wik-Consult • Study

Study for the Federal Network Agency

Towards More Flexible Spectrum Regulation

Authors:

J. Scott Marcus (WIK-C)
Dr. Lorenz Nett (WIK-C)
Mark Scanlan (WIK-C)
Dr. Ulrich Stumpf (WIK-C)

Prof. Dr. Martin Cave (University of Warwick)
Prof. Dr. Gerard Pogorel (ENST Paris)

Bad Honnef, December 2005

wik CONSULT

Contents

Tables

Figures

Abbreviations

2G	2. Generation
3G	3. Generation
4G	4. Generation
ABA	Australian Broadcasting Authority
ACA	Australian Communications Authority
ACA Act	Australian Communications Authority Act
ACCC	Australian Competition and Consumer Commission
ACMA	Australian Communications and Media Authority
AIP	Administrative Incentive Pricing
AM	Amplitude Modulation
ATA	Australian Telecommunications Authority
AUD	Australian Dollar
AWS	Advanced Wireless Service
BRS	Broadband Radio Service
BTCE	Bureau of Transport and Communications Economics
BWA	Broadband Wireless Access
CB	Citizen Band
CBS	Cell Broadcast Service
CEPT	Conférence Européenne des Administrations des Postes et Télécommunications
CENAC	Centro de Arbitraje y Conciliación
CRTC	Canadian Radio-television and Telecommunications Commission
dBM	decibel mW
dBW	decibel W

DCS	Digital Cellular System
DCITA	Department of Communications, Information and the Arts
DECT	Digital Enhanced Cordless Telecommunications
DFS	Dynamic Frequency Selection
DRCS	Digital Radio Concentrator Systems
DSI	Detailed Spectrum Investigations
DTV	Digital Television
EBS	Educational Broadband Service
EC	European Commission
ECC	European Communications Committee
EHF	Extremely High Frequency
EIRP	Equivalent Isotropically Radiated Power
E-mail	Electronic Mail
ERC	European Radiocommunications Committee
ERMES	European Radio Message System
ESMR	Enhanced Specialized Mobile Radio
ETSI	European Telecommunications Standards Institute
EU	European Union
FAC	Frequency Assignment Certificate
FCC	Federal Communications Commission
FCFS	First-Come, First-Served
FDD	Frequency Division Duplex
FM	Frequency Modulation
FreqBZP	Frequenzbereichszuweisungsplan (Frequency Allocation Plan)

FreqNP	Frequenznutzungsplan (Frequency User Plan)
FSS	Fixed-Satellite Service
FWA	Fixed Wireless Access
GHz	Gigahertz
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GSM-R	Global System for Mobile Communications - Railway
GUL	General User License
GURL	General User Radio License
GUSL	General User Spectrum License
HCRC	High Capacity Radio Concentrator
HDTV	High Definition Television
HF	High Frequency
HHI	Herfindahl-Hirschman-Index
IEEE	Institute of Electrical and Electronic Engineers
IIC	Interference Impact Certificate
ITFS	Instructional Television Fixed Service
ITU	International Telecommunication Union
kbps	kilobit per second
kH	Kilohertz
km	Kilometer
LAN	Local Area Networks
LMDS	Local Multipoint Distribution Service
LPFM	Low-Power FM Broadcasting

LPON	Low Power Open Narrowcasting
m	Meter
Mbits/s	Megabits per second
MCI	Mobile Communications International
MCS	Multichannel Communications Service
MDS	Multipoint-Distribution Service
MED	Ministry of Economic Development
MF	Medium Frequency
MHz	Megahertz
MMDS	Multichannel Multipoint Distribution Services
MoD	Ministry of Defence
MPL	Minimal Path Length
MR	Management Rights
MRR	Management Rights Regime
MSS	Mobile Satellite Services
MWS	Multimedia Wireless Systems
NGSO FSS	Non-Geostationary Fixed-Satellite Service
NGSO MSS	Non-Geostationary Mobile-Satellite Service
NHz	Nanohertz
NOI	Notice of Inquiry
NPRM	Notice of Proposed Rulemaking
NTIA	National Telecommunications and Information Administration
NZD	New Zealand Dollar
Ofcom	Office of Communications

OECD	Organisation for Economic Co-operation and Development
OET	Office of Engineering and Technology
OPP	Office of Plans and Policy
OSP	Office of Strategic Planning & Policy Analysis
P2MP	Point to Multipoint
P2P/ P-P	Point to Point
PAMR	Public Access Mobile Radio
PBR	Private Business Radio
PBRS	Private Business Radio Suppliers
PCS	Personal Communications Service
PFD	Power Flux Density
PIB	Public Information Brochures
PL	Path Length
PLMRS	Private Land Mobile Radio Service
PROBE	Provincial Broadband Extension
RA	Radiocommunications Agency
RC Act	Radio Communications Act
RFID	Radio Frequency Identification
RLR	Radio License Regime
RSM	Radio Spectrum Management
RSMG	Radio Spectrum Management Group
RSPG	Radio Spectrum Policy Group
RSPP	Radio Spectrum Policy and Planning
R&TTE	Radio and Telecommunications Terminal Equipment

SDR	Software Defined Radio
SDTV	Standard Definition Television
SMA	Spectrum Management Agency
SMART	Spectrum Management and Registration Technology
SMO	Spectrum Management Organisation
SMP	Significant Market Power
SMR	Specialized Mobile Radio or Simultaneous Multiple Round
SPTF	Spectrum Policy Task Force
SQBs	Spectrum Quality Benchmarks
SRD	Short Range Devices
SRR	Spectrum Rights Regime
STU	Spectrum Trade Unit
TCNZ	Telecom Corporation of New Zealand
TDD	Time-Division-Duplex
TFAC	Technical Frequency Assignment Criteria
TKG	Telekommunikationsgesetz (Telecommunications Act)
TLMS	Trunked Land Mobile Service
TP Act	Trade Practices Act
TPRC	Telecommunications Policy Research Conference
TUF	Títulos de Uso de Frecuencias
TVOB	Television Outdoor Broadcasting
UHF	Ultra High Frequency
UHF TV	Ultra High Frequency Television
UK	United Kingdom

UKPFA	UK Plan for Frequency Authorisation
UMTS	Universal Mobile Telecommunications Systems
USA	United States of America
USD	US Dollar
UWB	Ultra Wide Band
VHF	Very High Frequency
WAPECS	Wireless Access Platforms for Electronic Communications Services
WCS	Wireless Communication Service
WiFi / Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WLL	Wireless Local Loop
WRC	World Radiocommunication Conference
WRS	Wireless Radio Service

1 Introduction

The demand for radio-based applications continues to grow in line with the increasing mobility of the communication society. This demand can only be satisfied, however, if there is sufficient spectrum available. Furthermore, the pace of technological change, with accelerating cycles of innovation, calls for a regulatory regime that makes suitable spectrum available as quickly as possible.

These developments, driven by technological and market forces, present spectrum regulators with major challenges. On the one hand, the regulator must provide spectrum to meet demand, i.e. at the right time, in the right quantity and, if possible, for multiple applications. On the other hand, the regulator must ensure that spectrum use is efficient and interference-free and that there is a level playing field for competitors, as well as working to establish sustainable market competition. In addition, spectrum regulation must also take account of the interests of professional, scientific and military radio users, as well as the emergency services.

The aim of the study is to support the Federal Network Agency in devising possible approaches to a system of spectrum regulation that is both market-based and forward-looking. To this end, the study shall describe and evaluate the different routes by which other countries have reformed their system of spectrum regulation or wish to do so. The countries in question are the United Kingdom, the USA and Canada, Australia and New Zealand, and Guatemala.

The study shall examine the model of spectrum regulation in use in the selected countries, and the extent to which the countries operate – or intend to operate - flexible systems that permit a more efficient use of the spectrum. Efforts to introduce a more flexible approach to spectrum regulation fall into two broad categories: Liberalisation and spectrum trading/transfer, terms that are now widely used in Europe. *Liberalisation* addresses the extent to which spectrum usage rights should still be restricted and indeed whether any such restrictions are needed. *Spectrum trading,* on the other hand, focuses on the options available for transferring spectrum and the detailed institutional arrangements for a spectrum trading regime. In some countries, such as the UK, the topic of *spectrum pricing* is being discussed at the same time as liberalisation and spectrum trading. Indeed, usage charges that reflect the economic value of the spectrum are a further tool that can be used to promote an efficient use of spectrum. Such charges are also a means of preventing the original spectrum users from making windfall profits, in case the economic value of the spectrum increases sharply, for example as a result of technological advances or changes in the conditions of use.

The country studies also reveal the extent to which the regulatory regimes in the various countries respond to new developments in technology, for instance *software-defined radio*, which can access unused spectrum almost automatically. It is also necessary to examine the degree to which a regulatory regime should respond

flexibly in the context of securing the availability of spectrum and usage rights for new system technologies such as systems that comply with the IEEE 802.16 family of standards (e.g. WiMAX).

The literature on the topic reveals a wide variety of institutional arrangements for allocating spectrum, including band managers, spectrum exchanges, trading platforms and leasing. The study examines the extent to which these concepts are already in use or are in the pipeline.

The following text highlights some key factors that are of particular significance in the context of liberalisation and spectrum transfers/trading.

Liberalisation

- What key changes have there been in the conditions of use?
- To what extent is it possible to partition assigned spectrum?
- What kind of interference management regime is in place and how has this evolved over time? Are there still guard bands/maximum power flows? Is it possible for the parties involved to reach agreements that deviate from the prescribed thresholds? Are there different interference management regimes depending on the type of spectrum and blocks of frequency in question?
- What changes have there been with regard to obligations on use? (e.g. has there been a move away from coverage requirements? To what extent are quality standards specified for the intended service?)
- Is there a trade-off between (international) moves towards a harmonisation of spectrum use (e.g. GSM harmonisation) and liberal, less restrictive frequency usage plans?
- Do conditions of use apply in perpetuity or only for a certain period? How has this changed over time?
- How is it ensured that sufficient spectrum is available for applications that serve the public interest?
- Which frequency bands are assigned using the commons model, a command-and-control approach and market-based mechanisms respectively? The difference between a command-and-control and a market-based approach is that under the latter it is possible to trade spectrum usage rights, whereas a command-and-control approach requires redistribution by the regulatory authority.

Spectrum trading

- In which frequency bands is it possible to trade spectrum?
- Is it permitted to lease usage rights for a defined period? If so, under what conditions?
- What are the institutional arrangements for spectrum trading? Are there band managers for certain bands?
- To what extent does a functioning trading regime depend on the conditions of use and the degree of liberalisation?
- How are the trading mechanisms designed? Does the regulatory authority decide on the type of assignment mechanism?
- Are the original obligations of the spectrum user also transferred when spectrum is traded?
- To what extent are competition issues taken into account? Is the ex post application of competition law deemed sufficient or are there ex ante provisions governing spectrum trading, such as spectrum caps?
- How is the approved trading mechanism designed? Are there bilateral negotiations, auctions, trading platforms etc.?
- What information has to be provided to the regulatory authority when a trade takes place?
- Is spectrum trading only possible in certain frequency bands? Is there a timetable for its introduction etc.?
- Is trading permitted even if spectrum was not originally assigned in an auction?

Efforts to introduce a more flexible regulatory regime with regard to conditions of use and spectrum trading are sometimes accompanied by changes in the policy towards spectrum pricing, for instance with the aim of preventing windfall profits. Such changes will also be examined as part of this study.

Spectrum pricing

- How is the spectrum pricing regime designed?
- How has this evolved over time?

- Has administrative incentive pricing been employed, or are prices merely set at a level that recovers administrative costs?

The study shall examine the United Kingdom, the USA and Canada, Australia and New Zealand, and Guatemala, focusing in particular on the following points:

- What were the key reasons underlying the changes that have taken place?
- What specific changes have been made compared to the previous regulatory regime?
- Why were these measures chosen in particular?

This shall provide a framework for devising concrete proposals regarding the future of spectrum regulation in Germany. The proposals shall take particular account of the specific conditions that prevail in Germany (e.g. nine neighbouring countries, population density).

Structure of the study

The study is structured as follows: *Chapter 2* starts by outlining the fundamental economic considerations underpinning a more flexible approach to spectrum regulation. *Chapter 3* examines the current legal framework in Germany, pursuant to the new *Telekommunikationsgesetz* (TKG - German Telecommunications Act). This is followed by the country studies in *Chapter 4,* which focus on the United Kingdom, the USA and Canada, Australia and New Zealand, and Guatemala. At the end of each country study, there is a summary of the situation in that country as well as lessons that can be learned for Germany. Finally, *Chapter 5* draws on the knowledge gained from the country studies to present guiding principles for a flexible system of spectrum regulation in Germany.

2 Economic considerations underpinning a more flexible approach to spectrum regulation

2.1 Guiding principles of effective and flexible spectrum regulation

In the following section we examine the most important factors that need to be taken into account in any effort to establish an efficient system of spectrum regulation. The goal of a more flexible regulatory regime, in whatever form, should be a more efficient use of spectrum, which is a scarce resource. This goal should be reflected in the licence conditions (governing spectrum use), the rules for assigning frequencies and the options available for transferring rights of use, as well as in the relevant institutional arrangements. The conditions of use, for example, should impose only the minimum of restrictions, while it should also be possible to transfer or re-assign spectrum if, in the light of technological developments, it can be used more efficiently elsewhere.

It is also important to ensure that the transaction or administrative costs for spectrum users are as low as possible. This implies, for example, that there should be few bureaucratic obstacles to the transfer of spectrum. At the same time, there should be a source of clear information that allows prospective spectrum users to find out which frequencies are available, what they can be used for, who is currently using them and what needs to be done in order to obtain rights of use. This in turn implies the clear definition of spectrum usage rights.

The goal of ensuring that at any point in time, spectrum usage rights should be held by the person “best” able to use that spectrum, is not the only factor to consider when regulating frequencies. For instance, spectrum usage can be impaired by interference, which is caused by two users operating at a similar frequency. Any model used to distribute spectrum must take this factor into account. The public interest, something ignored in purely commercial transactions, also plays a part; there must be sufficient spectrum available for public broadcasting and military usage, for example. Competition policy is a further factor to be taken into consideration, whereby the relative transaction costs of *ex ante* and *ex post* regulation should also form part of the equation. International rules and agreements, emanating for example from the ITU and CEPT or deriving from European directives, must also be observed. Decisions to harmonise spectrum usage (e.g. in the case of GSM) impose limits on the services that can be offered, yet may well result in more efficient usage because they lower the costs of coordination and open up the possibility of international applications (e.g. international mobile roaming). This highlights the factors that need to be taken into account in any effort to establish an efficient system of spectrum regulation, and shows just how complex the subject is.

The following points revisit the most important principles in any discussion about how to improve the flexibility of the current system.

- *Ensuring the efficient use of the radio spectrum*: In view of the fact that spectrum is a scarce resource, the goal of spectrum regulation should be to ensure that frequencies are assigned to those who, in economic terms, can use them most efficiently. This calls for a selection process that assigns the right to use spectrum to the person who is willing to pay the most for that right. The amount users are willing to pay corresponds to the economic benefit they expect to derive from using the frequencies. This approach implies that users must not benefit from hoarding spectrum, while it should also prevent users withholding spectrum from trading for speculative reasons or other strategic motives. Furthermore, there should be no barriers to market entry that prevent sound economic use of the spectrum. This means, for instance, that the charge for using the spectrum should never be higher than the corresponding opportunity cost, which is equal to the market price.

- *Creating incentives for investment and innovation*: One goal of spectrum regulation should be to encourage investment and innovation. This means that users must be able to use the spectrum for long enough to amortise their investments; a company must have adequate opportunity to make a profit. Care also needs to be taken to ensure that spectrum regulation does not have a negative impact on the returns that can be achieved in certain sectors.

- *Addressing issues of competition policy:* Regulatory policy seeks to create a market in which prices are as close to costs as possible and where consumers can choose from a wide range of services. Sustainable competition is usually only possible where there are competing infrastructures, yet the scarcity of radio spectrum creates restrictions which often mean that an oligopoly is the only possible outcome. Frequencies should therefore be distributed in such a way as to create a market structure that ensures the maximum possible degree of competition for the available spectrum.

- *Non-discrimination*: Spectrum regulation should be non-discriminatory and should not favour one group of users over another, unless there is an objective and relevant reason for doing so.

- *Transparency*: Every single action relating to spectrum regulation should be transparent.

- *Workability*: The system of spectrum regulation should be workable, administrative outlay should remain within reasonable bounds, and transaction costs should be kept as low as possible. The last point means in particular that institutional barriers to spectrum trading should be kept as low as possible.

- *Providing planning certainty*: The regulatory regime should enable companies to plan for the future with a high degree of confidence. Licence periods should be

clearly defined, as should the type of usage for the spectrum in question. In terms of spectrum trading, this calls for the authority to clearly define spectrum usage rights/rights of use at the time the spectrum is initially assigned to the user. The authority should also clarify, as far as possible, the extent to which the spectrum can be traded.

- *Minimising interference:* The use of similar frequencies for different services may lead to interference for both. This can occur within a country as well as in border regions. Interference limits the use of the spectrum, a negative external effect that results in economic inefficiencies (users of the GSM spectrum, for example, require a guard band separating them from their spectrum neighbours). Spectrum regulation should seek to avoid or at least minimise such interference.

- *Ensuring compatibility with the original frequency assignment:* The rules of spectrum trading should conform to the original assignment procedure. For instance, it would be extremely counter-productive if, when spectrum was initially assigned, care was taken to ensure that all prospective users had an equal (non-discriminatory) opportunity to acquire that spectrum, yet these concerns were then ignored in a subsequent trade.

- *Satisfying public interest requirements:* It is important to ensure that sufficient radio spectrum is available for emergency services, distress calls, military users and other institutions that serve the public interest. And insofar as certain types of private use are deemed to constitute merit goods, then these, too, should not be put at risk by the system of spectrum regulation. In Germany, for example, one of the goals is to ensure a diverse offering of television channels.

- *Observing international agreements on spectrum use:* International agreements on spectrum use have been drawn up by the ITU, the World Radio Conference and other bodies. These are legally binding and impose restrictions on the type of spectrum use.

- *Recovering administrative costs*: In line with the economic principle of benefit received, the administrative costs incurred by the regulatory authority should be recouped. Such costs are incurred during the assignment process, for instance, but also as a result of the administrative expense of central regulation (e.g. preparing the frequency usage plan, maintaining a central register of current spectrum use etc.)

2.2 Regulatory models

There are currently three basic models for regulating spectrum: Command and control, market mechanism and commons model.

Command and control: Under this model, the national regulatory authority (NRA) determines exactly how the spectrum may be used, notably in terms of technologies and services. The NRA also decides who may use the spectrum, for how long and under what further conditions (e.g. roll-out obligations). This is a restrictive approach, in which the NRA specifies all the important parameters. And in this case it will typically use a beauty contest to decide who initially receives the spectrum. Command and control has traditionally been the most common approach adopted by NRAs.

Market mechanism: This approach first requires the clear definition of exclusive spectrum usage rights. Once this stage is complete, market forces take over. This implies that the primary assignment of spectrum will take the form of an auction, after which usage rights can be transferred by the mechanism of spectrum trading. It is up to the users, who should be given as much freedom as possible in making this decision, to determine what services they will offer, and on the basis of which technology. This will be a commercial decision based on market factors.

Commons model: Under this model there are no exclusive usage rights and, where possible, multiple users share access to a single frequency band. Apart from the licence conditions, which stipulate the type of services and technologies permitted in this frequency band, there are therefore no restrictions on individuals and companies. However, this form of institutional arrangement is only suitable for short-range, low-power applications such as Bluetooth links, wireless TV remote controls and private or public LANs (Local Area Networks). It is not yet clear whether or not such a model is also suited to long-range, high-power radio applications. In the case of business models that require major investment and therefore have a lengthy payback period, an exclusive usage right would be essential. Otherwise there would be significant capacity risks as well as a major risk of interference. Consequently, frequency bands should only be shared in this fashion if the issue of interference can be well managed and if users do not require an exclusive right of use. Although open access would be desirable as a means of liberalising the market, there are technical and economic limits on how far it can be implemented in practice. The regulatory authority should therefore think very carefully before deciding to open a frequency band for general usage. Once a band has been released for all users, it is difficult to reverse this decision.

2.3 Mechanisms for the primary assignment of spectrum usage rights

Even under a flexible system of spectrum regulation that allows considerable scope for secondary trading, there will always be situations when the regulatory authority has to either assign frequencies for the first time or re-assign them. This would even be the case under a big-bang auction[1], for example. Any mechanism used by the regulator to

1 This refers to a re-assignment of usage rights for a particular frequency band, including the re-auctioning of existing spectrum usage rights.

assign spectrum should always conform to the aforementioned principles of efficient spectrum regulation. The following section offers an overview of the different mechanisms that can be used and the main features of each. Radio spectrum is initially assigned by a government body using one of the many different mechanisms available. These fall into four main categories:

- First-come, first-served
- Lotteries
- Beauty contests
- Auctions

With the exception of lotteries, all these mechanisms have been used to assign spectrum in Germany. To date, there have been three auctions: The ERMES auction in 1996, the auction of additional GSM-1800 frequencies (complementary spectrum) in 1999 and the UMTS auction in 2000. The GSM-900 and original GSM-1800 licences were assigned by means of a beauty contest, as were the WLL frequencies. The following pages briefly describe the main features of each mechanism.[2]

2.3.1 First-come, first-served

The central principle of this mechanism is that the right to use the spectrum is assigned to whichever candidate is first to apply. It relies on the ability to establish beyond doubt the time at which applications are received. If this is possible, then "first-come, first-served" will offer a clear, transparent and non-discriminatory means of distributing spectrum. It is recommended that applications be submitted by fax or e-mail in order to discern the precise sequence in which they arrive. The log of incoming messages will reveal the exact time each application was received and virtually rules out the possibility of two applications arriving simultaneously.

The first-come, first-served mechanism rewards a candidate's speed. Prospective users with a strong interest in the frequency block will therefore make every effort to submit an application as quickly as possible. At the same time, candidates with good information sources that give them adequate warning of the application process are also at an advantage.

The first-come, first-served principle is popular owing to its simplicity, while the associated administrative costs are low. Nevertheless, the mechanism also has disadvantages. For one, this method of distribution does not necessarily lead to an

---

2 The reader can find a more detailed description in Nett, L. (2001): *Marktorientierte Allokationsverfahren für Nummern*, WIK Discussion Paper No. 213, Bad Honnef, June 2001.

economically efficient assignment of spectrum. This is because selection is not determined by the price the prospective user is willing to pay. Instead, the first-come, first-served approach assigns spectrum usage rights to a few quick, well-informed applicants. Furthermore, spectrum trading then offers the successful applicants the chance of making windfall profits, especially if they are not in fact end users and intend to resell the spectrum usage rights. Such trading, however, would nevertheless tend to ensure that the spectrum ends up in the "right" hands. Alongside secondary trading, the spectrum usage charge levied by the regulatory authority also plays a crucial role. If the charge is low and its impact on the applicant negligible, there may be an incentive to hoard spectrum. However, the regulator has other tools at its disposal to prevent such behaviour, for example it can limit the number of frequencies that any one candidate can acquire. Beyond this, it is difficult to set clear criteria for determining whether demand is genuine, while verifying the usage criteria in practice presents a further difficulty.

2.3.2 Lotteries

If the distribution of spectrum entails a conflict of opposing interests, this can be resolved by opting for a lottery, whereby spectrum is assigned to applicants at random. This is intrinsically non-discriminatory and eliminates any competitive distortion. There are, however, different ways of designing a lottery and this means that the procedure must be defined precisely and unambiguously (for example, the lottery may assign packages of spectrum directly to users or it may give them the right to choose from the remaining packages available). Just how non-discriminatory the mechanism is ultimately depends on the exact form it takes.

Lotteries do not generally result in an efficient assignment of radio spectrum. If the assignment fee is relatively low, there is no restriction on who may apply and spectrum trading is legally permissible, this will create an incentive to acquire spectrum in order to resell it at a profit (windfall profits). In the USA, this led to the submission of thousands of applications, resulting in extremely high transaction costs. This was one of the reasons why the FCC chose to use auctions instead of lotteries to distribute spectrum.

2.3.3 Beauty contests

The most common mechanism for assigning spectrum is the beauty contest. The applicant is required to provide certain information that is then evaluated on the basis of a set of criteria. The experience of various other countries has shown that these criteria can be very extensive. It should also be mentioned at this point that this mechanism may be used in combination with – and not instead of – the first-come, first-served approach. In this case, the set of criteria would only be used if two applications for spectrum were, according to the rules of assignment, received simultaneously.

In order to employ this mechanism it is essential to first draw up a list of the criteria deemed to be important. These are usually the applicants' specialist knowledge and efficiency, the suitability of their plans for providing the telecommunications service in question, and the promotion of effective competition. It is then necessary to determine how each criteria is to be measured and to devise a system of weighting. This will ultimately allow a decision to be reached as to the best candidate. In practice, however, this process often proves difficult. The fact that it is impossible to completely exclude subjective judgements means that rejected applicants almost always accuse the regulator of partiality. This is exacerbated by the regulator's inability to publish and document information provided by companies in the course of the contest (e.g. business plans and strategies). Such information may have played a part in the decision yet must remain confidential. The result is that a mechanism of this type may no longer satisfy the criteria of transparency and therefore non-discrimination. This approach is consequently vulnerable to lobbying at the time the criteria are drawn up and during the contest itself, which in turn means that rejected applicants believe a legal challenge will have a good chance of success. Depending on the significance of the spectrum in question, legal battles are therefore likely to be less the exception than the norm.

A beauty contest does not necessarily result in an efficient assignment of spectrum. It is therefore possible that this system could also present successful applicants with an immediate incentive to resell spectrum. This incentive is likely to be lower than would be the case under a lottery model owing to the evaluation of the applicants' specialist knowledge and efficiency carried out by the regulator. Nevertheless, changes in the economic environment may in future create an incentive to resell spectrum usage rights and, depending on the size of the spectrum usage charge, this again offers the prospect of considerable windfall profits.

