radio services or technologies enables manufacturers to achieve economies of scale in the production of transmission and reception equipment across larger commercial markets, enabling more rapid and economical roll-out of new services.
35. International harmonisation activity takes place on several inter-connected levels:
 - Allocation of services to frequency bands

- Selection and co-ordination of specific frequencies for individual users (assignments)
- Harmonisation of operational procedures (e.g. access protocols, call-signs and qualification of maritime, aviation and amateur operators)
- Technical equipment standards
- Technical conditions within which various allocations can share frequencies
- Regulatory procedures including licensing.

These activities are carried out by several global and European organisations:

The **International Telecommunications Union (ITU)** is an intergovernmental agency of the UN, based in Geneva. The **Radiocommunications Sector (ITU-R)** is responsible for establishing the International Radio Regulations, which include the International Frequency Allocation Table and the Rules and Procedures for use of the frequencies. It is also responsible for agreeing formal recommendations on the technical conditions for frequency sharing between applicable services, equipment standards, and radiowave propagation. The Radio Regulations are updated every 2-3 years at World Radio Conferences (WRC) which require a continuous and extensive cycle of preparations by the various national administrations. Technical work is carried out within a number of ITU Study Groups.

The **European Conference of Post and Telecommunications Administrations (CEPT)** is composed of 43 member administrations. Its main priority is to work towards harmonising the planning and use of the spectrum and licensing arrangements. It is also responsible for co-ordinating common European positions for each of the World Radio Conferences. The **European Union (EU)** is playing an increasingly influential role in determining policies, covering all areas telecommunications including the use of radio, in member states. EU Directives such as those on Radio and Telecommunications Terminal Equipment and Licensing have major implications for UK. A key priority for EU is the eradication of barriers to trade and promotion of competition in telecommunications within its member states. The **European Telecommunications Standards Institute (ETSI)** is composed of manufacturers, operators and administrations. It is the principal telecommunications standardisation body in Europe.

36. The review recognises the significant constraints which the UK's international obligations as a member of the ITU and CEPT place on unilateral spectrum management decisions in the UK. The co-ordination of internationally mobile radio transmitters and trans-national radio signals is clearly vital, and provides benefits in terms of spectrum efficiency and interference management. The European Union is also showing a greater interest in spectrum management as part of the wider policy of developing the single European market in electronic communications.
37. There appears, however, to be a trade-off between the degree of international harmonisation on allocations to defined radio services and the flexibility for individual states to plan their own allocations (or even leave these to market forces to determine). Some jurisdictions (such as Australia, New Zealand, the

USA and Guatemala) have moved, in certain frequency ranges, towards a more technology- and service-neutral approach to spectrum management, which is nevertheless consistent with their obligations as ITU signatories. There is also a trade-off between internationally-mandated allocations, which give certainty to equipment manufacturers, and the less prescriptive approach of enabling industry-led standard setting bodies to deliver the benefits of technology harmonisation.

38. The review will consider these international trade-offs and constraints in achieving economic efficiency of spectrum use in the UK. It will also consider the extent to which the UK's international stance on spectrum harmonisation might reflect more directly the changing valuations placed on spectrum by different users.

Issues for discussion

- viii. How can the UK's stance towards international spectrum management policy best reflect the opportunity costs of different spectrum uses?
- ix. What scope is there for greater autonomy in domestic spectrum policy within the constraints imposed by the UK's international commitments?
- x. How should the UK Government judge the trade-off between a more liberal approach to spectrum management and one in which technology standards and spectrum access are mandated as part of a strategic industrial and trade policy?
- xi. If there were greater latitude in international allocations and/or the UK's implementation of such decisions, to what extent would market mechanisms result in harmonisation of equipment and transmission standards?

National dimension

39. The institutional arrangements for spectrum management in the UK have an important bearing on the delivery of the overall objective of spectrum efficiency. The Radiocommunications Agency plays the leading role in managing the allocation of spectrum and conducting the bulk of individual spectrum assignments. It also leads in representing the UK in international spectrum management fora.
40. The RA, like its regulatory counterparts overseas, tends to stipulate national allocations which are based on the ITU-R Radio Regulations. These national allocations tend to be sub-sets of the Radio Regulations. In other words, in a given frequency band the national regulator will permit the licensing of some, but not necessarily all, of the possible uses identified in the Radio Regulations. This decision is based on national telecommunications strategy, historic use and wider national considerations, such as defence and aircraft safety.

41. Having made a decision to licence a certain service in a given band the selection of licensees and the award (assignment) of frequencies can take a number of forms:
- *User-planned assignments*: (for example, public cellular mobile or point to multi-point systems) RA first endeavours to identify a number of tranches of suitable spectrum with a view to awarding (assigning) them on a national or regional basis to individual operators. Where there is clear evidence that the number of potential (candidate) licensees exceed the number of licences available, auctions may be used to select the successful licensees. Alternatively, where there is not a clear case for auctions, a process of comparative selection ('beauty contests') is also available. In either case the successful candidates are responsible for the necessary planning of the use of the assigned spectrum.
 - *RA-planned assignments*: (for example, fixed point to point links) RA manages a number of frequency bands from which it makes specific frequency assignments on an individual link by link basis, upon receipt of licence application from a large pool of UK operators.
- Some services (such as private business radio) use both assignment approaches, with smaller systems assigned licences on a case by case basis by RA regional offices, and larger systems assigned a block of frequency channels within which the operator will plan the network.
42. Satellite communications systems, which have shown rapid developments in technology and business applications⁷, are subject to a hybrid approach to licensing. Up-link transmissions from fixed earth satellite stations are subject to licensing under the W T Act. 'Receive only' terminals and certain mobile satellite system terminals are exempt from individual licensing under the W T Act. Finally, down-links from satellites into the UK are outside the scope of the W T Act, since the transmitter is not within UK territory. Nevertheless, such 'space to earth' transmissions may place some constraints (agreed in principle in the ITU-R) on other licensed terrestrial services which share the same frequency bands.
43. In addition to the RA, a number of other departments, agencies and public bodies have narrower spectrum policy interests and/or spectrum management/frequency planning functions in their own sectors. These include the Home Office, Ministry of Defence, Department of Culture Media and Sport, Scottish Executive, Civil Aviation Authority, Maritime and Coastguard Agency, Independent Television Commission, Radio Authority, and the BBC. A central Cabinet Office committee, jointly chaired by the RA and the MoD, provides an official forum for formulating and co-ordinating policy on frequency planning and allocation.
44. The delegation of frequency planning within the public sector is mirrored to some extent by delegation to a number of private sector groups. For example, the Joint Frequency Management Group assigns operating licenses to the programme making and special events sector, and the Joint Radio Committee of the fuel and power industries perform a similar function for these utilities. Also, certain fixed links bands have historically been self-managed by BT and

⁷ such as broadband internet access

Cable & Wireless on a block basis. This is a continuation of arrangements made during the monopoly and duopoly periods (prior to 1984). With the companies' agreement, RA is in the process of taking over management of these bands with a view to facilitating access to other operators of fixed links.

45. Delegation of certain spectrum management functions to experts within specialised agencies/departments can clearly provide benefits to particular constituencies of users, in terms of understanding of and responsiveness to their needs. Indeed, some jurisdictions, such as New Zealand, have applied this approach more widely, by auctioning off management rights to particular frequency bands to commercial intermediaries, for them to assign licences within this band to business users of spectrum. Such reforms are designed to encourage a more pro-active approach, with band managers encouraged to seek out profitable and innovative opportunities for the use of spectrum.
46. There are, however, factors which militate against a very devolved approach. It may reduce the scope for making more than marginal changes to the allocations across different uses. It may help entrench the interests of incumbent users (be they public or private sector) by increasing their informational advantage versus spectrum regulators and other potential spectrum users. The division of responsibility can also spread available expertise thinly.
47. One potential offset against these disadvantages is the provision of information to all spectrum users and regulators about current and prospective spectrum use. The RA has taken significant steps in this direction in recent years with the regular publication of a comprehensive report on spectrum strategy⁸. Other national regulators (such as the Australian Communications Authority) have taken provision of information a step further, with the publication (via internet web site) of data on individual apparatus and spectrum access licences⁹.
48. The RA is also working towards facilitating the reception of licence application forms via electronic media. Customers can download the blank application forms from the RA web site. A further development of this electronic interchange of licence documentation may be the development of an on-line database, maintained and protected by RA and containing the essential spectrum-utilisation details of existing systems. There are clearly some potential obstacles (e.g. customer confidentiality, national security) which would need to be addressed. However, the potential benefits, in terms of creating a more open, flexible and dynamic environment, could be significant.

Issues for discussion

- xii. Within the current and proposed statutory framework, what improvements (if any) could be made to the institutional arrangements for spectrum management in the UK?

