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**DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY
COMMITTEE FOR INFORMATION, COMPUTER AND COMMUNICATIONS POLICY**

Working Party on Telecommunication and Information Services Policies

SECONDARY MARKETS FOR SPECTRUM: POLICY ISSUES

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FOREWORD

This report was discussed by the Working Party on Telecommunication and Information Services Policies at its meeting on 29-30 November 2004. The Working Party recommended the declassification of the report to the ICCP Committee which agreed to this at its meeting in March 2005.

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MAINPOINTS

Many countries are grappling with spectrum reform in a climate of rapid technological change, convergence and relentlessly growing spectrum demand. There is increasing dissatisfaction with the current approach to spectrum management which suppresses competitive entry, blocks efficient transfer of spectrum to higher value use, and insulates old technologies from innovative challenge.

But there has been discord over whether a spectrum ‘commons’ approach or an ‘exclusive usage rights’ approach is appropriate. Both approaches have advantages and disadvantages. The policy challenge is to install the best blend of the different approaches drawing on the strengths of each.

An eclectic pragmatic approach is the exclusive ‘expanded usage rights’ approach (allowing spectrum sharing through ‘easements’) that could be applied to significant parts of the spectrum (where scarcity is high and transaction costs low).

Secondary markets to enable spectrum trading can be an important part of an “expanded usage rights” approach. This is because a major reason for the problem of inefficient underuse (the ‘tragedy of the anti-commons’) occurring is the failure to assign spectrum usage rights such that the resource may be effectively used by those who value it the most. Secondary markets will enable spectrum resources to shift from low-value uses to higher value uses.

Spectrum trading and liberalisation are separate developments. Even without liberalisation of spectrum use, spectrum trading has considerable benefits. However, liberalisation allows the needed flexibility giving spectrum users freedom to adopt new technologies and offer new services. Spectrum trading combined with liberalisation will enable the market to decide how much spectrum should be allocated to different uses; enable faster flexible access to spectrum, including unused and underused spectrum; help to promote the development of new, spectrum efficient technologies; and boost innovation in the use of the spectrum and spectrum-based products and services.

Even though spectrum trading is not applicable to all frequencies, it allows the opportunity cost of frequencies allocated by traditional command-and-control or the ‘commons’ approach to be imputed from those that are traded. With limited exceptions, all spectrum users should face incentives to use spectrum more efficiently. Administrative incentive pricing (based on the opportunity cost of spectrum) could be applied equally to public and private sectors. Such ‘incentive pricing’ will also provide incentives for a firm to engage in spectrum trading (since it increases the cost of holding spectrum it does not need.).

Practical experience in regard to spectrum trading has been limited to a handful of countries (Australia, New Zealand, United States, Canada, and Guatemala). Nonetheless, there are lessons to be gleaned from this experience. Some of the promised benefits have materialised. Certainly experience has demonstrated the viability of a spectrum trading regime. But there has also been disappointment *e.g.*, in regard to the lower than anticipated level of trading activity. At any rate, it is notable that in all these countries there is continuing support for further development of secondary markets for spectrum,

Notably, the attitude of the government, as well as operators in New Zealand and in Australia towards the spectrum trading regime remains positive. The FCC (in the United States) and Ofcom (in the United

Kingdom) have made recent decisions strongly in favour of the introduction of spectrum trading. There is wide expectation in all these countries that, given time to evolve and mature, spectrum trading will emerge as a valuable means of increasing the efficiency of spectrum usage.

Despite the persuasive rationale for spectrum trading countries have been slow to introduce them. This may be in part because a number of significant concerns remain in regard to spectrum trading and liberalisation. The concerns include:

- Low spectrum trading activity
- Inefficient use of spectrum
- High transactions costs
- Risk of increased interference
- Impact of spectrum trading on anti-competitive conduct
- Impact on investment and innovation
- Impact on international co-ordination / harmonisation
- Windfall gains
- Disruptive effect on consumers
- Reduced ability to achieve public interest objectives.

There are countries, cautious about introducing secondary markets because of such concerns, that are trying to achieve efficient usage of spectrum through different approaches. The results of these efforts should be carefully monitored. However, policies that are able to ameliorate these concerns would help encourage the development of well-functioning secondary markets for spectrum.

The presence of such concerns makes it understandable if countries decide to introduce spectrum trading through a phased stage-by-stage approach (as the United Kingdom has done). If so, spectrum trading could be introduced first in areas such as Land Mobile PMR, Fixed Links, Fixed Wireless Access, and Land Mobile Public, followed eventually by other areas. Liberalisation to allow flexibility of use can be permitted at a later stage.

National security, public safety, health and other public interest objectives need not be compromised under a spectrum trading regime. But where governments intervene in spectrum management decisions, this intervention should be clearly defined, transparent and limited in scope wherever possible.

Regulatory policies should consider establishment of a framework for secondary markets and to facilitate the transition to secondary markets. There will be continuing need to perform a wide range of regulatory tasks, as indicated below. Some of these tasks may be in conflict and this may require that decisions be made on appropriate trade-offs:

- Establishing clear and detailed rules for secondary trading, with clearly defined rights and obligations for all parties involved including interference and other technical issues.

- Publishing available information on tradable spectrum and status of processes in order to maximise transparency of the process and certainty of market players
- Maintaining in a transparent and non-discriminatory manner, detailed on-line registries recording the rights and obligations associated with each trade, and the corresponding assignments
- Controlling and evaluating proposals for change of use, with prior publication of requests for such changes, appropriate technical studies and industry consultation
- Establishing levels of acceptable/efficient interference and ensuring these levels are not exceeded
- Evaluating ways of minimising administrative overhead and processing time to help identify and implement more efficient processing techniques and procedures
- Guaranteeing and policing spectrum rights, investigating possible transgressions and managing disputes between users and where necessary, arbitrating and enforcing binding decisions
- Guaranteeing efficient and effective use of spectrum, in particular, preventing speculative hoarding, avoiding fragmentation of spectrum, re-assigning spectrum
- Continuing spectrum harmonisation to satisfy international commitments
- Ensuring observance of competition rules, detecting and preventing anti-competitive behaviour and monitoring concentrations of market power
- Minimising the transaction costs and time associated with completing agreements for transfer or lease of spectrum usage rights
- Modifying service definitions, where appropriate, to increase flexibility and allow multiple services to operate in the same spectrum
- Promoting the development and availability of frequency and technically agile equipment such as software-defined radios and multi-band transmitters and receivers wherever possible
- Eliminating barriers to the development of secondary markets for spectrum
- Eliminating unnecessary regulations and administrative requirements.

It needs to be stressed that the use of secondary markets for spectrum does not apply, and indeed cannot apply, to unlicensed bands since these bands are not allocated to any specific user or service. It is also important that such unlicensed bands continue to be set aside for unlicensed use.

SECONDARY MARKETS FOR SPECTRUM: POLICY ISSUES

1. INTRODUCTION

1.1 Dissatisfaction with the current system

Ensuring effective spectrum management is becoming a key policy issue. Radiofrequency spectrum is vital for modern communications and demand for it has been growing fast both nationally and internationally and is likely to continue to grow significantly. Since most “prime” spectrum has been assigned, it is becoming increasingly difficult to find spectrum for expansion of existing uses or for innovative new businesses spawned by technological developments and market convergence.

Some of the main concerns over the traditional “command and control” approach in current spectrum allocation policies and management - in which key aspects of the allocation of spectrum usage rights are controlled, including exactly which frequencies can be used, for precisely what purpose, and with what technologies – are that the traditional approach:

1. Does not ensure spectrum is used efficiently (or even used) after licenses are issued.
2. Is too slow and inflexible.
3. Prohibits licensees from being able to change spectrum use to offer new services.
4. Limits innovative uses of new technology.
5. Is too restrictive on entry of new technologies, such as low-powered devices.

Not only is access to more spectrum required in many countries¹, there is a pressing need to flexibly reassign unused and underused spectrum to users who will use it most efficiently.² An aspect of spectrum reform receiving increasing attention is the introduction of secondary markets for spectrum. The use of market forces in spectrum management is expected to improve economic efficiency in spectrum markets. Governments, as the largest users of spectrum, could also benefit significantly from the efficiencies that would be released by spectrum liberalisation and trading in well-functioning markets. This paper focusses on the policy issues relating to the development of such well-functioning secondary markets for spectrum. Initiatives to improve the “command and control” approach are not a major focus of this paper.

1.2 Aim of the paper

The paper seeks to review and take stock of developments in secondary markets for spectrum. It draws together key elements from the academic literature, the various government reports and government commissioned reports, and the practical experience of the few countries that have already introduced secondary markets. In doing so, the aim is to identify the policy development agenda relating to the introduction and development of secondary markets for spectrum to facilitate spectrum trading and leasing. There is considerable focus in this paper on concerns and potential costs relating to the introduction of spectrum trading and liberalisation. This has a constructive aim – to draw attention to the need to address these concerns in order to facilitate the development of spectrum trading.

In pursuit of its aim, the paper discusses:

- The growing need for spectrum management policy reform at a time of rapid technological change and convergence.
- The increasing interest in spectrum trading.
- The debate between those in favour of a ‘spectrum commons’ approach and those in favour of ‘exclusive licensing’ of spectrum usage rights.
- The policies implications of technological developments such as spread spectrum, ultra-wideband (UWB), and agile radios.
- Concerns over spectrum trading and liberalisation (such as the potential for increased interference) and policies that can address these concerns.
- The critical role that regulators will play in the introduction, facilitation and regulation of secondary markets for spectrum.

1.3 Previous work

There has been considerable debate in the literature over the need for and appropriate approach to spectrum reform. On one side are the proponents of open spectrum ‘commons’ (*e.g.* Reed³, Benkler⁴, and Ikeda⁵) who contend that it would increase spectrum utilisation and stimulate innovation by facilitating entry of sophisticated devices based on new advanced technology. On the other hand, proponents of the ‘exclusive’ spectrum usage rights approach (*e.g.* White⁶, Hazlett⁷, Faulhaber and Farber⁸) predict ‘tragedy’ under an open commons regime, arguing that growth in demand will lead eventually to scarcity. In this view, the solution is greater use of market forces⁹ that would enable faster, flexible and efficient access and utilisation of spectrum. There are also those who insist on the advantage of the present ‘command-and-control’ approach, at least in some restricted public service areas.

These divergent views have contributed to uncertainty over the appropriate nature and direction of reform. The arguments put by supporters of the different approaches point to persuasive benefits of each system. The policy challenge is to determine a regime comprising the optimal mix of these approaches, drawing upon the benefits of each approach while minimising the costs.

Governments and international organisations have responded to concerns over spectrum management by conducting and commissioning a number of inquiries. What policy conclusions can be drawn from these documents in regard to spectrum trading and liberalisation?

In the United Kingdom, the report of the Cave Independent Review¹⁰ recommended moving towards increased use of market mechanisms and of spectrum trading and liberalisation in particular. Ofcom undertook a consultation on trading in November 2003 followed by a statement in August 2004 that spectrum trading would be introduced in the United Kingdom through a phased stage-by-stage approach.¹¹ The statement explained the steps Ofcom would take to facilitate the process and was followed weeks later (in September 2004) by Ofcom’s “Consultation on Spectrum Market Liberalisation”.¹²

In March 2002, the European Commission released its Radio Spectrum Decision relating to the development of a regulatory framework for radio spectrum.¹³ The Commission subsequently established a Radio Spectrum Policy Group to co-ordinate work on spectrum and, in May 2004, published a consultancy

report that recommended the Commission mandates the introduction of both spectrum trading and liberalisation across the EU.¹⁴

In February 2004, the ITU responding to growing interest convened a Workshop on “Radio Spectrum Management for a Converging World”¹⁵ which was aimed at drawing attention to the need for spectrum management reform.

In the United States, reports released by the FCC¹⁶ have strongly advocated greater use of market forces, including spectrum trading and leasing. In Japan, the Info-communications Council released in 2003 a report outlining a spectrum policy vision that includes a review of spectrum refarming¹⁷ and a compensation scheme aimed at fostering an environment that would facilitate the development of advanced wireless broadband.¹⁸ In Australia, a country that had introduced secondary markets for spectrum back in 1989, the Australian Productivity Commission concluded its report (in December 2002) in support of further development of the scheme.¹⁹ The Australian Communications Authority (the spectrum management authority) also reiterated its support for spectrum trading in June 2004.²⁰

This paper also draws on the lessons of experience with spectrum trading in the small number of countries that have already implemented it, including Australia, New Zealand, Guatemala, Canada and the United States. While conditions in these countries may be markedly different from those in other countries (such as percentage of population living in boundary areas, the degree of spectrum scarcity and national and political objectives), there is nevertheless useful information to be gleaned from these countries’ experience with secondary markets for spectrum.