2.3.4 Auctions

According to McAfee and McMillan (1987, p.700)[3], an auction is a market transaction, conducted on the basis of explicit rules, that allocates resources and determines a price by comparing the bids submitted by market participants. The word "auction" is derived from the Latin word "augere", which literally means "to increase". The size of the bids generally corresponds to the amount prospective users are willing to pay, which in turn reflects the economic value they place on the resource in question. The bids that are submitted determine the price to be paid. This need not necessarily be the highest bid (see McAfee and McMillan (1987)). There are many different types of auction, some of which allow several rounds of bidding whereas others permit only one bid. It is also possible to auction multiple objects simultaneously or in sequence, depending on the

---

3 McAfee, R.P., McMillan, J. (1987): Auctions and bidding, Journal of Economic Literature Vol. XXV, p. 699-738.

chosen design. The following paragraphs describe the characteristics of each of the different types.[4]

The types of auction outlined in Table 1 are employed when there is only a single lot to be auctioned. The English auction involves repeated bidding which ends when no higher bids are forthcoming. The highest bidder then pays the price that she or he bid. In a Dutch auction, on the other hand, the auctioneer lowers the price until someone accepts. She or he then pays that price. The first-price, sealed-bid auction and the Vickrey auction are both single-round auctions. Each bidder submits just one bid (in a sealed envelope) and the person with the highest bid is successful. In a first-price auction, the winner then has to pay the highest bid, whereas in a Vickrey auction the price paid corresponds to the second-highest bid.

Table 2 outlines the different types of multiple-lot auctions. In a sequential English auction, each lot is sold individually in a series of separate English auctions. A simultaneous sealed, first-price auction comprises one round of bidding in which a single bid is submitted for each lot. The highest bidder in each case is successful and has to pay the bid price. A one-price auction is used where there are several homogenous lots. The auctioneer continues to raise the price until the market-clearing price is reached. Finally, simultaneous multiple (English) auctions are designed so that bidders can bid simultaneously for individual lots. The auction is conducted over an unlimited number of rounds and ends when no higher bids are forthcoming. The highest bidder then pays the price that she or he bid.

The following two tables outline the main features of these different forms of auction:

Table 1: Features of single-lot auctions

	English Auction	Sealed-bid auction	Vickrey Auction	Dutch Auction
Meets the market price	yes	only approximately	yes	only approximately
Identifies the bidder with highest esteem?	yes	not completely safe	yes	not completely safe
Possibility for pooling?	afflicted with risk	low risk	low risk	afflicted with risk
Winner's Curse?	provides some protection	afflicted with risk	afflicted with risk	afflicted with risk
Procedure comprehensible to the open public?	yes	yes, appropriate to complex situations	no, afflicted with political risks	no

Source: Nera/Smith (1996), p. 64.

4 See Nett (2001).

Table 2: Features of multiple-lot auctions

	Sequential English Auctions (or similar)	Simultaneous Sealed First Price Auction	One Price Auction	Simultane multiple Auction
Meets the market price	only approximately	only approximately	yes	yes
Identifies the bidder with highest esteem?	not completely safe	not completely safe	yes	yes
Possibility for pooling?	no	no	yes	yes
Winner's Curse?	provides some protection	afflicted with risk	afflicted with risk	provides some protection
Procedure comprehensible to the open public?	comprehensible procedure	comprehensible procedure, appropriate to complex situations	difficult to understand, afflicted with political risks, only at identical objects of auction	new, but easily to understand

Source: Nera/Smith (1996), p. 64.

It may be noted that, assuming the participants in the auction behave rationally, the outcome will generally be an assignment of spectrum that is economically efficient at the time the auction takes place. If this is the case, there will be no incentive to trade spectrum immediately after the auction has ended; any incentive for secondary trading will depend on future developments. If the auction succeeded in finding the market-clearing price, it will only be possible to make a profit if the market outperforms expectations.

Spectrum trading offers bidders a safety net in case their business model proves unsuccessful. This in turn tends to raise the amount they are willing to pay. On the other hand, it also gives companies the opportunity of dropping out of an auction if they believe they can acquire the licences/spectrum for less money at a later date. For instance, in the first PCS auction in the USA, MCI withdrew immediately because it believed that it could acquire second-hand licences more cheaply after the auction.

2.4 Liberalisation of spectrum usage

2.4.1 Elements of a system governing spectrum usage rights

Spectrum usage rights are subject to certain conditions. In the past, these have tended to impose fairly tight restrictions, for example on the services that could be offered in a particular frequency band, and even on the technologies that could be used. Liberalisation, however, seeks to lift such restrictions wherever possible. In a fully liberalised environment, there would be no restrictions on spectrum usage whatsoever.

Extensive liberalisation tends to offer the advantage that each frequency band is used for the most attractive service. In other words, there are no stipulations that would create an artificial scarcity of certain applications. This would also tend to ease the scarcity of spectrum for economically attractive applications such as mobile communications or broadcasting, thereby providing a possible boost to competition in these markets. On the other hand, flexible usage has the potential to cause considerable interference, while in certain areas it can actually make very good sense to internationally harmonise conditions of use. Although carefully defined rights of use should impose as few restrictions as possible, it is nevertheless important to establish a series of conventions.

Every system that governs spectrum usage rights has at least three dimensions:

- The spectrum band which can be used
- The geographical area where the spectrum band can be used
- The period of time during which it can be used

The following table provides a more detailed overview of the main elements that need to be defined in any regime governing rights of use.

Table 3: Elements of spectrum usage requiring definition

Element	Description
Nature of rights	Tradable spectrum access licences defined in terms of frequency, geography, emissions. Change of use within ITU allocation. Right to sign leasing agreements.
Type of licence	Possibility of partitioning assigned spectrum into tradable units, tradability of spectrum assigned to government bodies.
Method for transferring control	The Federal Network Agency decides on mechanism; parties apply for the Federal Network Agency approval of an intended trade; no restrictions on transfer if new licensee agrees to meet all the conditions within the original licence.
Transfer of control	Current spectrum use registered with the regulatory authority in a central database.
Aggregation/partitioning	Is this permitted or not? It may not be permissible if it is exclusively reserved for a specified public use (e.g. military use).
Duration	How long the spectrum may be used for, period during which trading is possible.
Technical parameters	Boundaries set for point at which negotiations between neighbours (for managing interference) are triggered.
Method of changing interference parameters	Framework for negotiations between spectrum users, role of regulatory authorities as referee.
Service/technology constraints	Change of use allowed within ITU allocation and European agreements.
Compliance with licence conditions	Ensuring that licensee and/or lessee complies with conditions and obligations.
Process for enforcing interference conditions	Licensees negotiate with each other. Regulator can take action if privately negotiated solutions breach interference norms and standards.

Source: Department of Trade and Industry, Review of Radio Spectrum Management (2002), p. 116, WIK Consult

The Radio Spectrum Policy Group has identified the following detailed parameters concerning spectrum usage rights:[5]

- Regulatory/administrative obligations
    - o Coverage requirements
    - o Quality of service requirements
    - o Interoperability requirements (e.g. roaming)

5 RSPG04-54 Rev. (final) – The RSPG Opinion on Secondary Trading of Rights to Use Radio Spectrum, 19 November 2004. Attachment to Annex I – Rights and obligations.

  - Minimum service offering (e.g. location-based services, high speed data transfer, video telephony, virtual domestic environment)
  - Access for third parties to the network
  - Public network obligations
  - Social aspects and universal service obligations, for instance special services for the disabled
  - Protection of health
  - Protection of environment (e.g. infrastructure sharing, camouflage of antennas)
  - Prevention of handset robbery

- Obligations that are part of a commitment which the undertaking obtaining the usage right has made in the course of the distribution process.
- Technical requirements of use
  - Obligations resulting from the Radio Regulations, applicable CEPT/ECC decisions/ EU directives and National Table of Frequency Allocations (service, system, applications, technical limitations, compatibility criteria, sharing criteria).
  - These obligations result from the need to optimise spectrum use for the benefit of the whole radiocommunication community.
  - These obligations include in particular, technical parameters such as limitations in order to limit interference (e.g. power limitations, spectrum masks, DFS, power control).
- Channelling arrangements (including duplex couplings) and essential requirements, in order to ensure efficient use of spectrum
- Payments for use of spectrum
  - Administrative charges to cover regulation of spectrum by Spectrum Management Authority (SMA)
  - Administrative incentive pricing (AIP)
- Information about use

- Provision of information to the spectrum management authority (SMA) or to the public
- Obligations to disclose air interfaces

- Other technical conditions for the use of the frequencies
  - The transmission to adhere to specific technical specifications, such as channel width, modulation technique, duty cycles etc.
  - Limitation of usage rights to certain “time slots”
  - Obligation to coordinate spectrum in case of potential interference

2.4.2 Spectrum regulation in the international and European arenas

The International Telecommunication Union (ITU) is responsible for the international regulation of the radio spectrum. The object of international efforts to coordinate spectrum use is to prevent harmful interference between the radio services of different countries. A further aim is to ensure that the spectrum is used efficiently and to create a level playing field for countries’ access to radiocommunication resources.[6]

The Radio Regulations (RR), which divide the world into three zones (Europe and Africa, North, Central and South America, and Asia and Australia), are the primary means by which the ITU manages radio spectrum, and constitute a global framework for allocating frequency bands. The ITU Table of Frequency Allocations sorts individual radio services into categories and allocates these to particular frequency bands, which are then reserved for that purpose. The ITU Table of Frequency Allocations is revised and updated at the World Radio Conference, which is held on a regular basis.

There are also individual international agreements in which the ITU establishes rules governing the use of frequency bands in certain sectors (e.g. broadcasting) or seeks to achieve global harmonisation (e.g. IMT-2000). The Stockholm Agreement of 1961[7], for example, specified how spectrum would be used for broadcasting, while at the WRC in 1995 and 2000 agreement was reached on the frequency bands allocated to third generation mobile communications services.[8]

---

6 cf. Withers, D. (1999): Radio Spectrum Management, 2nd edition, Management of the spectrum and regulation of radio services, London, p. 33 ff.

7 cf. Stockholm (1961): Regional Agreement for the European Broadcasting Area Concerning the Use of Frequencies by the Broadcasting Service in the VHF and UHF Bands (Stockholm, 1961).

8 The ITU’s 1995 World Radio Conference allocated globally harmonised frequency bands for the IMT-2000 standard, which includes UMTS. The WRC agreements provided a total bandwidth of 230 MHz for IMT-2000, of which 170 MHz is for terrestrial usage and 60 MHz for satellite services. The frequency bands are in the 1885-2025 MHz and the 2110-2200 MHz range. Within these bands,

At a European level, spectrum use is coordinated by the European Conference of Postal and Telecommunications Administrations (CEPT). Within the CEPT, the European Communications Committee (ECC) is responsible for the actual task of coordinating spectrum usage across Europe. CEPT members reach agreements on the use of frequency bands in order to harmonise and coordinate pan-European spectrum usage. These include the agreements reached in Wiesbaden in 1995 and in Chester two years later, which laid the groundwork for digital broadcasting.[9]

Following the WRC in 1992, the CEPT (or rather the ECC) began to draw up a general European frequency plan in order to advance the harmonisation of spectrum use in Europe. At the same time, this frequency plan was also intended to pave the way for the implementation of the WRC agreements. The European frequency plan seeks to harmonise spectrum allocation and usage by 2008. To this end, a series of Detailed Spectrum Investigations (DSI) have been carried out, resulting in the creation of a European Table of Frequency Allocations and Utilisations, the latest version of which dates from January 2002.[10]

As well as the CEPT agreements, the directives and decisions of the European Union must also be taken into account. These include, for example, the Decision of the European Parliament and of the Council on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision), the R&TTE Directive, and directives and decisions relating to specific services (including the GSM Directive and the UMTS Decision).[11]

---

the 1980-2010 MHz (up-link) and 2170-2200 MHz (down-link) sub-bands are reserved for satellite applications. In 2000, the WRC identified three optional frequency bands (806-960 MHz, 1710-1885 MHz and 2500-2690 MHz) in order to make additional spectrum available for the terrestrial component of IMT-2000 applications. It is up to ITU members to decide if, when and to what extent IMT-2000 applications will be introduced in the designated frequency bands. There has therefore been no agreement on global expansion bands for the terrestrial component of IMT-2000. cf. European Commission (2000), p. 6 ff.

9 The 1997 Chester agreement (Chester (1997): The Chester 1997 Multilateral Coordination Agreement relating to Technical Criteria, Coordination Principles and Procedures for the introduction of Terrestrial Digital Video Broadcasting (DVB-T), Chester, 25 July 1997) allocated bands III (174-230 MHz), IV (470-582 MHz) and V (582-862 MHz) for the introduction of digital terrestrial TV, although the 216-230 MHz band is to be used for digital radio (DAB, Digital Audio Broadcasting). At the Wiesbaden planning conference in 1995, a plan was adopted for distributing spectrum in the 47-68 MHz, 174-230 MHz, 230-240 MHz and 1452-1467.5 MHz ranges. cf. Lehnert (1995) (Lehnert, Joachim (1995): *Bericht über die CEPT-Planungskonferenz zur Einführung von DAB in Europa vom 3.-21./22. Juli 1995 in Wiesbaden*, published as volume 10 in a series by DAB-Plattform e.V., Munich), p. 4 f. and Chester (1997).

10 cf. ERC (2002): The European table of frequency allocations and utilisations covering the frequency range 9 kHz to 275 GHz, Lisboa, January 2002, ERC Report 25.

11 cf. Cave, M. (2002): Review of Radio Spectrum Management, Study for the Department of Trade and Industry and Her Majesty's Treasury, March 2002, p. 64 ff.

2.4.3 Spectrum regulation in Germany

Spectrum usage is determined primarily by the following three mechanisms, which occur in sequence.

- National Table of Frequency Allocations
- Frequency Usage Plan
- Frequency assignment

The *National Table of Frequency Allocations* allocates bands of spectrum to radio services and other applications. These allocations are stipulated by the Federal Government, which enacts ordinances to this effect. The main purpose of the National Table of Frequency Allocations is to implement international agreements concluded by the ITU (WRC), CEPT and EU.

Pursuant to Section 54 of the *Telekommunikationsgesetz* (TKG – German Telecommunications Act), the Federal Network Agency is responsible for drawing up the *Frequency Usage Plan* on the basis of the frequency bands identified in the table of allocations. The plan includes a more detailed allocation of the frequency bands to particular frequency usages, as well as determining the additional parameters required to ensure efficient and interference-free use of frequencies and the further rules needed concerning the use of frequencies in and along conductors. This includes, for example, provisions specifying the maximum permissible equivalent radiated power, channel separation, channel width, and channel subdivisions. Possible frequency usages include amateur radio, business radio, trunked radio, digital cellular mobile communications, aeronautical radionavigation, satellite-to-satellite links and maritime radio. The Frequency Usage Plan is binding, although Section 58 of the Telecommunications Act permits variant frequency assignments in justified particular cases, for example to provide frequencies required at short notice or to test innovative technologies.

As a rule, each frequency usage requires prior *frequency assignment,* in accordance with the Frequency Usage Plan and as part of a transparent and objective process. A general assignment is the first choice for assigning frequencies. However, when the risk of harmful interference cannot be ruled out otherwise or when this is necessary in order to secure efficient use of frequencies, individual assignments will be made. Pursuant to Section 55(9) of the Telecommunications Act, award proceedings are only used to assign frequencies where spectrum is scarce. The frequency assignment specifies, in particular, the type and extent of the frequency usage, insofar as is necessary to secure efficient and interference-free use of frequencies. Secondary conditions may also be attached. Frequencies may be assigned either in perpetuity or for a limited period.

Usage rights are also restricted to a particular geographical area. This may be the whole territory of the Federal Republic or one or more of its regions.

2.4.4 Influence of international agreements on spectrum regulation at national level

International and pan-European rules on spectrum usage affect the national regulatory environment, notably in terms of the services and technical constraints for specific frequency bands. There is only limited scope for national regulations to deviate from the international rules on spectrum usage. Frequency assignments that are at variance with the ITU Table of Frequency Allocations are only permissible "on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by stations operating in accordance with the provisions of the Constitution, the Convention and these Regulations"[12]. On the other hand, countries can choose whether or not to adhere to CEPT agreements, although once they have signed up to the agreements they are bound to abide by them when planning spectrum usage.

Table 4 illustrates, by way of example, how frequencies in the 890-960 MHz range are allocated at national and international level.

12 See Article 4.4 of the ITU Radio Regulations.

Table 4: Allocation of frequencies between 890-960 MHz

Frequency band (MHz)	ITU allocation	EU legislation	Frequency usage according to German Frequency Usage Plan
890 – 915	Fixed radio services, mobile services excluding aeronautical mobile services, broadcasting services, radiolocation services	GSM Directive[13]	GSM (D network)
915 – 921			Currently being surveyed with a view to future mobile applications
921 – 925			Digital rail communication using GSM-R technology
925 – 930			Fixed links (military)
930 – 932			Cordless telephone systems (CT1+)
932 – 935			Fixed links (military)
935 – 960	Fixed radio services, mobile services excluding aeronautical mobile services, broadcasting services	GSM Directive	GSM (D network)
NB: In the European Table of Frequency Allocations and Utilisations (dated January 2002), frequencies between 890 and 960 MHz are allocated to mobile services and aeronautical mobile services.			

Source: WIK Consult

The international rules on spectrum usage limit the trading of spectrum if the intention is to use it for services other than those set forth in the ITU Table of Frequency Allocations. However, the fact that the international allocations are usually formulated in very general terms allows national regulators some flexibility in drawing up their own tables of frequency allocation and frequency usage plans. As mentioned earlier, the CEPT agreements are voluntary, although the countries that sign up to them agree to be bound by their provisions.

In contrast, the European directives and decisions that allocate individual radio services to particular frequency bands offer less scope for independent action by national regulators. This applies to the following frequency bands:

- 1880–1900 MHz (DECT)[14]
- 169.4-169.8 MHz (ERMES)[15]

---

13 Council Directive of 25 June 1987 on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community (87/372/EEC).

14 Council Directive 91/287/EEC of 3 June 1991 on the frequency band to be designated for the coordinated introduction of digital European cordless telecommunications (DECT) into the Community.

15 Council Directive 90/544/EEC of 9 October 1990 on the frequency bands designated for the coordinated introduction of pan-European land-based public radio paging in the Community.

- 890–915 and 935–960 MHz (GSM)[16]
- 1900-1980 MHz, 2010-2025 MHz, 2110-2170 MHz for terrestrial applications and 1980-2010 and 2170-2200 for satellite applications (IMT-2000)[17]

If there is very little demand for the radio services on offer, it has proven possible to make the frequency bands available for other radio services. The CEPT is currently discussing how the ERMES spectrum may be used in the future.

2.4.5 Frequency Usage Plan

Rules on spectrum usage are made at both international and national level. These find their ultimate expression in the national frequency usage plan, which imposes legally binding constraints on the assignment and usage of spectrum. For instance, Frequency Usage Plan no. 287 of the Federal Republic of Germany (dated April 2003) contains the following sub-plan:

Table 5: Excerpt from the Frequency Usage Plan

Frequency Usage Sub-Plan	287	Entry	287002f
Frequency band	2695-2700 MHz		
Condition(-s) of use	D340 30 (specified in the National Table of Frequency Allocations)		
Radio service	RADIOASTRONOMY SERVICE		
Use	Civilian		
Frequency usage	Radioastronomy		
Frequency sub-band	2695-2700 MHz		
Conditions of frequency use	Receiving radio waves and radiated power in space. The protection criteria for this passive radio application are contained in ITU-R Recommendation RA.769.		

Source: Federal Network Agency - Frequency Usage Plan

Drawing up such a plan is both a necessary and a sensible step. It gives prospective users the information they need in order to devise business models or concepts based on the usage of particular frequencies. However, striking the right balance between restrictive rules and a more *laissez-faire* approach is another matter. Strong protective mechanisms are particularly advisable if there is a possibility of significant harmful

16 Council Directive of 25 June 1987 on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community (87/372/EEC).

17 Decision No. 128/1999/EC of the European Parliament and of the Council of 14 December 1998 on the coordinated introduction of a third-generation mobile and wireless communications system (UMTS) in the Community.

interference. Restrictions on spectrum usage become necessary when basic considerations, backed up by field trials or other practical experience, make it clear in advance that, from a regulatory standpoint, certain frequency bands are only suitable for certain applications. In addition, spectrum may be reserved for certain types of use if it is advisable, or even necessary, to harmonise usage at national level. This applies particularly in cases where international applications (e.g. GSM mobile communications) both encourage and require harmonisation and/or if such a step would lead to significant savings in the cost of developing the associated end-user services, thereby boosting technological progress.

2.4.6 Frequency bands particularly suited to liberalisation and flexible transfer arrangements

The study by Analysys et al revealed that the introduction of spectrum trading and liberalisation would bring the greatest economic benefits, in both political and social terms, in the following frequency bands. Their findings were based on a survey of users and an economic analysis.

Table 6: Frequency bands particularly suited to trading and liberalisation

Introduce *trading and liberalisation* throughout Europe in frequency bands currently allocated to the following services	**Introduce *trading (liberalisation optional)* throughout Europe in frequency bands currently allocated to the following services**
Broadcasting – satellite – for space-to-Earth links if and where a recognised spectrum access environment is deemed appropriate	Broadcasting – terrestrial (with a review of the case for liberalisation following the 2005 ITU Regional Radiocommunications Conference)
Fixed links (where usage rights are assigned exclusively to individual users)	Land mobile – private mobile radio (where usage rights are shared between users and the Spectrum Management Agency (SMA) undertakes co-ordination of individual users)
Fixed wireless access	
Land mobile – private mobile radio (where usage rights are assigned exclusively to individual users)	Fixed links (where spectrum rights are shared between users and the SMA undertakes coordination of individual users)
Land mobile – public mobile networks	
Satellite (fixed and mobile) – for space-to Earth fixed links if and where a recognised spectrum access environment is deemed appropriate; for mobile, subject to assessment of current co-ordination practices	
Special user groups (military, public safety, public transport), subject to ensuring that essential services are not disrupted	

Source: Analysys et al (2004): Summary of report no. 78.

Analysys also points out that the economic benefits of trading would be maximised if it would be introduced in the same way and under the same rules by all EU member states. The desire to minimise transaction costs again plays an important part in this

recommendation. There are consequently many advantages to adopting a coordinated approach. However, the report also emphasises that each specific frequency band should be examined in detail, implying that, before trading and liberalisation are implemented, an extensive consultation process should take place with all those who may be involved.

2.4.7 WAPECS initiative

Wireless Access Platforms for Electronic Communications Services (WAPECS) are platforms used for radio access to electronic communication networks and services, regardless of the bands in which they operate or the technology they use. WAPECS platforms can provide mobile, portable or fixed access to a range of electronic communications services. WAPECS applications may be either licensed or unlicensed, which means that the term encompasses all second and third-generation mobile communications services, wireless data transmission services and WLAN/WiFi as well as broadcasting and TV services. A survey of EU member states identified the following frequency bands as being suitable for WAPECS:

Table 7: Frequency bands identified for WAPECS

Broadcasting bands	174–230 MHz 470–862 MHz 1452–1479.5 MHz	
Fixed links/point to point (P2P)	5925–6425 MHz, 3600–4200 MHz, 1375–1400 MHz, 1492–1517 MHz, 1427–1452 MHz and 1350–1375 MHz	
Point to multipoint (P2MP)	(without MWS) 3400–3800 MHz, 24.5–26.5 GHz (with MWS) 24.5 GHz–26.5 GHz	
Mobile services	380–400 MHz 410–430 MHz 450–470 MHz 870–876 MHz 880–921 MHz 925–960 MHz	1710–1785 MHz 1805–1880 MHz 1900–1980 MHz 2010–2025 MHz 2110–2170 MHz
Unlicensed bands	1880–1900 MHz (DECT) 2400–2483.5 MHz (RLANs) 5150-5350 MHz (RLANs) 5470-5725 MHz (RLANs)	

Source: RSPG

The chosen definition represents a deliberate attempt to move away from restrictive definitions of spectrum allocation. The object is to enable the frequency bands in

question to be used by efficient, digital applications, while at the same time taking account of frequency restrictions designed to permit co-existence. One of the first questions to be resolved concerns the restrictions that the spectrum regulator must impose on the frequency bands in order to pursue the intended approach.

2.5 Transfer and trading of spectrum usage rights

2.5.1 General considerations

Spectrum trading, or the transfer of spectrum usage rights, denotes a mechanism whereby rights of use are transferred from one user to another for a certain price. In contrast to a system in which spectrum is returned and then re-assigned, the trading approach is characterised by the fact that:

- The transfer of the right to use the spectrum in question is initiated voluntarily by the present user.
- The sum paid by the new owner of the spectrum usage right is retained, either in full or in part, by the previous owner.

Spectrum trading contributes to a more efficient use of frequencies. This is because a trade will only take place if the spectrum is worth more to the new user than it was to the former user, reflecting the greater economic benefit the new user expects to derive from its use. In the absence of misjudgements or irrational behaviour on the part of the buyer or seller, and if the trade does not cause external effects, then it can be assumed that spectrum trading contributes to greater economic efficiency. Furthermore, the option of trading creates an incentive for the voluntary transfer of rights of use. As well as this direct effect, which at the same time boosts transparency by revealing the true opportunity cost of the spectrum, secondary trading also results in a series of indirect positive effects. Spectrum trading makes it possible for companies to expand more quickly. It also makes it easer for prospective new market entrants to acquire spectrum in order to enter the market. And if the introduction of spectrum trading is combined with an extensive liberalisation of spectrum usage rights, there will be a considerable incentive for incumbents to invest in new technology in order to ward off the threat of new entrants in the absence of other barriers to entry (i.e. the unavailability of spectrum). This in turn will boost market competition. These efficiency gains will not be realised, however, if transaction costs are too high or if external effects intervene. Possible external effects include anti-competitive behaviour and interference. In addition, it is important to ensure that the spectrum allocated for merit goods, such as military communications and the emergency services, is available in sufficient quantity and quality.