⁸ *Strategy for the future use of the Radio Spectrum in the UK*, Radiocommunications Agency, Fifth Edition, March 2001

⁹ www.aca.gov.au/database/radcomm/index.htm provides data on the majority of licences, excluding specific information on military and emergency service frequencies

- xiii. To what extent would greater transparency of specific data on current and prospective spectrum uses support efficient spectrum use? What are the key issues and trade-offs pertinent to the provision, by RA, of an on-line database containing spectrum-utilisation details? How far is transparency compatible with commercial confidentiality and public safety and security considerations?
- xiv. To what extent could intermediaries play a valuable role in buying rights to manage a particular frequency band and then selling access to parts of this spectrum to users on a commercial basis?

Spectrum use: marketed and non-marketed outputs

49. Spectrum users can be categorised by the degree to which the services for which spectrum is an input are marketed or non-marketed. At one extreme are private business radio users (such as taxi firms) and telecommunications operators, whose product is entirely commercial with no (or very limited) 'public goods'¹⁰ aspects at all. The supply of these services is very largely determined by the market, responding to consumer demands¹¹. The market into which these services are sold may or may not be subject to sector-specific regulation (for example, telecoms services) to deal with competition and consumer protection concerns. But there is no governmental interest in these spectrum users producing non-marketed services (including 'public goods' as classically defined) in addition to or as part of their commercial services.
50. Such spectrum users have tended to be the first to pay spectrum fees that bear some relation to the value of spectrum utilised, and have been the first to be subjected to spectrum auctions. The review's starting point is that there is no *prima facie* reason why such economic spectrum management tools (along with others, such as spectrum trading) should not be implemented across the full range of purely commercial radio services. Issues to be explored by the review will include:
- The relative benefits of auctions versus administrative pricing
 - The methodology used to derive administrative prices and to implement them in spectrum licence fees
 - The extent to which market reaction to auctions and pricing is systematically fed back into allocation and other spectrum licensing decisions.

¹⁰ public goods are classically defined as those where there is non-rivalry in consumption (e.g. my reception of TV broadcast does not prevent your reception of the same transmission) and non-excludability (e.g. one cannot prevent any one individual from enjoying the benefits of a national defence force)

¹¹ the universal service obligation on certain telecoms services is an exception to this rule.

51. At the other extreme are radio services which are non-marketed. The scale and definition of this activity is determined not through the meeting of supply and demand in a commercial market, but through Government determining the inputs and outputs through some political calculus. At the core of this category are pure 'public goods', such as defence of the UK. It also includes other publicly delivered non-marketed services, such as emergency ambulance services, which are not strictly public goods. There is no significant commercial market for the outputs of these services, which are by and large produced in the public sector. Most inputs to these services are, however, purchased in private sector commercial markets. Furthermore, services ancillary to the production of the main non-marketed service are increasingly contracted out to the private sector and bought back in as a commercial input.
52. The Government has already introduced administrative spectrum pricing to a number of public sector users, notably the Ministry of Defence and the emergency services. The review's starting point is that where spectrum is an essential input to the production of essential public goods, then the Government has a legitimate obligation in reserving sufficient spectrum for such public uses. But it should also impose incentives on public sector users to economise on their spectrum use. Issues to be explored by the review include:
- evidence on the impact of spectrum pricing to date on public sector users' short term spectrum usage
 - impact of pricing on longer term equipment procurement decisions
 - mechanisms to reward/compensate public sector users for releasing spectrum within their allocation for re-use by others
53. Between the two extremes of marketed and non-marketed outputs based on radio spectrum inputs are radio services which combine elements of each. The prime examples of these combined services are:
- Broadcasting: commercial broadcasters obtain spectrum as part of their regulatory franchises, in return for a franchise fee (which may be set through competition or administratively) and meeting public service broadcasting obligations. The BBC is allocated spectrum in order to meet its public service broadcasting obligations under the Corporation's Charter and Agreement. Both commercial and public sector broadcasters deliver programme streams which compete in part with each other, and in part with fully commercial entertainment services delivered by other wired and satellite technologies
 - Transport navigation and safety services: aeronautical and maritime companies produce transport services which are traded in a fully commercial market. They also contribute to public safety at large, not just for their own passengers, through their use of radio services.
54. Some spectrum users in this category (such as some aeronautical ground or maritime coastal stations) face direct charges related to the amount of spectrum they use and, in part, to the value of that spectrum. Others (for example, Channel 3 TV companies and independent national radio stations) pay franchise fees set through a competitive process which reflect in part the scarcity value of the spectrum which attaches to the franchise.

55. The review's starting point is to encourage spectrum efficiency, through the application of economic incentives, as the over-arching long-term principle for spectrum management which is most likely to deliver the greatest economic benefits. This long-term principle applies even where the scope for economising on spectrum may appear very limited in the short to medium term by the constraints of international harmonisation or public service/public safety requirements to achieve universal coverage. The review will consider:
- the scope for separating regulation of non-marketed and 'public goods' outputs from access to and charging for spectrum inputs
 - the link between ongoing spectrum access charges and major long-term network investment plans

The application of this general approach to specific sectors is described in more detail in the following sections, with regard in particular to defence, broadcasting, transport and emergency services. The aim is to ensure that public policy goals were achieved while at the same time introducing a greater incentive for efficient spectrum management over the longer term.

Issues for discussion

- xv. To what extent is the review's distinction between radio spectrum used for marketed and non-marketed goods a helpful one?
- xvi. How far can public policy objectives for the delivery of non-marketed goods be separated from the regulation of access to the spectrum necessary to deliver such services?

Issues in non-marketed uses of spectrum

Defence

56. There has been significant progress in recent years in the application of economic incentives to military spectrum use. This has already generated dividends for the UK economy as a whole, in the form of released spectrum bands and a greater willingness on the part of the MOD to accommodate spectrum sharing in return for lower annual spectrum fees. Economic incentives have tended to reinforce an increasingly open approach by the MOD to disclose information about their spectrum usage (within the constraints of national security requirements).
57. Defence uses are allocated significant amounts of spectrum to enable the MOD to deliver the UK's defence capability. The following table summarises allocation and use by band¹²:

¹² further detailed information is provided in Chapter 3 of *Strategy for the future use of the Radio Spectrum in the UK*, Radiocommunications Agency, March 2000

Spectrum band	Percentage of band allocated to defence uses	Summary of spectrum use
87.5 to 960 MHz	23	main NATO communications band at 225-400 MHz, long-range radar, tactical radio-relay, other mainly national bands
960 to 3000 MHz	16	radio-relays and radars
3 to 10 GHz	48	radars, fixed telecommunications networks and fixed-satellite links
10 to 30 GHz	21	fixed and fixed-satellite links, and some radar
30 to 60 GHz	28	Fixed, fixed-satellite and some radar

58. Spectrum fees have now been rolled out across those spectrum uses by MOD where the equivalent civilian commercial service has also been subject to incentive pricing (for example, mobile radio networks, fixed links, but not yet for aeronautical radars). MOD currently pay some £23 million per year for their spectrum usage, with the fees derived from earlier RA-commissioned Smith/NERA studies into spectrum valuation for commercial users. These fees represent around 2 per cent of the relevant annual budget for communications and information equipment, so at present they largely play a signalling role in highlighting an economic opportunity cost to MOD spectrum users, rather than being a decisive factor in procurement decisions.
59. Defence demands for access to spectrum when needed for training or operations are rising. Technological advances hold out the prospects for battlefield commanders to access a much wider and richer range of data delivered via the spectrum. For example, better sensor technology enables better battlefield management, provided spectrum is available to access data from remote sensors while simultaneously commanding forces. Even without competing demands from civil users, this trend places more pressure on military spectrum users to co-ordinate their own uses effectively in operational situations. The need for UK forces to be globally mobile and inter-operable with other coalition forces (e.g. in United Nations-mandated missions) also has an impact on the flexibility of equipment and frequency use.
60. Against this trend, there are other factors which may enable more efficient economic use of spectrum allocated to MOD. Much military spectrum use is sporadic in nature, dictated by training cycles and infrequent operational requirements. This creates inefficiencies in spectrum use over time. Advances in technology which enable time-sharing of spectrum to a greater degree can help offset this. For example, commercial digital data services which can accept some degree of interruption could co-exist with certain military spectrum users. With sharing protocols embedded in frequency management software, this time-sharing can become more dynamic, opening up the prospect of making more valuable slices of spectrum over time available to non-military users.