It should be said at the outset that this paper does not assess the use of auctions as a means of allocating spectrum because this is a major topic that warrants a depth of attention that is outside the scope of this paper.²¹

1.4 Structure of this paper

Following this introduction, Section 2 discusses arguments in favour of the so-called ‘commons’ approach and of the ‘exclusive usage rights’ approach to spectrum allocation. This debate is closely relevant to spectrum trading which requires use of an exclusive usage rights approach (since this is the ‘property’ that can be traded). Moreover, spectrum trading can incorporate the flexibility needed to minimise the risk of inefficient under-utilisation inherent in an exclusive usage rights approach.

Section 3 considers the potential benefits of secondary markets for spectrum, especially in view of developments in new technology. But there are also concerns and potential costs over spectrum trading and liberalisation. The policy issues relating to addressing these concerns is the subject of Section 4. Section 5 discusses the regulatory policy issues relating to the introduction, facilitation and transition to spectrum trading.

2. THE APPROPRIATE BALANCE BETWEEN SPECTRUM MANAGEMENT APPROACHES

2.1 New technology and spectrum management reform

Technological advances are providing scope for more efficient use of spectrum and enable more efficient sharing of the use of the same spectrum. The use of spread spectrum technology is allowing more effective use of spectrum. Ultra-wide band (UWB) is able to transmit data at very high speeds by sending the transmission over a wide range of frequencies but at very low power levels allowing effective transmission through objects, including walls and the ground. One of the striking elements of UWB communications is the ability to communicate below the noise floor, often referred to as “underlay”. In

theory, this implies that UWB could operate in the same bands as licensed spectrum without causing any harmful interference.

“Agile radios” make use of periods of inactivity on a wide range of spectrum offering the prospect of recovering large amounts of unused and underused spectrum. An agile radio will broadcast on an unused frequency until it “senses” another radio trying to use the same frequency. The radio then “hops” frequency to another temporarily unused portion of the radio spectrum. Agile radios are said to promise vast increases in the amount of available bandwidth (some estimate ten times current levels) without requiring any new frequency allocations.

Interference management techniques are likely to evolve to accommodate and exploit emerging technologies that have the potential to reduce the impact of the interference environment. Low-density power technologies like spread spectrum and ultra wide band systems appear to hold considerable promise in allowing spectrum underlay to be exploited, while frequency agility technologies and smart antenna technology offer potential in mitigating interference concerns.²²

The development of advanced technologies such as ultra-wideband and agile radios can be impeded if changes to spectrum policy do not occur. There is need for urgent review of the types of changes necessary to encourage the development and use of such new technologies. There is increasing argument that rules limiting flexible use of frequencies should be removed and laws and procedures blocking access to unused or under-utilised bands eliminated. Furthermore, that by prohibiting only additional spectrum uses that cause “harmful interference,” and by permitting all other uses of the spectrum, current spectrum uses can be protected and new technologies allowed to develop and flourish. It is also worth mentioning that spectrum trading would not necessarily facilitate the proliferation of these types of non-interfering technologies, and that users of these technologies are not seeking to be granted spectrum use rights.

2.2 The debate over spectrum usage rights

While there is wide agreement that the present system of allocating spectrum usage rights leads to economic inefficiency, there appear to be sharply different views in regard to what should replace it.

The ‘command-and-control’ approach

Without rules governing access to spectrum, competing users would crowd into the most desirable parts of the spectrum, interfering with the reception of each other’s signals.²³ Thus spectrum use has to be planned and managed. Historically, this has involved a so-called ‘command and control’ approach with the Spectrum Management Authority (SMA) specifying in detail how spectrum is used, including:

- The application to which the spectrum is to be put, *e.g.* mobile, point-to-point terrestrial links and type of business.
- Use to be made of the spectrum.
- Technology to be employed.
- Transmitter power, location and antenna height.
- Frequency and bandwidth.
- Who may use the spectrum given that there may be eligibility restrictions.

The command-and-control approach places great responsibility on spectrum authorities to pick appropriate uses, technologies and users. But SMAs may sometimes be handicapped by relatively limited information about the potential uses and users of spectrum and the potential value they generate. As the variety of spectrum uses and associated technologies changes and spectrum demand expands, the difficulties compound. In particular, such a system might be slow to respond to technological innovation and change and technological and market convergence. This has led to mounting concern that the present system is not conducive to efficient spectrum allocation and assignment, especially in an era of rapid technological change. Some countries have begun initiatives to improve the “command and control” approach after weighing the pros and cons of options including secondary markets. For example, in Japan, there have been efforts to encourage frequency refarming so as to promote rapid innovation and the more flexible assignment of spectrum.²⁴ The results of these efforts should be carefully watched. But there is a widening view that the command-and-control approach is suitable only in special situations (e.g. to accomplish public interest objectives or to ensure conformance with international agreements) and that more fundamental and extensive change in spectrum management is required.²⁵

The ‘exclusive usage rights’ approach

Under an ‘exclusive usage rights’ approach a licensee is accorded exclusive rights to use specified spectrum within a defined geographic area, with usage rights governed primarily by technical rules to protect spectrum users against interference.

An exclusive usage rights approach usually has the following characteristics: *i*) the band for a service is divided into blocks with exclusive usage rights for a given area and block of frequencies; *ii*) the SMA determines the initial number of blocks and their assignment to users through titles of ownership or licenses; *iii*) the SMA specifies maximum acceptable interference levels and enforces these levels by a combination of technical specifications and spectral separation between the signals of different service providers. For a spectrum band of fixed size, the maximum acceptable interference level determines the maximum number of firms that can enter the market.

The ‘commons’ approach

By contrast, with the exclusive rights approach, a licence-exempt ‘commons’ approach allows access to spectrum by all users (open access spectrum) or to a group of users who hold the rights to that spectrum in common (spectrum commons). Users comply with established technical “etiquettes” or standards that set power limits and other criteria for operation of unlicensed devices in order to contain interference.

Supporters of the open commons approach argue that it is particularly well-suited to exploit the advantages of intelligent radios and open networks that can share spectrum and utilise unused spectrum. They point to the success of Wi-Fi (wireless fidelity) and WLAN (wireless local area networks) to argue that it allows greater technological innovation and spectral efficiency than an exclusive usage approach. Because no spectrum is exclusively held, spectrum commons users have the incentive to create spectrally efficient ‘frequency-hopping’ technologies, whereas licensed spectrum is typically unused when the license-holder is not transmitting. Furthermore, proponents of an open commons approach argue that spectrum scarcity might actually be reduced under such a regime because of the efficiency-enhancing possibilities and fundamentally different spectrum demands of new system architectures such as mesh networks.

But spectrum allocated to a commons risks the “the tragedy of the commons” – the inefficient overuse of scarce resources that are held in common.²⁶ The additional use of a scarce resource by any one member of a commons accrues benefits entirely to that party, whereas the (‘spillover’) costs of this use are borne by all participants.²⁷ If there are many owners of a commonly held resource, then there may be a real risk of a

tragedy of the commons. Some argue that demand is growing so quickly that in the longer run, the commons portion of the spectrum (including any non-interfering easement) will become highly congested, and many users will seek owned spectrum to ensure access and quality of service. In other words, in the longer run, as spectrum becomes scarce, exclusively owned spectrum becomes more attractive as a superior method of managing scarcity.

The market for exclusive spectrum usage rights also runs the risk of inefficient underuse – a “tragedy of the anti-commons” – due to two different factors. First, inflexible usage rights (which includes both who may use the spectrum and technical restrictions on how it may be used) impede the movement of spectrum to its highest valued use, resulting in bands of intensive spectrum activity surrounded by lightly used bands. Second, high transaction costs associated with many users employing advanced technologies, such as frequency-hopping devices, also may result in inefficient under use. Transaction costs in secondary markets for spectrum include search costs, the cost of due diligence, regulatory compliance, legal costs, brokerage, stamp duties, and other taxes. Trading would only take place when the benefits are expected to outweigh these transactions costs. Thus when transaction costs are high, trading is less likely to occur.

The costs associated with the tragedy of the anti-commons may be reduced by creating more flexible usage rights to spectrum such as would be achieved by an “expanded usage rights” approach that allows flexible usage rights to all spectrum licensees. Moreover, spectrum trading would also have the potential to mitigate inefficient under use.

The tragedy of the commons problem of inefficient under use arises where spectrum licensees grant a highly restricted bundle of usage rights with service rules that significantly limit the types of services that may be offered (as is common practice at present) resulting in higher valued services being precluded. Reliance on exclusive usage rights where licensees do not allow secondary use of their spectrum – a rational decision when transaction costs are high – restricts other productive uses that would not interfere with their rights as licensees. In addition, a highly restricted bundle of usage rights may involve service rules that significantly limit which entities may use the spectrum.

2.3 Seeking the right blend of spectrum management approaches

The structure and magnitude of transaction costs influence the ‘optimal mix’ of the two approaches. The commons model is particularly suitable in bands where scarcity is low and the transaction costs associated with market mechanisms are high. If transactions costs of a usage rights regime are high, the costs of the tragedy of the commons must be very high to justify using a market regime. If the costs of a usage rights regime are relatively low, it is likely to be more efficient than a commons regime. The exclusive usage rights approach is particularly appropriate in bands where scarcity is relatively high and the transaction costs associated with market-based negotiation of access rights are relatively low. Where spectrum is scarce but transaction costs are high, the exclusive use approach may still be most appropriate, since wherever scarcity exists, there will be competing claims to this resource, and the exclusive use model is most effective at balancing these claims.²⁸

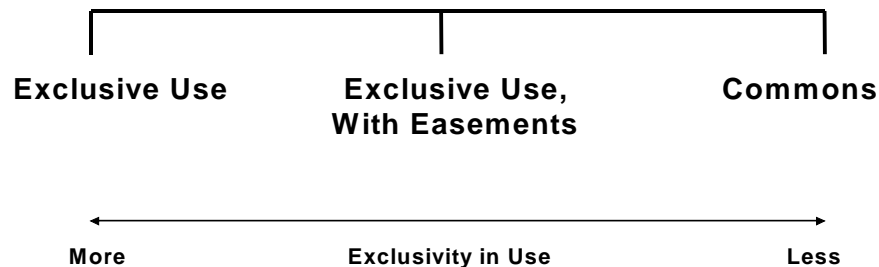
An intermediate point between exclusive use and commons, known as the “easement” approach, grants the licensee a restricted interest in the spectrum band and geographic area for which it holds a license. The licensee could have priority of use at all times. But when the licensee is not using the spectrum, a third party may use it. The third party that enters first has priority in use over other third parties. Upon entry of the licensee, the occupying party must evacuate. Faulhaber and Farber²⁹ and Leighton³⁰ have discussed this model and how it might be applied. Figure 2 illustrates the relationship between this easement model, exclusive use, and a spectrum commons.

Such an “expanded usage rights” approach³¹ grants rights to flexibility and transferability but can also rely on secondary markets (and other private mechanisms) to help move spectrum to its highest valued use. Secondary markets can help address the tragedy of the anti-commons problem (of inefficient under use) inherent in the exclusive usage rights approach. This is because a major reason for the problem of inefficient under use occurring is the failure of government to assign property rights such that the resource may be effectively used by those who value it the most. The crucial factor is to enable spectrum resources to shift from low-value uses to higher value uses. Arrangements or rights configurations that impede spectrum resources from doing this must be avoided.³²

One size does not fit all

Since there are different segments of the spectrum with different demand and technical characteristics, in spectrum policy, “one size does not fit all”. Spectrum policy can therefore vary in terms of the balance struck between the exclusive usage rights and the commons approaches. Granting flexible exclusive usage rights to spectrum users does not preclude imposing some regulatory limitations on use, analogous to zoning restrictions that are placed on property owners by local governments. Others argue that unlicensed spectrum can co-exist with licensed spectrum since some spectrum can be set aside for unlicensed use in the same manner that some land is set aside for public parks. (This includes the introduction of non-interfering unlicensed “underlays” in exclusive usage rights bands to provide additional efficiency benefits.)

Figure 2. Models of spectrum allocation



Source: Leighton, W. A., “Models for Spectrum Allocation: Which is Most Efficient and How Do We Achieve It?” Paper presented to the International Telecommunications Society, Berlin, Germany, 5-7 September 2004.