These criteria constitute the framework for a whole raft of institutional arrangements that determine the precise form of spectrum trading and set forth exactly how rights of use can be transferred. Institutional arrangements stipulate precisely who can make what decisions, when they can do so and under what conditions. They also set forth the implications this will have for the parties involved. Ideally, such a system will include full details pertaining to all aspects of spectrum transfers and trading. At the same time, one of the aims of any spectrum trading regime should be to keep down transaction costs. After all, the goal is to facilitate transfers by establishing a swift and inexpensive mechanism. However, the vast quantity of important details means that both primary legislation and secondary legal texts are limited in terms of how far they can specify actual arrangements.

Any attempt to specify institutional arrangements must answer the following questions (please note that this list is necessarily incomplete):

- Does the national regulatory authority specify the transfer mechanism when an application is submitted by a prospective seller, or does the trade take place in an *ex ante* regulatory environment?
- Does the Federal Network Agency has the authority to completely specify the transfer mechanism, or is it only able to stipulate auxiliary conditions?
- Who has the de facto authority to carry out the trade. Is it the current user, the Federal Network Agency or certain companies or institutions that have been certified to do so?
- Is there one preferred transfer mechanism or is the choice made on a case-by-case basis?
- Does the form of spectrum trading depend on the original assignment mechanism (auction, beauty contest)?
- Who bears the costs of the transfer?
- Who receives the sum paid by the new owner of the spectrum usage right? (If the price exceeds the amount paid by the original owner, is the difference then paid to the state?)
- If the Federal Network Agency specifies the transfer mechanism, how much influence does the person have who initiated the transfer? (Can they set a minimum price? If it is decided to sell the right of use by means of an auction, does the original user have the right to bid at the auction?)

- To what extent must the new user comply with the previous conditions of use/licence conditions? Is alternate use possible (e.g. using spectrum that was initially allocated for point-to-multipoint links for point-to-point links instead)?

- If free trading is allowed, are there spectrum caps that limit the maximum amount of spectrum that can be acquired?

- If the current user puts forward a proposal, can they advocate a transfer to a specific user for a certain price or may they only express their wish to trade and their preferred mechanism for doing so?

The following criteria should be used when assessing whether a specific transfer mechanism is suitable or which of the possible institutional arrangements is most appropriate:

- Care should be taken to ensure that spectrum trading conforms to a great extent with the aforementioned principles of effective spectrum regulation (i.e. it ensures the efficient use of the radio spectrum; it constitutes a transparent, objective and non-discriminatory method of distributing spectrum; it is compatible with the primary assignment mechanism; it recovers administrative costs etc.).

- The institutional arrangements should not be designed so that owners of spectrum usage rights run the risk of obtaining a disproportionately low price. Nor should they give rise to such complexity and inherent uncertainty that it is not worthwhile for the current owner to even contemplate a transfer, even though the transaction itself makes sense. Furthermore, the transfer must be completed within a reasonable period of time. Indeed, time is one of the most important factors, therefore it is important that the transfer can be completed without unreasonable delay.

2.5.2 Forms of spectrum trading

In their report for the European Commission, Analysys et al identify the following methods for transferring rights of use:

- *Sale* – Ownership of the usage right is transferred to another party.

- *Buy-back* – A usage right is sold to another party with an agreement that the seller will buy back the usage right at a fixed point in the future.

- *Leasing* – The right to exploit the usage right is transferred to another party for a defined period of time but ownership, including the obligations this imposes, remains with the original rights holder.

- *Mortgage* – The usage right is used as collateral for a loan, analogous to taking out a mortgage on an apartment or house.

The transfer of usage rights by sale or lease is typical of countries that have introduced spectrum trading. Mortgage-style transactions are possible in Guatemala and New Zealand.

It is also helpful to distinguish between management rights and usage rights. Management rights confer the right to issue individual spectrum usage rights within a given block of spectrum and are used in New Zealand, for example. In practice, management rights create a situation similar to leasing, in which the primary holder of the usage right leases this to users.

In terms of the trade itself, there are a variety of mechanisms that can be used. These include:

Bilateral negotiation: The seller and (prospective) buyer directly negotiate the terms of the sale and are not subject to any particular constraints set by the regulator.

Auctions: Once a type of auction has been chosen and the rules have been decided, prospective buyers have the opportunity to acquire the spectrum usage rights by bidding in the auction.

Brokerage: Buyers and sellers employ a broker to negotiate, with their consent, the contractual terms under which the transfer of usage rights can take place.

Exchange: This refers to the establishment of a trading platform, similar to a stock market, where transfers take place according to specific rules.

It is also possible to combine more than one of these approaches. Ideally, the regulatory authority should, as far as possible, leave the transfer mechanisms in the hands of the market participants. In other words, any regulatory provision should be motivated by the intention to meet the principles of effective spectrum regulation as outlined earlier.

2.5.3 Spectrum trading and the duration of usage rights

The introduction of spectrum trading diminishes the need to set a fixed expiry date for usage rights. Under a system of spectrum trading, rights are transferred to users who have identified an alternate use that promises greater returns. This transfer takes the form of a commercial transaction. Furthermore, the choice of an expiry date, be it five, ten or twenty years hence, is always somewhat arbitrary. In view of uncertainty about technological developments and changes in demand, it seems doubtful that an expiry date can be set on the basis of rational considerations of economic efficiency. One

argument in favour of granting spectrum usage rights in perpetuity is that users make complementary investments in stages. Each investment has a different payback period, with the result that specifying a limited licence period inevitably results in inefficiencies at the end of that period. Economists who place their trust in unfettered market forces therefore advocate that spectrum usage rights be granted in perpetuity. This implies that, after the primary assignment of spectrum, the regulator would only have to intervene if users wished to return spectrum or if their right of use were withdrawn owing to a breach of the conditions of use. This argument carries even greater weight if, in addition, the spectrum charges are set at a level that reflects their economic value.

Nevertheless, if there are significant imperfections in the market it may make sense to give the national regulatory authority the option of withdrawing spectrum usage rights. Alternatively, a certain period of time could be specified at the end of which the regulator decides whether or not the spectrum usage right shall be extended.

2.5.4 Necessity of maintaining a central register for spectrum trading

In order for spectrum trading to be both transparent and efficient, it makes sense to give all interested parties direct access to information on current spectrum usage. To this end, it is advisable to set up a central database, which, for practical purposes, should be the direct responsibility of the institution in charge of assigning spectrum.

The database should contain the following information in particular:

- Current assignment table (name and address of users plus details of their respective blocks of radio spectrum, e.g. size and frequencies).
- Type of usage for the spectrum in question.
- Indication of the relevant legal provisions governing spectrum trading.

If a spectrum usage right has already been transferred on a previous occasion, this should at least be noted, together with information on the date of the transaction, the price that was paid and the identity of the parties involved.

Access to the database should be as simple as possible. Indeed, unless there are any legal obstacles, the information in the database should be made available on the Internet. One possible location would be the homepage of the Federal Network Agency.[18]

---

18 Creating a trading market in radio spectrum in the UK, a presentation given by Darrin Mylet, Vice President of Wireless Services, Cantor Fitzgerald Telecom Services, at the Radio Spectrum Liberalisation & Trading in the UK conference held in the BSG Conference Centre in London from 24–25 November 2004.

In view of efforts to achieve greater pan-European harmonisation it would also seem advisable to aim for the greatest possible degree of standardisation when devising a format for a public register of this type. This would significantly reduce the transaction costs for spectrum users who operate in more than one country.

2.5.5 Spectrum trading and primary assignment

Irrespective of the mechanism used for primary assignment, spectrum trading represents a means of improving economic efficiency in terms of how the radio spectrum is used. Nevertheless, the mechanism used does have implications with regard to the incentives for spectrum trading and the possibility of making windfall profits. If it is assumed that auctions result in an efficient assignment of spectrum, then there shall initially be no incentive for a trade. However, in the case of other assignment mechanisms that do not depend directly on the amount users are willing to pay, there may be an immediate incentive to trade. Furthermore, subsequent external changes may create an incentive to trade, regardless of the primary assignment mechanism employed. Whatever the situation, spectrum trading may lead to more efficient usage. The possibility of making windfall profits depends on the size of the fee charged for frequency assignment and on changes affecting the market value of the spectrum in question. If it is assumed that the winner of an auction pays the current market-clearing price, then it will be impossible to make a profit right away.

2.5.6 Flexible spectrum regulation and windfall profits

Windfall profits accrue to owners of specific property rights without any effort or economic activity on their part. It is not clear just how precisely the term “windfall profits” has been defined in the context of assigning spectrum usage rights. The basic premise holds that a distribution of scarce resources gives the recipients an opportunity to make a profit. If they do so as a result of commercial activity, associated with the roll-out of a network infrastructure, then there are no grounds for censure. On the contrary, there would only be cause for concern if it were possible for the user to make excessive profits without taking on correspondingly higher risks, or if profits could be made simply by trading, without engaging in any productive activity. The latter might be the case if, for example, spectrum usage rights could be acquired for a comparatively low price in a lottery and then, without the owner having put the spectrum to economic use, sold for a much greater sum either shortly afterwards or at a later date. Such cases raise doubts about profits of this kind, which are ultimately an outcome of quasi-monopolistic or -oligopolistic markets (the result of a system that grants exclusive usage rights). These profits may be considerable and the question is: Can they be justified in terms of the distribution of welfare benefits?

As a general rule, windfall profits are less likely to occur where:

- An auction was used as the primary assignment mechanism and the price achieved at auction corresponded to the market-clearing price at the time
- The fee charged for spectrum assignment reflects the economic value of that spectrum
- The value of the spectrum falls over time
- The first user to whom the spectrum was assigned had to satisfy strict requirements as to their suitability
- There is effective market competition

It should be noted that, while trading clearly reveals windfall profits (or profit-making potential), these gains could also accrue to users who choose to retain their usage rights. In this case, however, they would take the form of company profits and would therefore be less immediately apparent. Users who acquire usage rights for a low price have the opportunity to make profits that are unusually large for the market. From an economist's perspective, such profits can be a cause for concern, especially in the absence of effective competition. They should therefore be countered by appropriate regulation. If existing competition law is deemed inadequate for this purpose, then specific regulations must be enacted for this sector.

Windfall profits that result solely from trading might be viewed as problematic in terms of the equitable distribution of welfare benefits among economic actors. They do not, however, have an immediate impact on economic efficiency. On the contrary, any attempt to block trading may even prevent spectrum from being transferred to the most efficient user.

From a purely economic standpoint, windfall profits do not constitute an argument against spectrum trading. If, however, they are regarded as problematic for other reasons, there are various means of limiting such gains in the context of spectrum trading. First of all, usage rights should initially be assigned in an auction. Other options include a spectrum charge, effective market regulation, a windfall tax or a trading duty whereby the state recoups a proportion of the net gain when a trade takes place. Nor should it be forgotten that even windfall profits which accrue solely to the seller can also boost government finances. This is most immediately apparent if the seller in question is a state-run or state-funded institution. If, for example, the armed forces were to sell off surplus spectrum, the additional funds this would bring would generally mean that less funding was needed from other sources. Furthermore, the more efficient use of spectrum that is expected to result from trading also implies that the new users will make higher profits. This in turn will result in increased tax revenues for the state (from income and capital gains tax and, if revenue also increases, from value-added tax).

Once all factors have been taken into account, the issue of windfall profits therefore presents far less of a problem than is often portrayed.

2.6 Interference

Interference occurs when the use of a particular frequency band has an effect on the use of neighbouring bands. From an economic perspective, this constitutes a negative external effect. Interference can be prevented by designating guard bands (frequency bands that nobody is entitled to use), or by specifying maximum power levels or spectrum masks. These regulatory measures should be designed in such a way as to ensure that users can operate with maximum economic efficiency. The technical usability of the frequency bands in question will also have a decisive influence on what steps are taken in each case. Thresholds of acceptable interference are established with reference to a base level. It is generally the responsibility of the regulatory authority to specify these thresholds and then ensure that they are adhered to. Technological developments or changing usage brought about by liberalisation may mean, however, that at some point these limits no longer satisfy the criterion of efficient use. In order to permit the efficient use of spectrum in such situations, it should therefore be possible to adjust the interference thresholds set by the regulator. In other words, if all those affected agree to a modification, the regulator should accept the change. In this scenario, the role of the regulator is reduced to that of a referee.

2.7 Competition issues

2.7.1 General considerations

Market failure can be caused by economies of scale and scope, external demand effects and restrictions on market access (a consequence of the fact that spectrum is a scarce resource). The *ex post* mechanisms of competition law plus regulatory oversight by the competition authority are, on their own, inadequate for policing markets, especially those that exhibit the above features. This means that *ex ante* regulation is required, particularly when it comes to distributing the scarce resource of spectrum. The design of the assignment mechanism, and of the associated licence conditions or conditions of use, is therefore crucial to the establishment of infrastructure-based competition. The assignment mechanism chosen by the regulatory authority shapes the market structure by dividing up the spectrum and limiting the maximum amount of spectrum any one user may acquire. It is generally believed that the greater the number of spectrum users, the more competitive the market and the less need there is for regulating end users.

Imagine for a moment that all the frequencies available for GSM mobile applications were auctioned in small parcels with no restriction on the maximum amount of spectrum that any one bidder may acquire. It is conceivable that one company might acquire all the parcels of spectrum, resulting in a monopoly of the mobile communications market. Without undertaking an exact analysis as to the likelihood of such an outcome occurring under different types of auction, it is nevertheless true that, according to economic theory, an unregulated monopolist is in a position to make the highest profit and will therefore be willing to pay the most for the spectrum.

Depending on the auction design and the companies' expectations of how the market will be regulated, it is possible that the primary assignment may result in a monopoly situation. However, in order to eliminate the possibility of such an outcome, regulators will rightly devise certain constraints in advance of the assignment process (e.g. creating a certain number of licences with a fixed minimum amount of spectrum).

Efforts to establish a competitive market structure do not stop at spectrum assignment. Unrestricted spectrum trading could be exploited by users acting in concert to create a monopoly or at least a more concentrated oligopoly. Spectrum regulation must therefore be a permanent fixture; the responsibility to counter anti-competitive practices does not end with the assignment process. In an extreme scenario, unregulated spectrum trading might result in all frequencies being transferred to one company, with benefits (and disbenefits) distributed by means of a profit and loss transfer agreement. If competition authorities were then to intervene *ex post*, they would be faced with the difficult task of gathering sufficient information in order to prove wrongdoing.

In the past, it has been assumed that frequency bands are reserved for certain types of use. A liberalisation of spectrum usage rights, however, might also make it feasible to re-designate spectrum for different uses, thereby lowering the barriers to market entry in certain sectors. In the first instance, this would tend to affect those parts of the spectrum that offer the greatest profit potential. If accompanied by a liberalisation of spectrum usage rights, unconstrained spectrum trading can therefore serve to boost competition.

2.7.2 Strategic motives for the acquisition of spectrum, including motives for hoarding

It may be the case that companies who own the right to use spectrum do not actually exercise this right immediately. This typically occurs when companies first enter a market and have yet to acquire a customer base. Nevertheless, it is assumed that the assigned spectrum will be needed at some point in the future.

In contrast, the practice of hoarding spectrum refers to companies that hold unused spectrum which they have no intention of actively using in the future. There are two motives for spectrum hoarding:

- Unused spectrum may held for speculative reasons in order to sell it for a profit at a later date.

- Spectrum may be hoarded in order to prevent others from using it. This may be motivated by anti-competitive considerations.

There are two main determinants that will allow a company to obtain spectrum that it does not actually need and to retain spectrum usage rights. Such a development signals that, firstly, the process of spectrum assignment contains inefficiencies and, secondly, the system of spectrum regulation is ineffective and does not permit the withdrawal of usage rights where spectrum remains unused. If there is perfect information and oversight in the market, an efficient system of spectrum regulation would prevent frequencies from being hoarded in this way. If, however, information and contracts are imperfect, then it is certainly possible that such a situation might arise. Should this be the case, then a company can be in a position where it is holding spectrum but not, in effect, using it. The introduction of spectrum trading creates a particular incentive for the speculative acquisition of frequencies. At the same time, spectrum usage also imposes costs. These are incurred in fulfilling licence conditions and paying one-time and recurring fees.

In a competitive market, companies seek to gain strategic advantages over their competitors. Spectrum owned by one company cannot be used by another and, owing to the fact that spectrum is generally a scarce resource, this means that, in economic terms, a strategic decision to hold spectrum has a negative external effect on the competition. Imagine, for instance, that all the spectrum allocated for GSM was assigned to individual mobile network operators and that, although two of the companies have a combined market share of almost 80%, the spectrum was distributed equally to all operators. This may result in the market leaders experiencing bottlenecks in capacity at certain times and in certain regions. This could be avoided either by investing in additional network infrastructure in order to divide the network into smaller cells, or by using more spectrum. In our scenario, however, the smaller network operators have fewer users and could therefore afford to lease spectrum to the market leaders, at least for a limited period. Although a commercial leasing arrangement along these lines would generate additional revenue for the smaller operators, they may nevertheless reject such a deal. In so doing, their strategic thinking would hold that a deterioration in the quality of the market leaders' networks should prompt some customers to switch providers.

The introduction of spectrum trading might conceivably result in a middleman acquiring all the spectrum that is available at a low price, before engineering artificial scarcity in order to resell the spectrum at a high price and thereby make a profit. This type of

behaviour can be prevented by means of carefully drafted licence conditions that include the option of withdrawing usage rights, as well as by other provisions.[19]

2.7.3 Tools to prevent anti-competitive behaviour

Anti-competitive behaviour, in the form of an "excessive" acquisition of spectrum, can be prevented in different ways using the following tools:

- Spectrum caps
- The regulatory authority establishes rules that specify how spectrum trading should take place
- Trades or transfers of spectrum are subject to approval by the regulatory authority

The German Telecommunications Act contains provision for all three of these instruments, which can be employed by the national regulatory authority (NRA) to ensure that competitors, whether already in the market or seeking to enter, are able to gain access to the scarce resource of spectrum. Spectrum caps have already been used in the USA; they place restrictions on how much spectrum a company may acquire in a particular range (e.g. a mobile communications company may acquire at most two 20 MHz bands in the 900 MHz range). If the NRA employs an *ex ante* mechanism, its object will be to restrict the transfer arrangements so that issues of excessive market power never arise. Finally, by making transfers subject to its approval, the NRA is able to examine competition issues before giving the go-ahead. The NRA consequently has sufficient opportunity to take adequate account of issues of market power. The choice as to which of the three tools is most appropriate in any given circumstance will certainly depend on the situation in the market, the available spectrum and the extent to which the conditions of use have been liberalised. Furthermore, and although this would be procedurally more difficult, the NRA also has the ability to withdraw spectrum usage rights that are not being used. This gives it the means to prevent companies from hoarding spectrum. A comparison of how equivalent companies in Germany and abroad use spectrum will doubtless offer a useful indication as to whether usage rights are being employed strategically or are simply being hoarded.

---

19 Such conduct may, however, conflict with the Coase theorem, which holds that durable goods monopolists can only achieve a fair market price because they cannot credibly withhold goods for which they themselves have no need. Everyone knows that these goods will be placed on the market at some point and, as the costs of waiting are identical for all parties, it is better for the monopolist to sell all unused goods right away.

The above remarks clearly show that, even under a more flexible regulatory regime, issues of market power will continue to be important. This, however, is not a reason to reject such a regime. In fact, a more flexible approach to spectrum regulation, which not only allows multiple transfers of spectrum but, moreover, is also accompanied by a far-reaching liberalisation of usage rights, would actually tend to diminish rather than amplify potential problems of market power.

It should be noted in addition that competition law also gives the Federal Cartel Office the ability to ban mergers that, in its view, raise concerns relating to competition policy.

2.8 Economic pricing of spectrum usage rights

2.8.1 Principles of spectrum pricing

In its 1993 recommendations[20], the ITU identifies the following key principles for setting spectrum charges. Although these recommendations were drawn up some time ago, the principles remain valid and address almost all aspects of spectrum pricing.

- All spectrum users should pay a charge.
- The spectrum charge should be calculated fairly, i.e. if two users are using the same amount of spectrum in the same way, both should pay the same charge.
- The spectrum charge should be proportionate to the amount of bandwidth used.
- The charges should reflect the spectrum's value to society, i.e. frequencies used for public services should be subject to lower charges.
- The cost of spectrum regulation should not be borne by the state.
- Spectrum users should be consulted about intended adjustments in spectrum charges.
- The pricing structure should be clear, transparent and comprehensive, without unnecessarily lengthening the licensing process.
- The pricing structure should reflect the scarcity of available spectrum and the level of demand for spectrum in different frequency bands.

20 ITU (1993): Spectrum Pricing Study, Communication Study Groups, ITU-R SM.2012.

- The spectrum charge should be calculated so as to recover the costs of spectrum regulation. Spectrum pricing should not seek to maximise revenue for the government.
- The ability to levy spectrum charges should be anchored in law.

2.8.2 Administrative versus incentive pricing

Administrative (cost-recovery) pricing: Spectrum management incurs administrative costs. These result in particular from the process of spectrum assignment, measurements to prevent interference and planning preparations. In accordance with the principle of causation, these administrative costs should be borne by the spectrum users. Administrative charges should therefore start at the level of cost recovery. Although national regulatory authorities generally operate on the principle that charging should at least cover administrative costs, it is difficult to determine to what extent this is achieved in practice. This is due to the fact that there is either no detailed breakdown of spectrum management costs, or that third parties are not given access to this information. In an effort to establish a common framework, a system of cost accounting should therefore be developed in order to apportion administrative costs to individual usages, as far as this is possible. “Overhead” costs should also be identified and assigned to each type of usage in accordance with an appropriate allocation mechanism. At least in some areas, these costs are likely to represent a considerable portion of all administrative charges and, when dividing them up, the scarcity factor and principles of efficient assignment can also play a part. This constitutes a move towards the concept of administrative incentive pricing, which is described in the next paragraph.

Administrative incentive pricing (AIP): Administrative incentive pricing aims to ensure that spectrum is used efficiently, and addresses both static and dynamic efficiency. If spectrum was initially assigned in an economically efficient auction and if the usage rights can then be traded, there is some doubt as to whether charges of this type are necessary if transaction costs are negligible. Imperfections in the auction design, incomplete information and transaction costs may, however, mean that it is advisable to implement AIP so that spectrum is used more efficiently. In addition to the incentive effect, spectrum charges can also be treated as a source of revenue for the government. As a general rule, AIP should result in a higher charge than would be levied under an administrative pricing model. This way, in addition to shaping market behaviour, it also has an impact on the public finances.

There are a range of methods for determining the economic value of spectrum usage. One such method is to calculate the discounted cash flow (income minus expenses) of an assigned right of use with regard to the business model of which it forms a part. Alternative methods focus on the relative costs of using other services or technologies. Ideally, it would be possible to calculate the precise opportunity cost, which represents

the economic value associated with the best alternative use of the spectrum. Whichever method is chosen, it throws up numerous questions of methodology and design, to which there are no simple answers. This is likely to result in workable solutions being employed to meet theoretical standards. Furthermore, owing to missing or incomplete information, the figures that emerge will at best be estimates. This means that care must be taken in order not to overestimate the economic value of spectrum usage. Taken to an extreme, this would result in rights of use being overpriced and not taken up by prospective users.

2.8.3 Factors to take into account when calculating spectrum charges

In a recent study, Yu et al identified the following factors that were taken into account by certain countries (UK, Canada, Australia, Korea, Singapore, France and Israel) when setting spectrum charges:[21]

Bandwidth (spectrum endowment): The amount of bandwidth is generally a good proxy for the amount of resource being used. In view of the scarcity of the resource, the charge should rise in line with the bandwidth.

Field strength: The strength of the field generated by a base station determines the area within which nobody else can use that spectrum. This is therefore a good measurement of de facto spectrum usage.

Geographical area: The spectrum charge may depend on the region in which the frequency bands can be used. The calculation will take account of regional population density and income levels, whereby the value of the spectrum usage right will rise in line with the region's economic appeal, measured in terms of the people who live there.

Frequency band: It becomes more difficult to transmit signals at the higher end of the radio spectrum. In order to encourage greater use of this part of the spectrum, some countries create an incentive by gradually lowering the usage charge at higher frequencies.

Exclusive rights vs. commons model: The spectrum usage charge reflects whether one user has an exclusive right to use the spectrum or whether there is open access.

Duration of access: The spectrum usage right may be granted on a permanent basis or may only be valid at certain times. The charge generally increases in line with the amount of time during which the spectrum may be used.

---

21 Hsiao-Cheng Yu, Zon-Yau Lee, Hung-Yuh Lee (2004): Revising Taiwan's frequency usage fee regulation, Telecommunications Policy 28 (2004), 679–695.

Transmission/reception: Stations may be configured to both send and receive radio signals, or they can be used solely for reception. In the latter case, there will typically be no charge.

Services: The economic value of spectrum usage depends on the services that can be provided using that spectrum. This is reflected in administrative incentive pricing.

Supply and demand: There are tremendous variations in supply and demand for particular frequency bands. AIP takes this into consideration.

Specific applications: Spectrum used in the public interest, for instance by security services, emergency services or defence forces, will usually be subject to a far lower charge.

3 Underlying legal conditions under the TKG

The new *Telekommunkationsgesetz* (TKG – German Telecommunications Act) creates the framework in which a more flexible system of spectrum regulation can be structured. The key legal provisions for spectrum policy are set out in sections 52 – 65 of the TKG. According to these sections, the primary objective of spectrum regulation is to ensure efficient, undisrupted spectrum use, with the further objectives detailed in section 2 (2) of the TKG also applying. In view of spectrum policy, these are securing fair competition and promoting telecommunications markets with sustainable competition in services and networks and in associated facilities and services, in rural areas as well.

As a result, spectrum use is primarily determined by the following three stages:

- The National Table of Frequency Allocations
- The Frequency Usage Plan
- Frequency assignment.

We already discussed the main characteristics of these three stages in the previous section on national conditions of use.