61. Implementing such sharing arrangements can involve initial investment to scope the technical possibilities of time-sharing and the business case for commercial partners, and assessment of the impact on military capabilities. This could well require more internal resources to manage this process. Thereafter, there may need to be re-investment in new military equipment to enable some radio services to be migrated to different bands. The review will investigate whether abatement at the margins of spectrum fees at their current level provides a sufficiently strong positive incentive on the MOD to explore commercial spectrum sharing opportunities. It may be necessary to strengthen these incentives, for example though enabling MOD to strike public-private partnerships for commercial exploitation of shared spectrum, with revenues from such agreements flowing back into the defence budget.
62. There may also be scope for time sharing over a much longer time horizon, where MOD is reserving a particular frequency for possible use in future years, depending on the outcome of a particular equipment development programme or capability review. At present, there may be a tendency for MOD to reserve spectrum in the absence of a reliable means of exerting pre-emption rights at a later date. The review will explore the scope for public-private deals under which MOD could release spectrum to commercial use with an option to buy back at a later date.

Issues for discussion

- xvii. Is this a valid description of the factors affecting defence use of radio spectrum?
- xviii. What opportunities exist for commercial and other civil users to share spectrum with the defence establishment in the UK?
- xix. What further incentives could be introduced to encourage more intensive and efficient use of spectrum allocated to defence?

Broadcasting

63. A complex set of arrangements and relationships exists in the licensing and pricing of broadcast services and their use of the radio spectrum. These involve the Government (including the RA), the independent broadcasting regulators, the BBC, commercial broadcasters, and their transmission providers. The review aims to explore the extent to which spectrum management policy might be disentangled from broadcasting policy, at the same time enabling Government to continue to achieve its policy goals in the broadcasting arena.
64. The suggested goal is for all broadcasters, whatever their public service broadcasting (PSB) obligations or their revenue source, to face incentives towards the efficient use of spectrum to meet their PSB and/or commercial objectives. This has for some time been the aim of Government policy, and is articulated in the W T Act 1998, but has yet to be implemented in practice. Moving from analogue to digital terrestrial broadcasting, and thus making a major step-change improvement in spectrum efficiency, is the major economic 'windfall' which could help motivate, and in turn be facilitated by, changes in spectrum management policy.

65. The management of broadcasting spectrum is multi-layered. The Government determines the amount of spectrum to make available for broadcasting and how it is shared between the BBC (for the delivery of the Corporation's services under the terms of the Charter and Agreement) and the independent regulators (for the delivery of commercial services according to the requirements of the Broadcasting Acts). Depending, in particular, on the extent to which the Government requires the spectrum to be used to deliver, for example, PSB obligations, the Government makes other stipulations which impact on the way in which the BBC and the regulators may plan the spectrum¹³.
66. The BBC is then charged with planning the spectrum usage for its UK-based transmissions: these plans are then passed to its transmission providers¹⁴ for implementation. The transmission providers are then granted W T Act licences by the RA, with terms and conditions on spectrum use built into the licences.
67. The ITC and the Radio Authority (RAu) plan the relevant spectrum and regulate independent broadcasting services under the Broadcasting Acts 1990 and 1996. The quantum of spectrum to enable them to perform their function is made available to them by the Secretary of State (acting through the RA) also through the provisions in the Broadcasting Acts. The ITC and RAu are responsible for planning (or arranging the planning) of the spectrum for their licensed services. Licences are awarded via a variety of arrangements depending on the service concerned. For example, for Channel 3 TV services, licences were awarded via a comparative selection ('beauty contest') combined with an auction; for independent local radio and for the digital sound and TV multiplexes, licences are granted solely through comparative selection. As with the transmission of BBC services, the use of spectrum has to be licensed by the RA under the terms of the W T Act. These licences are held by either transmission providers or, in a number of cases, by the broadcasters themselves.
68. Spectrum planning is closely interleaved with, and in some cases dictated by, broadcasting policy considerations. The Government plays a pivotal role in the economics of the broadcasting sector by:
- granting a specific quantum of spectrum to the broadcasting sector and its distribution between BBC and commercial broadcasters
 - setting spectrum prices under the W T Act 1998
 - setting out conditions (including PSB requirements) for the way in which spectrum might be used by the BBC and the independent regulators
 - laying out rules for franchise payments and licence duration and renewal in broadcasting legislation.
- Given the invested infrastructure of terrestrial TV transmission masts and households' own purchases of analogue radios, TVs and video recorders, access to this Government-reserved spectrum is currently a *sine qua non* for

¹³ for example, the Broadcasting Act 1990 is prescriptive about providing for TV Channels 3 and 5 and the three analogue national radio services

¹⁴ independent companies such as Crown Castle International and NTL

public service broadcasters with an obligation to deliver universal coverage. It is also vital for commercial broadcasters whose business depends upon advertising revenue from 'free-to-air' terrestrial transmissions.

69. But as other delivery platforms develop, this perfect identification between delivery of universal coverage and other PSB obligations in return for privileged access to the current quantum of spectrum is beginning to erode. This calls into question the implicit spectrum pact between Government and the broadcast sector.
70. Digital terrestrial TV (DTT) offers the prospect of delivering the current 'free to air' services and others using a fraction of the spectrum currently allocated to TV broadcasting (some 368 MHz in the UHF band). Six TV services of standard picture quality can be carried in digital form in the spectrum currently used for one analogue service (and even more at a quality equivalent to, say, VHS video recorders). Extending the coverage of DTT requires further investment in the transmission infrastructure and, to match terrestrial coverage of analogue services, the switch-off of analogue signals. Also, crucially, the take up of DTT requires investment by individual households in digital receiving TVs and/or decoding boxes, which feed into analogue TVs and VCRs. Digital satellite TV (DST) has a broadcast 'footprint' encompassing some 94-97 per cent of residential locations (i.e. including multi-household buildings). Actual DST usage again depends on take-up by households of subscription channels and/or investment in new reception hardware. Finally, cable TV passes by the front door of around 50 per cent of UK homes, offering these households another means of obtaining TV other than via analogue broadcasts.
71. In the longer term, there is significant scope for broadcasters to make dramatic reductions in their spectrum use. The Government has already signalled that the conditions for switchover from analogue to DTT digital, including 99.4 per cent coverage of households by public service broadcasts and the availability of affordable equipment, may be met in the period 2006 to 2010. The review will consider the extent to which spectrum management policy towards the broadcasting sector can contribute to the implementation of this strategy. In this context, the review concurs with the findings of an earlier study for the RA¹⁵ that "... for television and radio there is merit in pricing the use of spectrum to encourage migration from analogue to digital use".
72. There are at present few financial incentives on incumbent or new entrant terrestrial broadcasters to economise on current spectrum usage. Nor are there clear incentives for broadcasters to consider the longer-term trade-offs between terrestrial analogue and digital transmission, digital satellite and digital cable transmission as means of delivering their services to households in the UK. Licences under the W T Act are fixed at the levels pertaining prior to the W T Act 1998, i.e. set simply to cover RA's administrative costs.

¹⁵ *Study into the use of spectrum pricing*, NERA and Smith System Engineering Ltd, published by the Radiocommunications Agency, June 1996

73. Where broadcasters have been subject to an auction to assign spectrum and broadcast licences (eg Channels 3 and 5), the resulting franchise fees can be considered in part as payment for spectrum usage. But the franchise fee does not vary with the amount of spectrum subsequently used for broadcasting, so there is little incentive to economise on spectrum. The franchise fee also implicitly bundles a number of factors, which if decomposed would comprise:
- payments for the right to an exclusive franchise from the ITC within the respective TV regions
 - payment for the granting of 'must carry' status on other delivery platforms, and
 - subsidy for the broadcaster to meet certain PSB obligations.
- Total tender payments from Channel 3 companies amounted to some £350 million in 2000 and are forecast to fall to around £335 million in 2001. These sums equate to around £2 million per MHz per annum as a price for spectrum usage (with the associated privileges and obligations).
74. The Government has recognised¹⁶ that:
- “Broadcasters, like other major users of spectrum, must use spectrum efficiently, and there should be effective mechanisms to ensure this, which might include regulation or spectrum pricing. The Government has therefore decided that spectrum should be valued. However, the extent to which payment is required for use of this spectrum will need to take account of the particular circumstances of broadcasting. These include the substantial payments already made under the Broadcasting Acts by commercial broadcasters; the level of public service obligations undertaken by the broadcasters; and the forthcoming switchover to digital broadcasting.”
75. The review welcomes this first step which could lead towards the introduction of financial incentives to economise on spectrum use. The review will examine options for introducing such incentives across the full range of spectrum-using broadcasters, and doing so in a manner consistent with the Government's broadcasting policy.
76. For the BBC, there are a number of possible mechanisms for inducing greater spectrum efficiency in the short and medium term. Building on the commitment to value spectrum use, the Government could set up a spectrum account for the BBC, which measured objectively the value of the spectrum used so that the full economic cost of public broadcasting became more transparent.
77. As a further step, the BBC might be encouraged financially to share the use of its allocated spectrum with other users (for example, business data providers which could use under-utilised spectrum on a digital broadcasting multiplex during off peak hours). The commercial revenues from such deals could provide an incentive for the BBC to economise on spectrum use and open up opportunities for new spectrum-based services, to the benefit of the wider economy.