The FCC’s Spectrum Policy Task Force concluded that “one size does not fit all” in spectrum policy and recommended that the FCC move towards a balance of the three spectrum rights models: an exclusive use approach, a commons approach, and a command-and-control approach. The Group further recommended that the FCC fundamentally alter the existing balance among these models - which is dominated by command-and-control regulation - by expanding the use of both the exclusive use and commons models throughout the spectrum, and limiting the use of the command-and-control model to those instances where there are compelling public policy reasons.

The Spectrum Policy Task Force recommended that the FCC apply the exclusive use model to much of the spectrum, particularly in bands where scarcity is high and transaction costs are low. (These conditions primarily exist below 5 GHz, but may also occur in some higher frequency bands.) The Working Group also recommended that the FCC set aside additional spectrum for spectrum commons since such spectrum would facilitate certain types of innovation and the creation of new technologies and services. Like a national park, a spectrum commons would be open to all parties that abide by certain rules and/or etiquettes that are necessary in order to ensure efficient use of the spectrum and minimise interference. The Working Group recommended that, in addition to allocating more unlicensed spectrum, the FCC permit unlicensed devices that can operate within licensed bands without interfering with licensees (*e.g.* UWB) to do so, with certain conditions (*e.g.* limited to particular bands).³³

2.4 Incentive pricing

In addition to initial one-off assignment fees, owners of frequency usage rights to use frequencies in many countries pay recurring user fees. These fees can be based on administrative costs or the opportunity costs of spectrum usage. In the latter case, user fees are usually known as administrative incentive pricing. Administrative incentive pricing is important in a spectrum trading regime since, by imposing a cost on hoarding, they provide incentives to sell and lease under-utilised spectrum.

The opportunity cost of a particular block of spectrum is the cost of denying use of the spectrum to any other use or user. If the value of the spectrum to the incumbent use/user is less than the opportunity cost, then the distribution of spectrum can be said to be sub-optimal in the sense that more value would be created by reallocating the spectrum. If users are faced with the opportunity cost of spectrum, they will have incentives to increase/decrease their use if they value spectrum more/less than the opportunity cost.³⁴ In theory, current users would therefore be willing to transfer rights to use spectrum if the opportunity costs of using spectrum, reflected through administrative incentive pricing, are higher than the economic value to the user.

The administrative pricing mechanism based on opportunity costs is consistent with higher fees applying in areas where there is high demand (congestion), and lower fees in areas where there is less demand. In principle, fees set should mimic the operation of a market for spectrum bands since where fees do not reflect market values, this can lead to inefficient use of the spectrum. The notion of opportunity cost can play a crucial part in ensuring that resources are being used efficiently, however there are complexities in determining the appropriate opportunity costs and basing fees on these costs.

3. POTENTIAL BENEFITS OF SECONDARY MARKETS FOR SPECTRUM

3.1 Spectrum trading and liberalisation

Spectrum management reform can be designed to encourage more efficient spectrum allocation, assignment and use. Spectrum ‘allocation’ refers to the division of the spectrum into bands for particular services (such as fixed links, mobile communications and broadcasting). Once decisions on how to *allocate* spectrum in a particular band to specific uses are made, the next step is to determine how to *assign* usage rights for that spectrum to particular users. Spectrum ‘assignment’ is the authorisation given to an individual user to use a specific frequency or frequencies under specified conditions.

Spectrum trading and liberalisation may be characterised by mode, duration, extent and flexibility.

Mode refers to how, and whether, trade is organised to permit reconfiguration (meaning ability to partition or sub-divide licences and/or to aggregate licences) and change of use, as well as change of ownership. Several modes of trading can be identified, the principal ones being:

- Trading that comprises solely change of ownership of a licence.
- Reconfiguration, which may involve either partition or aggregation of spectrum assignments, as well as change of ownership.
- Change of use, which may be limited or extensive, as well as reconfiguration and change of ownership.

Duration relates to the length in time of a transaction. The economically efficient use of spectrum requires that arrangements be as flexible as possible to allow for variants such as short-term leases, long-term leases, sale and buy back, as well as outright sale for the remainder of the licence term.

Extent refers to the degree to which rights and obligations are transferred. These may be transferred as a whole with the licence or shared by the parties to the transaction.

Flexibility in the use of spectrum might take the form of:

- Change of technology (*e.g.* from GSM to 3G/UMTS).
- Change of market (which may have implications on the deployment of transmitters, in turn impacting on users of adjacent spectrum).
- Change of service type (*e.g.* between a mobile and fixed wireless service).
- Change in the applicable technical rules, which may prohibit certain new and efficient technologies from using the spectrum.

Spectrum reconfiguration

The ability to partition and aggregate spectrum to a user's needs can be an important element in achieving greater flexibility and efficiency in spectrum use. Users would be able to only purchase or retain what they require and respond to changing spectrum needs over time. Allowing spectrum partitioning would also provide incentives for licensees' to use spectrum more efficiently as they could partition and sell off unused spectrum. Also allowing spectrum aggregation could facilitate the introduction of wider networks that may be of greater value than independent and isolated systems. Also, giving users the ability to sub-divide spectrum, known as "dissagregation", is another important element in achieving flexibility and efficiency in spectrum use.

Changes in use

Allowing changes in spectrum use increases exposure of spectrum management to market forces. Lifting restrictions on usage to increase flexibility allows the full benefits of spectrum trading to materialise. In view of the unpredictable nature of spectrum demand and technological progress, the best approach would seem to be to devolve as many spectrum management decisions to market players (who are most likely to have the necessary information and agility to respond fastest to changes in consumer preferences).

The extent to which change of use is permitted can vary widely. For example, it could be very limited *e.g.* allowing a private mobile radio license originally issued for taxi use to be used by courier services, or it could be very flexible *e.g.* allowing mobile spectrum to be used for broadcasting. The degree of

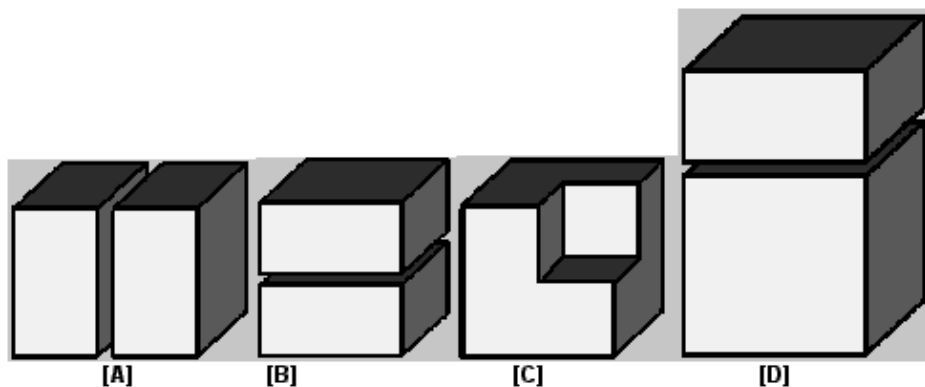
flexibility can also depend on the geographic isolation of the country, international obligations (such as the ITU Radio Regulations), spectrum harmonisation requirements and bilateral agreements.

Trading in spectrum licences

In countries where spectrum trading has been introduced, the trend is to provide greater flexibility in services and use of technologies. For example, in New Zealand no service or technology constraints are specified in spectrum licences. In New Zealand, spectrum sold originally for multipoint distribution service is being used flexibly as multipoint broadband wireless local loop. In Australia, “standard trading units” of spectrum have been designed to accommodate all likely uses. A licence is not limited to any particular technology, or system. However, there are limits on the services that can be provided with a spectrum licence. For example, spectrum licences cannot be used to provide broadcast services in Australia. Broadcast services are provided by a transmitter (apparatus) licence that is issued together with a broadcasting licence by the Australian Broadcasting Authority, through provisions of the Broadcasting Services Act 1992. Instead of authorising the use of a specific radiocommunications device at a fixed site, spectrum licences give licensees the freedom to deploy devices anywhere within their licence area, provided the devices are compatible with the core conditions of the licence and the technical framework for the bands.

Licensees are free to operate whatever type of communications service they choose, and are able to change that service in response to technical improvements or changes in consumer demand. Licensees can negotiate to buy and sell spectrum space as the need arises, or authorise third parties to use their spectrum space. Spectrum licences can be combined or sub-divided to form new licences.

A spectrum licence can be traded in whole or in part by geography (illustrated by **A** below), by bandwidth (see **B** below) or by both (see **C** below). Licences may also be leased in whole or in part to third parties. A licensee can extend the geographic coverage and/or bandwidth of their licence by acquiring an adjacent spectrum licence from another licensee (see **D** below).



Source: Australian Communications Authority at <http://www.aca.gov.au>

3.2 Secondary markets and spectrum efficiency

Several steps can be taken to improve the efficient access to and use of spectrum, including:

- i) Improving access through power, time, frequency, bandwidth, and space.
- ii) Permitting other users or uses to facilitate efficient utilisation.

- iii) Discouraging inefficient spectrum use (or encouraging efficient spectrum use).
- iv) Grouping technically-compatible systems by allowing sharing and leasing.
- v) Adjusting regulations as technology develops.
- vi) Revising technical rules for spectrum use.
- vii) Permitting more uses within a spectrum license.

Secondary markets already play an important allocative role in many sectors of the economy (for example in property, motor vehicles, computer equipment, industrial machinery, commodities and financial securities such as bonds, notes and shares). The key function of these markets is to re-allocate resources between different users and/or uses.

Secondary markets in spectrum will help to promote efficient allocation, assignment and use of spectrum.³⁵ They offer opportunities for licence holders to trade licences or lease spectrum when demand and supply conditions change. As a result of changes in technology, business strategy and/or market share, some licensees may hold spectrum they no longer need. They can on-sell or lease their surplus spectrum to users, including other licensees who desire access to that spectrum. Secondary markets also allow the emergence of intermediaries that may trade in spectrum or lease it to third parties.

It is noteworthy too that if a properly functioning secondary market for spectrum exists, there would be less riding on the outcome of auctions. Moreover, companies might be able to use their resources more efficiently if they were able to purchase spectrum closer to the time it is used (at which time their plans and needs would also be clearer). Instead without a secondary market facility, they are forced to acquire spectrum according to the country's allocation programme.

The main potential benefits of introducing spectrum trading include:

- More efficient use of spectrum.
- More flexibility in spectrum management, including removal of rigidities in primary assignment.
- Ability to evaluate spectrum licences, and gain knowledge of market value of spectrum.
- Facilitating market entry.
- Encouragement of innovation, enabling new technologies and market development.
- Speedier process, with better and faster decision-making by those with information.
- Increase in competition and reduced barriers to market entry.
- Reduction in administrative workload.
- Reassignment of spectrum from low economic value uses to high economic value uses.
- Allows efficient companies to expand and displace less efficient companies.

- Increasing opportunities for entrepreneurs to access spectrum to introduce innovative technologies and services.
- Reduction in the transactions costs of acquiring rights to use spectrum.
- Permitting more rapid redeployment and faster spectrum access for innovators and new players without the need for regulators to re-plan and re-farm spectrum.
- Allowing new technologies to gain access to spectrum more quickly.
- Opportunity (for existing operators) to sell unused or under-used spectrum and make more flexible use of spectrum.

Spectrum trading and liberalisation will benefit spectrum users of various types:

- Large users of spectrum, such as telecommunications companies, will benefit from a greater certainty over the term of their rights to use spectrum, the opportunity to improve returns from under-used spectrum resources, and the potential to access more spectrum for expanding technologies.
- Small users of spectrum, such as private business radio users, will benefit from the opportunity to profit from investing in new equipment and selling any spectrum that is released as a result, or to purchase more spectrum if they require it due to the expansion of their business.
- Firms will have more opportunity to compete for spectrum for new technologies or services with incumbents. Spectrum trading and opportunities to change the use of spectrum will also remove barriers to entry in markets where lack of access to spectrum previously restricted entry by new players.

Trading and liberalisation provide enhanced flexibility to all those involved in spectrum use, including incumbents, potential market entrants and equipment manufacturers. Specific examples where there are potential advantages resulting from the introduction of a secondary spectrum market, include enabling³⁶:

- Trading in underused spectrum to meet demand where and when it is needed by another operator in the same or another service.
- Parts of low-used defence or emergency service spectrum to be leased to commercial operators to permit time or geography-based sharing.
- Spectrum to be made available on a basis limited by time or geography for test and development.
- An operator to dispose of part of its spectrum holding following market consolidation.
- Trading to allow local niche Fixed Wireless Access (FWA) operators to emerge.
- New sources of spectrum to emerge to benefit newly emerging technologies and services.
- Leasing of spectrum for an event, *eg.* Olympic Games, that creates a short-term “spike” in demand.