Once assigned, spectrum can be assigned to other users at a later date in various manners. There are various possibilities for this:

- Spectrum usage rights are withdrawn or revoked (example: WLL spectrum) if these are not used or not efficiently used.
- Spectrum usage rights are restricted to specific bands and are then extended or re-assigned, not necessarily to the previous user (e.g., UMTS spectrum usage rights have a limited term of 20 years).
- Spectrum usage rights are voluntarily returned to the Federal Network Agency (e.g., C-Network spectrum)
- Spectrum can be transferred (WLL spectrum)
- Spectrum can be traded (no example to date).

Within the meaning of section 55 (7) of the TKG, *spectrum can be transferred*, to the extent that this does not distort competition in the relevant market and if efficient and interference-free use can be secured. This can occur via singular or universal succession to an associated company within the meaning of section 15 of the *Aktiengesetz* (AktG – German Public Companies Act), from an individual to a legal entity in which the individual holds an equity interest, or as inheritance.

Spectrum trading: After hearing the parties concerned, the Federal Network Agency may release frequency bands for trading and stipulate the framework conditions of and the procedure for trading when there is interest in trading usage rights for the spectrum concerned. According to section 62 of the TKG, the framework conditions of and the procedure for trading must ensure, in particular, that spectrum efficiency is increased or maintained, that the original award proceedings do not preclude frequency assignment after spectrum trading, that no distortion of competition in the relevant product and geographic market is to be feared, that other legal framework conditions, in particular the conditions of use and international agreements on spectrum use are complied with, and that the regulatory aims according to section 2 (2) of the TKG are secured (however, to date no spectrum band has yet been identified in which spectrum trading can take place).

The above comments show that according to the new Act it is possible to flexibly change spectrum usage rights either via transfer or via spectrum trading, however the model for this has still to be determined by the national regulatory authority. The conditions of use can also be structured liberally in the Frequency Usage Plan or also in the assignment rules.

In addition to purely economic issues, however, other criteria must also be taken into account for spectrum use. To ensure that public requirements – relating to social, cultural or meritorious issues or defence policy – are guaranteed, corresponding spectrum must be reserved for these purposes.

4 Country studies regarding flexibilisation of spectrum regulation

4.1 United Kingdom

4.1.1 Spectrum regulation model in the United Kingdom

4.1.1.1 Fundamental considerations by the UK frequency regulation authority[22]

In the United Kingdom, spectrum is primarily regulated by Ofcom (Office of Communications). Spectrum has been managed in the United Kingdom for around 100 years. The prevailing regulatory approach has been for the national regulatory authority to decide on both the use of a particular spectrum band and which users are allowed to transmit in the band. Although this approach was regarded as being appropriate in the past, it is believed that a more flexible approach is needed due to increased demand for spectrum. The following primary objectives determine Ofcom's Spectrum Management Agenda[23]:

- Ensuring optimum use of the spectrum,
- Considering all needs of spectrum users,
- Maximizing economic welfare.

In so doing, Ofcom attaches particular importance to the two issues of spectrum availability and the current and future demand for spectrum. The external effects of using spectrum must also be considered along side efficient management. In addition, the development of innovative services and competition for electronic communication services also have to be considered.

The national regulatory authority in the United Kingdom has high ambitions for the future, which include developing the UK to become the leading nation for investment and innovation. A uniform market approach aims to bring great planning security. This also entails a flexible system of spectrum management. At the same time, competitive communication markets are to be created, which open up the opportunity of generating a reasonable return on the invested capital. The liberalisation of spectrum usage rights

---

22 Philip Rutnam (Parnter, Competition and Strategic Resources, Ofcom): Spectrum trading and liberalisation: Ofcom's approach in the wider context of spectrum management, BSG Conference " Radio Spectrum Liberalisation and trading in the UK" in London 23 – 24 November. Ofcom (2004): Spectrum Framework Review, issued: 28 Juni 2005.

23 In the following country studies, the term "spectrum management" is often used instead of "spectrum regulation".

and the possibility of spectrum trading aim to create the opportunity to guarantee optimum economic spectrum use thanks to the effect of competitive forces. At the same time, Ofcom also recognizes that it is necessary to ensure that interference does not spiral out of control, that spectrum for essential services, such as emergency services, is available, and that spectrum management is in line with international harmonisation. An adequate spectrum charge policy will complement and support Ofcom's objectives.

The following table lists Ofcom's recent activities with the aim of making spectrum management more flexible:

Table 8: Ofcom's activities to make spectrum management more flexible

Date of publication	Document
November 2003	Consultation on "Spectrum Trading and Liberalisation" by Ofcom and the Radiocommunications Agency (ended in February 2004)
August 2004	Statement on Spectrum Trading
September 2004	Consultation on spectrum liberalisation (ended on November 12, 2004)
September 2004	Draft spectrum trading regulations (with subsequent consultation to 1 November 2004)
September 2004	Opinion on issue of "Ensuring effective competition" consultation to June 2005
November 2004	Publication of Spectrum Framework Review
January 2005	Publication of Spectrum Framework Review Implementation Plan
February 2005	Publication of a statement on "spectrum pricing"
June 2005	Statement on Spectrum Framework Review

Source: Ofcom

Ofcom's spectrum management vision is summarized in Figure 1 below.

Figure 1: Ofcom's Vision

The Ofcom Spectrum Vision

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

Source: Ofcom, Spectrum Framework Review

Ofcom is of the opinion that the introduction of spectrum trading and liberalisation of spectrum use will make spectrum management more flexible.

Spectrum trading: Trading spectrum usage rights between users, so that these can buy, sell, aggregate and disaggregate these rights.

Liberalisation: Users can change the technology or type of use according to their needs.

In Ofcom's opinion, liberalisation and spectrum trading have a positive impact on consumers:

- Lower prices for the most profitable and attractive wireless services, to the extent that more spectrum is available for these applications, which will make competition more intense.
- Greater freedom of choice and innovations, to the extent that alternative companies enter the market by acquiring spectrum usage rights.
- A possible negative effect is believed to be that the opportunity costs for less attractive offerings increase, because these may have to pay a higher price for spectrum usage rights under certain circumstances.

Ofcom gives the following examples of future uses:[24]

24 Summary of the Spectrum Framework Review Statement (http://www.ofcom.org.uk/consult/condocs/sfr/sfr/

- An operator acquires some spectrum previously used for fixed applications and deploys a WiMAX mobile data service, providing multi Mbits/s mobile laptop coverage across major parts of the country.
- Cellular operators gain more spectrum, allowing them to offer a raft of new applications like interactive gaming and personal broadcast services at low cost.
- Emergency services can temporarily use spectrum to enable video from the helmets of fire-fighters and other emergency medical workers to be transmitted.
- Consolidation occurs in the private mobile radio market, resulting in higher capacity service, while reducing operating costs for the likes of taxi companies.

4.1.1.2 Current use of spectrum in the UK

The spectrum which can be technically used is currently between 9 kH and up to almost 100 GHz. The characteristics of radio spectrum vary according to bandwidth. In low spectrum bands, signals can be transmitted over large distances, however it is only possible to transmit a low quantity of data. Substantial quantities of data can be transmitted in high frequency ranges, however the range is comparatively low. Buildings and trees can easily cause disruptions. The prime spectrum is between 100 MHz and 3 GHz, as this range offers the optimum combination of distance and information carrying. The following Table 9 shows the current breakdown of use in the UK.

Table 9: Type of current use of spectrum in the United Kingdom in percent

	0 – 300 MHz	300 MHZ – 3 GHz	3 – 10 GHz	10 – 30 GHz	30 – 60 GHz	Total
Defence	33	21	48	21	28	28
Broadcasting	16	14	0	4	0	2
Mobile	28	20	1	0	0	2
Fixed / Satellite	0	4	33	68	54	53
Aeronautical and Maritime	16	22	16	2	0	3
Science Services	0	2	0	3	11	6
Others	7	17	2	2	7	6
Totals	100	100	100	100	100	100

Source: Ofcom (2005), p. 12

4.1.1.3 Spectrum regulation model

4.1.1.3.1 Rough classification

As a rule, spectrum management systems are initially broken down into to three categories: Command and control, market mechanisms and licence exemption.

Command and control: Under this approach, the regulator decides the specific applications for which the spectrum can be used and who may use the spectrum. This is the traditional regulatory approach which has been used to date for approx. 95% of spectrum in the United Kingdom.

Market mechanism: First of all the licenses (spectrum usage rights) need to be clearly defined. The spectrum usage rights thus defined are then handed over to the market. Upon initial assignment this implies that spectrum usage rights are assigned via an auction (In general, auctions should be used primarily for a repeat (new) assignment of spectrum). Spectrum trading then allows these usage rights to be reassigned.

License exemption (general assignment): Irrespective of technical requirements (in particular with regard to "power levels"), aimed at preventing interference, there are no restrictions on use. This therefore constitutes a general assignment.

In view of flexible spectrum management, this results in the following preference for the three variants. As far as possible, no licenses for use should be required. In other words general assignment should be given general priority. If general assignments are not pertinent, the market mechanism should have priority. This also means that command and control should only be used for spectrum bands in which other methods would cause major problems. This corresponds to Ofcom's perception of itself as being a "light touch" regulator. Admitting the largest possible number of spectrum bands for license-free use or handing these over to the market means that transaction costs for the acquisition of usage rights are kept to a minimum. High transaction costs can also prevent efficient use of the spectrum. Of course this means that spectrum trading has to be simple and transparent.

The following tables provide an overview or an indication of the extent to which these three models are used for spectrum management.

Table 10: Spectrum management model below 3 GHz

	Command & Control	Market mechanism	Licence Exempt
1995	95,8 %	0,0 %	4,2 %
2000	95,8 %	0,0 %	4,2 %
2005	68,8 %	27,1 %	4,2 %

2010	22,1 %	73,7 %	4,2 %

Source: Ofcom, Spectrum Framework Review – Statement (2005), p. 36.

Table 11: Spectrum management model between 3 GHz and 60 GHz

	Command & Control	**Market mechanism**	**Licence Exempt**
1995	95,6 %	0,0 %	4,4 %
2000	95,3 %	0,0 %	4,7 %
2005	30,6 %	61,3 %	8,2 %
2010	21,1 %	69,3 %	9,6 %

Source: Ofcom, Spectrum Framework Review – Statement (2005), p. 36.

4.1.1.3.2 General assignments

Ofcom believes that, due to interference problems, it is illusory to think that the entire spectrum can be made available via general assignment. Applications for general assignment typically only have a short range (less than 100 m). A range of applications of this type are primarily used *at home*: Remote controls for TV, online gaming or cordless phones at home. General assignment would also provide latitude for innovation. Wi-Fi and Bluetooth are examples from the recent past. In general, a maximum range of 200 m between nodes is regarded as being the upper threshold for general assignment, as is the case for Wi-Fi. With regard to demand, Ofcom believes that 800 MHz is sufficient to the extent that data transfer rates of up to 100 Mbits/s are needed. The results are based on studies conducted by Ofcom based on the ITU methodology ITU-R M 1651. At the start of 2005, Ofcom made 535 MHz available in the range of 2.4 GHz and 5 GHz for "common usage". In the range below 1 GHz, a number of smaller bands have been made available for general assignment, which are widely used for telemetry applications. At higher ranges, such as 5 GHz, a larger quantity of spectrum was earmarked for general assignment. However, this range is currently practically unused. In extreme cases, there are only "power limit" requirements for this range. However, these are indispensable if interference is to be minimized.

The spectrum requirement for general assignments should be reviewed from time to time, and, based on measurements and calculations, the respective future requirement should be identified as part of an economic calculation which determines the macroeconomic effects. In doing so, a review is to be conducted for specific spectrum bands, to assess the extent to which these are being overused, and to make a prediction regarding how high the requirement for spectrum in the corresponding area is. It is not easy to measure whether spectrum bands are actually being used. If these are not being used at a specific point in time, this can be due to the fact that the operators are not transferring signals at that point in time, however it is also possible

that the signal does not reach the receiver. This is why it may be that current measurements underestimate the actual level of use of the spectrum band.

4.1.1.3.3 Command and control

In the past and at present, *command and control* was and is the dominant method. Even though it is Ofcom's objective to implement flexible spectrum management, Ofcom believes that, for many applications, the opportunities for implementing spectrum trading and liberalisation are highly limited. This applies in particular to spectrum bands that are fully internationally harmonised or which are used in the public interest for the likes of public broadcasting or emergency call services. The following table lists the services which Ofcom regards as belonging to this category.

Table 12: Current applications where trading and liberalisation cannot be fully applied

Services	Usage and comment
Satellite	The international nature of satellite services and the fact that the frequencies are harmonised internationally limits the scope for allowing change of use in the UK. However, some earth stations use shared bands and there could be advantage in permitting some flexibility.
EC harmonised bands	EC regulation prohibits reductions of the restrictions on permitted use in these bands.
Maritime and aviation bands	The international nature of these bands and the treaties associated with them will prevent reductions of restrictions on permitted use. However there are also some commercial bands (e.g. maritime business radio) which offer some flexibility.
Services operating below 30MHz	Propagation at these frequencies is such that almost all usage will need international coordination.
All broadcasting	Broadcasting is governed by both national broadcasting legislation and a number of international agreements. Technical constraints around broadcasting parameters are also problematic.
Radio astronomy	Radio astronomers need access to particular protected frequencies and work on an international basis.
Radio amateurs	This is a use of the spectrum where there is an operational need for harmonisation on an international basis.

Source: Ofcom Spectrum Framework Review, p. 25.

To the extent that certain major events require a large amount of spectrum, it may be that the market mechanism does not guarantee that sufficient spectrum usage rights can be acquired. For these cases, Ofcom believes that it is necessary to use supplementary spectrum management instruments.

4.1.1.3.4 Market mechanisms

Auctions are to be used for the remaining area, trading is to be approved, and the usage rights are to be kept as open as possible.

Spectrum usage rights that are to be newly issued or re-issued by the authorities should be assigned via an auction if these are scarce. In Ofcom's opinion, the choice of assignment mechanism will depend on the specific characteristics of the spectrum bands. This requires precise logistics and timing for the auction, as well as the definition of a reasonable auction design. In addition, the items or lots to be auctioned are to be precisely defined in view of the bandwidth, the spectrum mask, geographic use, etc. The spectrum has to be formed into packages with a lower and an upper frequency, thus defining the bandwidth. Small packages result in greater flexibility, however these may result in fragmentation of the spectrum. As a result there are trade-offs, which may

not necessarily make it advisable to bundle packages - the aim of ensuring the greatest flexibility. Ofcom's comments in its Spectrum Framework Review clearly show that there are no fundamental changes in the essential issues which must be considered for new assignments via auction. In this case too, it is sensible and necessary to conduct a market analysis in advance, in order to design the distribution mechanism in a reasonable manner. During this process, when determining the elements to be auctioned and the technical requirements, an application will be used as a reference for which it is expected that this is most likely to be used when the spectrum is assigned. The issue of whether spectrum is to be assigned locally would also be determined using this view. As a rule, there is a preference to issue national spectrum usage rights.

4.1.1.4 Indispensable tasks for the spectrum regulator

4.1.1.4.1 Interference management

Ofcom still intends to retain the sovereign decision-making powers for interference caused. Two courses are to be taken to solve the interference problem:

Monitoring system: Ofcom is considering deploying a dense network of monitoring stations across the country, which would seek out unusual activity across the spectrum. In most cases these would be able to pin-point the location of the signal and the type of signal. If there appears to be illegal interference, Ofcom will launch an investigation.

Definition of interference requirements: An interference model which defines the status quo can only be optimized in view of actual use. However, flexible, technology-neutral license conditions will not stipulate actual use in detail. In view of this, when defining the interference model, an outline of the most probable uses or the greatest causers of interference must be drawn up, at the same time bearing in mind that other uses are also possible.

Arbitration role: If holders of spectrum usage rights have a case of interference that they are unable to resolve themselves, Ofcom will work to identify the cause of the interference and be the final arbiter as to who is at fault.

Interference with neighbouring countries: Ofcom will continue to reach clarifying agreements with neighbouring countries.

4.1.1.4.2 Promoting innovations

One of Ofcom's most urgent tasks is to stimulate innovation. The UK spectrum regulator believes that this task is primarily to be achieved by using market mechanisms to

regulate spectrum use and also by allowing spectrum bands to be used without licensing. The latter would allow, in particular, the spread of technologies with low-power signals, such as WiFi.

4.1.1.4.3 Management of jointly used frequencies

In certain areas, Ofcom intends to clearly define usage rights for joint use, and then to authorize spectrum trading. Either *band managers*, free use or overlay auctions will be established as management instruments on a case-by-case basis.

4.1.1.4.4 Harmonisation of spectrum use

Harmonisation means the identification of a joint spectrum band for a certain region, (e.g. Europe) as well as a specific application and, in some cases, also the identification of a specific technical standard (these are normally developed by ETSI and IEEE in Europe). As a rule, Ofcom is of the opinion that a combination of standardization and harmonisation can bring a range of benefits. These include, for example, reduced interference, lower costs for end terminals as a result of positive economies of scale, greater forecasting security for terminal manufacturers and the possibility of international roaming. In some areas, such as aviation and shipping, a harmonisation of mobile applications is indispensable to ensure technical interoperability. GSM is typically regarded as being a successful example of European harmonisation. In contrast, ERMES is a negative example, as the paging service was not able to become established in Europe. In particular, harmonisation is also required if specific spectrum bands are to be available for general assignment. This would allow the industry to quickly test its technology supra-nationally.

Ofcom's long-term objective is that harmonisation be primarily determined by the market with minimum regulatory intervention. At the same time, Ofcom is aware that this is only possible if a critical mass of countries have established market mechanisms in the respective spectrum bands. In the transitional phase, Ofcom will actively participate in international harmonisation negotiations.

The following aspects are important for the success of harmonisation efforts at CEPT and the European Commission:

- Technology-neutrality and application-neutrality as well as flexibility, so that other uses of the spectrum band are not precluded. However, technical compatibility is indispensable, as is the prevention of interference.
- The conventions agreed should be periodically reviewed to bear out market developments. This applies, in particular, if the application for which

harmonisation was primarily put in place, was not able to succeed on the market.

- *Sunset provisions*, so that harmonisation ceases after a certain period and market forces re-determine the use of the spectrum.
- An advance cost/benefits analysis is regarded as being a must-have to legitimate the harmonisation decision. This applies in particular if harmonisation takes the form of exclusive access for specific applications or a specific standard.
- Harmonisation, so that exclusive access for specific applications or standards is defined for specific spectrum bands, should be the exception rather than the rule.

4.1.1.5 Ofcom's opinion on dividing spectrum

The traditional manner of dividing spectrum is to break down the usable spectrum range into discrete spectrum bands.

In addition, certain spectrum bands are then divided geographically or using an angular basis (one operator may be assigned a fixed link starting from a particular mast and pointing, say, North, whereas another operator might be assigned a link from the same mast but pointing East.)

New technologies such as Ultra Wideband (UWB) and Software Defined Radio (SDR) generally allow parallel use of specific spectrum bands. This brings up the issue of whether further dividing spectrum usage rights makes sense from a regulatory perspective.

UWB is a technology with which a spectrum can be broken down with regard to the transmission power. This would mean that transmission level 1-5 can be assigned to one user, with transmission levels 6-10 assigned to another user. Ofcom does not believe that this type of approach is suitable, as higher transmission levels cause stronger interference for lower transmission levels. If possible, given the boundaries, Ofcom believes that such a breakdown of usage rights could be performed by an independent, third-party band manager. This manager would have more specific knowledge and a higher incentive or responsibility to secure user interests.

Software defined radio (SDR) Radios have been developed which can scan various spectrum bands, make use of specific spectrum bands and, if required, change to another spectrum band. From a technical standpoint, a system which works on this basis requires central management by the owner of the usage right. As a result, Ofcom believes that this type of system should be implemented de-centrally by users. Ofcom

will continue to track the development of this technology, and if required it will identify bands in which this system could work well. In Ofcom's opinion, these will mostly be bands in which there are strong temporary usage fluctuations, such as spectrum bands which are used for emergency call services.

At the end of the day, this shows that Ofcom is currently adhering to the traditional approach of dividing spectrum.

4.1.1.6 Perceived risks of more flexible spectrum management

The following Table 13 lists the risks of introducing a more flexible system of spectrum management.

Table 13: Risks of more flexible spectrum management

Area of risk	Possible effects	Mitigation
Market mechanisms applied too widely	Subsequent change of use breaches international agreements. Increased interference results	Ofcom will check international agreements before making licences tradable. Careful introduction of liberalisation to allow the interference risk to be assessed.
Market mechanisms not applied widely enough	Potential benefits of trading not fully achieved. Distortion of competition in the case that competing providers have differing abilities to trade.	Ofcom will make trading as widely available as possible. Ofcom will consider all competing users of spectrum and ensure a level playing field as far as possible.
Insufficient spectrum available for licence-exempt use	Congestion in existing spectrum, reducing benefits to users. Lack of innovation.	Careful and periodic monitoring of spectrum available for licence-exempt use to understand how usage is growing.
Excessive spectrum available for licence-exempt use	Spectrum unused or little used with resulting loss in potential economic value.	Release spectrum available for licence-exempt use carefully and in stages to avoid excessive supply.
Changes to harmonisation	UK moves out of line with other countries. Valuable services not launched because of inability to harmonise.	Monitor international harmonisation and any UK differences and evaluate whether they require corrective action.
Market failures	Abuse of market power. Transaction costs	Use competition powers. Intervention to clear spectrum, overlay auctions, spectrum efficiency grants.
Disruption to customers	As spectrum is traded some services may be withdrawn with subsequent disruption.	Limited action from Ofcom – this is part of a standard market and would not normally require intervention.

Source: Ofcom (2005), p. 54

4.1.1.7 Simplified licensing model in specific bands

Aviation and maritime licenses for on-board equipment

Full de-regulation is not possible due to international requirements. A consultation is currently underway for maritime licenses, a consultation for aviation licenses is planned for winter 2005.

Amateur radio

The basic licensing model should not be changed. It is being considered whether it should be possible to apply for a lifetime license online free of charge. Ofcom believes that it will continue to be responsible for providing frequencies for radio amateurs and representing their interests in international forums.

On-site business radio

A consultation is intended for this area for autumn 2005. Ofcom believes that it is certainly possible to have stronger de-regulation in this area.

4.1.1.8 Publicly accessible information on spectrum use

Ofcom has a commitment to publish the *UK Plan for Frequency Authorisation* (UKPFA). This aims to show for which specific purpose spectrum can be used, and which spectrum is available for assignment (see Communications Act).

According to the *Radio Spectrum Decision*, a spectrum plan must be published which includes data-based tables with designated purposes. The *Frequency Allocation Plan*, which was published in December 2004, includes the spectrum and the associated license classes as basic data. It is now intended to also include in this plan the type of license classes that can be traded, as well as links to new license registers and links to license information (e.g. methods that can be used to obtain a license, coordination requirements, rights and commitments, spectrum charges to be paid) and the commitments that must be upheld for general assignments.

4.1.2 Liberalisation of spectrum use[25]

4.1.2.1 Basic comments

Ofcom has statutory duties under the Communications Act 2003 to further the interests of citizen-consumers in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by promoting competition, and to secure optimal use of the radio spectrum. As a result, Ofcom believes that it has a commitment to modify spectrum availability to current and future demand. Competition,

---

25 Ofcom (2004): Spectrum Liberalisation – A consultation on proposals to reduce or remove certain restrictions on spectrum us; Consultation document 17. September 2004.
Ofcom (2005), A statement on spectrum liberalisation, Implementation in 2005, 26. Januar 2005.

innovation, and, at the end of the day, the welfare of end users will be furthered by efficient management.

In the past, the *command and control* approach meant that the manner in which spectrum could be used was regulated down to the last detail. This included the application for which the spectrum can be used (e.g., mobile access, terrestrial point-to-point links, etc.); spectrum use, technology to be used, transmission strength, localization and the height of the transmission masts, spectrum and bandwidth. Liberalisation means removing and reducing these restrictions on usage. To the extent that liberalisation and spectrum trading are to be introduced in parallel, these allow the migration of spectrum usage rights to more efficient uses. This boosts efficiency, furthers innovation and makes competition more intense. However, in so doing, it must be considered that specific restrictions are necessary to avoid harmful interference, while other requirements are necessary to satisfy international agreements and farther-reaching political objectives. In this regard, in particular, it must be considered that usage rights should continue to be harmonised as far as this is pertinent. For example, this is the case if significant positive economies of scale result, thus avoiding competition between standards which results in resources being wasted.

Ofcom believes that the objective is to reduce restrictions on spectrum usage as far as possible – thanks to the light-touch approach to regulation described above.

The liberalisation of spectrum usage rights is legitimized as follows in terms of regulatory economics:

- Users have better information than central regulators regarding their own costs and preferences. They have a stronger incentive to react to the situation in the market so that frequencies are used efficiently.

- Market mechanisms are better than administrative processes at allocating spectrum to efficient use.

- Market mechanisms react faster to changes in the market situation, making spectrum available for innovations and efficient uses. At the end of the day, only successful ideas will survive on the market.

- However, it is important that, in addition to the liberalisation of spectrum usage rights, spectrum trading is possible, administrative incentive pricing (AIP) is used and the spectrum is originally assigned via auctions.

4.1.2.2 Ofcom's fundamental considerations on liberalisation

- *Harmonisation:* Ofcom believes that industry is also able to define standards in a cooperative manner using negotiations, so that harmonisation will also occur decentrally if there is a strong incentive for this.

- *Implication for competition:* Ofcom believes that liberalisation furthers competition. In the widest sense, liberalisation means that there is more spectrum available for applications that are in great demand. Market entry and market exit are intensified in connection with spectrum trading. As a rule, a negative impact on competition is not ruled out, however this is regarded as tending to be the exception. In these cases, a possible market failure can be combated via competition law.

- *Interference and quality standards:* Ofcom believes that there have to be sufficient protective provisions to minimize interference. The current Technical Frequency Assessment Criteria (TFAC) are believed to provide a sufficient basis for the SQBs (spectrum quality benchmarks). TFAC are based on technical calculations, which are based on model calculations that do not necessarily reflect what happens in reality. In the near future, technical details are to be published as part of the "liberalisation guidance". To the extent that, as a result of a change to the license, emission levels lead to higher interference in neighbouring frequencies than had originally been predicted, Ofcom undertakes to react within 24 hours where life-saving services are affected. The deadline is five days if commercial activities are affected. In addition, Ofcom is planning technical assistance to aid users or potential users in applying and interpreting TFAC. TFAC are to be used as an SQB that serves as a basis when Ofcom assigns and implements technical standards. Current emission levels should not represent the standard, as lower interference may also be caused by lower use of the neighbouring frequencies. The TFAC's technical standards should be reduced more sharply over the medium term.