¹⁶ in section 2.7.3, *Communications White Paper*, December 2000

78. This positive incentive to spectrum sharing could be augmented with full charging by the RA/Ofcom for the BBC's spectrum use. To ensure that the introduction of such spectrum efficiency incentives did not impinge on the BBC's ability to meet its public service remit, there would need to be a corresponding transfer from the Government to the BBC equal to the initial spectrum charge. Changes in the price per MHz charged might subsequently be offset by changes in the Government transfer. But changes in the quantum of spectrum used could be internalised within the BBC: reduction in spectrum use (through relinquishing or sharing frequencies) would benefit BBC revenues.
79. Clearly such a spectrum charging arrangement would need to be carefully designed to maintain the BBC's financial independence from Government. There are, however, already examples of interaction between delivery of Government's wider policy goals and the BBC's finances: for example, the £300m annual transfer from the pension budget to the BBC to compensate for the introduction of free TV licences for over 75 year olds.
80. Many of these mechanisms could also be applied to Channel 4 as the other public sector broadcaster. Universal coverage obligations may constrain Channel 4's ability to make significant reductions in its spectrum usage in the short to medium term. But price signals could have a positive role to play in encouraging Channel 4 to switch from analogue to digital broadcasting.
81. For ITV Channel 3 and 5 broadcasters and the national analogue sound broadcasting services, the franchise fee (as noted above) already implicitly incorporates a charge for the use of analogue spectrum. During the passage of the W T Act 1998, Ministers gave a commitment that commercial broadcasters who faced an auction for their franchises under the Broadcasting Act would not face a 'double jeopardy' in terms of a further auction for the use of spectrum. The Government also indicated that account would be taken in setting spectrum fees for broadcasters of amounts paid under the Broadcasting Act. Against this background, the review will examine the scope for 'unbundling' the franchise fee to recognise explicitly the value of spectrum usage by each of the franchisees. There may also be scope to relax licence terms to enable broadcasters to share spectrum usage with others, with possible gains in terms of reduced franchise fees and/or commercial revenue from such deals.
82. To encourage the development and adoption of DTT, the Government awarded franchises for digital commercial broadcasting with a zero tariff on the revenues from such services for the first 12 years of the franchise. Accordingly, the review will not investigate charging for DTT spectrum use up to the point of analogue digital switchover. This may be counter-productive to the wider goal of making the step-change to digital TV which has the potential to make a dramatic improvement in spectrum efficiency. The review will examine, though, mechanisms for applying incentives towards spectrum efficiency after digital switchover, and the role of financial incentives for analogue spectrum use up to switchover. It will also explore options for re-allocating spectrum released from analogue broadcasting to economically valuable uses.

83. Commercial radio licences are awarded against public service broadcasting criteria. Independent national radio licences are assigned on the basis of competitive financial bids which implicitly incorporate a value to the broadcaster of the assigned spectrum. Local radio licences are, however, assigned only on the comparative quality of the respective bids. Trading in the shares of companies subsequent to their winning a local radio broadcast licence suggests strongly that there may be a significant market value attached to the use of this broadcast spectrum, and an only an indirect means by which this spectrum value is reflected in assignment of licences. The review will examine the scope to introduce spectrum pricing and licence auctions to all parts of the radio broadcasting spectrum.
84. In both TV and radio, the Government has objectives to maintain the plurality and diversity of broadcasting. To meet the needs of different communities of interest the RAU (in addition to licensing local radio) and the ITC license restricted radio and TV services. Proposals have also been made in the Communications White Paper concerning a tier of 'Access Radio'. Other community TV channels are carried on a variety of delivery platforms, as part of a commercial package of channels. If measures are introduced to encourage greater spectrum efficiency, and certainly following digital switchover, the spectrum access constraints on enabling local and community broadcasting should be eased, both technically and economically. But such broadcasts are likely to continue to need special treatment in terms of access to commercial delivery platforms or access to their own spectrum. The review will explore ways in which spectrum efficiency goals can be made compatible with plurality and diversity objectives of broadcasting policy.

Issues for discussion

- xx. Is this a valid description of the factors affecting use of radio spectrum by the broadcasting sector?
- xxi. How can the Government's commitment to value the spectrum used by broadcasters be implemented in a way which encourages spectrum efficiency?
- xxii. What further incentives might be introduced, consistent with wider broadcasting policy and with previous Government commitments about television and radio franchise fees, to encourage greater spectrum efficiency by commercial broadcasters? Are there differences in the approach to incentives before and after the proposed switchover from analogue to digital terrestrial TV broadcasting?
- xxiii. What incentives might be introduced, consistent with wider broadcasting policy and the Government's approach to the funding of the BBC and its public service remit, to encourage greater spectrum efficiency by the BBC?

Aeronautical and maritime services

85. Aeronautical uses of spectrum include:

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- Air traffic control: communications from plane to ground and vice versa
- Radiolocation and radionavigation radar: ground based and aircraft based
- Navigational beacons: distance and direction finding equipment
- Instrument landing systems
- Terrestrial flight telephone system

These account for some 26 per cent of allocated bands between 960 and 3000 MHz, and 10 per cent of bands between 3 and 10 GHz, with radar accounting for the bulk of spectrum usage.

86. Maritime uses include:

- Ship to ship and ship to shore communications
- Radionavigation systems
- Radiolocation radars
- Navigational beacons

These account for some 5 per cent of allocated spectrum in 960 to 3000 MHz, and 6 per cent in 3 to 10 GHz.

87. Use of spectrum in these sectors supports both fully marketed services (transportation of freight and passengers by air and sea) as well as a wider public benefit of safety of life for passengers, other transport users, and the population at large. This must be taken into account when considering moves towards a more market-based approach to spectrum management. Furthermore, the global nature of aircraft and ship movements mandates virtually complete international harmonisation of communications standards, including the technical specification of on-board equipment. Spectrum allocation for aeronautical services is mandated by the International Civil Aviation Organisation, and managed in the UK by the Civil Aviation Authority.

88. The review recognises the limited room for manoeuvre of UK authorities in incentivising greater spectrum efficiency in services which rely on particular on-board systems, which are themselves reliant on specific radio frequencies. There may, however, be greater scope to encourage efficiency in UK-based radars and other ground-based transmitters which do not require full international harmonisation of inter-operable equipment on board aircraft. The RA is in the process of conducting a study, with the CAA and the Maritime and Coastguard Agency, on the characteristics, operation and protection requirements of civil aeronautical and maritime radars.

89. The review will explore the scope for the selective application of economic incentives to the spectrum use of civil radars. In the short term there may be no immediate alternative spectrum-efficient means to provide the same degree of coverage and reliability to meet safety standards. In the longer term, though, there is likely to be some degree of trade-off between spectrum use and investment in new equipment which can operate with less bandwidth or which is more tolerant of spectrum sharing. The review will consider possible incentive mechanisms to make such trade-offs account for the opportunity cost of spectrum use, for example by benchmarking spectrum charges for particular radars against the most spectrum-efficient radar currently available which meets the relevant safety standards.

Issues for discussion

- xxiv. Is this a valid description of the factors affecting use of radio spectrum by aeronautical and maritime services?
- xxv. Given the international harmonisation constraints, where could new economic incentives most encourage more efficient use of spectrum in the UK?
- xxvi. How far could changes in spectrum use charges be reflected in air traffic control fees which are passed on to users of UK airspace and landing services?

Emergency services

- 90. The spectrum use by the emergency services is overseen by the Home Office¹⁷, which also make spectrum assignments to specialist covert units in other agencies (eg H M Customs & Excise, Inland Revenue) which require facility for joint operations with the police. Spectrum usage covers a wide range of applications including personal and mobile radio; secure voice, data and video links; location devices; and telemetry links. Spectrum is planned to a high standard to reduce probability of co-channel interference. Many assignments are national to allow for inter-operability and movement of officers around the UK.
- 91. Although police forces and fire brigades are independent and have responsibility for their own procurement, the demands for inter-operability have led to commonality in the type of systems deployed. This process is being taken forward with the introduction over the next few years of a major new national trunked radio system, the Public Safety Radio Communications Service (PSRC-S). This service, procured by the Home Office under a private finance initiative contract, will allow significant rationalisation of spectrum allocated to the Home Office.
- 92. Spectrum pricing is being phased in to this sector, with charges calculated on a comparable basis to the equivalent commercial use of the spectrum. The review will explore the extent to which these price signals could influence spectrum use by the emergency services over the medium term, as communication equipment comes up for renewal. Price signals may point up opportunities for efficient use by some emergency services of private business radio. Conversely, there may be scope (subject to competition policy considerations) for non-emergency service users to buy into radio services developed under the PSRC-S project, thus making more intensive use of the spectrum allocated to the emergency services.