The welfare benefits deriving from trading and/or liberalisation would arise through stimulating increases in efficiency via:

- Increases in the value of services derived from a given unit of spectrum as a result of existing users making better use of spectrum, or transferring it to someone else who can do so.
- Increased transparency raising awareness of the true value of spectrum and market entry opportunities, and reducing barriers to entry.
- New market entry stimulating competition in downstream markets.
- Innovation benefits owing to more rapid adoption of new services and technologies, and greater opportunity for innovation.

Universal access

Another notable benefit of spectrum trading is that it enhances the prospect of greater wireless deployment in underserved areas *e.g.* rural areas. For example, a carrier with a nationwide license can, without significant transactions costs, lease or sell spectrum to rural carriers to build networks in rural areas. Rural carriers thus have increased potential to obtain spectrum and build networks suited to their particular geography, while at the same time enabling the national carrier to seek its own partners to achieve its coverage strategies. Spectrum leasing and transfers – along with partitioning and disaggregation – can thus help to provide the flexibility needed for the development of additional and innovative services in rural areas. This is crucially important as wireless overtakes fixed line in both developed as well as developing countries because it is likely to be in wireless spectrum-based telecommunications that innovative means to deliver universal access and universal service are found.³⁷ However, there is concern that spectrum trading activity may remain low in rural areas where the scarcity of frequency is low, compared with demand.

Quantifying benefits and costs

There have been a number of attempts to quantify the benefits and costs of spectrum trading.

A consultancy report produced for the European Commission³⁸ estimates that the annual benefits to the European Union of introducing liberalisation and trading would amount to around EUR 9 billion whereas the benefits from trading alone would be just 10% of that amount. The study also estimates that the additional costs of liberalisation, for example in terms of additional interference co-ordination, would amount to less than EUR 100 million a year across the EU and so would be small relative to the potential benefits. The figures are likely to underestimate the value of the benefits. They were conservatively estimated and they do not take into account additional benefits from any changes of use that might result from existing licensees taking advantage of liberalisation to offer new services themselves without transfer of rights by trading.

The main source of the economic gains is substantiated by an increase in innovation efficiency and improvements in competitiveness. In this context, the consultancy study for the EU stresses the economic impact of introducing simultaneously - and from the beginning - both spectrum trading and a flexible approach to the change-of-use ("liberalisation"). The study also clearly demonstrates that the benefit of secondary trading would be significantly higher if it is introduced in all Members States of the EU rather than in a limited number of Member States. (Presumably the estimated benefits would be even larger if introduced globally.) These projections and assessments should be considered as approximations but have

been significant enough to encourage the Commission to undertake further work to consider the introduction of secondary trading.

In the United Kingdom, Ofcom estimated³⁹ that the benefits of introducing spectrum trading will substantially exceed costs with net economic benefits ranging from GBP 67 million to GBP 144 million if the impact of increased competition is taken into account. Even if the volume of spectrum trading is only half that assumed in these estimates, the basic conclusion is unchanged, that the benefits range from GBP 33 million to GBP 72 million if the impact of greater competition is taken into account.

A study for Ofcom by Analysys, DotEcon and Hogan & Hartson estimated that benefits due to the additional competition that would result from spectrum trading on its own would be roughly equal to the direct benefits of spectrum trading.⁴⁰ This would increase the Net Present Value of the benefits to the United Kingdom to GBP 154 million. The study concluded that there are powerful synergies between trading and liberalisation and estimated that benefits from both are over nine times the benefits from trading alone.

3.3 Spectrum trading in practice

Changes in spectrum ownership or licensee through secondary trading have been permitted in some bands in Australia, Canada, New Zealand and the United States as well as Guatemala in the non-OECD area.

The New Zealand government has favoured a progressive conversion of licences to a spectrum usage rights regime.⁴¹ Spectrum managers are free to decide whether or not to trade their rights and on what basis. There are no restrictions on the activities of operators, the number of entrants into the markets, or specialised licensing requirements. General competition law is relied upon to constrain anti-competitive conduct.

Box 1: Spectrum trading in New Zealand

New Zealand has shown that it is feasible to create tradable spectrum rights and to auction these rights despite the presence of incumbents in the bands. This was largely accomplished through a three-tier system of rights:

Management rights accord the exclusive right to the management of a nationwide band of frequencies for a period of up to 20 years. Within this band, the manager can issue licences. They are not constrained as to the uses for which licences are issued.

Licence rights are derived from spectrum licences that are issued by the management rights holder which allow licensees the right to use frequencies within their bands. Licences are use specific and defined in terms of transmitter sites. The management rights holder can issue licences to itself.

In blocks of spectrum where management rights have not been created, the legacy regime of non-tradable **apparatus licences** continues (In the past a concept of licensing specific apparatus was used rather than licensing the use of particular frequencies.)

The government favoured a progressive conversion of licences to a spectrum rights regime. As the initial owner of all management rights, the government used auctions to make primary assignments of tradable management rights. There were 91 management rights as at February 2004, with the New Zealand Government retaining ownership of 15 of these rights, predominantly over spectrum used to provide public services.

It is left to the ensuing management rights holders whether or not to trade their rights. There are no restrictions on the activities of the operators, the number of entrants into the markets or specialised licensing requirements.

Source: Ministry of Economic Development at <http://www.med.govt.nz/rsm/> and <http://spectrumonline.med.govt.nz/>.

In the United States, the FCC has allowed trading in licences in secondary markets subject to its approval. In fact existing rules in the United States already provide the flexibility for some licensees to make all or some unused portions of their spectrum available to others through transfer arrangements. For example, rules for Commercial Mobile Radio Services, *e.g.* cellular telephone service, PCS, and advanced paging systems, allow licensees to partially transfer, subject to regulatory approval: *i*) portions of their right to use frequency bands across their service area (disaggregation); *ii*) their rights to use frequency bands in portions of their service area (partitioning); or *iii*) portions of their right to use frequency bands in a portion of their service area (a combination of both disaggregation and partitioning). These provisions allow licensees to tailor their operations in accordance with the spectrum needs and service areas in their business plans as well as promote the availability of unused spectrum for use by others. In other instances, rules expressly allow leasing or resale arrangements in which a third party can use licensed spectrum without the licensee transferring rights outright. For example, rules allow the lease of spectrum between Multichannel-Multipoint Distribution Service (MMDS) and Instructional TV Fixed Service (ITFS) licensees, resale of satellite transponder capacity, and Private Land Mobile Radio Services (PLMRS) licensees may share the use of their facilities by permitting persons not licensed for the station to operate the station for their own purposes with the licensee's authorisation.

Spectrum leasing and sharing

Spectrum leasing or sharing typically involves a partial transfer of a licensee's rights to spectrum to another user/operator either for a limited period of time and/or for a portion of the spectrum encompassed in the licence. This includes, for example, the transfer of the right to transmit from one site under a multi-site licence for a temporary period. The flexibility afforded by such an arrangement is particularly suitable for situations where a lessee's requirements are minor or temporary. It also allows licensees to benefit by allowing them to receive returns on portions of their assignment for which they have no present need. This allows unused spectrum to be released into the market and creates a financial incentive for licensees to adopt more efficient ways of utilising their existing spectrum.

Allowing licensees to enter into leasing or some other form of spectrum sharing arrangement may introduce an economic incentive for public sector services to release some amount of spectrum for commercial use and to adopt practices and technologies that increase spectrum efficiency. The FCC, for example, has expanded the leasing regime in the United States to allow public-safety entities to lease out their spectrum to each other (although not to commercial users).

Public sector entities might be allowed to keep the proceeds of leasing and other forms of spectrum sharing in order to augment incentives to do so.

Box 2: Spectrum leasing in the United States

In May 2003, the Federal Communications Commission (FCC) adopted a “landmark” order on spectrum leasing that authorised most wireless radio licensees with exclusive rights to their assigned spectrum to enter into spectrum leasing arrangements.

Under the leasing rules adopted, licensees in certain services are allowed to lease some or all of their spectrum usage rights to third parties for any amount of spectrum and in any geographic area encompassed by the licence, and for any time within the term of the licence.

The order also creates two different mechanisms for spectrum leasing depending on the scope and responsibilities to be assumed by the lessee:

The first leasing option – “spectrum manager” leasing – enables parties to enter into spectrum leasing arrangements without obtaining prior FCC approval so long as the licensee retains both *de jure* control of the license and *de facto* control over the leased spectrum. The licensee must maintain an oversight role to ensure lessee compliance with the Communications Act and all spectrum related FCC rules. In enforcing the rules, the FCC will look primarily at the licensee on compliance issues but lessees are potentially accountable as well.

The second option – *de facto* transfer leasing – permits parties to enter into leasing arrangements, with prior approval of the FCC, whereby the licensee retains *de jure* control of the license while *de facto* control is transferred to the lessee for the term of the lease. Lessees are directly and primarily responsible for ensuring compliance with all FCC rules. For enforcement purposes the FCC will look primarily to the lessee for compliance, and lessees will be subject to enforcement action as appropriate. Licensees will be responsible for lessee compliance in so far as they have constructive knowledge of the lessee’s failure to comply or violation. The FCC released in September 2004 additional rules regarding secondary markets for spectrum. Building on the 2003 spectrum leasing policies, the FCC expanded the availability of spectrum leasing to more wireless services and devices, further streamlined the processing of spectrum lease applications and notifications, as well as traditional license transfers and assignments, and clarified certain aspects of the original spectrum leasing rules (including that leasing parties may enter into “dynamic” spectrum leasing arrangements whereby more than one entity could, using agile radio devices, share use of the same spectrum). The FCC also established a “private commons” option for licensees who wish to provide spectrum access to individuals or groups using advanced devices.

Source: Report and Order and Further Notice of Proposed Rulemaking (FCC 03-113), Federal Communications Commission.

In the EU, while secondary trading is permitted under EC legislation, the constraint imposed by this legislation is that trading may not result in the change of use in a band harmonised under either a specific directive or the EC’s Spectrum Decision.

4. POTENTIAL COSTS OF SPECTRUM TRADING AND LIBERALISATION

4.1 Concerns over spectrum trading and liberalisation

In view of the huge potential for improving the efficient usage of unused and under-used spectrum, the case for introducing spectrum trading and liberalisation seems compelling in principle. However, there are a number of concerns that need to be addressed by means of appropriate policy measures. This section examines these concerns and policies required to address them. Where concerns and uncertainty remain, it would seem sensible to move towards spectrum trading and liberalisation using a phased stage-by-stage approach implemented over a period of time, while also ensuring scope to amend/reverse the programme as experience proves necessary.

A number of the concerns relating to secondary markets for spectrum are common to all markets. Thus in addressing these concerns, regulators would be installing the preconditions of a properly functioning market for any good or service.

The main concerns or potential costs that could constitute barriers to successful development of secondary spectrum markets include.⁴²

- Low spectrum trading activity in practice.⁴³
- Inefficient use of spectrum.
- High transactions costs of spectrum trading.
- Risk of increased interference.
- Impact of spectrum trading on anti-competitive conduct.
- Impact on investment and innovation.
- Impact on international co-ordination/ harmonisation.
- Windfall gains.
- Disruptive effect on consumers.
- Reduced ability to achieve public interest objectives.

The following discussion focuses on policies for addressing these concerns in more detail. Actual policies countries have installed are referred to as a reference point rather than necessarily an endorsement of these policies.

4.2 Low spectrum trading activity

As with other scarce resource there are incentives for licensees to maintain their right to use spectrum because of: *i*) concerns they will need spectrum for future capacity; *ii*) speculation that future increases in value make it worthwhile to hold on for higher prices later; *iii*) a perception that disaggregation or partitioning would reduce the value of their spectrum usage rights; or *iv*) a desire to preclude competitors. Licensees may also believe that administrative requirements create transaction and opportunity costs that exceed the potential benefits from making all or part of their spectrum license available to others.

Trading activity in spectrum usage rights could be limited by a combination of factors that include: *i*) high transactions costs due *e.g.* to a lack of adequate systems and information for the conduct of effective trading and market operations; and *ii*) any regulatory requirements/approval and constraints that have to be satisfied. Improvements in these areas can be achieved to enable progress towards a more freely functioning system of secondary markets for spectrum usage rights.