- As a rule, Ofcom prefers to define emission rights in terms of a maximum power level within geographic boundaries, and not by defining the locations and technical specifications of the transmission antennae. However, this approach is not suitable in certain cases, in particular if a large number of licensees only use a small spectrum band or operate within very tight geographic boundaries. In addition, defining boundary conditions and spectrum masks is also not sufficient to guarantee a certain spectrum quality. In these cases, it may also be necessary to make stipulations regarding transmission masts.

- *Predictability and forecasting security:* The issue of spectrum quality is relevant, irrespective of the liberalisation process. Theoretical forecast models are incomplete as a result of existing uncertainties. For example, devices which are

not directly frequency related, such as computers and microwave ovens, can affect emissions and thus potential interference. At the same time, Ofcom points out that these uncertainties, which were also relevant in the past, have not prevented companies from making significant investments in networks and services. Nevertheless, Ofcom will do everything in its power to keep this uncertainty as low as possible.

- *Consultation process:* To ensure that the liberalisation process does not result in exorbitant transaction costs, a public consultation should not be undertaken for each individual change to license conditions. This should only take place for major issues.

4.1.2.3 Liberalisation

Ofcom is liberalising spectrum management in two different ways. Firstly, by means of changing existing individual licenses. In this case, license holders can apply for a change to the usage conditions or requirements with regard to the technical parameters for their license(s). This type of application can be filed by the current user, in order to sell this license or to allow other use. Changing the existing individual license conditions upon request gives Ofcom greater control of the interference potential, however it creates insecurity for the applicant as a result of the uncertain outcome, which is only revealed with Ofcom's final decision. This approach is also linked to high administrative costs. The second course of action is to generically change the license conditions. This type of approach has the aim of generally making license conditions as flexible and technology-neutral as possible. It creates greater forecasting security and is associated with lower transaction costs for those concerned. However, the definition of technology-neutral and use-neutral emission rights brings up complex, challenging issues. When spectrum usage rights are liberalized, Ofcom will perform a detailed review of compatibility with international commitments (i.e., directives and harmonisation agreements at a European level, ITU Radio Regulations), statutory obligations, directions from the secretary of state and general statutory principles. When reviewing whether it is possible to liberalize usage provisions, Ofcom will use benchmarks for spectrum quality with regard to interference. Ofcom will initially start with the initial liberalisation approach – variation of existing individual license conditions.

As a rule, Ofcom will proceed cautiously and carefully by initially only considering individual areas, and then dealing with changes to license conditions in these sectors only. A fundamental revision of spectrum usage rights is not planned until a later date, and will be based on the experience gained up to that point.

The extent and date of liberalisation will thus vary from license class to license class, depending, for example, on the practical viewpoint, the complexity of the coordination required and the ability of users to solve interference issues.

Steps to liberalisation:

- Some specific changes to individual licenses at Ofcom's initiative;
- Some specific changes to individual licenses upon application;
- Change to entire classes of licenses with reduced technology requirements and restrictions on use;
- Publication of guidelines for license holders in view of acceptable interference (spectrum quality benchmarks), which are to be used as a standard for intended changes to the use restrictions or as a reference in the event of complaints to Ofcom.

Ofcom launched the liberalisation process in 2005 in three license sectors: Business radio, fixed wireless access and fixed links. The following table shows Ofcom's liberalisation efforts for the coming years.

Table 14: Liberalisation timetable

Phasing and timescale	Liberalisation
Phase 1: early 2005	Any change of licence class by licence variation between the following licence classes within each of the following sectors: • BR sector: analogue PAMR, Data Networks, National Paging, National and Regional PBR classes • FWA sector (all classes) • FL sector (all classes) Other proposals welcome • But it may take longer to assess whether they will cause excessive interference to other legitimate users
Phase 2: late 2005	Greater flexibility in BR within fewer but broader licence classes • Extend liberalisation to wide-area PBR and CBS
Phase 3: beyond 2005	• Change within 2G/3G bands • Change to 3G use in bands other than those allocated to 3G • Change to mobile in FWA bands
	• Radical reform of licences to be technology-neutral and flexible

Source: Ofcom Statement on Spectrum Liberalisation 2005, S. 3

Ofcom's detailed liberalisation plan for 2005 is as follows:

Table 15: Spectrum liberalisation for 2005

Licence sector	Licence Class	Changes to be permitted: licensee, frequency, coverage, illustrative technology and use
Business radio *previously known as Public Mobile Operator (PMO)*	Analogue PAMR	Phase 1 - early 2005 • Liberalised technology through new single Interface Requirement • Change of licence class and type of use within and between PMO and PBR sectors by licence variation (see exhibit 2)
		Phase 2 - late 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning
	Digital PAMR	Later 2005 • Completion of realignment exercise with MoD will enable introduction of trading and liberalisation
	National Paging *420-450 MHz band excluded from proposals because of sharing requirements* *The ERMES paging bands (169 MHz paired with 870 MHz) excluded as all licences have been returned to Ofcom. Use of band currently under review within Europe.*	Phase 1 - early 2005 • Liberalised technology through new single Interface Requirement • Change of licence class and type of use within and between PMO and PBR sectors by licence variation (see exhibit 2)
		Phase 2 - late 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning
	Data Networks (174-208 MHz) *420-450 MHz band excluded because of sharing requirements* *866-868 MHz band excluded pending consultation on deregulation* *Transfer of rights only for single narrowband licence for asset-tracking at 133 and 146 kHz*	Phase 1 - early 2005 • Liberalised technology through new single Interface requirement • Change of licence class and type of use within sector by licence variation (see exhibit 2)
		Phase 2 - late 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning
	Common Base Stations *420-450 MHz band excluded from proposals because of sharing requirements*	Phase 1 early 2005 • Liberalised technology through new single Interface Requirement • Removal of minimum subscriber requirement

		Phase 2 - late 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning
Business radio *previously known as Private Business Radio (PBR)*	National & Regional Private Business Radio *420-450 MHz band excluded from proposals because of sharing requirements* *Licences in this class held by the emergency services will not be subject to trading before 2006*	Phase 1 - early 2005 • Liberalised technology through new single Interface Requirement • Change of licence class and type of use within and between PMO and PBR sectors by licence variation (see exhibit 2)
		Phase 2 - late 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning
	Wide area PBR	Phase 2 - late 2005 • Licence classes and licences simplified to offer greater flexibility on use • Geographical partitioning and more flexible frequency partitioning
	On-Site PBR	Phase 2 - late 2005 • Liberalised technology through new single Interface Requirement • Licence classes and licences more usage-neutral
Fixed Wireless Access	3.4 GHz	Phase 1 - early 2005 • Liberalised technology for fixed use • Flexible frequency and geographical partitioning through partial transfer • *Further liberalisation discussed in SFR:IP*
See SFR:IP for discussion of future use of other FWA bands at 10 and 40 GHz	3.6 GHz	Phase 1 early 2005 • Liberalised technology for fixed use • Flexible frequency and geographical partitioning through licence variation • *Further liberalisation discussed in SFR:IP*
	28 GHz	Phase 1 early 2005 • Liberalised technology for fixed use • Flexible frequency and geographical partitioning by partial transfer
Fixed links	Scanning Telemetry	Phase 1 - early 2005 • Technical change by licence variation
		Phase 2 – late 2005 • Consider liberalisation of technology

	Point-to-point fixed links	Phase 1 - early 2005
		Phase 2 - late 2005 • Examine on-line application for change of licence characteristic
	32 GHz	Phase 1 - early 2005 • One-third of 32 GHz band currently used for point-to-point fixed links will be liberalised to the same extent as other terrestrial fixed link spectrum
		2005 and beyond • Two-thirds of 32 GHz band is currently vacant • *Future use under consideration – see SFR:IP*

Source: Ofcom (2005), Statement on Spectrum Liberalisation 2005, p. 33

To date, there was one license class in each case for analogue PAMR, public mobile data, national and regional PBR and for national paging. These are now to be specified as shown by the following table:

Table 16: Liberalisation of business radio

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

Source: Ofcom (2005), Statement on Spectrum Liberalisation 2005, p. 34

4.1.2.4 Spectrum management and liberalisation plans for specific areas[26]

4.1.2.4.1 Spectrum band 1781.7 – 1785 MHz coupled with 1876.7 – 1880 MHz (GSM/DECT guard bands)

These bands were identified for the provision of mobile telephone services based on GSM technology in the ERC decision (95)03. When, at that stage, GSM frequencies were assigned, the prevailing opinion was that these bands were necessary as a guard to prevent interference between GSM 1800 services and DECT systems. According to the latest analyses (ERC Report 100 and Ofcom's own analyses), it is no longer necessary for these frequencies to act as guard bands. The 1781.7 – 1785.0 MHz range is currently being used by the Ministry for Defence to a certain extent. The military uses transmitting earth stations in Menwith Hill (Yorkshire), Oakhanger (Hampshire) and Colerne (Wiltshire) in these bands or neighbouring bands. Any commercial use of these bands must accept the implications which go hand-in-hand with this use.

As part of a consultation on these bands, the Radiocommunications Agency (RA) has put forward three scenarios for discussion :

- Provision of frequencies – nationally or regionally – for GSM providers or a newcomer to make offers to public mobile telecommunications services;
- Provision of frequencies for short-range, *low-power use* by means of a license-exempt general assignment;
- Not using the spectrum band, in order to make the migration of GSM 1800 to IMT-2000 applications easier.

In this context, a NERA study has been commissioned. This came to the conclusion that the second alternative is the best, generating an economic value of £ 943m, as new, innovative services would emerge. However, Ofcom came to the conclusion that coordinated behaviour is necessary, as the risk of interference is otherwise too high.

In its Implementation Report (2005), Ofcom now represents the following opinion:

A small number of "low power licenses" are to be assigned, with the number being between 3 and 6 licenses. All licenses have joint access to the total spectrum band in the same manner – no license has priority over any other license. To minimize interference, all licensees are to coordinate their use with each other. Ofcom's role is limited to acting as an arbiter in case of conflict. The type of services and technology

---

26 Ofcom (2005): Spectrum Framework Review: Implementation Plan, Januar 13, 2005

are not to be prescribed - only *power limits* are to be set. Trading with licenses is to be permitted. If one company holds all licenses, or if the number of licensees is low, "high power use" may also be possible in certain circumstances.

This should allow the introduction of a range of innovative services. The low number of licenses aims to make coordinated behaviour possible, so that interference is kept to a minimum. Tradability of licenses in connection with the opportunity for "high power use" aims to make future market developments possible. In 2005/2006, Ofcom intends to assign the spectrum in an objective, non-discriminatory, reasonable and transparent manner.

4.1.2.4.2 Spectrum band 1790 – 1798 MHz

These 8 MHz can best be used for mobile applications. This spectrum is close to the range which is used for 2G and 3G mobile telecommunications, which can used for both fixed and mobile applications such as WiMAX (IEEE802.16) and mobile broadband services (IEEE802.20). At present, however, this spectrum is used by emergency services (police, fire brigade and rescue services) in England, Scotland and Wales. The spectrum is currently used by an out-of-date analogue technology to establish long-distance point-to-point radio connections. Ofcom intends to develop a plan as to how this spectrum can be made available. A new consultation is intended in this regard. It is intended to make these bands available in the period 2007/2008 via an auction.

4.1.2.4.3 Spectrum band 2010 – 2025 MHz

This spectrum band is currently available for non-licensed use, with it being possible to use self-provided services that are self-coordinated and belong to the IMT 2000 family. When the UMTS licenses were auctioned in 2000, it was pointed out that this band would initially not be available for a 3G auction.

This band was classified at a national and international level as being suitable for 3G services. It can also be used by fixed and mobile applications such as WiMAX and mobile broadband. This spectrum band is subject to a range of international and national rules. At present this band is dedicated as IMT-2000 TDD spectrum. It is expected that, by the end of 2005, there will be clarity surrounding future use at an international level.

In addition, however, Ofcom intends to issue one or two national (UK) licenses. The technologies and services which can be used are not to be restricted. However, they should be compatible with the spectrum masks which have been set up for the IMT-2000 family. The restrictions are to be kept to an absolute minimum to guarantee the most efficient possible use. Further studies by Ofcom are planned to identify the best

business applications. The results are to be used as a basis to tie up spectrum packages and specify license conditions and the assignment method. In addition, Ofcom intends to auction these spectrum bands in parallel with the spectrum band 2290 – 2302 MHz. This will allow users to create spectrum that they have paired themselves. This type of auction is to be expected at the earliest in 2005/2006.

4.1.2.4.4 Spectrum band 2290 – 2302 MHz

Historically, this band was used by the military, which has now released this band. The band is currently unused. At an international level, the 2290 – 2300 MHz band is reserved for fixed and mobile services, with the exception of aeronautical mobile and space research applications. In the 2300 – 2302 MHz band, the latter is allowed but not possible in the UK. There are no harmonisation agreements at a European level. Ofcom regards this band as being best suited for fixed and mobile services such as IMT-2000, WiMAX and mobile broadband access. Issue is planned in line with the 2010 – 2025 MHz range.

4.1.2.4.5 Spectrum band 2500 – 2690 MHz (3G expansion band)

At present, this band is used for radio video links (ENG OB). However, the current user was already instructed by the Radiocommunications Agency (RA) in 2003 to vacate this band by 31 December 2006. At an international level, this band is earmarked as an expansion band for IMT-2000. In Ofcom's opinion, however, there is no technology-based reason why this band should be restricted to this technology. This band is suitable for fixed and mobile applications such as WiMAX and mobile broadband access. Since the WRC-2000 conference, the European Commission has passed two mandates (Requirements 4 and 5) Mandate 4 stipulates that this spectrum is to be assigned at the latest by 1 January 2008. In mandate 5, CEPT is required to create harmonised agreements for this band in Europe. According to the ECC Draft Decision, the following requirements should prevail:

- Spectrum band 2500 – 2570 MHz is paired with 2620 – 2690 MHz for FDD applications.
- The regulatory authority can assign the 2570 – 2620 MHz band either for TDD or FDD. Within this band, guard bands are also defined at a national level.
- The individual block sizes that are assigned are to be a multiple of 5.0 MHz.

Ofcom's opinion

In Ofcom's opinion, the draft does not yet provide the flexibility Ofcom desires. Ofcom would like this band to be open for all fixed and mobile applications, so that in particular WiMAX and mobile broadband access are possible. At the end of the day, only the spectrum masks which are to be defined in the harmonised European approach are to be upheld.

Ofcom agrees with the instructions that 2 x 70 MHz paired frequencies and 50 MHz unpaired frequencies are to be assigned, and that the block size should be a multiple of 5 MHz. In the mobile telecommunications market no company has been identified that has significant market power, as a result Ofcom does not understand why newcomer licenses should be reserved. It is intended to hold an auction in 2006/2007. The precise auction rules, in particular including the size of the spectrum packages to be auctioned, are currently still being discussed.

4.1.2.4.6 Pending assignments and liberalisation in the range above 3 GHz.

The spectrum bands available here (3.6 – 4.2 GHz, 10 GHz, 28 GHz, 32 GHz and 40 GHz) have very recently been mostly assigned for FWA (fixed wireless access). Where this is not the case, the spectrum is used for fixed services and fixed satellite services. The bulk of the spectrum has already been assigned in the past. In the case of renewed assignments, Ofcom will, as far as possible, pursue a technology-neutral, service-neutral approach. In the range dealt with here, this will allow users to offer broadband services for mobile, nomadic and fixed applications. To the extent that previous users wish to trade the spectrum, they can apply for a change to the license conditions in this regard. In addition, it may also be that the current consultation on the issue of ultrawide band (UWB) will impact the spectrum usage rights in the 3.6 GHz and 10 GHz ranges. The spectrum which can currently be used is already causing an increased spread of broadband services. The assignment of 5.8 GHz spectrum has played a significant role in the complementary support of WiFi hotspots and broadband services which are already offered in the non-licensed 2.4 GHz band, as this allows links over greater distances in rural regions. In particular, permission to trade spectrum, where geographic and spectrum division is possible, aims to bring about more efficient use.

4.1.2.4.6.1 Spectrum band 3.6 – 4.2 GHz (3695 – 3875 MHz paired with 4015 – 4195 MHz)

At present, use of this band is split among fixed point-to-point applications (P-P), fixed satellite services and point-to-multipoint fixed wireless access. 2 x 84 MHz have been assigned for fixed wireless access. After the success of the assignment of 15 regional

FWA licenses in the 3.4 GHz band in June 2003 it is now being considered whether to make further bands available for FWA in this spectrum band.

Ofcom intends to make more spectrum available for FWA in a technology-neutral and service-neutral manner. However, this is currently still being discussed, as the operation of satellite reception stations is very intensive and this must continue to be guaranteed. It is not expected for assignment to take place before 2006/2007.

4.1.2.4.6.2 Spectrum band 10 GHz (10.125 – 10.225 GHz paired with 10.475 – 10.575 GHz)

The 10 GHz range is used almost exclusively by the military. The ministry of defence, which administers this range, has made it available for civilian use. Civilian applications that are being considered for this range are FWA and short-range devices (*low-power level* and *flow-detection devices*). In addition, point-to-point telecommunications and program transmission are possible. Ofcom intends to auction this band as a national license in 2006/2007. To the extent possible, the conditions of use are to be designed in a technology-neutral and service-neutral manner. Trading should be possible from that start and include spectral and geographic partitioning. The license holder should undertake to coordinate use with the ministry of defense.

4.1.2.4.6.3 Spectrum band 28 GHz (28.0525 GHz to 29.455 GHz)

In November 2000, and as a result of a lack of demand, again in October 2001, a total of 42 licenses were offered for FWA. The licenses have a term of 15 years and have been tradable since December 2004, with geographic and spectrum division possible. The licenses were already relatively neutral in terms of technology and application, there were no restrictions in view of modulation, technology or antenna characteristics. Licenses were assigned for 11 regions in England, Scotland, Wales and Northern Ireland. The licenses specify in detail the regions in which base stations can be sited, and the technical characteristics of these base stations. Guard bands of 2 x 28 MHz are left between the spectrum assigned to each of the three licenses. The following Table 17 shows the spectrum bands already assigned as well as those still available.

Table 17: Status of available licenses in 28 GHz range

Region	Lizenz 1 (28.0525 – 28.1645 GHz paired with 29.0605 – 29.1725 GHz)	Lizenz 2 (28.1925 – 28.3045 GHz paired with 29.2005 – 29.3125 GHz)	Lizenz 3 (28.3325 – 28.4445 GHz paired with 29.3405 – 29.4525 GHz)
Greater London	Energis Local Access Ltd	Broadnet UK Ltd	Pipex UK Ltd
Greater Manchester	Your Communications Ltd	Energis Local Access Ltd	Pipex UK Ltd
West Midlands	Energis Local Access Ltd	Your Communications Ltd	Pipex UK Ltd
Home countries – west	available	available	available
Home countries – north	available	available	available
East Anglia	available	available	available
East Midlands	available	available	available
Home countries – south	available	available	available
Yorkshire	Energis Local Access Ltd	Your Communications Ltd	available
Northern England	available	Your Communications Ltd	available
South-west England	available	available	available
Scotland	available	Energis Local Access Ltd	available
Wales	available	available	available
Northern Ireland	Energis Local Access Ltd	Chorus Communication Ltd	available

Source: Ofcom

Ofcom intends to make another attempt to assign the spectrum still available at the end of 2005. The underlying conditions, structure of the regions and division of the spectrum are to remain unchanged. General assignment has been rejected as a result of interference issues, in particular in view of the fact that operators have to guarantee their users a certain quality. Individual assignments for base stations using the first-come, first-served principle has been rejected, as assignments of this nature can be better guaranteed via secondary trading in view of minimizing transaction costs. In addition, the regions are structured such that interference is kept to a minimum. There are no restrictions with regard to the service to be provided and the technology to be used. Competition is to be ensured via the issue of three licenses in each region. Assignments are immediate if demand is less than the available licenses. Otherwise, a simple auction – a single-round, sealed-bid auction is being considered – is to be held. The minimum offers are to be significantly reduced.

4.1.2.4.6.4 Spectrum band 40 GHz (40.5 GHz to 43.5 GHz)

This spectrum band is potentially suitable for the provision of multimedia wireless systems (MWS). In June 1999, the ERC dedicated this band to MWS. This is defined as a terrestrial multi-point system which offers fixed wireless access to end customers for multimedia services (ECC/DEC(99)15). It allows higher bandwidths to be made available, which are suitable for TV broadcasting as well as video on demand, games, webcasting, etc. However, a survey of operators showed that they believed that the market will only be mature enough for services of this type from 2005, with the business customer market being addressed far before the private market. During this consultation, which was conducted by the *Radiocommunications Agency* in 2002, the opinion was also expressed that the 28 GHz band should initially be fully used before assignments are made in the 40 GHz range. As a rule, there are various assignment options: Licenses for location-specific point-to-point links, licenses for various systems upon application, licenses for trials, assignment of regional licenses, license-free use and licensing according to a simple assignment process.

Ofcom's objective is to promote the development of new technologies and to investigate development opportunities for new services. As a result, spectrum bands are to be provided flexibly and in a light-handed manner. As a result of uncertainties surrounding development, the original assignment is to have a time limit. A pair of 250 MHz channels are to be made available for the provision of high bandwidths and various technologies. Licenses are to be provided for geographic regions upon application (no exclusive use). There are to be no restrictions on technology or service. Nor are there to be restrictions regarding the number of licenses. Licenses are to be initially assigned for 5 years. Operators are to make detailed reports to Ofcom about their usage, so that Ofcom has a basis on which to make future spectrum assignments in this range.

4.1.2.4.7 Summary

The following Table 18 summarizes the intended liberalisation policy for the selected spectrum bands.

Table 18: Intended liberalisation policy for selected spectrum bands[27]

Band	Proposal	Next Steps	Possible Award Date
Part of 174 - 230 MHz (Band III)	Possible award discussed in full in Radio – Preparing for the future (December 2004)	The band will taken forward in line with the proposals in Radio – Preparing for the future	To be determined
410 - 425 MHz	Award on a service and technology neutral basis	Analyse business potential of the band and technologies that might be employed. Subject to the outcome of that analysis and the current consultation process, preparations will be made for the licence award in 2005/6. If the band is to be auctioned there will be prior consultation on draft Regulations and an Information Memorandum for the auction	2005/6
470 - 854 MHz	To await the outcome of RRC in 2006	Prepare the UK's position for the RRC	To be determined
870 - 921 MHz	As for 410 – 425 MHz	As for 410 – 425 MHz	2005/6
1452 - 1492 MHz (L Band)	Auction on a service and technology neutral basis.	Further analysis of the options and timing for an award in the light of responses to this consultation document. Further consultation is planned for 2005/6 to allow award in 2006/7.	2006/7
DECT guard bands (1781.7 – 1785 MHz paired with 1876.7 – 1880 MHz)	Auction 3 - 6 concurrent low power licences.	Subject to the outcome of the current consultation process, and further analysis, preparations will be made for the licence award probably in 2005/6, with the publication of draft Regulations and an Information Memorandum for the auction.	2005/6
1790 - 1798 MHz	Possible auction on servers and technology neutral basis.	Further discussions with Government users to determine if an award can be made and by when, and in light of this further consultation is planned for 2005/6.	2007/8

27 Ofcom (2005) Spectrum Framework Review Implementation Plan, p. 117.

2010 - 2025 MHz	Auction on a service and technology neutral basis, subject to resolution of EU harmonisation issues.	Further discussions in Europe in early 2005 on harmonisation measures. In parallel analyse business potential of the band and technologies that might be employed. Subject to the outcome of that analysis, the current consultation process and EU process, preparations will be made for the licence award in 2005/6, with the publication of draft Regulations and an Information Memorandum for the auction.	2005/6
2290 - 2302 MHz	Auction on a service and technology neutral basis.	Preparations for an award to be made on same timing as 2010 – 2025 MHz band.	2005/6
2302 - 2310 MHz	As for 1790 – 1798 MHz	As for 1790 – 1798 (see above)	2006/7
2500 - 2690 MHz	Auction on a service and technology neutral basis, subject to resolution of EU harmonisation issues.	Further discussions in Europe in 2005/06 on harmonisation measures. Further consultation planned for late 2005/6	2006/7
3.6 – 4.2 GHz	Make more spectrum available for new services, taking account of the interests of existing users of the band	Clarify current usage of the band and explore regulatory position of receive only earth stations in light of responses to this consultation document. Further consultation planned for 2005/6.	To be determined
10 GHz	Auction on a service and technology neutral basis	Agree with MoD the arrangements for civil use alongside continued military use. Subject to those discussions and responses to this consultation document, prepare to award the spectrum in 2006/7.	2006/7
28 GHz	Award remaining regional licences via an open-ended auction process	Subject to the outcome of the current consultation process, Ofcom's plan is to offer licences for award in, with the publication of draft Regulations and an Information Memorandum for the auction.	2005/6
32 GHz	Auction on a service and technology neutral basis	Consult CAA about its interests in the band. Subject to those discussions and responses to this consultation document, prepare to award the spectrum in 2006/7.	2006/7
40 GHz	Make more spectrum available for new services, taking account of the interests of existing users of the band	Subject to the outcome of the current consultation process, Ofcom's provisional plan is to design and consult on a licensing process to be opened by end of 2005/6.	2005/6

Source: Ofcom 2005/6

4.1.3 Spectrum trading

According to Ofcom's definition[28], spectrum trading means the transfer of rights and the associated obligations to use spectrum. In the United Kingdom, this will allow the license holders under the Wireless Telegraphy Act to sell to third parties one or all of the rights and associated commitments which they hold as a result of their licenses. This allows spectrum to migrate to those users which can use it most efficiently. Spectrum trading is totally voluntary and Ofcom does not force any license holder to trade. At the same time, a range of obligations have to be upheld, for example the obligation not to act outside certain power levels.