Issues for discussion

- xxvii. Is this a valid description of the factors affecting use of radio spectrum by the emergency services?

¹⁷ for England and Wales; there are parallel devolved but co-ordinated arrangements for other parts of the UK and the Islands

- xxviii. How far can spectrum pricing influence emergency services to make efficient use of spectrum over time?
- xxix. What scope might there be for sharing of spectrum access with other users to enable more efficient spectrum use?

Spectrum valuation: pricing and auctions

93. The Radiocommunications Agency has been in the vanguard among national spectrum authorities in introducing economic incentives on users with the aim of improving the dynamic efficiency of spectrum use. As the RA has said itself¹⁸: “The challenge for spectrum managers in the 21st century is how to satisfy demand for spectrum that is simultaneously growing quantitatively and changing qualitatively. Unless that challenge can be met, there is a real danger that spectrum congestion and shortages will hold back growth and slow down innovation”. Spectrum pricing and auctions are vital spectrum management tools to enable the RA to meet its increasingly difficult challenge.
94. The RA adopted a consultative and open approach over a period of years in order to secure consensus for the shift from cost-based spectrum licence fees to incentive pricing, under which fees are set by reference to the degree of congestion pertaining in the relevant spectrum space. This work, including commissioning a major analysis of the application of spectrum pricing and proposed methodology for setting incentive prices¹⁹, has been a vital precursor to subsequent changes in legislation.
95. The Wireless Telegraphy Act 1998 introduced two new forms of spectrum pricing:
- Administrative pricing, in which fees are set by regulation on the basis of spectrum management criteria (referred to alternatively here as incentive pricing, since the objective is to set fees to produce incentives on users to make efficient and economical use of spectrum); and
 - Auctions, in which fees are set directly by the market.
- These new forms of pricing superseded the previous cost-recovery basis of pricing.
96. Under administrative (incentive) pricing, the Secretary of State (acting through the offices of the RA) is required in setting spectrum licence fees to have regard to various spectrum management factors. These are:
- The balance between spectrum availability and current and expected future demand; and
 - The desirability of promoting:
 - Efficient spectrum use and management
 - Economic benefits
 - Development of innovative services

¹⁸ *Spectrum Pricing: Third Stage Update and Consultation*, Radiocommunications Agency, December 2000,

¹⁹ *Study into the Use of Spectrum Pricing*, by NERA and Smith System Engineering Ltd, published by the Radiocommunications Agency, June 1996

- Competition.
97. Since enactment of the WT Act 1998, the RA has progressively introduced spectrum pricing across a wide range of spectrum-using sectors. Implementation has been staged, with pricing applied first to those sectors judged to be most congested and then progressively rolled out across others. Within each sector, transition from old licence fees to the new incentive prices has generally been phased over a four year period in order to allow users to adjust to the new regime. In order to enable the effects of pricing to be monitored and to minimise the rise in fees, the Government decided that only half the amount of the increases suggested by the Smith/NERA study should be implemented in this first phase²⁰. The table in **Annex C** summarises the extent of current and planned spectrum pricing across the full range of spectrum-using sectors.
98. The review agrees strongly with the underlying premise of spectrum pricing, that users facing a charge which reflects as fully as possible the marginal value will tend to make more efficient use of their spectrum. The aggregate result of these individual decisions by users, to economise on their own spectrum use, should be an overall improvement in economic welfare. The review will consider whether and if so how the RA's application of spectrum pricing could more effectively contribute to economically efficient spectrum management. In particular, the review will investigate:
- Evidence on the impact of spectrum pricing as it has been introduced in the UK to date
 - The extent to which the administratively set prices could be updated on a regular basis to reflect new information, from surveys and auction results, about current valuations of spectrum use
 - The balance between the application of incentive pricing and the more direct incentive of auctioning spectrum on a competitive basis.
99. The auctioning of spectrum licences is now a well-established practice among many national spectrum authorities. In the UK, there have been two spectrum auctions to date, for 3G licences and broadband fixed wireless access spectrum at 28 GHz, both of which took place last year. UK broadcasting authorities have also, for some years, auctioned franchises for analogue commercial television and national radio stations; spectrum is one of the major and valuable assets bundled within the rights and obligations associated with each franchise.
100. Auctions have the potential to generate allocatively efficient outcomes at relatively low transactions costs. They also provide spectrum and other regulators (e.g. telecoms, broadcasting) the ability to factor other policy considerations into the design of the auction process in a transparent manner. For example, roll-out requirements for service networks can be incorporated in licence terms, and competition policy factors can modify the structure of the auction in order to achieve a desired market structure.

²⁰

Spectrum Management: into the 21st Century, DTI White Paper, June 1996

101. The specifics of auction design are the subject of a lively discourse between spectrum regulators, academics and economic consultants across the developed world. This review does not propose to add to that debate. Much of this research and its application, though, takes as a given the quantum of spectrum to be auctioned. The review will consider the prior questions of how regulators should decide:
- The range of frequencies for which licences are to be auctioned
 - The packaging of those frequencies by the regulator or as an outcome of the auction process
 - The boundary between auctions and administrative pricing
 - The interactions between auctions and subsequent secondary trading and leasing of spectrum access

Issues for discussion

- xxx. How far have economic incentives from spectrum prices helped to encourage efficient spectrum use?
- xxx. Where should the balance lie between administratively-set incentive prices and competitive auction of spectrum licences? To what extent could the two approaches be combined to encourage spectrum efficiency?
- xxx. What factors should determine the choice of frequencies subject to auction of licences?

Spectrum trading

102. Spectrum trading is an obvious extension of auctions. It has the potential to add a new dimension to the incentives on current and potential spectrum users to optimise their use of spectrum on ongoing basis. It has been long advocated by economists as a means of introducing greater flexibility and efficiency in spectrum use.
103. The Government is committed to introducing spectrum trading and is in the process of devising a practical means of doing so. It has already indicated (during the passage of the W T Act 1998) that it saw considerable attractions in the introduction of trading of spectrum licences “at an appropriate time and within a suitable statutory framework”. In 1998, the Radiocommunications Agency issued a preliminary consultation paper on developing spectrum trading and reducing the administrative burden on the transfer of licences²¹. The responses to this were supportive of the concept of spectrum trading. The Spectrum Management Advisory Group, established to give Ministers independent strategic advice on spectrum management matters, described trading as “an essential and inevitable progression”.
104. There was broad agreement among consultees that a spectrum market could:
- Improve the economic efficiency of spectrum management
 - Help ensure that spectrum was assigned to those who could produce the greatest benefit from it

²¹ *Managing spectrum through the market*, Radiocommunications Agency, 1998

- Provide valuable additional flexibility for spectrum assignments to be adjusted through the market in response to demand changes
105. There was also consensus on the need for a clear and effective regulatory framework within which trading could take place. Consultees stressed a range of objectives of such regulation:
- Control interference
 - Minimising scope for anti-competitive practices
 - Prevent hoarding
 - Allow for strategic management of spectrum
 - Protect access by small and medium sized enterprises
 - Ensure compliance with international requirements on spectrum use.
- There were differences of opinion about how restrictive such a regulatory framework would need to be.
106. The review recognises the need for an effective means of managing interference. It also agrees that prevention of abuse of a market power is an important economic goal, and that controls over spectrum inputs may have a role to play in effecting this competition policy. But it has reservations about the extent to which spectrum trading should be circumscribed by a desire to protect certain classes of commercial spectrum user, or to impose a centrally-determined strategic view of future spectrum use.
107. The Government has committed (in the Communications White Paper of December 2000) to develop further its market-based approach by introducing trading as a new way of gaining access to spectrum. This policy is subject to changes to EC law, via the draft directive on a common regulatory framework for electronic communications networks and services²², which is currently being considered by the European Parliament and the Council of Ministers. Once EC law has been amended (which is anticipated during the first half of 2002), the Radiocommunications Agency plans to introduce spectrum trading on a selective basis within a clear and effective framework of market supervisions and regulation. The RA is due to issue a further consultation paper later this summer, setting out in more detail its proposals for spectrum trading. The review will aim to address the issues raised by this consultation in its final report to Ministers.
108. Perhaps more than spectrum pricing for initial allocation of licences, spectrum trading challenges many tenets of the traditional regulatory approach to spectrum allocation and assignment. In moving down this road, regulators in other jurisdictions have adopted a more or less radical approach to reform of spectrum management practice. But all have found it necessary to move towards greater definition of the rights and responsibilities of spectrum licensees and users, which in turn helps define their economic interests. This approach is based upon the fundamentals of an effective market:
- Property rights, including the right to use the property for a specified period, to divide the property and transfer its use to others within this