As the economic theory of well-functioning markets indicates, elements that need to be present for a market system to operate most effectively include: *i*) clearly defined economic rights; *ii*) full information on prices and products available to all participants; *iii*) mechanisms for bringing buyers and sellers together to make transactions with a minimum of administrative cost and delay; *iv*) easy entry and exit to the market by both buyers and sellers; and *v*) effective competition, with many buyers and sellers.

A report prepared for the EU⁴⁴ suggested a number of reasons why spectrum trading may not be used extensively where trading is permitted, including:

- The secondary market has less impact when the primary assignment mechanism is already market-based (*i.e.* an auction).
- Purchasers of spectrum, being often operators intending to build out networks, have little intention to sell this spectrum on in the short term.⁴⁵
- Uncertainty regarding the timing of future primary allocations of spectrum, and thus uncertainty about the scarcity and value of spectrum available in secondary markets.
- Availability of information regarding both current legislation and current spectrum allocations, by frequency and geographical locations, is important for prospective buyers of spectrum. The lack of a publicly searchable register of management rights and licenses has been highlighted as a potential reason for lack of secondary trading. In addition, as existing holders have an informational advantage, lack of transparency can have an anti-competitive effect.
- Concern about the adequacy of competition safeguards, particularly for commercially valuable spectrum.
- The secondary market having no formal structure with trades evolving from bilateral negotiations resulting in scarce information regarding spectrum valuations.

Lower than expected spectrum trading activity in Australia

Table 1 provides a breakdown of spectrum licences traded by band. As can be seen, a total of 246 licences were traded during 1998-2004, with most of the licences traded in the strongly demanded (below 3.5 GHz) bands.

Table 1. Breakdown of spectrum licences traded by band

Band	No. licences
500 MHz	71
800 MHz	32
1.8 GHz	71
2 GHz	10
2.3 GHz	10
3.4 GHz	50
28 GHz	1
31 GHz	1
Total	246

Source: Australian Communications Authority. Available at <http://www.aca.gov.au>.

Nevertheless, the Australian Productivity Commission concluded in a report published in 2002 that secondary markets in spectrum in Australia were not well developed.⁴⁶ The Productivity Commission calculated that turnover rates for spectrum licenses was 7.7% in 2000-01 (see Table 2) rising to 8.4% in 2001-02 and 8.8% in 2002-03. However, in 2003-04, the number of licenses traded fell from 54 in 2002-03 (8.8%) to 22 (3.6%).

The level of trading in apparatus licenses has been somewhat lower at about 2-3% per annum. The low turnover rate in apparatus licenses may be in part due to the natural properties of the spectrum, such as its lack of portability, or to the nature of the licenses themselves. For example, they are usually technology or application specific.⁴⁷

Table 2. Trading in spectrum licences in Australia

Year	Licences traded a	Turnover rate b
	no.	%
1998-99	50	13.8
1999-2000	22	5.4
2000-01	47	7.7
2001-02 c	51	8.4
2002-03	54	8.8
2003-04	22	3.6

Notes: **a** Includes sub-divisions and amalgamations. **b** The turnover rate is measured as the number of licences traded relative to the licences on issue. **c** July 2001 to May 2002 inclusive.

Source: Australian Communications Authority.

Such turnover rates may not correlate closely with the amount or value of spectrum traded and therefore, may only serve as crude indicators of secondary trading. Moreover, whether the level of trading in spectrum licenses is considered high or low depends on the criterion used. For instance, the Australian Productivity Commission pointed out that trading in spectrum licenses is similar to annual turnover rates in the Australian residential property market. In any case, the Productivity Commission considered that spectrum trading in Australia could be encouraged by:

- Applying a statutory presumption of renewal to apparatus licenses (which should improve their tradability).
- Further deployment of spectrum licenses to add greater depth to secondary markets.
- Introduction of perpetual spectrum licenses (that would enhance secondary markets by giving licensees the flexibility to hold licenses long enough to make a return on their investments).
- Improvements to the public register and the publication of trading information which would also assist the functioning of secondary markets for spectrum.

Lower than anticipated spectrum trading also in New Zealand

In New Zealand too, overall spectrum trading activity has been lower than anticipated and a number of explanatory reasons have been offered for this:

- There was some confusion regarding old and new licences, as well as nervousness in the industry about the expiry date of the present licences.
- Uncertainty about the way spectrum will be treated for international planning purposes since the availability of equipment also often constrains spectrum utility.
- Concern about the adequacy of competition safeguards, particularly for commercially valuable spectrum.
- The secondary market has less impact when the primary assignment mechanism is already market-based (*i.e.* an auction was used).
- Primary spectrum assignments were already economically efficient.

- Purchasers of spectrum are operators intending to build out networks (thus with little intention to sell the spectrum).
- There have been few operators vying for spectrum in New Zealand; for instance, in the 3G spectrum auction, six blocks of spectrum were offered but only four bids received.
- Low spectrum scarcity (*e.g.* both New Zealand and Australia are sparsely populated).
- Uncertainty over future usage of spectrum in relation to future international plans.
- Confusion over licence conditions, *e.g.* expiry and transfer of licence rights.
- High transactions costs.
- Concerns that carving up the spectrum devalues the asset (and licensees may have a view to later sale).
- Licensees preserving their ability to serve the area in the future.
- Even if they are interested in trading, transaction costs are often too high.

Despite the level of spectrum trading activity being lower than expected, experience in countries that have introduced spectrum trading has demonstrated the viability of a spectrum trading regime. Low trade volumes do not necessarily mean that secondary markets are not working, and high trading volumes may suggest that spectrum was not efficiently assigned in the first instance (as in the case of the numerous cellular licences won at lottery in the United States that were almost uniformly sold to others in the private market). The US experience with spectrum leasing is also instructive – in implementing leasing rules, it was not anticipated that a flood of leasing applications would result, nor was it considered to be necessary to the success of the policy. Instead, leasing volumes have started slowly and are increasing gradually over time, suggesting that it is normal to expect the market to take some time to adapt to secondary market regulatory policies when they are newly implemented. Moreover, the attitude of the government, as well as operators in New Zealand and in Australia towards the spectrum trading regime remain positive. As the Australian Communications Authority (ACA) stated in a recent report⁴⁸ (June 2004) “Secondary markets could potentially play a much greater role in ensuring the efficient allocation and use of the spectrum...The ACA anticipates that secondary markets will play an increasingly significant role in allocating spectrum among different uses or users in Australia.” (p. 14).

The FCC (in the United States) and Ofcom (in the United Kingdom) have made recent decisions strongly in favour of the introduction of spectrum trading. There is wide expectation in these countries that, given time to evolve and mature, spectrum trading will emerge as a valuable means of increasing the efficiency of spectrum usage. In the United States, as of 25 February 2005, 185 spectrum lease filings had been submitted (167 for new leases, 7 for early termination of an existing lease, 7 for transfers of control, 3 for an assignment of a lease, and one for an extension of an existing lease). Table 3 provides additional details on the status of spectrum lease filings under the US secondary markets regime.

Table 3 US Spectrum Lease Filings

107 de facto transfer lease applications
- 73 long term leases
- 30 short term leases
- 4 withdrawn (2 long term and 2 short term)
78 spectrum manager lease notifications
- 51 long term leases
- 17 short term leases

Note: Most filings involve one or more of the following types of licences: Broadband PCS, Cellular, Specialised Mobile Radio, 39 GHz (microwave), of Broadband Radio Service.

4.3 Inefficient use of spectrum

There are concerns that spectrum trading could result in incumbents occupying small sections of the spectrum scattered throughout bands with high transactions costs preventing acquisition of continuous blocks of sufficient size to allow introduction of new applications. Greater inter-user separation may be needed in the form of “guard bands” between dissimilar applications. There may be a need to counter potential inefficient fragmentation through negotiation with licensees. It is possible that a regulator might have to give notice of termination of licences to facilitate re-planning of a spectrum band. The anticipation of such circumstances could result in investors limiting commitments resulting in less network infrastructure.

Having considered such concerns, Ofcom concluded that some reduction in efficiency could result.⁴⁹ However, such reduced technical efficiency would be more than offset by the increased economic efficiency of a secondary market that Ofcom believes is superior to ‘command-and-control’ regulation at delivering efficient use of a scarce resource.

Hazlett points out that the potential inefficiencies of spectrum fragmentation could be minimised in a regime of exclusive usage rights (flexible-use) spectrum because operators would have incentives to create substantial national networks, deploy advanced technologies, compete to drive down costs, and co-ordinate complex spectrum sharing arrangements.⁵⁰

4.4 High transactions costs

High transaction costs could hinder spectrum trading and serve as a barrier to entry. Accordingly, trading should be introduced in a way that minimises the transactions costs of trading, consistent with maintaining the integrity of the spectrum management regime.

Some transactions costs may be associated with a lack of information on spectrum available for sale. Other costs arise from negotiating a sale contract and regulatory review. For example, questions regarding regulatory rights and status, interference, technical parameters, indemnification, and contract terms may complicate and slow a transaction. Facilitating the establishment of brokerage agents and institutions such as spectrum exchanges can help in reducing transaction costs.

Policies to reduce market information costs are discussed further in Section 5 of this paper.

4.5 Risk of increased interference

Liberalisation carries a risk of increased harmful interference from other services within a country and from services in neighbouring countries (if innovation in a country is ahead of international spectrum planning). The risk of interference may be especially great in bands that are currently subject to a high degree of planning and co-ordination in making assignments, such as private business radio and terrestrial point-to-point fixed links.

In some countries where spectrum trading has been introduced, the regulator sets the initial limit for interference parameters (*e.g.* New Zealand, Australia and the United States) or they may be set by industry with oversight by the regulator. For example, in Australia, interference levels are set by the regulator at the geographic boundaries of each standard trading unit (STU) while in New Zealand, area and frequency parameters are defined on a case-by-case basis for initial licence assignments.

The monitoring of interference conditions in these countries is largely left up to users. Users are typically given the option of varying initial boundary conditions either through bilateral negotiations or through administrative appeal. For example, in Canada, initial boundary conditions are set conservatively to minimise the potential for interference but are open to negotiation.

If an agreement between the affected parties is not possible, some form of dispute resolution procedure typically applies. For example, in Australia, an independent conciliator may be appointed by the regulator if parties are unable to arrive at an agreement. In New Zealand a “management rights” owner would essentially assume the role of the regulator in setting boundary conditions for its “licensees” within the band for which it holds “management rights”. This approach seeks to reduce the interference management burden on the regulator.

In the United Kingdom, Ofcom concluded that appropriate action can be taken to mitigate the risks of increased interference resulting from spectrum trading and liberalisation.⁵¹ Ofcom’s proposed approaches to addressing these risks are summarised in Table 3 below. To guard against excessive increases in interference initially, licences will not be fundamentally altered to allow more flexibility of use but it will be open to individual users to apply to Ofcom for licence characteristics to be varied on a case-by-case basis.

Table 3. Ofcom's proposed approach to mitigating interference

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

Source: Ofcom, "A Consultation on Spectrum Liberalisation", September 2004. Available at www.ofcom.org.uk

4.6 Impact on international co-ordination / harmonisation

With globalisation and with people becoming increasingly mobile, it is increasingly important that services offered across borders (such as mobile telephony) can co-operate smoothly. Radio signals do not respect national boundaries and it is therefore necessary for a country to co-ordinate its usage of the radio spectrum with its immediate neighbours.⁵² In the case of some satellite and low frequency services, co-ordination with more distant countries may also be required. The national regulatory authority must often comply with international / regional regulation required for the cross-border movement of certain wireless services such as radio communications on ships and aircraft as well as global roaming on mobile phones. In addition, the harmonisation of spectrum usage across countries may assist international roaming by consumers, facilitate the roll-out of innovative services as operators have greater certainty about spectrum availability, and provide scope for economies of scale in equipment manufacture.

But as well as the benefits offered, international harmonisation requirements, both global and regional, also constrain changes in spectrum use. This can result in inefficiencies in the form of regulatory delay and can act as a barrier to the development of new and alternative services for that frequency. Bilateral agreements may constrain what can be done if neighbours do not wish to make similar changes. This constraint is likely to be more important for countries with multiple land borders and/or significant

proportions of their populations lying within co-ordination zones. There is therefore a trade-off between national flexibility in regard to spectrum management and the benefits of harmonisation.

Thus, although a flexible spectrum management regime may increase economic efficiency on a national level, this may threaten the benefits of co-ordination/harmonisation. Indeed, differing spectrum management regimes among countries could make international coordination more difficult.