4.1.3.1 Implementation timetable

Ofcom intends to implement a differentiated approach; this can include a full or partial transfer of rights or obligations, as well as the facility to have joint usage rights. The following table shows the timetable for the introduction of spectrum trading (Ofcom, 2004, as specified above, p.4)

Table 19: Timetable for the introduction of spectrum trading

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

Source: Ofcom 2004

4.1.3.2 Principles for the introduction of spectrum trading

The introduction of spectrum trading is guided by the following principles:

- Sequential introduction of spectrum trading for specific spectrum bands, as soon as possible.

---

28 Ofcom (2004): A statement on Spectrum Trading: Implementation in 2004 and beyond, p. 3.

- Requirements for spectrum trading are to be as low as possible. A simple, rapid and foreseeable process is to be put in place to implement spectrum trading.

- Transfers are to be transparently designed and should be completed as quickly as possible. Ultimately, spectrum use transfer should be able to happen almost automatically, and it should be possible to trade spectrum using an electronic platform.

- At present, Ofcom does not intend charging a fee for spectrum trading.

- Ofcom's objective is to implement a flexible process for spectrum trading, which creates incentives for investments and innovation. Given this background, it should be possible for industry to develop a wide range of transaction types, which allow a host of commercial arrangements between the parties.

- The introduction of spectrum trading and liberalisation should run in parallel. This implies that the license usage conditions should be designed to be as flexible as possible.

- Not only the full transfer of rights and obligations is to be allowed, but also the partial transfer of rights and obligations. The latter would also include leasing. In addition, as a rule it should also be possible for two or more parties to have joint usage rights to spectrum.

- Existing licenses should be modified. In order to ensure continuity, the spectrum term should generally be unrestricted, with licenses to be withdrawn only in clearly outlined cases with a prior announcement of five years[29]. Ofcom does not believe that a class-specific notice period is in line with the objective of flexible spectrum policy.

- It should also be possible to withdraw spectrum usage rights if required for spectrum management reasons. Reasons for this could be international agreements, political decisions, or instructions by the Secretary of State. However this may also be in order to prevent fragmentation or to fulfil statutory obligations. These conditions are to be specified in each case with the introduction of spectrum trading for the respective licenses.

- Spectrum usage rights for licenses which are assigned as part of an auction are to remain unchanged.

---

29 However, frequencies which are allocated via an auction have different periods of use: 21 years for 3G licenses, 12 years for FWA licenses in the 28 GHz band and in the 3.4 GHz band.

- In parallel to the introduction of spectrum trading, license conditions are again to be subject to a detailed review. All obligations that are no longer regarded as being necessary are to be removed.
- Ofcom intends to publish all of the details of the individual licenses on the Internet (Trading Web Page) as well as in a "register of licenses". In addition, all assignments and transfers are to be made available in the Internet. However, sensitive information, for example concerning trade secrets, is not to be published.
- Spectrum fees are to continue to follow the principle of administrative incentive pricing for both tradable and non-tradable spectrum.
- At the same time, Ofcom believes that, given the current spectrum fragmentation and the current licenses, at present only a low transfer of spectrum usage rights is to be expected.
- As a rule, Ofcom believes that intermediaries can promote trading between partners who would otherwise be difficult to bring together. As a result, these should be encouraged to the extent that they do not establish themselves on the market.
- Ofcom also believes that a series of arrangements for temporary assignment ("hiring arrangements") could also increase the flexibility of use.

4.1.3.3 Methods of transferring spectrum usage rights

Ofcom distinguishes between the three following types of transfer for spectrum use:

Outright total transfer: An outright transfer of all the rights and obligations arising under a licence to a third party.

Concurrent total transfer: A transfer of all the rights and obligations to a third party which results in a concurrent holding of those rights and obligations by the transferor and the transferee(s).

Outright partial transfer: An outright transfer of some of the rights and obligations arising under a license to a third party.

Concurrent partial transfer: A transfer of some of the rights and obligations to a third party which results in a concurrent holding of those partial rights and obligations by the transferor and the transferee(s)

A partial transfer of spectrum usage rights can, as a rule, be linked to spectrum bands or it can also be defined geographically. For example, Ofcom intends to approve frequency trading so that a fixed wireless license holder can sell comprehensive spectrum usage rights for spectrum in the 3.4 GHz or 28 GHz range exclusively for Scotland, although this license holder has a national spectrum usage right for the UK. Ofcom is aware of the fact that other divisions could make sense. However, as part of the license variation process the original licenses would then have to be broken down into at least two parts. Ofcom believes that this dual division process is necessary in order to do justice to the issue of interference.

In addition, it should be possible to transfer rights and obligations for a limited period. However, transfers of this nature should be made subject to the definition of a fixed final date. This allows clear legal determination of the date on which the rights are re-transferred. This would banish any uncertainty which, as a result of unclear contractual agreements, could otherwise result in possible negotiations with an undetermined outcome. It is only intended to transfer spectrum usage rights for limited periods from the current year 2005.

4.1.3.4 Dedicated timetable and launch of spectrum trading

The following tables show when Ofcom plans to launch spectrum trading.

Table 20: Launch of spectrum trading in 2004

Licence sector	Licence Class	Types of Transfer
Public Mobile Operator	Analogue PAMR	Transfer of all rights and obligations and spectrum partitioning to a minimum channel spacing of 12.5 kHz. Geographical partitioning and more flexible frequency partitioning planned for 2005.
Public Mobile Operator	Public Wide Area Paging (National paging)	Transfers of all rights and obligations and spectrum partitioning to a minimum channel spacing of 12.5 kHz in the 153 MHz and 450 – 470 MHz bands. Geographical partitioning and more flexible frequency partitioning planned for 2005. 420 – 450 MHz band excluded from proposals due to sharing requirements. All ERMES paging licences returned to Ofcom. Decision on future of band awaiting European harmonisation developments.

Public Mobile Operator	Public Mobile Data, Non-voice only Operations	Transfers of all rights and obligations and spectrum partitioning to a minimum channel spacing of 12.5 kHz in all bands except 420 – 450 MHz and 866 – 868 MHz. Geographical partitioning and more flexible frequency partitioning planned for 2005. 420 – 450 MHz band excluded from proposals due to sharing requirements. Consultation planned on deregulation of 866 – 868 MHz band.
Public Mobile Operator	Common Base Station Operator	Transfers of all rights and obligations and spectrum partitioning to a minimum channel spacing of 12.5 kHz in all bands except 420 – 450 MHz. 420 – 450 MHz band excluded from proposals due to sharing requirements.
Private Business Radio	National & Regional Private Business Radio (PBR)	Transfers of all rights and obligations and spectrum partitioning to a minimum channel spacing of 12.5 kHz all bands except 420 – 450 MHz. Geographical partitioning and more flexible frequency partitioning planned for 2005. 420 – 450 MHz band excluded from proposals due to sharing requirements. Ofcom will give further consideration to the possibility of permitting trading of licences in this class held by the Emergency Services, and will review options for the introduction of trading in 2006.
Fixed Wireless Access	3.4 GHz	Transfers of all rights and obligations and ability to partition licence geographically and/or spectrally.
	3.6 GHz	Transfers of all rights and obligations
Broadband Fixed Wireless Access	28 GHz	Transfers of all rights and obligations and ability to partition licence geographically and/or spectrally.
Fixed Services	Scanning Telemetry	Transfers of all rights and obligations and spectrum partitioning to a minimum channel spacing of 12.5 kHz.
Fixed Services	Point to Point Fixed Links	Transfers of all rights and obligations under licences and individual links under a licence.
Fixed Services	32 GHz	One third of 32 GHz band currently used for point-to-point fixed links will be made tradable under the same conditions as other fixed terrestrial link spectrum. Two thirds of 32 GHz band is currently vacant and Ofcom is considering appropriate award process for this spectrum.

Source: Ofcom (2004): A Statement on Spectrum Trading, p. 67 et seq.

Table 21: Launch of spectrum trading from 2005

2005	
Wide area PBR	Introduction of MASTS will facilitate trading in this class.
On-Site PBR	Completion of review of on-site services will enable spectrum not identified for deregulation or lighter licensing to be made tradable.
Digital PAMR	Completion of realignment exercise with MOD will enable introduction of trading.
10 GHz	Ofcom is exploring the future use of this band and does not propose to introduce trading before 2005.
31 GHz	Ofcom is reviewing spectrum use of this band prior to developing plans for trading.
32 GHz	Portion of band currently vacant. Expected that tradability will be permissible on issue.
40 GHz	Currently vacant spectrum. Expected that tradability will be permissible on issue.
2006	
Emergency Services	Delayed until questions regarding the future organisation and assignment of spectrum of the emergency services have been resolved.
2007	
PMSE	Ofcom proposes to introduce trading in 2007 though this date will be subject to review nearer the time.
2G and 3 G mobile spectrum	Still under review alongside issues associated with the future of 2G spectrum and release of 3G expansion spectrum.
Aviation and maritime communications	Ofcom, CAA and MCA will work together to decide on the feasibility of trading for ground-based aviation and maritime coastal communication rights of use. A decision will be made by 2007 Trading will be within the constraints of international harmonisation agreements, safety of life considerations, and within principles agreed with sector regulators CAA and MCA.
Radionavigation (radar)	Decision by Ofcom and CAA on the feasibility of trading of radio navigation rights between 2007 and 2009 Trading will be within the constraints of international harmonisation agreements, safety of life considerations, and within principles agreed with sector regulators CAA and MCA.
5.8 GHz Band C	Further analysis has suggested that trading may not be appropriate for this band. Ofcom intends to review this situation in 2007.
Others	
Radio Broadcasting	Current arrangements for licensing radio broadcasting effectively permit the transfer of WT Act licences. This position will be kept under review.
Television Broadcasting	Ofcom will review options for the introduction of trading, once plans for digital switchover are clearer.
Mobile Satellite	Tradability subject to introduction of Recognised Spectrum Access.
Remote Meter Reading	Tradability subject to introduction of Recognised Spectrum Access.
Satellite Shared with terrestrial services	Tradability subject to introduction of Recognised Spectrum Access.

Source: Ofcom (2004): A Statement on Spectrum Trading, p. 67 et seq.

4.1.3.5 Ofcom's role in transferring licenses/spectrum usage rights

4.1.3.5.1 Right of revocation

Transferring licenses or spectrum usage rights requires Ofcom's approval. Ofcom's reasons for refusal are to remain restricted to the following cases:

- If parties are attempting to gain a license which they otherwise would be ineligible to apply for under Ofcom's assignment process.
- If parties are attempting to escape license obligations or enforcement action by Ofcom.
- If Ofcom may have to meet national security concerns, comply with European Community or international obligations or a direction by the secretary of state.

Where a license to be transferred includes a non-spectrum license condition (such as a roll-out obligation) Ofcom will assess the ability of the transferee to fulfil the condition. In addition, it may be that Ofcom only approves a trade under certain conditions.

4.1.3.5.2 Executing the transfer

If satisfied that the parties comply with all requirements for a trade, Ofcom will contact the trade parties and inform them that it consents. Ofcom may request a date by or on which the transfer is to be formally completed.

In the case of a total transfer, Ofcom will then grant a new license on exactly the same terms and conditions to the transferee. In the case of a partial transfer, Ofcom will grant new licences with the appropriate terms and conditions.

Once the transfer has been effected, Ofcom will announce this in a public notice of the transfer and update the "Register of Licenses".

Ofcom does not currently believe that an exclusively electronic trading platform is adequate. However, this is not ruled out for the future.

4.1.3.6 Additional charges in the event of spectrum trading

The license fee or spectrum usage charge payable is not affected by the transfer. Ofcom has decided that it will not charge a fee in the first year in which spectrum trading is launched, however it reserves the right to reassess this position in future. Information on the transfers conducted and the Register of Licenses is available on

Ofcom's website. Service on the website is to be free of charge. However, paper copies are subject to charge in order to cover the additional costs.

4.1.3.7 Spectrum usage charge

Ofcom intends to continue AIP (administrative incentive pricing) even after the launch of spectrum trading. Ofcom believes that, in a market which is not fully effective, AIP will continue to help to promote economically efficient use. Reasons for the imperfection of spectrum trading could be:

- If transaction costs are higher than the difference between the buyer's and the seller's valuation of the spectrum, trades will not take place.
- Asymmetric and incomplete information may also prevent trades that are beneficial.
- Unused spectrum may initially be hoarded for speculative reasons in the expectation of a higher price in the future.

Ofcom is of the opinion that AIP will not have any negative effects on efficient spectrum use as long as this instrument is used in moderation. Ofcom also believes that, in the event that new markets are created, it may be just as pertinent for Ofcom to determine usage prices as it is for companies to determine these.

4.1.3.8 Intermediary spectrum trading institutions

Even if Ofcom does not want to actively promote this type of institution, it recognizes that intermediaries such as brokers or spectrum management organisations can make a positive contribution to effective use of the spectrum. Together with the creation of an open trade model, the creation of this type of institution should also be made possible. A specific licensing model is not believed to be necessary for this type of institution. Market forces, i.e. competition, should decide which institutions become established and which do not.

Spectrum management organisations are companies whose task is to manage specific spectrum blocks in view of spectrum use. At present, there are already organisations of this type in the United Kingdom for TV programme makers and special events, for scanning telemetry and for spectrum used by aviation.

Band managers: Band managers are one variant of the market mechanism. These acquire ownership rights for a specific spectrum band and can then sell or lease the right to use parts of this spectrum to third parties. In Ofcom's opinion, there is currently no empirical evidence of the success of this approach in countries where spectrum

trading is possible. However, license rights are to be designed such that band managers can become institutionalized if the market decides that way.

4.1.3.9 Leasing – temporary spectrum usage rights

As a rule, leasing should be possible for a range of license classes. At present, it is already possible for private business radio suppliers (PBRS). Under such arrangements the license holder retains all legal obligations. Ofcom believes that the following fundamental conditions are required for leasing: Leasing must be agreed for a short period with a fixed, pre-defined final date. License holders who lease spectrum usage rights temporarily must provide Ofcom with detailed information on the lessee upon request. In addition, they must inform the lessee in detail of the license obligations, and without delay should these change.

4.1.3.10 Publication of information

According to the Communications Act, Ofcom has the opportunity to publish specific information which relates to spectrum trading. In this context, Ofcom intends to publish as much information as possible. In general, markets perform better the more information there is available. However, at the same time security concerns and the disclosure of trade secrets must also be considered. As a result, Ofcom intends to find the correct balance between the various aspects. As a rule, information policy falls under the following categories:

- A new register of licenses,
- Publishing basic information about proposed transfers,
- Developing a framework plan for spectrum authorisation,

This basic information is to be interlinked and provided free of charge on Ofcom's website until the end of 2007.

4.1.3.10.1 Register of licenses

The following table shows which information Ofcom intends to publish in this regard. Ofcom will pay attention to ensure that information is precise and up to date.

Table 22: Register of licenses

Information	Description
Licensee's name	Name of the person or company which holds a license
Contact	Postal address, e-mail address, telephone number or agent's contact details
License class	Description of license class that is applicable to the licensee
Limits of spectrum usage rights	Spectrum band and scope for which the licensee has usage rights
Geographic information	Description of geographic area for which spectrum usage rights exist

Source: Ofcom

Initially, Ofcom will not, on its own behest, publish the fact that a license has been withdrawn from a licensee because the licensee did not fulfil the license obligations or did not pay the spectrum usage charge. Measures of that type are only possible with the agreement of the original license holder.

4.1.3.10.2 Information on trades conducted

In view of trading, the following items should be published in advance:

- Details of the license being traded (license class, number of licenses, possible description of the license area),
- License holder's name and buyer’s name,
- Date by which information required by Ofcom must have been provided so that Ofcom can consider whether or not to consent to the transfer,
- Details of a partial transfer.

In addition, Ofcom also intends to publish the reasons for an intended transfer not coming to pass. If a transfer comes to pass, complete information on this transfer is to be available on Ofcom's website for one year, and thereafter it is to be available on request. From time to time, Ofcom intends to publish a report on the subject of spectrum trading.

4.1.3.10.3 UK Plan for Frequency Authorisation (PFA)

This type of plan should clearly show which spectrum and licenses are available and for which different purposes frequencies are made available. The following information is to be published:

- License class,
- License product,
- Availability,
- Description of spectrum band,
- Detailed information on the spectrum charge to be paid,
- License conditions,
- Additional information.

In addition to this essential information, the possibility of making further information available is being considered. This includes radio interface requirements, details of technical usage conditions, details of license products which use the same licenses, international coordination agreements and access to Ofcom's strategic frequency policy papers.

4.1.3.10.4 Monitoring of the market

In addition to the basic information detailed above as part of the trading and license registry, Ofcom intends to obtain additional information from the market on a voluntary basis. In particular, the nature of the contractual arrangements between the trading parties are regarded as being of interest. This data is to be collected confidentially, and published in an aggregated form so that it is not possible to draw conclusions about the original information. This will clearly show trends in spectrum trading.

4.1.3.11 Public consultation about the intended transfer

Ofcom believes that there should only be a public consultation about an intended transfer if competition policy issues are important.

4.1.3.12 Tax issues in connection with spectrum trading

These are not addressed by Ofcom as it is not responsible for this issue.

4.1.4 Interference prevention

4.1.4.1 Fundamental considerations

Ofcom still intends to retain the final responsibility for interference caused. Two courses are to be taken to solve the interference problem:

Active approach: Ofcom is considering deploying a dense network of monitoring stations across the country, which would seek out unusual activity across the spectrum. If there appears to be illegal interference, Ofcom will launch an investigation.

Reactive approach: If license holders have a case of interference that they are unable to resolve themselves, Ofcom will work to identify the cause of the interference and be the final arbiter.

Interference with neighbouring countries: Ofcom will continue to reach clarifying agreements with neighbouring countries.

Interference models can only be optimized with a view towards concrete use. However, flexible, technology-neutral license conditions will not stipulate actual use in detail. As a result, when defining the interference model an idea of the most probable uses must be formed, and at the same time it must also be considered that other uses may arise.

4.1.4.2 Re-oriented definition of spectrum usage rights[30]

In principle, Ofcom intends to approve in future any kind of change to usage that does not cause others any undue interference and which is in harmony with binding national and international undertakings. However, in view of spectrum fragmentation it may be that only a small number of changes are possible in practice.

The definition of these usage rights should, on the one hand, allow the farest-reaching, most flexible use possible, on the other hand current users should be protected against possible interference. It is believed that defining two types of usage rights is one possible approach to deal with this issue. On the one hand, there is to be a "specific" usage right for each spectrum band. In addition, there should also be a "restrictive usage right". The "specific usage right" varies in the various spectrum bands. This is subject to de facto changes as a result of actions or user initiatives. It is so precisely defined that it is apparent if a change of use occurs. The "restrictive usage right" applies to all users and is defined by Ofcom. It is to be defined such that, irrespective of the old or new use, neighbouring users do not experience any additional interference in the

30 Ofcom (2004), Spectrum Framework Review, p. 20

event of a trade or other use. In Ofcom's opinion, "restrictive" usage rights are thus designed for "worst case" use.

In view of the channels currently used for UHF TV and radio, the worst case would be that this (neighbouring) spectrum is used for 3G. "Restrictive usage rights" that might conceivably be applied in this case are listed in the following table.

Table 23: Restrictive usage rights for current radio applications

Description of parameter	Limits of apply
Frequency band owned	Will vary, eg 1,995 MHz – 2,010 MHz and 2,060 MHz – 2,075 MHz
Geographical limits	Will vary, eg UK national boundaries
Downlink Parameters	
Maximum in-band power allowed at > 100 m from mast side	- 41 dBm / 1 MHz measured at 1.5 m AGL
Maximum out of band power allowed at > 100 m from mast side	- 86 dBM / 1 MHz in bands +/- 5 MHz from band edge measured at 1.5 m AGL
Indicative noise floor at > 100 m from a neighbouring mast site	- 83 dBm / 1 MHz measured at 1.5 m AGL
Maximum in-band power allowed beyond geographical limits	- 86 dBm / 1 MHz measured at 1.5 m AGL
Uplink parameters	
Maximum in-band power allowed at > 10 m from a mobile	- 51 dBm / 1 MHz measured at 1.5 m AGL
Maximum out of band power allowed at > 10 m from a mobile	- 95 dBm / 1 MHz measured at 1.5 m AGL
Indicative noise floor at > 10 m from neighbouring mobiles	- 90 dBm / 1 MHz measured at 1.5 AGL
Maximum in-band power allowed beyond geographical limits	- 95 dBm / 1 MHz measured at 1.5 m AGL

Source: Ofcom (2005), Spectrum Framework Review, p. 65.

These restrictive usage rights can be modified by the users to the extent that all of those affected by this type of usage change concur with this type of agreement. For example a mobile network operator will reach agreements with everyone who uses spectrum adjoining their spectrum that is in a range of +/- 10 MHz. Modifications could, for instance, be in line with those that can be found in the 3G licenses regarding the above parameters. Ofcom must be informed of this type of change to the specific licenses, and after reviewing the issue the specific licenses will be changed accordingly.

4.1.5 Ensuring effective competition[31]

According to the European Union's Framework Directive it is Ofcom's obligation to ensure that competition is not distorted by spectrum trading transactions. Ofcom is aware that the transfer of spectrum usage rights could potentially distort competition. Two examples of this are:

- Companies can restrict competition on secondary markets by acquiring spectrum which forms an essential or necessary input for this type of secondary products.
- Intermediaries such as spectrum management organisations (SMOs) can dominate the availability of specific spectrum and thus demand excessive prices for spectrum usage charges.

After its consultation, Ofcom believes that its opinion has been confirmed that the Competition Act 1998 in connection with the Communications Act 2003 and the Enterprise Act 2002 is sufficient to ensure effective competition. This means that Ofcom does not intend to implement an ex ante check as part of the spectrum trading process. Here, Ofcom is also guided by the fact that spectrum trading is likely to be all the more successful the lower the administrative hurdles and the resulting transaction costs. The aim is thus a flexible and simple transfer system. Ofcom rejects any ex ante competition control as being unreasonable, too costly, and too great a challenge with regard to development and implementation As a result, it would increase uncertainty among those affected, thereby restricting trade and thus endangering the success of spectrum trading. In addition, in Ofcom's opinion, there are no evident signs or verification that an ex ante regulation model is required. In spite of this, however, Ofcom would like to be able to introduce this type of trading at a later date. In this connection, it should also be mentioned that Ofcom only introduces spectrum trading for one specific license class at a time.

Ofcom believes that the Competition Act can only be applied if behaviour is ascertained that is anti-competitive. However, Ofcom believes that the possibility of imposing fines will be frightening enough for companies not to behave in an anti-competitive manner.

Under the Telecommunications Act, companies can be subject to reasonable conditions if they command significant market power (SMP). This also applies to companies such as mobile radio sub-network operators that use spectrum.

---

31 Ofcom (2004) Ensuring effective competition following the introduction of spectrum trading - Statement – Issued 29. September 2004.

However, the Enterprise Act can generally only be used during mergers. On the other hand, Ofcom also has the ability to instigate a review by the Competition Commission if it has reasons to believe that competition is being distorted.

In addition to these instruments, Ofcom also believes that AIP is a suitable instrument to prevent anti-competitive behaviour.

In addition, Ofcom has the opportunity to withdraw spectrum usage rights in specific cases, although this instrument is only to be applied in serious exceptional cases that relate to the violation of obligations.

Finally, it should also be mentioned that Ofcom does not regard spectrum caps as being a suitable instrument for the control of anti-competitive behaviour. On the one hand, these could create artificial barriers for the development of markets. In addition, their specification would lead to controversial discussions, in particular the issue of which market is to be used as a reference for the determination of spectrum caps.

"Use it or lose it" conditions are not believed to be effective to ensure the efficient use of spectrum. The reason for this is the difficulty of monitoring this in practice, as evidence as to whether spectrum is being hoarded or inefficiently used is hard to provide.

4.1.6 Spectrum charging policy

4.1.6.1 Fundamental principle

According to the Wireless Telegraphy Act 1998 (Sections 1 and 2(2)), Ofcom is able to charge fees for spectrum use or licenses that go beyond administrative costs. This is conditional upon it being in harmony with the obligations within the meaning of Section 154 of the Communications Act 2003. When determining the amount, the following issues in particular must be taken into account according to the Communications Act:

- Efficient use of parts of the electromagnetic spectrum,
- Economic and other benefits which result from spectrum use,
- The development of innovative services,
- Competition for the provision of electronic communication services.

Ofcom refers to a spectrum charge policy that takes into account these issues as AIP (administrative incentive pricing). In an ideal situation, these fees would correspond exactly to the economic opportunity costs.

Ofcom has now been using AIP since 1998. AIP signals to the users the current value of the spectrum. This approach is geared to ensure that the entity which acquires the usage right is the one which can best use the spectrum. It thereby sets the right incentives for efficient use.

Spectrum value was first determined by NERA and Smith Systems. They determined the opportunity costs, i.e. the value that the corresponding spectrum has for a potential user. This basis was used to set the charges, although a level of only 50% was applied when estimating opportunity costs. In the Cave Review, a proposal was made to increase the charge level. Ofcom believes that AIP should continue to be used in parallel to spectrum trading.

It should be noted that there are some license classes (i.e., joint use of spectrum) for which no AIP fees are charged. License charges for spectrum used for radio and TV are also not determined strictly in accordance with the AIP principle.

4.1.6.2 License charge structure in selected areas

The following section discusses the charge structure for licenses for the use of spectrum in designated areas.

4.1.6.2.1 License charges for 2G spectrum

Fee calculations are based on £/MHz/km²: According to Statutory Instrument 2005 No. 1378, the Wireless Telegraphy (License Charges) Regulations 2005 (<http://www.opsi.gov.uk/si/si2005/20051378.htm>) – which came into effect on 13 June 2005 – the current charges are currently as follows:

- £ 142,560 per 2 x 200 kHz, i.e., a national channel in the 880.0-960.0 MHz band.
- £ 110,880 per 2 x 200 kHz , i.e., a national channel in the 1710.0-1880.0 MHz band.