²²

COM(2000)393

- period, as well as the right to exclude others from encroaching on the property
- Enforcement and liability rules, to protect property holders/users and to oblige them to protect the legitimate use of others
 - Information on the ownership and transfer of property, to enable current and potential users to identify opportunities for mutually beneficial transfers
109. Spectrum trading utilises the dispersed information and varying judgements held by a wide variety of current and potential users about the economic value of spectrum. This discovery mechanism could supplant to some extent the central planning role of the RA. There may therefore be a shift in emphasis in the RA's approach to spectrum management, away from specific detailed assignments and towards more generic allocation policies, definition of tradable spectrum units with associated rights and responsibilities, and policing the operation of the secondary markets in spectrum usage.
110. Change of spectrum usage rights from one entity to another will be motivated by the higher value which the buyer places on using the spectrum than the seller, either through delivering the current spectrum-consuming services more efficiently, or using the spectrum to deliver other higher value services. Trading on the latter basis will only be feasible if the spectrum usage rights to be transferred allow some degree of latitude in the type of service to be delivered using that spectrum.
111. Restrictions on spectrum usage which may hinder spectrum trading include:
- Eligibility requirements: specifying the type of licensee by business sector
 - Service requirements: specifying the provision of certain services and proscribing the provision of others
 - Technical restrictions (aside from measures designed to minimise harmful interference): specifying the type of technology to be used
 - Implementation requirements: specifying the pace at which licence holders must 'build out' their network and provision of services across the geography covered by the licence.
112. Many of these requirements flow from international agreements about harmonised spectrum allocation. Others may stem from domestic policy considerations about guaranteed access to spectrum for public sector users and commercial organisations producing some elements of public goods. Finally, some requirements (such as 'use it or lose it' terms) may substitute a regulatory penalty for a market-based opportunity cost. The application of spectrum trading will therefore require a fundamental review of the range of restrictions currently placed on spectrum usage by licence holders. Trading within allocations may be feasible and introduce some efficiency gains with only some relaxation of technical and implementation requirements. Trading across allocation boundaries is likely to require a more substantial relaxation of eligibility and service requirements as well.
113. Other restrictions include market competition parameters imposed on spectrum allocation via auctions. These may specify the maximum number of

licences which any one bidder may hold in total, or by region, or may reserve particular licences to bids from new entrants to a particular radio service market. These restrictions provide some degree of certainty to the market at the time of the initial spectrum assignment via auction about the degree of concentration in access to the spectrum input which the regulatory authorities will tolerate. This decision is based on an *ex ante* judgement about the extent of competition likely to pertain in the radio service market given a certain division of spectrum at auction.

114. Markets evolve, though, and subsequent changes in technology, consumer tastes, competing services using different radio frequencies or non-radio delivery mechanisms may undermine the initial competition analysis which determined the auction design. In that case, secondary trading may help deliver an efficient reallocation of spectrum, even if the subsequent pattern of spectrum usage did not meet the terms of the original auction. Spectrum trading could help improve allocative efficiency over time, provided that competition authorities remained vigilant to the accumulation and potential abuse of market power, supported in part through the accumulation of spectrum access rights.
115. Trading of spectrum, as of any other asset, will require clear specification of enforceable rights and obligations attaching to use of spectrum in particular frequencies, geographical space and time. At present, these terms are established bilaterally between the RA and the spectrum licence-holder at the award of the licence, on the basis of the whole of the spectrum subject to the licence. To enable spectrum trading to operate efficiently, it may be advantageous to enable licence holders to divide up their spectrum usage by time, geography, and/or frequency, to create spectrum 'packages' which may be of value to other potential users. As each division by geography and frequency creates a new set of boundary conditions, the licence holder and the transferee would have to agree a binding contract defining interference protocols. This process, while enabling spectrum users to choose the level of interference they are willing to accept, could add significantly to the transactions' costs of spectrum trading. The central regulatory authority could therefore define, for the frequencies subject to spectrum trading, minimum indivisible units of spectrum with associated interference limits.
116. A key parameter of any licence is the length of the period of spectrum usage. Traditionally, licences in the UK have been issued on a quasi perpetual basis, non-time limited but with W T Act fees collected on an annual basis, and with an unfettered legal right for the RA to revoke the licence after the current fee period expires, consequently making further use of the spectrum illegal. In practice, removing licences from incumbent spectrum users is a more protracted process, often involving detailed work to migrate users to new frequencies. More recently, the RA has fettered its discretion with respect to auctioned licences, which have been sold with a well-defined time limit of 15-20 years. Furthermore, some W T Act licences are inter-dependent on the award of telecommunications or broadcasting licences which may also guarantee rights of tenure.

117. There is a balance between providing licences of sufficient length to enable users to plan services and recoup their investments over time, and the flexibility for the RA in reallocating spectrum from short term licences. If a spectrum market develops, then there may be a case for moving towards longer term or even perpetual licences, as the market could provide a means by which incumbents could be 'bought out' to facilitate re-allocation of the spectrum. There are also questions about the starting conditions for spectrum trading, whether it should apply to spectrum subject to auctions for initial licence assignment or more generally. In either case, licence holders could be subject to 'windfall' gains or losses in the 'secondary market' for spectrum.
118. As well as enabling licence holders to 'parcel up' their spectrum usage by its physical parameters, it would also be advantageous to allow some 'unbundling' of the legal rights and obligations associated with spectrum use. For example, licence holders may wish to 'lease' spectrum usage to others while retaining the obligation under the terms of their licence to prevent interference. Alternatively, they may wish to transfer the full bundle of rights and responsibilities to lessees for a period of time, with the aim of subsequently taking back control of the spectrum at the end of the lease.
119. Whichever approach is adopted, it would be important for the parties to the transfer, the regulator and other spectrum users to have clear information about where responsibility for meeting interference obligations lies. This is a further argument in favour of introducing greater transparency in spectrum usage as part of a move towards spectrum trading.
120. The need to ensure some degree of transparency about spectrum usage rights and responsibilities suggests that at the very least there should be a central system for the registration of spectrum licences and transfers. It is debatable whether any further intervention by the RA in the spectrum market is necessary. In principle, the rights and obligations attaching to spectrum use will have been clearly specified at the outset. So the division and/or transfer of such usage rights should not necessarily impede RA's overall spectrum management function. If spectrum were not being used in accordance with the terms of the licence, then the RA would have legitimate grounds for action against the licence holder and/or the lessee (depending whether usage obligations had been transferred as well usage rights). Where the issue involved a dispute over legitimate rights (as opposed to 'pirate radio' type infringements), then there may be a role for some form of independent arbitration.
121. There are other arguments for a greater degree of intervention in the spectrum market, for example:
- To mandate minimum standards to manage interference on transfer of spectrum use, for example through requiring an audit of the transferee's proposed spectrum use (either by the RA or a qualified independent third party). Such an audit might be a condition for a spectrum transfer to become registered
 - To ensure that whichever party retained the obligation to meet service type and coverage requirements was able and willing to meet these. As discussed above, moves towards spectrum trading may reduce the extent

to which such requirements (over and above the need to minimise interference) are mandated in certain spectrum bands.

Issues for discussion

- xxxiii. Which areas of spectrum use are most amenable to, and which areas offer the greatest potential efficiency gains from, the introduction of spectrum trading?
- xxxiv. To what extent would a move to licensing of spectrum access, as opposed to wireless apparatus licensing as now, facilitate spectrum trading?
- xxxv. What changes to the terms and conditions of licences for the operation of wireless equipment and/or for access to spectrum would facilitate spectrum trading?
- xxxvi. If new modes of licensing spectrum access (rather than equipment operation) were introduced, how could rights to spectrum usage, such as interference standards and length of licences, best be defined to facilitate spectrum trading?
- xxxvii. What market infrastructure, such as spectrum registers and dispute resolution procedures, could facilitate spectrum trading?
- xxxviii. What lessons can be learnt from the experiences of other countries (such as Australia, New Zealand and the United States) in introducing different modes of spectrum trading?

The boundaries of spectrum regulation

- 122. A wide range of spectrum use is exempt from individual licensing, typically because the power and propagation characteristics of these services is so localised that they do not materially interfere with other spectrum users. With advances in radio technology, there is growing commercial interest in developing products which utilise such licence-exempt spectrum, for example, home/office local area wireless networks (such as the 'Bluetooth' standard). Some of the services developed for such licence-exempt spectrum can be partial substitutes for and/or complements to licensed spectrum applications, such as mobile phones. The absence of spectrum usage charges may encourage commercial operators to focus their research efforts on using this spectrum. Conversely, the lack of protection from interference offered to users of such spectrum may militate against operators providing a commercial service, since they may face difficulties in guaranteeing the quality of transmissions.
- 123. Use of licence-exempt spectrum is on a non-interference non-protected basis. Users of such deregulated spectrum must not cause interference to other authorised spectrum users, nor can they claim protection from interference from such services. With short range propagation and few devices in any given geography, the risk of interference caused by such low power licence-exempt spectrum use has historically been relatively low. At the same time, the absence of regulations covering receivers' standards has meant that in some cases equipment can be very vulnerable to interference from other

services. Technology now offers the prospect of increasing the intensity of spectrum use in these unregulated bands through the use of systems which are automatically self-protecting and 'polite'. These avoid interference coming into the band and avoid transmitting over other signals within the band.