There seem to be no simple answers. The policy challenge is to increase the flexibility of the spectrum management regime, while seeking to retain the main benefits of harmonisation and standardisation measures and to minimise costs.⁵³

Some co-ordination of spectrum trading could yield significant benefits

Some co-ordination of the development of trading frameworks to ensure that countries take similar generic approaches (but with the details of spectrum trading implementation devolved to individual countries) could be beneficial. For example, limited co-ordination measures might include:

- Setting parameters for what a country should not do in relation to a specific aspect of spectrum trading.
- Requiring that a country defines clear rules on a specific aspect of trading, but leaving countries free to develop these rules themselves; and
- Restricting SMAs from taking steps that would hinder particular developments in trading and liberalisation, but without prescribing specific action regarding these developments.

Common benefits that might be expected from such an approach include increases in the transparency of regulations and regulatory cost savings. Such co-ordination can take place relatively easily within existing regional and international frameworks.

4.7 Impact of spectrum trading on anti-competitive conduct

There are concerns that spectrum trading can increase the potential for anti-competitive conduct in the supply of services to end-users.⁵⁴ This might occur either through concentration in spectrum holdings currently used to supply a particular service (*e.g.* consolidation of two previously assigned usage rights) or through an incumbent precluding potential competitors providing new services by buying the spectrum necessary for such services. In this context, spectrum hoarding has been voiced as a key concern.

Competition safeguards are certainly an important aspect of a spectrum trading framework since the threat of spectrum consolidation and anti-competitive conduct could deter new entrants and, accordingly, competition. In countries where spectrum trading has already been implemented (*e.g.* Australia and New Zealand) general competition law is considered as adequate and is depended upon to constrain any anti-competitive conduct. In the United Kingdom, Ofcom has concluded that existing competition law is sufficient to deal with anti-competitive conduct and that further new controls are unnecessary.⁵⁵

However, if it does prove necessary, regulators can apply supplementary *ex ante* measures, such as a requirement for regulatory approval of spectrum trades. For example, in the United States, FCC approval is required before a licence transfer can be made. In the United Kingdom although approval is required, it will not include an *ex ante* competition check. Other safeguards include spectrum ownership caps that limit the maximum amount of spectrum a single entity is allowed to own. For instance, spectrum caps have been used in the United States, New Zealand and until September 2004 when they were abandoned in Canada.

4.8 Impact on investment and innovation

There are concerns that incentives to invest and innovate may be compromised by uncertainty over the impact of spectrum trading. In New Zealand, a review of spectrum trading found that there was confusion and uncertainty regarding the transitional rights of sitting tenants and the expiry of existing spectrum rights.⁵⁶ This had resulted in some nervousness in the industry and uncertainty about committing further investment detrimental to longer term forward-planning decisions. The New Zealand review concluded that these concerns could be resolved through careful design of the spectrum trading mechanism. For example, concerns over innovation could be reduced by clear specification of the rules and rights of spectrum trading. As spectrum trading becomes more common and familiar, it can be expected confidence in the mechanism will increase.

4.9 Windfall gains

There could be concern that the conversion of licences to tradable licences may result in incumbent licensees receiving capital gains, especially when the original licence was not obtained through an auction process. The case for levying a tax on net ('windfall') gains from spectrum trades should be assessed against the objective of encouraging efficient use of spectrum and in the context of a country's capital gains taxation provisions.

4.10 Disruptive effects on consumers

There are concerns that change of spectrum use resulting from spectrum trading may leave some consumers deprived of service and with redundant equipment. Also that change of assignment characteristics may be profitable for manufacturers but could require consumers to retune or replace equipment. These concerns can be appropriately addressed. For instance, Ofcom will require that licensees obtain its approval for change of use and will consider impacts on consumers in making decisions.⁵⁷

4.11 Reduced ability to achieve public interest objectives

In most countries, public services are allocated a significant portion of valuable spectrum. Important services such as defence, law enforcement, public safety, public service broadcasting and air traffic control rely on spectrum for much of their communications needs. Under the command-and-control spectrum management approach, spectrum bands are reserved for the delivery of such services by the government. There may be concerns about whether this reserved spectrum for public services will be lost under a system of spectrum trading and liberalisation.

Countries that have introduced spectrum trading have continued to reserve spectrum for public services and for global frequencies dedicated to aviation and maritime communications and navigation. For example, Australia does not subject satellite services to secondary trading (although it does apply incentive pricing) while the New Zealand government retains the rights over spectrum used for public service broadcasting. Nevertheless, a number of countries have exposed public services to economic incentives to promote efficient spectrum use. Some have argued that spectrum to support services for which governments require universal service provision should be deemed unsuitable for secondary trading. An alternative policy is for governments to pay market rates for the spectrum input that is required to achieve universal service goals.

Defence Ministries (DMs) manage a significant proportion of spectrum (in the United Kingdom nearly 30% of the spectrum below 60 GHz). They have an obligation to make the best possible use of this spectrum both for operational purposes and through making it available for civilian users where this can be done without compromising operational effectiveness. This would be encouraged if DMs bear the full

'opportunity cost' of spectrum. The UK military already pay market rates for spectrum they use on a comparable basis to commercial users.

The broadcasting sector too might be exposed to the full opportunity cost of spectrum use. Indeed, this is a very important issue since broadcasters take up considerable amounts of spectrum and as they move to digital TV, they may increase their usage of spectrum when simulcasting is required. To reinforce incentives for efficient spectrum usage, consideration might be given to allowing DMs and broadcasters to keep the proceeds of spectrum-related commercial activities (including spectrum leasing).⁵⁸

National security, public safety, health and other public interest objectives need not be compromised under a spectrum trading regime. They could continue to benefit from guaranteed access to radio spectrum. Protection of public safety services could be made a paramount consideration in a regulatory decision to grant approval to spectrum trading. But in principle, all spectrum users should be subject to full spectrum pricing as far as possible. This will provide an important incentive for spectrum to be used efficiently and economically and for spectrum no longer needed to be sold or leased to a higher valued use.

5. REGULATORY POLICY ISSUES RELATING TO SPECTRUM TRADING

Despite the compelling potential benefits, the secondary market for spectrum remains under-developed in countries that have introduced it. This section draws on various government documents and government commissioned reports and the experience in the countries that have introduced spectrum trading to identify a range of regulatory policy issues relating to spectrum trading.

5.1 Establishing a framework and preconditions for secondary markets for spectrum

There are a number of basic steps to establishing secondary markets for trading spectrum:

- Establish a framework for secondary markets.
- Define the tradable usage rights.
- Create the tradable usage rights and obligations.
- Permit various forms of trading of these rights.
- Establish rights to protection from interference and obligations not to create harmful interference in relation to liberalisation of use.
- Clarify rules on the expiry of usage rights and regulatory powers to reclaim them.
- Develop clear rules to ensure effective enforcement of rights and obligations.
- Establish and clarify enforcement mechanisms, whether regulatory or through private rights of action in courts.

Markets function best when property rights and liability rules are clearly defined. This requires spectrum licensees with clearly defined usage rights to their spectrum, including frequency bands, service areas, license terms of sufficient length and with reasonable renewal expectancy. Licenses and spectrum usage rights would be transferable for lease or sale, divisible, or available for aggregation. Licensees/users would have flexibility to determine services to be provided and the technology used for operation consistent with the other policies and rules governing the service.

Defining property rights

To reduce uncertainty and enhance spectrum trading there must be a clear definition of usage rights. The usage rights package could include technical features regarding time, area (including power limitations) and frequency. Overly restrictive conditions can act as a barrier to spectrum trading.

Usage rights should be defined to allow spectrum to be subsequently aggregated and disaggregated including geographical partitioning. As discussed earlier, incorporation of a non-interfering 'easement' is desirable (but would require a careful definition of what constitutes acceptable interference).

There needs to be legal clarity and security concerning the tenure of incumbent licensees, band by band, to provide some certainty for licensees to engage in trading. The term of a licence could span a rolling five to ten year period, or a perpetual licence with a compulsory re-purchase provision for the regulator. Usage rights could contain limits on emissions at the boundaries of licences in order to manage interference problems and to provide guidelines in case of disputes. The regulator would need adequate power to act as an arbitrator in case of disputes over interference problems and ability to enforce decisions.

Market information

Potential buyers and sellers of licences require a range of information for secondary markets to operate efficiently. This includes readily accessible information allowing prospective buyers and sellers to identify price levels and movements as well as demand and supply trends in the market. Buyers or sellers can obtain an indication of the current market value of licences thereby helping to formulate bids and offers. The prices of traded licences may also assist in determining what prices to charge for some new or converted licences in the primary market.

A relatively simple, cost-effective means for identifying licensees desiring to trade in spectrum usage rights or who might have unused spectrum rights that could be sold or leased to potential buyers could significantly facilitate the development of secondary markets.

A public register of spectrum licences could facilitate secondary trading by reducing search costs and transaction times. In Australia, New Zealand and Canada, there are publicly available on line databases of information on spectrum and apparatus licences. In the United States, the FCC has proposed that with the advent of spectrum leasing, the more detailed databases, containing spectrum licence information required, be managed by the private sector.

In the United Kingdom, Ofcom will publish information about licences, transfers, variations and monitor the market developments since access to a range of accurate and up-to-date information is a prerequisite for a successful market. Ofcom listed the major benefits of establishing a wireless telegraphy register, in conjunction with introducing a spectrum trading⁵⁹, as including:

- Transaction costs of spectrum trades are lower – since the relevant information on the rights and obligations of frequencies that can be traded is available.
- Potential users of spectrum are fully aware of the opportunities for trading.
- Gaps in spectrum usage are more transparent, facilitating access to spectrum for innovative users.
- Greater transparency engenders confidence in the trading process.

- Transmitter and receiver manufacturers can evaluate and monitor the size of their markets more accurately.

Forms of spectrum markets

The various forms that spectrum markets may take should be permitted to emerge, including:

- A direct search market where buyers and sellers seek each other out directly.
- A brokered market where brokers offer search services to buyers and sellers.
- A dealer market where dealers buy assets for their own stock.
- An auction market, where potential buyers are brought together to bid for an asset.

In addition, intermediary companies might offer online databases of market information and trading mechanisms to assist potential buyers and sellers. Some analysts in the United States argue that these intermediaries, which may have an expertise in the telecommunication market or in trading (such as trading of broadband capacity), might be able to identify potential needs of a market and provide more information than would exist in a spectrum register to potential buyers and sellers. This could help reduce transaction costs associated with spectrum trading. Future possibilities would also allow for the use of electronic trading for spectrum licences which could reduce transaction costs and increase efficiency, as well as ensure a better monitoring of trading activities.

5.2 Transition to a spectrum trading regime

Contrary to some of the bolder proposals for change that have been advanced (including a so-called 'big bang' approach⁶⁰), countries that have implemented spectrum trading have tended to adopt a progressive phased approach to its introduction. A step-by-step approach to trading gives regulators time to facilitate spectrum reorganisation and markets the opportunity to become familiar with the new regime. One proposal for a phased approach to the development of spectrum trading is set out below in Box 4.

Box 4. Phased approach to spectrum trading

Phase 1	Implement legislative framework supporting principle of spectrum trading Forecast future demands for spectrum and volume of spectrum trades for individual services
Phase 2	Review and implement trades on a case-by-case basis Key policy issues: windfall gains of existing licensees, anti-competitive behaviour
Phase 3	Establish trading systems for services where trading volumes suggest this would be warranted Key policy issue: switch of service or technology from original licence conditions
Phase 4	Division of spectrum into standard units (by frequency and geography) Key policy issue: minimisation of interference and frequency co-ordination
Phase 5	Make majority of commercial spectrum open to trading Key policy issue: repossession of harmonised spectrum in future

Source: Amit Nagpal, "One trade at a time: phased implementation of spectrum trading", Analysys, 2002. Available at <http://www.analysys.com>

To reap the full potential benefits of spectrum trading, the longer-term aim should be to remove usage restrictions. Some factors to be considered in determining whether a category of licence is suitable for trading, when this should occur and through what mode (change of ownership, change of use, etc.) include:

- Demand for re-allocation of spectrum in the particular band or class of licensees.
- Degree of scarcity for frequencies in the particular band.
- The estimated trading volumes in the future since the introduction of spectrum trading may not be worthwhile if low trading volumes are expected.
- Stability of the band, which can be influenced by either imminent changes in international spectrum allocation or the introduction of new technology in networks with uncertain market and technical factors; and
- International co-ordination requirements, and any arrangements for harmonised use that may constrain spectrum trading.