Ofcom intends to retain the current charge scheme and level for the next three years and then to subject it to a review.

4.1.6.2.2 License charges for fixed links[32]

A range of various factors must be included in the algorithm used to determine the charge for fixed links in order to take the actual use into account in a suitable form. Currently, charges are calculated based on the following algorithm. This is the result of a more than four-year discussion process with industry.

	Spectrum price
	x Bandwidth factor
Charge for fixed links	**x** Band factor
	x Path length factor
	x Availability factor

Spectrum price

£ 88 per 2 x 1 MHz

Bandwidth factor

The greater the scope of the used spectrum, the greater the opportunity costs. Fixed links are typically operated in both directions. A factor of 28 is applied for 2 x 28 MHz. For fixed links in one direction, a discount of 25% only is granted. The minimum value of this factor is 1.

Band factor

The band factor reflects supply and demand in the various spectrum bands. The band factors are shown in the following table.

32 See Annex 3, Ofocm (2005): Spectrum pricing ,23 Februar 2005

Band (GHz)	Band factor
1,4	1
2	1
4	1
L6, U6	0.74
7,5	0.74
11	0.43
13,14,15	0.43
18	0.3
22, 23	0.3
25, 26, 28, 31,32	0.3
38	0.26
50, 52, 55	0.26

Path length factor

Ofcom has defined a minimum path length (MPL) so that lower spectrum bands can be reserved for longer links.

Spectrum band (GHz)	Low data rates	Higher data rates
	Minimum path length (km) Data rate < 2Mbit/s	Minimum path length (km) Data rate > 2Mbit/s
1,4	No minimum path length	30
2	No minimum path length	30
Spectrum band (GHz)	Low data rates	Higher data rates
	Minimum path length (km) Data rate < 140 Mbit/s	Minimum path length (km) Data rate > 140 Mbit/s
1,4	14,5	16
L6/U6	24,5	16
7,5	15,5	9,5
11	10	6
13/14/15	9,5	5,5
17/18	4	2,5
22/23	4	2
25/26	3	2
28	3	2
31	0	0
32	3	1,5
38	0	0
50/52/55	0	0

Calculation of the path length factor (PL) is then as follows:

PL >/= MPL	PL=1
PL< MPL	PL = min(square root (MPL/PL);4)

Availability factor

Availability requirement	Availability factor
99.9 %	0.7
99.99 %	1.0
99.999 %	1.4

4.1.6.2.3 Spectrum charges for BWA

Charges for spectrum which has currently been assigned for FWA licenses are as follows in the 3.6 – 4.2 GHz band:

- £ 8,436 for each 1 MHz of a national slot, to the extent that coordination with ground stations is required;
- £ 2,226 for each 1 MHz of a national slot, to the extent that coordination with ground stations and fixed links is required.

License charges in the 5.8 GHz band are:

- £ 1 for each terminal, with the minimum charge totalling £ 50 if less than 49 terminals are installed.

4.1.7 Specific spectrum management issues

4.1.7.1 Digital TV switchover (in 470 – 854 MHz band)

It is intended to turn off transmissions of analogue terrestrial TV due to the increasing numbers of viewers who receive terrestrial TV using cable, satellite or digital. The government has set itself 2012 as a target. This means that spectrum previously used for analogue TV (14 channels or 112 MHz) will become free for other applications. The precise amount of spectrum actually available depends on international negotiations and on TV and radio policy. As a rule, there is a range of applications for which this

released spectrum could be used: Mobile communications, more radio and TV, license-free applications and private radio systems.

A definitive decision on the precise use of this spectrum has not yet been made. At the same time, Ofcom would currently prefer to re-assign this spectrum in a technology-neutral auction. During this process, however, politically relevant issues should also be considered.

There is no definitive schedule in view of the background detailed above. Ofcom is awaiting the results of the Radio Conference in 2006 in particular. It must also be taken into account that there are restrictions with regard to usability, if analogue TV continues to be broadcasted in neighbouring countries.

4.1.7.2 Mobile communication specific spectrum policy

4.1.7.2.1 General considerations

In view of the use of spectrum for 2G and 3G, Ofcom faces a range of interdependent issues which are currently being discussed. These relate to the not yet implemented expansion of opportunities for trading and liberalisation to the assigned 2G and 3G bands, and the future timetable for the assignment of spectrum usage rights for spectrum below 4 GHz. Ofcom is planning further consultations for the transition process during the current year 2005.

A total of 4 GSM mobile communication network operators are active in the UK – O2, Vodafone, T-Mobile and Orange. O2 and Vodafone were initially assigned 900 MHz spectrum, whereas T-Mobile and Orange were assigned licenses to operate networks in the 1800 MHz band. O2 and Vodafone, which already had mobile communications networks in the analogue GSM standard, were assigned 1800 MHz spectrum in addition to their licenses in the GSM 900 MHz spectrum band in order to avoid capacity bottlenecks. Both mobile communications operators who started out with 1800 MHz spectrum – T-Mobile and Orange – still do not have spectrum in the other band. Whereas all GSM network operators also have a UMTS license, the newcomer H3G only has a UMTS license. The following Table 24 shows the current breakdown of spectrum in the UK among the mobile communications network operators.

Table 24: Spectrum assigned to mobile communications network operators in the UK

Operator	GSM spectrum	UMTS spectrum
O2	2 x 17.2 MHz (GSM 900) 2 x 5.8 MHz (GSM 1800)	2 x 10 MHz, 5 MHz
Vodafone	2 x 17.2 MHz (GSM 900) 2 x 5.8 MHz (GSM 1800)	2 x 14.6 MHz
Orange	2 x 30 MHz (GSM 1800)	2 x 10 MHz, 5 MHz
T-Mobile	2 x 30 MHz (GSM 1800)	2 x 10 MHz, 5 MHz
H3G		2 x 14.6 MHz, 5.1 MHz

Source: Ofcom (2005), Implementation Report, p. 80

O2 started its services in January 1994, T-Mobile in September 1993, Orange in April 1994 and Vodafone in July 1992. 2G licenses are technology-specific. GSM mobile communications network operators pay an AIP charge. The licenses were assigned for an unlimited period, however, Ofcom has the ability to withdraw these with advance notice of one year. The UMTS licenses issued in 2000 are also technology-specific.

However, Ofcom is aware that competition should be encouraged over the long term, and that spectrum trading and liberalisation should also apply to this area. The long term spectrum policy intended for this type of application will, however, be outlined as clearly as possible by Ofcom and is in line with the WAPECS initiative by the Radio Spectrum Policy Group. This vision pursues a market-oriented and technology-neutral approach. In this regard, spectrum usage rights are no longer to be differentiated between fixed and mobile access, unless this causes unreasonable interference. As a rule, there should only be technological restrictions to use. Usage rights are to be assigned via an auction. Restrictions should only be imposed in well-founded exceptional cases, so that in general there are no supply obligations or reservations for newcomer licenses. The availability of more spectrum would thus also make market entry possible.

At the same time, Ofcom is also aware that the previous mobile communications network operators have invested in establishing the networks, and that they are currently also doing this for 3G. As a result, Ofcom believes that it is correct to ensure that the mobile communications operators have a high incentive to build up their networks. As a result, Ofcom believes that there should be a sliding transition process to the new model. In Ofcom's opinion, an abrupt transition could result in undesired and distorting effects for the market and the competitive situation.

4.1.7.2.2 Removal of restrictions that prohibit use for mobile services

4.1.7.2.2.1 Mobile use apart from 3G

In this context, a differentiation must be made as to whether spectrum usage rights should be expanded for existing licenses so that other mobile services (apart from 3G) can be offered, and if, for future license assignments, the opportunity should be opened up to also offer other mobile services (apart from 3G). Ofcom believes that, for spectrum bands for which there are no technological reasons or international agreements, mobile services (apart from 3G) should also be offered. This would make competition more intense, promote innovation and ensure more efficient spectrum use. As a result, for future license assignments Ofcom does not intend to impose license restrictions which do not allow use of mobile services, unless there are statutory reasons, interference issues or international obligations to the contrary.

However, Ofcom does not yet intend to directly approve licenses for 3.4 GHz spectrum, which are now all owned by UK Broadband, for mobile applications. A transitional period, so that this is only possible from 2007, is believed to be reasonable. Ofcom states that the reason for this is that bidders who were not successful during the license assignment could otherwise be subject to possible discrimination. At the same time, it was known in line with the license conditions that the spectrum usage conditions could change.

4.1.7.2.2.2 Use for 3G

Regarding the issue of whether existing licenses or spectrum assigned in future could also be used for 3G applications, five criteria are being discussed as key issues: Promotion of efficient spectrum use, promotion of competition, promotion of investment and innovation, promotion of citizens' and consumers' interests as well as the criteria of reasonableness, transparency and freedom from discrimination. With regard to existing licenses, direct authorisation to also offer 3G services would tend to promote more efficient use of the corresponding spectrum. The competitive impact is not directly clear, as the business case of the current UMTS mobile communications operators could be imperiled as a result. It is thus also not clear over the short term if the effect would be positive on investment or innovation. However, Ofcom believes that the long-term effect would be positive. Depending on the short-term implications for the mobile communications market, the implications for consumers could be positive or negative, however they are regarded as being positive over the long term. As a rule the approach of imposing as few restrictions as possible is in citizens' and consumers' best interests.

After weighing up the issues, Ofcom prefers the following options: From 2007 it should be made possible to offer 3G for existing licenses, to the extent that this is technically and legally feasible. For new assignments, users should immediately be able to offer

3G services, to the extent that this is technically and legally possible. As a result of the time lag for the service, which results from the requisite set-up phase for the network infrastructure, possible turbulence on the UMTS mobile communications market is regarded as not being too dramatic.

The spectrum bands 2010 – 2025 MHz and 2500 – 2690 MHz are to be approved directly for 3G applications, as this has been discussed for years, and as this was known to all spectrum users.

4.1.7.2.2.3 Proposal for a working definition in view of 3G services

Ofcom proposes to use the following definition for 3G services in future. According to this definition, 3G services must fulfil the following four criteria:

- Use of a radio interface in the IT 2000 family;
- Offer of truly mobile functionality, i.e., use is possible at speeds of 10 km/h;
- Automated handover between cells for wireless connections;
- Provision of effective data transfer rates that are higher than 58 kbps either for uplink or downlink bands.

4.1.7.2.3 Liberalisation and spectrum trading in spectrum bands which have been assigned for 2G and 3G

Ofcom is aware that a range of issues must be discussed in connection with the current 2G and 3G licenses before a timetable is prepared for when specific restrictions for these licenses are to be removed. At present, the pros and cons of various options are being discussed.

- General opinion is that further liberalisation of spectrum usage conditions would promote more efficient use of spectrum. Market-based solutions are, as a rule, more flexible and efficient.
- Depending on the development of 3G services, it may be that part of the traffic migrates from 2G to 3G. The development from 3G to 4G is also relevant. Developments in this regard, which are still in their infancy, may make it worthwhile to wait before decisions are taken.
- Ofcom's current interpretation is that approx. 71% of assigned GSM 900 spectrum is limited in use to the ETSI GSM Standard. This relates to the spectrum used by Vodafone and O2. New international agreements which are reached in future could restrict opportunities for use.

- Harmonisation of use by Ofcom is no longer regarded as being absolutely compulsory. It is much rather the case that Ofcom believes that international roaming will also be possible as part of the market mechanism.
- Ofcom believes that the competitive implications of removing restrictions must be analyzed in detail. In so doing, both the implications for the competitive situation between 2G mobile operators must be considered, as well as the situation for 3G operators, in particular UMTS newcomers. Possible implications could be higher spectrum availability (in particular for 3G) as well as lower network expansion costs in less built-up areas, as it is also possible to acquire spectrum for GSM 900, generate windfall profits, etc.
- If other spectrum bands can also be used for 3G services, it is no longer so important to focus just on current UMTS licensees.
- It is intended to make 2G and 3G licenses tradable from 2007, however a final decision in this regard has not yet been taken.

4.1.7.2.4 Summary

The following Table 25 summarizes the key spectrum policy issues and Ofcom's intended spectrum policy in this regard.

Table 25: Spectrum policy issues and Ofcom's intended activities

Issue	Proposal	Next steps
Remove restrictions in licenses which prohibit offering mobile services apart from 3G	General removal of this type of restriction taking into account legal requirements. Additional considerations for 3.4 GHz licenses	Opinion planned for summer 2005
Remove restrictions in licenses which prohibit offering mobile 3G services	General removal of this type of restriction taking into account legal requirements after a transitional period, possibly from 2007.	Opinion planned for summer 2005
Launch of spectrum trading for 2G	Fundamental intention of permitting this after critical issues on 2G liberalisation have been clarified	Detailed economic analysis, publication of an opinion in summer
Launch of spectrum trading for 3G	Fundamental intention of permitting this after critical issues on 2G liberalisation have been clarified	Detailed economic analysis, publication of an opinion in summer
Liberalisation of 2G spectrum band	Analysis of potential impact and identification of reasonable requirements	Statement in summer after analysis for 2G/3G has been conducted
Liberalisation of 3G band	Parallel discussion in connection with liberalisation of 2G band	Statement in summer after analysis for 2G/3G has been conducted
Assertion of 3G supply obligations	Draw up draft	Publication of guidelines in summer 2005
Renewed discussion of non-spectrum specific license obligations for mobile communications operators	Renewed discussion before spectrum trading is launched in this area.	Currently no steps

Source: Ofcom (2005), Implementation Report, p. 119/120

4.1.7.3 Broadband wireless access (BWA)

In line with "light touch" regulation and the application of market mechanisms, Ofcom does not believe that a preference for BWA should be created from a regulatory perspective. It is much rather the case that Ofcom believes that spectrum should be made available for a broad range of applications, with BWA being one possible application but then competing with other applications. In areas where scarcity is to be feared, general assignment is also being considered. In this connection, Ofcom intends to liberalize the conditions of use as far as possible in the 2GHz to 10GHz band. To this extent, as already mentioned, there are no plans to reserve specific spectrum bands exclusively for BWA in the near future. Details of the intended liberalisation policy in the areas relevant for BWA have been presented in the previous chapters.

4.1.8 Conclusions

In line with spectrum regulation policy objectives, the UK aims to make spectrum regulation as flexible as possible. This is to be implemented in such a way as to ensure optimum spectrum use and that the needs of end users are satisfied in an optimum manner.

In terms of liberalisation, this means that the usage conditions are to be as free as possible of technology restrictions or other types of restrictions such as roll-out obligations. Regulatory policy restrictions should only be imposed if this is justified. In view of possible restrictions, three issues are of key importance: Harmonisation, competition problems and interference issues. In terms of harmonisation, Ofcom believes that industry is able – via negotiations – to define standards and harmonised use in a cooperative manner. In the case of far-reaching liberalisation, Ofcom believes that ex post application of competition law is sufficient to prevent anti-competitive behaviour. In Ofcom's opinion, there have to be sufficient protective conditions to prevent interference. These conditions should be designed such that far-reaching, flexible use is possible. The details of how the interference norms are to be designed in practice is, however, still a difficult issue to be defined.

In addition, Ofcom intends to replace the command and control spectrum management model with market mechanisms and general assignments. In so doing, however, it must be considered that general assignments are only possible if joint use does not lead to unacceptable mutual impairment. General assignments are thus primarily suitable for applications with a range of less than 100 m, for example for WiFi, etc. This type of general assignment offers, in particular, the advantage that innovative technology can be tested in these bandwidths and developed to become market-ready. The spectrum bands for which this spectrum management mechanism is suitable are thus restricted. Ofcom believes that they total less than 10%.

This means that a market mechanism should thus enjoy priority implementation. Private spectrum usage rights for spectrum bands should therefore be clearly defined. A change to *property rights* could occur for the issue of new licenses or for existing licenses at Ofcom's initiative, or for current license holders at their initiative, which then need Ofcom's approval for implementation. This type of license, ownership rights or spectrum usage rights should then be auctioned for new issues, and should then, with Ofcom's permission, mostly be tradable without restriction. If national security interests are affected, or if the parties do not fulfil the admission criteria for use of the spectrum, this type of transfer may be prohibited. The transfer of spectrum usage rights should be as flexible as possible. In this regard leasing, i.e. a temporary transfer of spectrum usage rights, should also be made possible, however a fixed final date for the temporary use must be determined. Band managers should be allowed, although not actively encouraged by Ofcom. In Ofcom's opinion, the more information there is available, the better markets function. As a result, Ofcom intends to publish a register of

licenses, which at least includes the names of license holders, contact information, license classes, limits of spectrum usage rights and geographic information. In addition, information on the implemented trade should be published.

Ofcom's policy of increasing flexibility is, however, currently in its infancy. This means that no empirical recommendations can be made for the use of successful spectrum management systems in Germany from observing spectrum policy in the UK. The first individual areas, such as BWA spectrum, where spectrum trading is possible, are only just emerging. The WAPECS concept in view of liberalizing spectrum usage rights is only just starting to be discussed. In particular, it must be noted that Ofcom is currently still hesitant about admitting mobile applications in addition to the spectrum assigned for GSM and UMTS. This is only being considered from 2007. Here too, Ofcom believes that there has to be investment protection. In fact, Ofcom currently still implements ex ante regulation in view of competition issues. If trading is not possible and if a specific auction model is defined for the primary assignment of spectrum, this implies that there will be this type of ex ante regulation. Other discussions also show that Ofcom tends to take a cautious and well-thought-out approach for practical implementation. This is also documented in detailed consultations. In addition, Ofcom points out that it believes that it is bound by international agreements, so that existing harmonisation agreements at a supranational level continue to apply to national spectrum use.

Ofcom's approach clearly shows that – even though they have a liberal vision – one can and should only take a step-by-step approach for spectrum policy due to the issue's complexity. This means that international agreements can only be made more flexible one at a time, and individual spectrum ranges must be investigated in detail in view of adequate interference conditions and conditions of use. An intense consultation is required in this regard.

Irrespective of this, it is Ofcom's intention to continue to welcome AIP as an instrument to promote efficient use when determining spectrum usage charges. This instrument reduces the incentive to hoard spectrum for speculative reasons, and it also means that the national regulatory authority has an instrument to tax potential windfall profits. This thereby increases society's acceptance of the introduction of market instruments such as spectrum trading.

4.2 The United States

The United States has been a clear leader in regard to spectrum liberalisation, in line with generally liberal or *laissez-faire* economic leanings. In most but not all cases, industry and consumers have been pleased with the results.

Some are now arguing that the U.S. needs to become much more aggressive about liberalisation in order to reap the benefits of new technology, notably cognitive radio and software-defined radio.

4.2.1 Overview of spectrum management in the United States

In this section of the report, we consider the institutional components of spectrum management in the United States, and provide an overview of the spectrum management program.

4.2.1.1 Institutions of frequency regulation

In the United States, the bedrock upon which all telecommunications regulation rests is the *Communications Act of 1934*. This body of law has been substantially amended over the years, most notably by the Telecommunications Act of 1996. For simplicity, throughout this discussion of U.S. policy we will refer to the Communications Act as amended as *the Act*.[33]

In speaking of spectrum management in the United States, it is necessary to distinguish between spectrum assigned to the Federal Government versus all other spectrum. In the U.S., spectrum associated with equipment and services that are operated and used by the U.S. Government is nominally managed by the President.[34] This function is delegated to the National Telecommunications and Information Administration (NTIA)[35], a unit of the Department of Commerce. The spectrum associated with all other equipment and services is managed by the Federal Communications Commission (FCC). The NTIA is part of a Cabinet agency, and thus reports up to the President, while the FCC is an independent regulatory body that is in some senses closer to the Congress. The two agencies usually manage to work together well; nonetheless, this division of responsibility does not contribute to efficiency.

---

33 Where we cite specific provisions in the Act, we will use section numbers that correspond to the Act as codified at 47 U.S.C. This will facilitate cross-checking with FCC documents, which use the same convention.

34 See 47 U.S.C. section 301: "The Commission may, consistent with the public interest, convenience, and necessity, make regulations …" but "The provisions of this section shall not be applicable to … equipment and systems procured for use by the United States or any agency thereof. Devices and home electronics equipment and systems for use by the Government of the United States or any agency thereof shall be developed, procured, or otherwise acquired, including offshore procurement, under United States Government criteria, standards or specifications designed to achieve the objectives of reducing interference to radio reception and to home electronic equipment and systems, taking into account the unique needs of national defense and security."

35 This delegation is effected by the *National Telecommunications and Information Administration Organization Act of 1992*. See in particular section 103(b)(2)(A), which delegates the authority "… to assign frequencies to radio stations or classes of radio stations belonging to and operated by the United States, including the authority to amend, modify, or revoke such assignments …"

Liberalized spectrum management primarily relates to the non-government spectrum. There are a few instances of market-oriented allocation on the part of the NTIA, notably including the procedures that they jointly follow with the FCC for the 70-80-90 GHz bands (discussed later in this report), but for the most part government spectrum management continues to be a traditional command and control operation.

The Congress can in a sense be viewed as a third, and generally decisive, participant in the spectrum management process. Their critical role is sometimes overlooked. Legislation in the U.S. often contains surprisingly specific directions to the FCC as regards specific spectrum bands. There are several factors that encourage Congressional intervention, including (1) the Government's desire for auction revenues, (2) the inability of the FCC to reach closure on particularly contentious issues, and (3) the importance that individual Congressmen ascribe to access to the media.

The complex division of authority and responsibilities among the FCC, NTIA and the Congress appears to negatively impact the coherence of the strategic planning process for spectrum management. The report of the Spectrum Policy Task Force notes that its efforts were the first systematic overall review of spectrum management at the FCC.[36] Yet a cursory review of the *SPTF Report* shows that they did not in fact achieve a "systematic and comprehensive review" of overall spectrum management policy, instead, they compiled a list of interesting potential future directions and research projects. The absence, in general, of publicly available overview strategic planning documents about spectrum management poses a striking contrast with other countries in this study, and notably with the UK.

4.2.1.2 Basic lines of development of frequency policy in the United States

The United States has long been a leader in the move to liberalized spectrum allocation policies. The transition to market-oriented approaches for spectrum management did not happen overnight in the United States. There is a long tradition of forward-looking economists proposing a migration to market-oriented mechanisms. Indeed, most elements of market-based spectrum management as practiced by the FCC today are already visible in a remarkably prescient white paper that FCCer Douglas Webbink wrote a full twenty-five years ago.[37]

---

36 *SPTF Report*, page 1, describes the SPTF project as the "first ever comprehensive and systematic review of spectrum policy at the FCC".

37 Douglas W. Webbink, *Frequency Spectrum Deregulation Alternatives*, FCC OPP Working Paper 2, October 1980. Webbink, then the Deputy Chief of the FCC's Office of Plans and Policy, argued that auctions should be used to allocate spectrum, that spectrum trading should be subject to few if any restrictions, and that the FCC should eliminate most technical restrictions on usage except to the extent necessary to address interference. See also John O. Robinson, *Spectrum Management Policy in the United States: An Historical Account*, FCC OPP Working Paper 15, April 1985.

4.2.1.2.1 Spectrum Auctions

The use of spectrum auctions also has a long history. Kwerel and Felker proposed the use of auctions, in preference to comparative proceedings or assignment by lottery, in 1985.[38] Auctions have been a standard FCC practice since the mid-Nineties. Today, the use of an auction to make a new exclusive assignment of spectrum is the default choice unless public policy considerations dictate otherwise[39] (as might be the case, for example, for spectrum for public safety).

4.2.1.2.2 Spectrum Lotteries

Historically, where there were competing applicants for an exclusive license, spectrum assignment was implemented initially by comparative hearing, and then in the more recent past by lotteries.[40] In the context of lotteries, the Act requires that the Commission ensure that "… significant preferences will be granted to applicants or groups of applicants, the grant to which of the license or permit would increase the diversification of the media of mass communications. To further diversify the ownership of the media …, an additional significant preference shall be granted to any applicant controlled by a member or members of a minority group."[41]

The FCC's authority to conduct lotteries was formally withdrawn as of July 1, 1997, except for applications made by "noncommercial educational broadcast stations" or "public broadcast stations".[42]

4.2.1.2.3 The Spectrum Policy Task Force Report

In June 2002, FCC Chairman Powell commissioned a task force to perform a comprehensive review of FCC spectrum management practices. This task force created an influential report[43] in which they advocated a move away from traditional spectrum management (which they characterized as a "command and control" methodology") and toward an increased reliance on market-based mechanisms.

The SPTF report characterized spectrum management approaches as falling into three categories:

---

38 See Evan Kwerel and Alex D. Felker, *Using Auctions to Select FCC Licensees*, FCC OPP Working Paper 16, May 1985.

39 There are other exceptions. For example, there is a statutory prohibition on the auctioning of licenses for international satellite service.

40 47 U.S.C. section 309(i).

41 47 U.S.C. section 309(i)(3). For these purposes, "minority group" includes "Blacks, Hispanics, American Indians, Alaska Natives, Asians and Pacific Islanders." See 47 U.S.C. 309(i)(3)(C)(ii).

42 47 U.S.C. sections 309(i)(5) and 397(6).

43 FCC, *Spectrum Policy Task Force Report*, ET Docket 02-135, November 2002. Available at: http://www.fcc.gov/sptf/reports.html.

- "Exclusive use" model. A licensing model in which a licensee has exclusive and transferable flexible use rights for specified spectrum within a defined geographic area, with flexible use rights that are governed primarily by technical rules to protect spectrum users against interference.
- "Commons" model. Allows unlimited numbers of unlicensed users to share frequencies, with usage rights that are governed by technical standards or etiquettes but with no right to protection from interference.
- "Command-and-control" model. The traditional process of spectrum management in the United States, currently used for most spectrum within the Commission's jurisdiction, in which allowable spectrum uses are limited based on regulatory judgments.[44]

The SPTF report advocated increased reliance on both the exclusive use and the commons models, and reduced use of command-and-control allocation mechanisms.