124. Use of licence-exempt spectrum therefore poses a number of regulatory challenges:
- Whether, where and how to regulate growing congestion in licence-exempt spectrum use
 - If so, how to do so in way which targets regulation where it is needed, to help different spectrum users resolve efficiently their competing demands to use a particular radio frequency, thus avoiding unnecessary over-regulation
 - The choice of regulatory tools, for example channel access protocols which mandate a minimum level of self-protection and 'politeness'
 - Whether to widen the uses to which licence-exempt spectrum can be applied (for example, licence exemption does not currently apply in the UK to the provision of a low power public mobile radio system provided commercially for use by others)
 - How to reduce the impact of the regulatory boundary between licence-exempt spectrum use (which attracts no spectrum charge) and regulated spectrum where opportunity cost pricing prevails.
125. There is currently significant market interest in the development of wireless local area networks which could utilise several licence-exempt frequency bands (such as the Digital Enhanced Cordless Telephone band at 1880 to 1900 MHz, the 2400 to 2483.5 MHz band, and the 5 GHz bands). In light of this demand, the RA is proposing to consult later this year on the removal of the prohibition on the use of deregulated spectrum for the provision of public telecommunications services. In light of the information generated by this RA consultation, the review will consider the division between licensed and licence-exempt spectrum use, and assess regulatory approaches which might be adopted to deal with growing congestion problems in unlicensed spectrum.

Issues for discussion

- xxxix. What factors should guide regulators in setting the boundaries of licence-exempt spectrum use?
- xl. What remit should regulators hold over licence-exempt spectrum use, other ensuring that it does not interfere unduly with licensed spectrum use?
- xli. How far can developments in radio technology provide an alternative to regulation in licence-exempt spectrum bands, particularly where the potential for interference with other users is very low given the propagation and power characteristics of the signals concerned?

Annex A

Summary of issues for discussion

Economic gains from efficient use of spectrum

- i. How best can Government assess the economic gains from enabling more efficient use to be made of spectrum?
- ii. How could information from market transactions and economic impact studies best help inform the design of spectrum management policies?

Economic principles of spectrum management

- iii. How far can the over-arching principle, that spectrum users should bear the opportunity cost of their usage, be applied in practice?
- iv. How can the trade-offs between competing economic and social uses of spectrum be more clearly articulated in the principles governing spectrum management?

Legislative basis for spectrum management

- v. To what extent would a separate spectrum management duty for Ofcom be helpful, and how could this best be articulated in a new statutory framework for communications regulation?
- vi. What additional statutory alternatives to apparatus licensing could assist Ofcom in meeting its spectrum management objectives?
- vii. How far can new modes of licensing, based upon access to defined spectrum rather than defined wireless apparatus, assist in enabling more efficient use to be made of spectrum?

Regulatory framework for spectrum management

International dimension

- viii. How can the UK's stance towards international spectrum management policy best reflect the opportunity costs of different spectrum uses?
- ix. What scope is there for greater autonomy in domestic spectrum policy within the constraints imposed by the UK's international commitments?
- x. How should the UK Government judge the trade-off between a more liberal approach to spectrum management and one in which technology standards and spectrum access are mandated as part of a strategic industrial and trade policy?
- xi. If there were greater latitude in international allocations and/or the UK's implementation of such decisions, to what extent would market mechanisms result in harmonisation of equipment and transmission standards?

National dimension

- xii. Within the current and proposed statutory framework, what improvements (if any) could be made to the institutional arrangements for spectrum management in the UK?
- xiii. To what extent would greater transparency of specific data on current and prospective spectrum uses support efficient spectrum use? What are the key issues and trade-offs pertinent to the provision, by RA, of an on-line database

- containing spectrum-utilisation details? How far is transparency compatible with commercial confidentiality and public safety and security considerations?
- xiv. To what extent could intermediaries play a valuable role in buying rights to manage a particular frequency band and then selling access to parts of this spectrum to users on a commercial basis?

Spectrum use: marketed and non-marketed outputs

- xv. To what extent is the review's distinction between radio spectrum used for marketed and non-marketed goods a helpful one?
- xvi. How far can public policy objectives for the delivery of non-marketed goods be separated from the regulation of access to the spectrum necessary to deliver such services?

Issues in non-marketed uses of spectrum

Defence

- xvii. Is this a valid description of the factors affecting defence use of radio spectrum?
- xviii. What opportunities exist for commercial and other civil users to share spectrum with the defence establishment in the UK?
- xix. What further incentives could be introduced to encourage more intensive and efficient use of spectrum allocated to defence?

Broadcasting

- xx. Is this a valid description of the factors affecting use of radio spectrum by the broadcasting sector?
- xxi. How can the Government's commitment to value the spectrum used by broadcasters be implemented in a way which encourages spectrum efficiency?
- xxii. What further incentives might be introduced, consistent with wider broadcasting policy and with previous Government about television and radio franchise fees, to encourage greater spectrum efficiency by commercial broadcasters? Are there differences in the approach to incentives before and after the proposed switchover from analogue to digital terrestrial TV broadcasting?
- xxiii. What incentives might be introduced, consistent with wider broadcasting policy and the Government's approach to the funding of the BBC and its public service remit, to encourage greater spectrum efficiency by the BBC?

Aeronautical and maritime services

- xxiv. Is this a valid description of the factors affecting use of radio spectrum by aeronautical and maritime services?
- xxv. Given the international harmonisation constraints, where could new economic incentives most encourage more efficient use of spectrum in the UK?
- xxvi. How far could changes in spectrum use charges be reflected in air traffic control fees which are passed on to users of UK airspace and landing services?

Emergency services

- xxvii. Is this a valid description of the factors affecting use of radio spectrum by the emergency services?

- xxviii. How far can spectrum pricing influence emergency services to make efficient use of spectrum over time?
- xxix. What scope might there be for sharing of spectrum access with other users to enable more efficient spectrum use?

Spectrum pricing and auctions

- xxx. How far have economic incentives from spectrum prices helped to encourage efficient spectrum use?
- xxxi. Where should the balance lie between administratively-set incentive prices and competitive auction of spectrum licences? To what extent could the two approaches be combined to encourage spectrum efficiency?
- xxxii. What factors should determine the choice of frequencies subject to auction of licences?

Spectrum trading

- xxxiii. Which areas of spectrum use are most amenable to and which areas offer the greatest potential efficiency gains from the introduction of spectrum trading?
- xxxiv. To what extent would a move to licensing of spectrum access, as opposed to wireless apparatus licensing as now, facilitate spectrum trading?
- xxxv. What changes to the terms and conditions of licences for the operation of wireless equipment and/or for access to spectrum would facilitate spectrum trading?
- xxxvi. If new modes of licensing spectrum access (rather than equipment operation) were introduced, how could rights to spectrum usage, such as interference standards and length of licences, best be defined to facilitate spectrum trading?
- xxxvii. What market infrastructure, such as spectrum registers and dispute resolution procedures, could facilitate spectrum trading?
- xxxviii. What lessons can be learnt from the experiences of other countries (such as Australia, New Zealand and the United States) in introducing different modes of spectrum trading?

The boundaries of spectrum regulation

- xxxix. What factors should guide regulators in setting the boundaries of licence-exempt spectrum use?
- xl. What remit should regulators hold over licence-exempt spectrum use, other ensuring that it does not interfere unduly with licensed spectrum use?
- xli. How far can developments in radio technology provide an alternative to regulation in licence-exempt spectrum bands, particularly where the potential for interference with other users is very low given the propagation and power characteristics of the signals concerned?

Annex B

Review remit: H M Treasury press release of 22 March 2001

35/01

22 March 2001

REMIT OF RADIO SPECTRUM MANAGEMENT REVIEW ANNOUNCED- CAVE

The radio spectrum is a key resource for many new and developing high-tech industries. The management and development of the spectrum will play an important role in creating a knowledge driven economy.

The Chancellor announced in Budget 2001 that Professor Martin Cave, Vice Principal at Brunel University, will lead the independent review of spectrum management.

The review will publish an issues paper in May 2001, setting out initial areas of interest.

Professor Cave said:

“The radio spectrum is a key resource for many new and developing high-tech industries that are important to the future growth and productivity of the UK. Ensuring spectrum is managed in the best interests of the economy will mean we fully benefit from these new technologies. Consultation by the review will be wide and extensive, and involve many interested parties in industry, academia and government.”