Phased approach in the United Kingdom

In the United Kingdom, Ofcom has decided upon a phased approach beginning in late 2004 and proceeding in subsequent years, as set out in Box 5. Such a phased approach offers a way to achieve early and substantial progress without excessive risk. Concerns about the risk of increased interference and that the complexity of defining emission rights and spectrum quality in a technology neutral manner while avoiding increases in interference make it prudent to adopt a phased approach. This will enable restrictions to be removed in a gradual, controlled manner and for experience to be gained before proceeding further.

Box 5. Ofcom's phased stage-by-stage approach

From late 2004	From 2005	2006	2007	Other
Analogue PAMR	Wide area PBR	Emergency services	2G and 3G mobile	Mobile satellite
National paging	On-site PBR		PMSE	Satellite shared with terrestrial services
Data networks	Digital PAMR		Aviation and maritime communication	Radio broadcasting
National and regional PBR	10 GHz FWA		Radionavigation (Radar)	Television broadcasting
Common Base Stations	32 GHz			
Fixed wireless access	40 GHz			
Scanning telemetry				
Fixed terrestrial links				

Source: Ofcom, "Implementing Spectrum Trading", London, September 2004. Available at <http://www.ofcom.org.uk>

Ofcom proposes to liberalise initially through individual licence variation. Licensees wishing to change their spectrum usage beyond the terms of their existing licences would need to apply to Ofcom for a licence variation, except in cases in which the risk of interference was judged to be sufficiently low. This will enable Ofcom to exercise control over each change of use. In the light of experience, Ofcom will consider reducing further the licence restrictions on services and technologies. Notably, Ofcom aims to move quickly towards making some licences more intrinsically flexible. In addition, some types of change of geographical and frequency boundaries do not involve significant risk of interference and will be allowed through spectrum trading as a partial transfer. This will be a more streamlined process than licence variation.

From 2005. Additional licence classes will become tradeable and restrictions on change of use will be liberalised in 2005 and in each of the subsequent three years. Throughout, Ofcom will also continue to auction released and returned spectrum.

After 2005. Licences will be made more intrinsically flexible and more technology neutral. Ofcom will also explore the scope for innovative use of other spectrum management tools, such as overlay licences.

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

A wider range of short term hiring arrangements than previously allowed will be permitted. This will provide spectrum access to users who may be unwilling to directly assume the rights and obligations of a spectrum licence.

3G

In a number of countries, 3G licence holders have been obliged to hand back their licences to regulators rather than allowed to resell them (as would presumably have been possible if a spectrum trading regime existed).

In January 2005, Ofcom issued a consultation document on extending spectrum liberalisation and trading to mobile services⁶¹ that considered in particular two sets of issues:

- The removal of restrictions from licences that presently prevent the use of spectrum for the provision of mobile services, including 3G services and mobile services other than 3G.
- The potential extension of spectrum trading and liberalisation to the bands currently licensed for 2G and 3G mobile services.

On the first of these issues, the consultation document proposes that Ofcom should in general (as soon as practicable) be willing to remove licence restrictions that prevent the use of spectrum for mobile services other than 3G services, where it is possible to do so under law and subject to interference constraints and international obligations. Other considerations may also be relevant in some cases, including the terms on which certain licences were auctioned.

Ofcom's consultation document also considers the removal of restrictions from licences that prevent the use of spectrum for 3G mobile services. It identifies a range of considerations that need to be taken into account, and a range of options for balancing these. It suggests that for licences other than the existing 2G licences, the option of allowing the removal of such restrictions after a transitional period has elapsed might offer an appropriate balance between the relevant considerations, and might maximise the interests of citizens and consumers. It suggests that a suitable transitional period might last to 2007. Restrictions on the provision of 3G services could only be removed where it is possible to do so under law and subject to interference constraints and international obligations.

On the second issue, the consultation document identifies several issues that make the extension of trading and liberalisation to the existing 2G bands more complex than is the case with most other bands, including the existence of European harmonisation measures affecting the use of the bands.

In view of these important complications, Ofcom considers that further work is needed before firm proposals can be made for liberalising the bands currently used for 2G services.

Recovery reservation

The usage rights regime could include a recovery reservation designed to allow the government to re-designate the frequencies *e.g.* through a buyback option. Recovery reservation provisions appear in fact to be common. For example, the Canadian government retains sovereign rights over the spectrum and can implement any reallocation required under international regulations (or to meet national security concerns).

5.3 Regulating spectrum trading

At least for some considerable time a spectrum trading scheme that is introduced will co-exist alongside other spectrum management approaches. In such a regime, the regulator's range of tasks include:

- Setting up the trading framework.
- Revising technical rules to define the rights and obligations of lessees with regard to interference and other technical issues; consider areas where waiver of technical requirements may be appropriate.
- Changing rules and processes to facilitate transferability of spectrum usage rights.
- Establishing clear and detailed rules for secondary trading, with clearly defined rights and obligations for all parties involved.
- Facilitating an incumbent's ability to lease or transfer portions of its capacity.
- Maintaining in a transparent and non-discriminatory manner, detailed online registries recording the rights and obligations associated with each trade, and the corresponding assignments.
- Establishing levels of acceptable/efficient interference and ensuring these levels are not exceeded.
- Addressing concerns over the rights of spectrum lessees with regard to occupancy, including length of the contract term (since this impacts on the ability to raise capital and invest in infrastructure).
- Controlling and evaluating proposals for change of use, with prior publication of requests for such changes, appropriate technical studies and industry consultation.
- Augmenting enforcement infrastructure to support the growth of secondary spectrum markets.
- Publishing available information on tradable spectrum and status of processes in order to maximise transparency of the process and certainty of market players.
- Guaranteeing and policing spectrum rights, investigating possible transgressions and managing disputes between users and where necessary, arbitrating binding decisions.
- Guaranteeing efficient and effective use of spectrum, in particular, preventing speculative hoarding, avoiding fragmentation of spectrum, re-assigning spectrum.
- Continuing spectrum harmonisation to satisfy international commitments.
- Ensuring observance of competition rules, detecting and preventing anti-competitive behaviour and controlling concentrations of market power.
- Minimising the transaction costs and time associated with completing agreements for transfer or lease of spectrum usage rights.
- Evaluating ways to minimise administrative overhead and processing time as part of an effort to identify and implement more efficient processing techniques and procedures.
- Harmonising operating rules for similar services to promote spectrum fungibility (substitutability).
- Modifying service definitions, where appropriate, to increase flexibility and allow multiple services to operate in the same spectrum.
- Enhancing the capability of enforcement staff to deal with accidental or deliberate interference in a timely and effective way.
- Promoting the development and availability of frequency and technically agile equipment such as software-defined radios and multi-band transmitters and receivers wherever possible.
- Eliminating barriers to the development of secondary markets for spectrum.
- Eliminating unnecessary regulations and administrative requirements.

APPENDIX 1

BOX A1. EXAMPLES OF POSSIBLE MEASURES FOR ADDRESSING CONCERNS OVER SPECTRUM TRADING

Area of concern	Example of concern	Addressing concern
Lack of trading activity	<p>Inertia: owners are unwilling to migrate, thus preventing the benefits of spectrum reallocation</p> <p>Limited initial pool of tradable spectrum: the amount of tradable spectrum may be too limited to give sufficient liquidity to the market</p> <p>Limited liquidity: ‘thin’ market results with limited opportunities to trade, preventing incoming users easily acquiring spectrum, including in the market for short-term access to spectrum</p> <p>Intermediaries may not emerge: this inhibits trading and prevents flow of information to the market</p>	<ul style="list-style-type: none"> - Provide further incentive to trade under-used spectrum through incentive pricing that reflects opportunity costs - Seek to introduce tradability as quickly, and in as many licence classes, as possible - Make as large a pool of spectrum available as possible to aid liquidity and publish information to facilitate trading in a register to create a favourable environment for trading - Limits on trade, such as restrictions on change of use should be limited to those essential for engineering, harmonisation or policy reasons - Encourage the emergence of trading through public provision of sufficient data to enable trading activity
Anti-competitive action	<p>Anti-competitive hoarding: players occupy spectrum in order to block entry by competitors into their markets</p> <p>Excessive pricing: where holders of usage rights are effectively monopolists in particular spectrum bands, they may seek to extract monopoly pricing from spectrum users. This risk is particularly strong for bands with non-frequency agile equipment, preventing users migrating to other bands and other suppliers of spectrum</p>	<ul style="list-style-type: none"> - Address anti-competitive action through timely and rigorous application of competition and merger rules - Assess trades preventing those that effect a substantial lessening of competition

Area of concern	Example of concern	Addressing concern
Ineffective use of spectrum	<p>Fragmentation: trading results in incumbents occupying small sections of the spectrum scattered throughout bands. High transaction costs prevent acquisition of continuous blocks of sufficient size to introduce new application</p> <p>Definition of spectrum access rights: there may be a need for greater inter-user separation in the form of guard bands than currently, resulting in reduced spectral efficiency</p> <p>Single user blocking access: a user of a small proportion of a particular band may attempt to 'hold out' when an incoming user buys a whole block of spectrum. The small user may attempt to extract the majority of the economic rent available to the incoming user</p>	<ul style="list-style-type: none"> - The market is best placed to deliver efficient use of a scarce resource, rather than regulatory alternative - Counter potential inefficient fragmentation through negotiation with licensees, and ultimately give notice of termination of licences to facilitate re-planning of a spectrum band - Some reduction in efficiency may result from licence re-definition. However, such reduced technical efficiency will be more than offset by the increased economic efficiency resulting from the action of a secondary market.
Increased interference	<p>Reduced flexibility on interference issues: licensees may be less flexible in adjusting their own usage to avoid interference</p> <p>Increase in number and complexity of interference complaints</p> <p>Changes in the definition of emissions rights do not accurately reflect rights currently held, or customary use by users, resulting in interference disputes over current transmission levels</p>	<ul style="list-style-type: none"> - Install a robust dispute resolution procedure, including scope for bilateral negotiations to resolve interference disputes and adjudication by regulator where mutually agreed solutions cannot be found. - Proposed changes of use or re-configuration can be made subject to prior approval, and refused if considered that they may result in undue interference to other spectrum users

Area of concern	Example of concern	Addressing concern
Reduced innovation	Reluctance to accommodate testing and development: with a more 'ownership-oriented' model for spectrum use, incumbents may not be as accommodating to non-commercial use of spectrum for test and development. Innovation and spectral efficiency may be reduced as individuals may lack the financial wherewithal to compete on the secondary market.	- In general trading will encourage innovation, development and investment in new technologies through reducing barriers to acquisition of spectrum for new users
Risk to safety of life services	Difficulty of acquisition for safety of life applications: public bodies may only be able to acquire any additional spectrum requirements by purchasing through the market, which may be prohibitively expensive. Increased interference potential interruption of safety of life services by undue incoming interference from other users	- Protection for safety of life services can be paramount in considering interference disputes and prior approval for changes of use and reconfiguration. - Public sector users will be exposed to the economic value of the spectrum in the same way as private sector organisations - If it was considered that the overall economic and social benefits from the potential use exceeded the cost of the spectrum, then the necessary public sector funds would need to be sourced to meet this spectrum need
Implementation risks	Licence amendments: the need to complete the necessary licence amendments before licences become tradeable may delay the introduction of trading in certain classes	- The timetable for the introduction of trading should be feasible and desirable to deliver maximum possible economic benefit as soon as possible. - However, need to monitor progress and expenditure in order to counteract implementation risk, through speedy resolution of unforeseen problems and effective specification requirements

Area of concern	Example of concern	Addressing concern
Disruption to consumers	Costs to customers: Where licensees decide that a service is unprofitable and sell their licences, consumers may be left with redundant radio equipment Reconfiguration of licences may be profitable for suppliers of certain services but may require consumers of those services to retune their reception equipment, or even buy new equipment	- Regulator's approval will be required before any proposed change of use is approved. Where necessary, licensees be required to consult with end users before approval is granted.