The review will ensure that the spectrum management framework is at the forefront of change. It will advise on the principles that should govern spectrum management and what more needs to be done to ensure that all users, including non-commercial users, are focussed on using their spectrum as efficiently as possible. The review will consider the use of spectrum management tools such as spectrum valuation, trading and pricing.

The review will report to the Chancellor and the Secretary of State for Trade and Industry by the end of the year. It will address issues early where its advice will be relevant to the institutional framework for spectrum management proposed in the Communications White Paper.

NOTES FOR EDITORS

1. Professor Martin Cave, professor of economics and Vice-Principal at Brunel University, has published on a wide range of subjects, including telecommunications regulation and spectrum management as well as competition policy and higher education. He has also advised OFTEL and a number of regulatory bodies. He is a member of the Competition Commission.

2. The Communications White Paper was published in December 2000 by the Department for Trade and Industry, and the Department for Culture, Media and Sport. It sets out the institutional framework for communications regulation, including

the establishment of a single regulator for the sector. This single regulator will incorporate the spectrum management functions of the Radiocommunications Agency.

3. The Review invites initial responses from all interested parties to the following addresses: spectrum.review@ra.gsi.gov.uk and/or to the Secretary to the Review, Daniel Storey, at

Radio Spectrum Management Review
c/o Radiocommunications Agency
Wyndham House
189 Marsh Wall
London
E14 9SX

In light of initial responses and analysis, the Review will publish an issues paper in May. This press notice, and subsequent Review documents, will be available at the following web address: www.spectrumreview.radio.gov.uk or via the Radiocommunications Agency website: www.radio.gov.uk

ANNEX TO PRESS NOTICE

Independent review of radio spectrum management: terms of reference

1. In the November 2000 Pre-Budget Report, the Government announced an independent review of radio spectrum management.
2. The review will advise on the principles that should govern spectrum management, and what more needs to be done to ensure that all users, including non-commercial users, are focused on using their spectrum in the most efficient way possible. In doing so, it will consider the use of spectrum management tools such as spectrum valuation, pricing and trading.
3. The review will report to the Chancellor and to the Secretary of State for Trade and Industry.

Context and timing

4. In December 2000 the Government published the Communications White Paper. This sets out the future for regulation in the communications sector, including the transfer of spectrum management functions into the new unified regulator, OFCOM.
5. The purpose of the review is not to revisit these institutional arrangements. However, it may be the case that the review wishes to make recommendations for the implementation of the legislation. In order to ensure that this is possible, the review will provide advice on these areas for late summer 2001.
6. The review will provide a final report by the end of the year, and if possible for the 2001 Pre-Budget Report.

Process

7. In order to ensure that the review is fully informed and authoritative, it will carry out full consultation with interested parties, including from the private sector (such as broadcasters, telecommunications companies, manufacturers, etc), and from relevant Government departments (including, but not necessarily limited to, the Ministry of Defence, the Department of Culture, Media and Sport and the Department for the Environment, Transport and the Regions).
8. The recommendations that the review produces need to be practical as well as desirable. It will consider not only analytical issues but also the incentives facing different users and realistic mechanisms for improving spectrum management.

Annex C

Application of incentive pricing to spectrum users

Sector	Smith/NERA recommendation on incentive pricing	Basis for prices	Date of introduction of incentive pricing (or other measures taken eg. Simplification)	Phased Introduction period position proposed for July 2001	Full implementation date	Fixed Sum (Administrative)	Fee Rate (£/MHz/Km ²)	Annual accrued fees received for 2000 - 2001
Aeronautical	Administrative pricing limited to TFTS, channel 36. Needed to recognise international dimension for the pricing of Ground Station.	Set relative to alternative use.	Simplification of Ground Station licence classes (July 2000). Radar deferred for further study. No demand for TFTS.	N/A	N/A	Range £20 to £250	N/A	£0.3 M
Aircraft	All aircraft share the same spectrum worldwide.	Cost recovery only, flat fees.	Simplification of licence classes (July 2000).	N/A	N/A	Range £15 to £350 by aircraft size and usage.	N/A	£0.6M
Amateur/Citizens' Band	Administrative pricing not appropriate.	Cost recovery only, flat fees.	Simplification of licence class (July 2000).	N/A	N/A	£15 for most users.	N/A	£1.2M
Broadcasting (Audio and TV only)	Administrative pricing seen as worthwhile, subject to resolution of policy issues.	Cost recovery only, flat fees at pre-1998 levels.	N/A	N/A	N/A	N/A	N/A	£4.9M
Fixed Links	Administrative pricing seen as worthwhile. Set relative to cost of alternate services.	Standard (fixed) Tariff Unit. Scaled to reflect efficiency and congestion.	From 1998 (for point to point) other products from 1999.	Year 3 of 4	July 2002	N/A	Up to £1.05 ≡ £925 Fixed Link reference fee ^φ	£18.3M

^φ Licence fee = Fixed Links Reference Fee x Frequency Band Factor x Adjusted Bandwidth Factor. This is equivalent to using the STU of £1.05

Radio spectrum management review: a consultation paper

Sector	Smith/NERA recommendation on incentive pricing	Basis for prices	Date of introduction of incentive pricing (or simplification of sector)	Phased Introduction period position proposed for July 2001	Full implementation date	Fixed Sum (Administrative)	Fee Rate (£/MHz/Km2)	Annual accrued fees received for 2000 - 2001
Maritime	Administrative pricing seen as only worthwhile for Maritime Business Radio. Need to recognise international dimension for pricing maritime use.	Benchmarked from other mobile prices.	Rationalisation July 2000.	N/A	N/A	Range £75 to £1000 per channel of base station.	N/A	£0.3M
Ships	Administrative pricing seen as only worthwhile. All ships share the same spectrum worldwide.	Cost recovery only, flat fees.	Rationalisation from July 2001.	N/A	N/A	£15 to £20 from July 2001.	N/A	£1.3M
Private Business Radio	Administrative pricing seen as worthwhile.	Standard (mobile) Tariff Unit or scaled proportion according to congestion or pricing incentives.	From July 1998.	Several classes each year	July 2000.	N/A	Up to £1.65	£8.1M
Programme Making and Special Events	Administrative pricing seen as worthwhile. Recommend that account be taken of the mobile & fixed STU.	Incentive pricing introduced from July 2001.	From July 2001.	Year 1 of 4	July 2004.	Range £2 to £2,400 depending on channel and/or region.	N/A	£1.1M

Radio spectrum management review: a consultation paper

Sector	Smith/NERA recommendation on incentive pricing	Basis for prices	Date of introduction of incentive pricing (or simplification of sector)	Phased Introduction period position proposed for July 2001	Full implementation date	Fixed Sum (Administrative)	Fee Rate (£/MHz/Km2)	Annual accrued fees received for 2000 - 2001
Public Telecoms Networks	Administrative pricing seen as worthwhile. Set relative to cost of alternate services.	Standard (Mobile) Tariff Unit.	From July 1998.	Year 4 of 4 for public telephony	July 2001	N/A	Up to £1.65	£40.0M
				2 of 4 for RFA	July 2003	N/A	Up to £1.65	£0.8M
				3 of 4 other PMO	July 2002	N/A	Up to £1.65	£2.9M
				3 of 4 for CBS	July 2002	N/A	Up to £1.65	£0.7M
Satellite uplinks (inc. PES, TES & VSATS)	Administrative pricing seen as worthwhile, incentive pricing should be applied to all licensing products.	Benchmarked from Standard (fixed) Tariff Unit.	July 2001.	Year 1 of 2	July 2001 (TES) Oct 2001 (PES)	N/A	Up to £1.05 (by benchmarking)	£2.9M
Scanning Telemetry	Administrative pricing seen as worthwhile. Benchmarked to PBR.	Cost recovery, plus introduction national channel which is incentive priced.	July 2001 National incentive priced channel.	Year 1 of 2	July 2002.	£40 per station or £7,920	Up to £1.65	£0.4M

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Sector	Smith/NERA recommendation on incentive pricing	Basis for prices	Date of introduction of incentive pricing (or simplification of sector)	Phased Introduction period position proposed for July 2001	Full implementation date	Fixed Sum (Administrative)	Fee Rate (£/MHz/Km2)	Annual accrued fees received for 2000 - 2001
PUBLIC USE								
Defence	Administrative pricing seen as worthwhile.	Set relative to fixed links, mobile radio fees depending on the band.	1999	Year 3 of 3	2001	N/A	As for appropriate PMO or Fixed links	£22.7M
Home Office	Not covered. RA have taken same approach as Defence	As Defence	2000	Year 2 of 4	2004	N/A	ditto	£1.0 M
Radio Astronomy, space research, meteorology	Administrative pricing seen as worthwhile, although there are some policy issues.	Needs further consideration	N/A	N/A	N/A	N/A	N/A	£0.3 M