Source: Adapted from Ofcom, *Spectrum Trading Consultation*, 2003. Available at <http://www.ofcom.org.uk>

NOTES

- 1 In some countries, such as Finland, spectrum scarcity is not seen to be a problem, at least not yet.
- 2 For an analysis of the need for spectrum management reform see “Report of the US Spectrum Policy Task Force – Findings and Recommendations”, December 2002. Available at <http://www.fcc.gov/sptf>
- 3 Reed, David, 2002, “Comments for FCC Spectrum Task Force on Spectrum Policy,” filed July 10 at http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=
- 3 Yochai Benkler, *Some Economics of Wireless Communications* 78, *Harvard Journal of Law & Technology* [Vol. 16 No. 1 Fall 2002].
- 5 Ikeda, Nobuo, 2002, “The Spectrum as Commons: Digital Wireless Technologies and the Radio Policy,” RIETI Discussion Paper Series 02-E-002 (March).
- 6 White, L. J. “Propertizing the Electromagnetic Spectrum: Why It’s Important and How to Begin,” in J.A. Eisenach and R.J. May, eds., *Communications Deregulation and FCC Reform: What Comes Next?* The Progress & Freedom Foundation 2001.
- 7 Hazlett, Thomas, 2001, “The Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auction Faux Pas, and the Punchline to Ronald Coase's "Big Joke": An Essay on Airwave Allocation Policy,” *Harvard J. Law & Tech*, 14(2), Spring, 335-545. Also Hazlett, T “Spectrum Tragedies”, *Yale Journal on Regulation*, (forthcoming) Spring 2005.
- 8 Faulhaber, G and Farber (2002), D, “Spectrum Management: property rights, markets and the commons,” Paper presented at the 14th Biennial Conference of the International Telecommunications Society, August 18-21, 2002Seoul, Korea.
- 9 FCC WT Docket No. 00-230, “Comments of 37 Concerned Economists” in response to FCC 00-402, “In the matter of Promoting Efficient Use of Spectrum Through Elimination of Barriers to Secondary Markets,” (February 7, 2001).
- 10 Cave, M, Review of Radio Spectrum Management, An independent review for Department of Trade and Industry and HM Treasury (2002).
- 11 http://www.ofcom.org.uk/consultations/past/spec_trad/statement
- 12 UK Office of Communications (Ofcom), “Statement on Spectrum Market Liberalisation”. London, September, 2004.
- 13 Decision No 676/2002/EC of 7 March 2002.
- 14 Analysys, DotEcon and Hogan & Hartson, “Study on conditions and options in introducing secondary trading of radio spectrum in the European Community”, May 2004. Available electronically at <http://www.ofcom.org.uk>
- 15 ITU Working Party 1b-3, “Improving the International Spectrum Regulatory Framework”, November 2003. ITU Workshop on “Radio Spectrum Management for a Converging World”, Geneva, Switzerland, February 2004.

¹⁶ Federal Communications Commission, In the Matter of Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, Report and Order and Further Notice of Proposed Rulemaking, 18 FCC Rcd 20604 (released October 6, 2003); FCC, In the Matter of Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, Second Report and Order, Order on Reconsideration, and Second Further Notice of Proposed Rulemaking, 19 FCC Rcd 17503 (released September 2, 2004). Final Report of the Spectrum Policy Task Force (SPTF); [Http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf). See also Department of Commerce, Spectrum Policy for the 21st Century – The President’s Spectrum Policy Initiative: Report 1, Recommendations of the Federal Government Spectrum Task Force (June 2004); Department of Commerce, Spectrum Policy for the 21st Century – The President’s Spectrum Policy Initiative: Report 2, Recommendations From State and Local Government and Private Sector Responders (June 2004) Presidential Report that contains recommendations for developing a U.S. spectrum policy highlighting the need for economic incentives to promote spectrum efficiency. These are available at http://www.ntia.doc.gov/reports/specpolini/pressspecpolini_report1_06242004.pdf; http://www.ntia.doc.gov/reports/specpolini/pressspecpolini_report2_06242004.htm

Report 1, which presented the recommendations of the Federal government spectrum Task Force, called on NTIA and the federal agencies to identify and implement economic incentives that promote more efficient and effective use of the spectrum. Report two also called for incentives and recommended specifically that the FCC expand the application of secondary markets across services.

¹⁷ Spectrum refarming is a process of redeploying spectrum from existing users and reallocating it to others.

¹⁸ Japan Info-communications Council, “Chutyoki ni okeru Denpariyō no Tenbo to Gyosei ga Hatasubeki Yakuwari: Denpa Seisaku Vision [Spectrum Policy Vision]. Tokyo: Ministry of Public Management, Home Affairs, Posts and Telecommunication, 2003.

¹⁹ Australian Productivity Commission, “Report of the Public Inquiry into Radiocommunications Acts and of the Market Based Reforms and Activities undertaken by the Australian Communications Authority”, December 2002. Available at <http://www.pc.gov.au/inquiry/radiocomms/finalreport/radiocomms/pdf>

²⁰ Australian Communications Authority, “From DC to Daylight – Accounting for Use of the Spectrum in Australia”, Melbourne, September 2004.

²¹ See, OECD (2002), *Spectrum Allocation: Auctions and Comparative Selection Procedures*, Paris, 2002. In this regard, the assessment of the use of auctions by the Australian Communications Authority may be of interest: “The ACA plans to continue its policy of using auctions where appropriate to allocate spectrum. Auctions have proved to be quick, fair and transparent in the way that allocations are decided. Underpinned by a technology approach to licensing, they have also proved to be successful in facilitating the introduction of new services, greater competition and greater choice for consumers. Auctions are also effective in revealing market valuations of spectrum. Where auctions are inappropriate, the ACA expects to make greater use of market information derived from auctions within the administrative pricing model.” Australian Communications Authority, “From DC to Daylight – Accounting for Use of the Spectrum in Australia”, Melbourne, September 2004, p. 14.

²² For a more detailed discussion see Taylor Reynolds, “Background Paper: advanced wireless technologies and spectrum management” ITU, Workshop on Radio Spectrum Management for a Converging World, 16-18 February 2004.

²³ In the terminology of economic theory, interference is an example of a ‘negative spillover’, where the actions of one user impinge on the interests of others without compensation being paid to ‘internalise’ the externality.

- 24 Specifically, in Japan this initiative has included surveys on actual radio spectrum usage, the evaluation of the efficiency of usage through public consultation procedures, and the modification of the frequency allotment plan, with, where necessary, a compensation system applied to withdrawing radio systems.
- 25 See for instance, Robert M. Entman, “Challenging the Theology of Spectrum – Policy Reformation Ahead”, A Report from the Aspen Institute Roundtable on Spectrum Policy, The Aspen Institute, Washington DC, November 2004. The basic assumptions challenged at the Aspen Institute meeting and found wanting included, for instance: “conceptualizing spectrum as ‘frequencies’ whereas others now see it as a collection of codes; that spectrum is scarce, whereas if one looked at the resource differently, and if new technologies progress, that may be a relic of the past; that all interference is harmful, whereas it might be better to think in terms of interference temperatures, and see that some levels are tolerable; and that regulation of transmission is the way to address spectrum instead of placing emphasis, as new approaches do, on the receiving technology.” (p.vi) Also see: Final Report of the Spectrum Policy Task Force (SPTF); http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf.
- 26 Heller, M, “The Tragedy of the Anticommons: Property in the Transition from Marx to Markets,” *Harvard Law Review*, Vol. 111, pp. 621-88, 1998.
- 27 Hazlett, T, “Spectrum Tragedies”, *Yale Journal on Regulation*, (forthcoming) Spring 2005.
- 28 See Final Report of the Spectrum Policy Task Force (SPTF); http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf.
- 29 Faulhaber, G, and Farber, D, “In the Matter of Issues Related to the Commission’s Spectrum Policies,” E.T. Docket No. 02-135, Comments of Professors Gerald R. Faulhaber and David J. Farber, July 18, 2002.
- 30 Leighton, W. A., “Models for Spectrum Allocation: Which is Most Efficient, and How Do We Achieve It?” Presentation to the International Telecommunications Society Berlin, Germany, September 5-7, 2004.
- 31 For a detailed discussion of this approach see Leighton, W. A., “Models for Spectrum Allocation: Which is Most Efficient, and How Do We Achieve It?” Presentation to the International Telecommunications Society Berlin, Germany, September 5-7, 2004.
- 32 Leighton, W. A., *op cit*.
- 33 See also the Report of the Rights and Responsibilities Working Group <http://www.fcc.gov/sptf/files/SRRWGFinalReport.pdf>.
- 34 For a detailed discussion see UK Office of Communications, “Spectrum Pricing – A consultation on proposals for setting wireless telegraphy act licence fees,” London, 29 September 2004. Available at <http://www.ofcom.org.uk>
- 35 Valletti put the case for reform in favour of spectrum trading and liberalisation succinctly arguing that “...the ‘old’ model of spectrum management, that makes a drastic distinction between spectrum allocation and spectrum assignment, is highly inefficient. It does not make much sense from an economic point of view to first allocate – centrally – spectrum for a certain use, and then find some mechanism – perhaps market-based – to assign it. Individuals or companies that have a need for spectrum are different economic agents with different willingness-to-pay. This abstract picture can encompass 3G operators with alternative business plans, or a broadcaster that uses the spectrum to provide digital TV. Since the point about a market system is to create an environment in which scarce resources end up in the ownership of the agents that value them most highly, it is important that we introduce the price mechanism in the market for spectrum in the most flexible way. This can be achieved by replacing the old system of spectrum management with one based on *spectrum trading*.” Valletti, T. M, “Spectrum Trading” *Telecommunications Policy*, 25 (2001) pp. 655-670.

36 Analysys, DotEcon and Hogan & Hartson, *op cit.*,

37 See for instance, Oestmann. S, “Mobile Operators: their Contribution to Universal Service and Public
Access”, Intelcon Research & Consultancy, January 2003.

38 Analysys, DotEcon and Hogan & Hartson, *op cit.*,

39 UK Office of Communications, “Notice of Ofcom’s proposals to make regulations: Spectrum Trading and
the Wireless Telegraphy Register”, 29 September 2004. Available at
http://www.ofcom.org.uk/consultations/current/spt_wtr/

40 UK Office of Communications, *op cit.*

41 “Study into the use of Spectrum Pricing: The Case of New Zealand”, NERA and Smith System
Engineering, at www.ofcom.org.uk/static/archive/ra/topics/spectrum-price/documents/smith/smith8.doc

42 *Implementing Spectrum Trading*, published July 2002 by the Radiocommunications Agency and available
electronically at www.radio.gov.uk.

43 In and of itself, low spectrum activity is not a barrier, though it may be a result of other barriers existing.

44 Analysys, DotEcon and Hogan & Hartson, *op cit.*

45 The availability of spectrum leasing is one way to address this problem, because it provides a vehicle for
licensees to make spectrum available in the short term without giving up their licensee rights permanently.

46 Australian Productivity Commission, *op cit.*

47 Australian Communications Authority, *op cit.*, p. 14.

48 Australian Communications Authority, *op cit.*,

49 Ofcom, “Statement on Spectrum Liberalisation”, London, September 2004. Available at
www.ofcom.org.uk

50 Hazlett, T “Spectrum Tragedies”, Yale Journal on Regulation, (forthcoming) Spring 2005

51 UK Office of Communications, *op cit.*

52 For a detailed discussion of international constraints on national spectrum management in the context of
the United Kingdom, see AEGIS Spectrum Engineering, “Implications of International Regulation and
Technical Considerations on market mechanisms in Spectrum Management”, 2001. Available at
<http://www.aegis-systems.co.uk/download/spreview.pdf>.

53 The ability of smart radios to change frequencies and transmission modes, depending on the country in
which the radio is used, provides an example of how some of the problems faced in international
harmonisation and standardisation can be mitigated.

54 Valletti argues that spectrum trading could make it more difficult for an incumbent to exclude rivals from
supplying a competing service since the incumbent would have to hoard much more spectrum in order to
exclude rivals from all bands that could potentially be used to provide a substitute service. Valletti, T. M,
“Spectrum Trading” *Telecommunications Policy*, 25 (2001) pp. 655-670.

- 55 UK Office of Communications (Ofcom), “Statement on Spectrum Market Liberalisation”. London, September, 2004.
- 56 “Final report: allocation and acquisition of radio spectrum” Report prepared for the New Zealand Ministry of Economic Development on competition safeguards in relation to initial allocation of and secondary markets for radiofrequency spectrum in New Zealand, prepared by market dynamics Pty Ltd and Moore Wright Associates Pty Ltd, April 2003.
- 57 Ofcom, “A Consultation on Spectrum Liberalisation”, September 2004. Available at www.ofcom.org.uk
- 58 Broadcasting spectrum cannot be traded on the secondary market in Australia.
- 59 UK Office of Communications (Ofcom), *op cit*.
- 60 For a discussion of the “Big Bang” approach, see Kwerel, Evan, and John Williams, “A Proposal for a Rapid Transition to Market Allocation of Spectrum,” OPP Working Paper No. 38, Federal Communications Commission, 2002.
- 61 Ofcom (UK Office of Communications), “Spectrum Framework Review: Implementation Plan,” Consultation Document, issued on 13 January 2005.