The report advocated a great many further market-oriented reforms, notably including:

- Increased clarity as to the rights provided under any license.
- Maximum feasible flexibility for licensees, limited only by interference concerns.
- A quantitative approach to interference, based on the interference temperature (discussed later in this report).
- Increased use of spectrum trading, including the ability to lease spectrum on a rapid or underlay basis.
- Recognition that reliance solely on transmitter obligations may not be appropriate in today's world, and possible introduction of performance standards for receivers.

Some of these reforms have already been implemented, at least in part. Some of them may be implemented in the next few years. And some are either so controversial or so *avant-garde* that they are unlikely to be implemented for decades, if at all. Notable in this latter group are the interference temperature, especially as it relates to underlay rights or "easements", and regulatory standards for receiver performance.

---

44 *SPTF Report*, page 5. See also page 35. Note, incidentally, that the command-and-control model also generates many licenses that are *exclusive*; however, these licenses are generally not *flexible*.

Even among the *avant-garde* proposals, preliminary proceedings (NOIs) were launched.[45] These proceedings have not concluded, and are not expected to conclude any time soon, if ever.

The *SPTF Report* constitutes an important statement of policy, but it is not a ruling. It has no formal, legal weight. At the same time, former FCC Chairman Powell clearly embraced the report, and took concrete steps to set many of its recommendations in motion. Current FCC Chairman Martin has not yet provided a clear articulation of his views on spectrum management, but his votes and comments as an FCC Commissioner suggest that, while his style may be more pragmatic and perhaps more diplomatic than that of his predecessor, his views on the substance are likely to be similar in most respects to those of Chairman Powell on spectrum management issues.[46]

4.2.1.2.4 The "Big Bang"

In 2002, two of the FCC's leading thinkers on spectrum management (Evan Kwerel, an economist, and John Williams, an engineer) published a white paper in which they proposed a radical reallocation of the most valuable spectrum in the United States. They proposed that the FCC hold a simultaneous two-sided auction[47] for some 438 MHz of spectrum in the 300 MHz – 3,000 MHz range.[48]

Existing licensees would be motivated to put their spectrum up for auction by the promise of flexible use, whether they actually transferred their licenses or not. The auction would make the economic opportunity costs associated with holding spectrum clear to all involved, even where spectrum did not ultimately change hands, and thus would move the entire system rapidly in a market-oriented direction.

There is much logic to the proposal, but it has not gained significant traction to date. Some industry participants apparently find it radical and unsettling.

---

45 Note that these proceedings are generally in the form of a *Notice of Inquiry (NOI),* a form that enables the FCC to solicit public comments but that generally cannot directly result in the promulgation of a rule.

46 Chairman Powell and then-Commissioner Martin did not see eye to eye on a number of issues, even though both are from the same political party. On spectrum, their views were aligned to the point where, on one ruling (*Promoting Efficient Use of the Spectrum Through Elimination of Barriers to the Development of Secondary Markets*…, May 2003) they issued a joint statement. Doing so is not unheard of, but neither is it routine.

47 A two-sided auction entails multiple sellers and multiple buyers. In the Kwerel-Williams proposal, the FCC and a number of existing spectrum licensees would simultaneously offer blocks of spectrum to bidders in a single, simultaneous auction, with the ability to make "package bids" (i.e. all-or-nothing bids on a package of licenses.

48 Evan Kwerel and John Williams, *A Proposal for a Rapid Transition to Market Allocation of Spectrum*, OSP Working Paper 38, November 2002. Note that Kwerel and Williams are widely respected, senior people who did the ground-breaking work that led to spectrum auctions, flexibly defined licenses, and other market based spectrum reforms at the FCC.

4.2.1.2.5 Likely future directions

Support for spectrum auctions, flexible usage, and secondary markets is widespread in the United States. These initiatives are likely to gradually expand over time.

Our interviewees uniformly felt that the approach that the United States has taken in regard to PCS licenses – primarily used for mobile telephony, but also usable for fixed wireless or nearly anything else, subject to interference constraints and treaty obligations – is the appropriate model for licensed spectrum, and should be expanded.

Support for unlicensed (i.e. license-exempt) spectrum allocations is strong. Some increase in the amount of spectrum available for unlicensed use is likely. Ongoing experimentation is likely with alternative allocation models that seek to provide spectrum access, possibly with some interference protection, to emerging technologies that can opportunistically use spectrum in real time (cognitive radio). At the same time, there have been instances where industry has expressed concerns that capital markets may not support infrastructure investments that aren't secured with exclusive licenses, notably in the proceedings associated with the 3650-3700 MHz band.

The U.S. Government continues to hold large blocks of spectrum. Some of the spectrum recently emarked by the FCC for Advanced Wireless Services (AWS) was transferred from Government users by legislation. Given the split authority of NTIA and the FCC, further transfers of Government spectrum to the FCC in more than token quantities seems unlikely unless the Congress orders it.

The transition to Digital Television (DTV) is widely expected to produce a "digital dividend". Some of the spectrum that is freed up in this process will be used to enhance public safety;[49] the balance will be auctioned off. At the moment, it is up to the Congress to determine the final cut-off date for analog television. The FCC has statutory authority,[50] but is unable to come to closure on the issue.

4.2.2 Liberalisation of frequency usage

The United States has moved progressively in the direction of flexible use of spectrum, in conjunction with generally liberalized practices. The Communications Act specifically authorizes the FCC to permit flexible use where:

> (1) such use is consistent with international agreements to which the United States is a party; and

---

49 Indeed, 24 MHz of the UHF TV to be reclaimed after the DTV transition has already been reallocated for public safety use.

50 47 U.S.C. 309(j)(14). See, however, Section 4.2.7.1 of this report. The statutory language is not altogether clear.

(2) the Commission finds, after notice and an opportunity for public comment, that –

(A) such an allocation would be in the public interest;

(B) such use would not deter investment in communications services and systems, or technology development; and

(C) such use would not result in harmful interference among users.[51]

For many new services, notably including PCS services (which are intended for use in support of mobile telephony, but can generally be used as the licensee sees fit) the FCC limits essentially only three things:

- Power radiated into adjacent frequency bands in the same geographic area, the so-called out-of-band emissions (typically -13 dBmW measured at the transmitter output);
- Power radiated into adjacent geographic areas in the same frequency band (typically 47 dBuV/m calculated field strength at the area boundary ;
- Power radiated inside the assigned band for each class of station (typically, e.g., 2 watts mobile, 100 watts base measured at transmitter output).

Otherwise, the licensee is free, for the most part, to provide any service – fixed, mobile, private, common carrier, whatever – unless precluded by international agreement, and is free to use any technology to do so.

4.2.2.1 An example – spectrum suitable for mobile telephony

One recent proceeding sheds enormous light on the practical implications of flexibility. In the *Second Report and Order on Secondary Markets*[52], the FCC sought to simplify spectrum leasing arrangements for transactions that met a number of criteria, including an absence of significant competitive issues. In general, they have been concerned that over-concentration of spectrum resulting from mergers or spectrum trades could reduce competition for mobile phone service. Significantly, they were not concerned about the impact on other services. The number of spectrum bands in which mobile phone service (voice and/or data) could potentially be offered is mind-boggling:[53]

---

51 47 U.S.C. 303(y).
52 The *Second Report on Secondary Markets*, document 04-167, September 2, 2004, section 26.
53 This large number of bands should not assuage the concern that spectrum is scarce. Many of the bands are small.

In light of the Commission's competition policies for Wireless Radio Services, we will permit spectrum leasing parties to proceed under our forbearance approach so long as the de facto transfer leasing arrangement does not raise potential competition concerns that merit prior public notice and Commission review before the application is approved. Consistent with our competition policies, however, we will exclude from this approach, at this time, all long-term de facto transfer leases involving spectrum that (1) is, or may reasonably be, used to provide interconnected mobile voice and/or data services and (2) creates a "geographic overlap" with other spectrum used to provide these services in which the spectrum lessee holds a direct or indirect interest (of 10 percent or more),62 either as a licensee or as a spectrum lessee. Because the latter class of de facto transfer leases potentially raise competition concerns, they will continue to be subject to case-by-case review and approval under the policies we adopted in the Report and Order. … The approach we adopt herein, pursuant to our forbearance authority, is designed to be consistent with our current competition policies with regard to Wireless Radio Services. In examining transactions for possible competitive harm, the Commission has primarily focused its efforts in recent years on services that could potentially affect the product market for mobile telephony, which includes interconnected mobile voice and/or data services.65 Cellular, broadband Personal Communications Service (PCS), and Specialized Mobile Radio (SMR) services currently are used to provide CMRS services that potentially affect the mobile telephony market, and expressly are subject to the Commission's competition policies set forth in the 2000 Biennial Review Order on CMRS Aggregation Limits.66 In addition, spectrum in several other services may currently, or at some time in the future, be used to provide such CMRS services; these services include several services licensed under Part 27 of our rules67 – including the Wireless Communications Service (WCS),68 Broadband Radio Service, Advanced Wireless Service (AWS), the upper and lower 700 MHz bands, and the 1390-1392 MHz, 1392-1395/1432-1435 MHz, and 2385-2390 MHz bands – as well as narrowband PCS,73 various paging Thus, if the spectrum leasing transaction does not involve a geographic overlap with spectrum held by the spectrum lessee in any of the particular services listed, as described above, we will permit the leasing arrangement to proceed without prior public notice or case-by-case review. We note, however, that because of the emergence of new technologies and the convergence of different services (e.g., wireline and wireless services), our identification of those classes of spectrum leasing arrangements currently raising possible competitive concerns may not always capture that class of transactions that may raise competitive concerns in the future.[54]

54 Ibid., sections 25 – 27.

4.2.2.2 Another example – MMDS / ITFS[55] educational broadband spectrum[56]

There are many recent rulemakings that demonstrate the degree of flexibility that the U.S. affords many of its licensees. The *MMDS/ITFS Order*[57] can serve as another example. The FCC has gradually expanded permissible use – a band that was once use primarily for one way analog broadcast is now available for digital two-way fixed and mobile services, including 3G.

The spectrum band in question is "…the 2500-2690 MHz band, which is currently used by Instructional Television Fixed Service ("ITFS") and Multichannel Multipoint Distribution Services ("MMDS") networks to provide educational and commercial fixed wireless services, including broadband services."[58]

The history and usage of this band are complex. As the Order explains, "…the 2500-2690 MHz band is allocated in Region 2 on a primary basis to the Fixed, Fixed Satellite, Mobile except aeronautical mobile, and Broadcasting-Satellite Services. In the United States, this band is allocated to the Fixed service and, as noted above, is used by ITFS and MMDS licensees. There are currently thirty-one 6 MHz channels and one 4 MHz channel, or 190 MHz of spectrum, assigned to ITFS/MMDS in this band. About 2,500 MMDS licensees transmit programming from one or more fixed stations, which is received by multiple receivers at various locations …" "Historically, the 2500-2690 MHz band has been predominantly used for one-way analog video transmission. Increasingly, ITFS/MMDS operators are using the band for two-way digital broadband services. Our July 1996 Digital Declaratory Ruling first permitted digital use of the band. In October 1996, we allowed high-speed digital data applications, including Internet access. In 1998, we approved the use of two-way transmissions, effectively enabling the provision of voice, video, and data services. Several major companies currently plan to use ITFS/MMDS spectrum to roll out high-speed Internet access in about 200 markets."[59]

In 2001, the MMDS/ITFS Order further liberalized use of this frequency band. "… [W]e are adding a mobile allocation to the 2500-2690 MHz band to provide additional near-

---

55 On July 29, 2004, the FCC restructured these bands (establishing a new band plan with paired low power channels and high power channels in between) and renamed them. MDS is now called Broadband Radio Service (BRS), while ITFS is called Educational Broadband Service (EBS). For the convenience of the reader, we refer to the bands in this report using the names that were in effect when the FCC orders in question were issued.

56 In July of 2004, the FCC restructured and renamed these bands (establishing a new band plan with paired low power channels and high power channels in between). MDS is now called Broadband Radio Service (BRS) and ITFS is called Educational Broadband Service (EBS).

57 FCC, *In the Matter of Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems: First Report and Order and Memorandum Opinion and Order* (referred to in this report as the *MMDS/ITFS Order*), ET Docket No. 00-258, Released: September 24, 2001.

58 MMDS/ITFS Order, section 1.

59 Ibid., sections 7 and 8.

term and long-term flexibility for use of this spectrum, thereby making this band potentially available for advanced mobile and fixed terrestrial wireless services, including third generation ("3G") and future generations of wireless systems. However, because the 2500-2690 MHz band is extensively used by incumbent ITFS and MMDS licensees, and in order to preserve the viability of the incumbent services, we are not relocating the existing licensees or otherwise modifying their licenses."[60] Rather than crafting rules to deal with potential interference, the FCC observed that "…licensees can negotiate among themselves arrangements for avoiding interference rather than relying on mandatory technical rules to control interference; relaxed service rules would allow licensees greater freedom in determining the specific services to be offered; and rules for similar services can be harmonised to provide regulatory neutrality to help establish a level playing field across technologies and foster more effective competition."[61]

The MMDS/ITFS Order then goes on to provide a succinct summary of FCC flexibility in action: "We have already provided such flexibility in many services, including PCS, WCS, and new services operating on television channels 60-69; and have proposed flexibility in other services, including new services operating on television channels 52-59. In permitting new services to operate on television channels 60-69, we added Fixed and Mobile services to the Broadcasting allocation in the 746-806 MHz band."[62]

4.2.2.3 Yet another example – Nextel

The recent *Nextel Order*[63] provides another example of spectrum flexibility. It provides many intriguing insights into both the strengths and the weaknesses of flexibility as implemented in the United States.

Flexibility in the so-called 800 MHz band (specifically 806-824/851-869 MHz), coupled with substantial growth of Nextel's service, led to intractable interference problems, even though the parties were apparently operating within the conditions permitted in their respective licenses.[64] As the FCC put it: "In recent years, … public safety systems

---

60 Ibid., section 2.

61 Ibid., section 20.

62 Ibid., section 20. The notes to this section observe that "… [i]n *Amendment of the Commission's Rules to Permit Flexible Service Offerings in the Commercial Mobile Radio Services*, WT Docket No. 96-6, the Commission expanded permitted offerings of fixed wireless service by Commercial Mobile Radio Service providers. … With respect to PCS, the Commission deleted 'footnotes US330 and US331, which prohibited narrowband and broadband PCS licensees from providing fixed service, except for ancillary fixed services used in support of mobile PCS.' … In general, the WCS permits licensees to "provide any services for which its frequency bands are allocated."

63 FCC, multiple titles including *Improving Public Safety Communications in the 800 MHz Band* (referred to in this report as the *Nextel Order*), WT Docket 02-55, Released: August 6, 2004.

64 A knowledgeable source interviewed for this study opined: "The interference problem arose because the rights granted to Nextel were incompletely defined. The FCC should have made Nextel (actually FleetCall at the time) explicitly responsible for interference to adjacent licensees. It didn't, and thus a long period of disruption and argument ensued. Had Nextel been told from the start that it would be

in this band have encountered increasing amounts of interference from commercial mobile radio service (CMRS) providers. The interference problem in the 800 MHz band is caused by a fundamentally incompatible mix of two types of communications systems: cellular-architecture multi-cell systems—used by ESMR and cellular telephone licensees—and high-site noncellular systems—used by public safety, private wireless, and some SMR licensees and stems primarily from the operations of Nextel Communications, Inc. (Nextel), an 'Enhanced' Specialized Mobile Radio (ESMR) provider in the 800 MHz band, as well as the operations of cellular telephone providers in the [adjacent] Cellular A and B bands."[65] For purposes of this discussion, CMRS can be viewed as mobile telephony, while SMR is "… Specialized Mobile Radio (SMR) systems [that] provide land mobile communications services (other than radiolocation services) in the 800 MHz and 900 MHz band on a commercial basis. … ESMR is a term coined by Nextel to describe SMR systems, such as Nextel's, that use cellular architecture, i.e., systems that use multiple, interconnected, multi-channel transmit/receive cells and employ frequency reuse to serve a larger number of subscribers than is possible using non-cellular technology."[66]

The parties and the FCC were able to mitigate interference through the application of agreed best practice techniques, but only to a point. Ultimately, the FCC found it necessary to mandate certain practices, and to reconfigure the bands so as to create sufficient separation between Nextel and public safety services.

We return to this proceeding several times in this report. It is instructive in regard to U.S. approaches to interference, to receiver performance standards, and to determining a value for spectrum.

4.2.2.4 Implications for 2G – 3G – 4G migration

Europeans often wonder how the United States will manage the migration from 2G mobile services to 3G. What sort of service overlap is envisioned? Will frequency bands associated with 2G eventually be retired, and if so, when?

Mobile phone services in the United States are among the most fully liberalized services. As a result, the question does not even come into play.

If a mobile phone service provider wishes to offer 3G service, they may utilize any licensed spectrum within which mobile services are permitted. If they already have

---

held responsible for any interference it caused to its neighbours, it may have never built its network in this spectrum. Or, it may have done other things, like buying its neighbours better receivers, to avoid greater liability later on. In any case, the emergence of Nextel as a strong third competitor in this market probably made it all worthwhile even if it was a bit messy."

65 Ibid., section 2.

66 Ibid., footnote 6.

unused licensed spectrum suitable for mobile services, they can choose to use it either for 2G or for 3G (or for that matter for 4G). If the provider has an existing license in which they are running 2G, there is no regulatory restriction on their using part of that assignment to support 2G services and part to support 3G services.

If they need more spectrum, they can attempt to obtain a license for additional spectrum (e.g. through a spectrum auction), or alternatively they may attempt to negotiate a lease or transfer with some other organisation that already has a license for suitable spectrum. The spectrum must be suitable for mobile services, but it need not be specifically 3G spectrum.

This has huge implications. Basically the migration from 2G to 3G and beyond is a purely commercial matter for the operators. They can manage their affairs so as to maximize profitability. No specific actions are required on the part of the regulatory body.

Flexibility brings a further advantage. Many concerns have been raised about European spectrum auctions that appeared to place too high a value on 3G spectrum. U.S. spectrum auctions have generally avoided this particular pitfall – since any mobile spectrum can be used for 3G, the scarcity problem is mitigated. Existing operators do not have the imperative to bid aggressively for specifically designated 3G licenses or risk being shut out of the market. The technological fungibility of U.S. mobile spectrum reduces its scarcity overall, and operators have the additional option, at the end of the day, to do something creative with the mobile spectrum already in hand if they are unsuccessful in the bidding for new licenses.

4.2.3 Frequency trading

The United States has long recognized that secondary market mechanisms can potentially serve as at least a partial correction to misallocation of spectrum. It has also long been clear that flexibility in the use of spectrum, in terms both of services and of technology, is an important facilitator to the effectiveness of spectrum trading.[67]

Thanks to this long history, the debate over secondary markets manifests quite differently in the U.S than it does in Europe. License *transfers* have been possible for most services for some time. The remaining regulatory open issues in the U.S. relate primarily to the appropriate degree of flexibility for various forms of spectrum *leasing*,

---

67 Cf. Douglas W. Webbink, *Frequency Spectrum Deregulation Alternatives*, FCC OPP Working Paper 2, October 1980. This twenty-five year old document is in all respects remarkably forward-looking. Webbink, then the Deputy Chief of the FCC's Office of Plans and Policy, argued that spectrum trading should be subject to few if any restrictions, that prior notification of the FCC should not be required, and that the FCC should eliminate most technical restrictions on usage except to the extent necessary to address interference.

and secondarily to measures to simplify transfers and to reduce or eliminate the FCC's role as a gatekeeper in the majority of instances of license transfer.

4.2.3.1 Introduction

Recent philosophical underpinnings of spectrum trading in the United States derive primarily from two documents: the FCC's *Policy Statement on Secondary Markets,* and the report of the Spectrum Policy Task Force (*SPTF Report*).

4.2.3.1.1 The Policy Statement on Secondary Markets

The FCC issued a comprehensive Policy Statement on secondary markets on December 1, 2000: Principles for Promoting the Efficient Use of Spectrum by Encouraging the Development of Secondary Markets.[68]

As a Policy Statement, the document falls in a rather strange category. It is an official FCC document that was voted on by the Commissioners, and it received a majority. At the same time, it has no particular legal force – it is not a rulemaking procedure. Industry tends to heed Policy Statements because the Commissioners who voted to support them are likely to still think the same way the next time that they encounter the same issue; however, none of the Commissioners who voted on this item are still at the Commission. Thus, it is difficult to say whether the document has effective force today.

At the same time, the Policy Statement represented an important and forward-looking overall look at the whole subject of spectrum trading, both transfers and leases, in the United States at the time.

The document does not deal solely with leases in the conventional sense. Rather, it seeks to facilitate the ability of licensees to engage in the "…transfer, assignment, disaggregation and partitioning of licenses …" in order "… to significantly expand and enhance the existing secondary markets for spectrum usage rights to permit spectrum to flow more freely among users and uses in response to economic demand..."[69] The primary concern is that, for any of a number of reasons, spectrum may be lying fallow, especially in rural areas.

The Policy Statement generally reflects a desire to move away from command and control mechanisms and toward market-based mechanisms (subject to the need to address interference); at the same time, it recognizes that a market approach might not

---

68 FCC docket number FCC 00-401.
69 *Secondary Markets Policy Statement*, page 3.

be suitable for "public safety, educational services, private wireless, amateur radio, and other important services".[70]

The report notes that considerable flexibility was already available to licensees in 2000:

> For example, our 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: 1) portions of their right to use frequency bands across their service area (disaggregation); 2) their rights to use frequency bands in portions of their service area (partitioning); or 3) 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, our rules expressly allow leasing or resale arrangements in which a third party can use licensed spectrum without the licensee transferring its rights outright. For example, our 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 pursuant to the licensee's authorisation.[71]

In achieving more effective secondary markets, with lower transaction costs, the Commissioners stated their intent to adhere to the following principles:

- Licensees should generally have clearly defined usage rights to their spectrum, including frequency bands, service areas, and license terms of sufficient length, with reasonable renewal expectancy, to encourage investment.
- Licenses and spectrum usage rights should be easily transferable for lease or sale, divisible, or aggregatable.
- Licensees/users should have flexibility in determining the services to be provided and the technology used for operation consistent with the other policies and rules governing the service.
- Licensees/users have a fundamental obligation to protect against and the right to be protected from interference to the extent provided in the Commission's rules.[72]

---

70 *Secondary Markets Policy Statement*, section 10.
71 Ibid., 14.
72 Ibid., section 20.

With all of this in mind, the Policy Statement identifies several areas where specific policy initiatives might be fruitful: (1) reduction of transaction costs through the elimination of unnecessary regulations and administrative requirements; (2) promotion of the availability of frequency and technically agile equipment; and (3) promotion of more effective market processes (notably making it easier for prospective buyers and sellers to identify potential rights [in terms of frequency, geography, and time] that might be available for sale or lease).[73] Subsequent FCC actions have primarily focused on elimination of unnecessary regulatory and administrative burdens.

4.2.3.1.2 The SPTF Report and frequency trading

The SPTF Report argued for a clear definition of property-like rights for spectrum, and for an enhanced ability to lease or transfer spectrum rights.[74] They promoted two alternative models of spectrum reuse: a *secondary markets* model, and an *easements*[75] or underlay model. In the former case, the licensee determines what rights it is willing to sublicense, if any, and to whom; in the latter, the FCC would determine what rights if any must be provided to third parties.

There has been no wide scale implementation of the easements (underlay) approach. Existing licensees were understandably uncomfortable with the risk of interference, and also with the risk that easements would lead to a "squatter's rights" problem – that once someone began to take advantage of an easement, it would be difficult or impossible to evict them later (for instance, in the event that they subsequently cause interference or limit the licensee's flexibility).[76]

The SPTF nonetheless recommended, first, that the FCC explore the future use of easements where an interference threshold can be established (using the interference temperature metric that is discussed in section 4.2.5) as a means of opening up spectrum to use below the threshold by new technology radios (e.g. software defined, frequency-agile radios). They note that the licensee would have to accept RF energy up to the level of the interference temperature threshold in any case.

The SPTF also recommended the use of secondary market mechanisms, perhaps complemented by limited use of easements, "to facilitate access to licensed spectrum for opportunistic, non-interfering devices that operate above the temperature

---

73 Ibid., sections 25-39.
74 *SPTF Report*, especially pages 55-58.
75 Under U.S. law, an easement is a limited right to use the real property belonging to another – for example, a legal right to cross someone else's property. Here, an easement would confer limited rights to use spectrum licensed to another.
76 There are, however, instances where the FCC permits unlicensed devices to operate in licensed spectrum without first obtaining the permission of the licensee. Ultrawideband (UWB) is a conspicuous example.

threshold."[77] They felt that it might in some cases be appropriate to enable some private entity (a band manager or frequency coordinator) to manage opportunistic secondary users on the primary licensee's behalf.

The SPTF advocated improvements in the FCC's mechanisms for spectrum leasing, including leasing in real time, in order to improve efficiency and to lower transaction costs.

4.2.3.2 Extent of trading

As previously noted, the main thrust of FCC actions over the past few years has primarily been to reduce the regulatory and administrative burdens associated with transferring and leasing spectrum. Given that spectrum transfers had already been widespread in the United States, the greatest impact of the FCC initiatives has likely been in the area of lease arrangements.[78]

4.2.3.2.1 Transfer of licenses

License transfers have in most cases been permitted for some years,[79] but with some notable exceptions, including most broadcast and satellite licenses. The *First Report and Order on Secondary Markets*[80] simplified procedures for transfers and for leases for a wide range of so-called *Wireless Radio Services (WRS).* The list of WRS services eligible for simplified transfer procedures is the same as the list of WRS services that are eligible for simplified leasing arrangements. This list of eligible services derives from several sources.[81] The FCC's original *Notice of Proposed Rulemaking (NPRM) on Secondary Markets* contained an extensive proposed list of bands licensed for exclusive use. The *First Report and Order* expanded on these defined categories, and clarified that the new flexible procedures were available not only to commercial licensees, but also to private or non-commercial licensees.[82] The *Second Report and*

---

77 *SPTF Report*, page 56.

78 The FCC's actions in regard to spectrum leasing are logical, but it remains unclear whether they are having much effect. Several interviewees expressed skepticism as to the level of activity to date.

79 Consider, for example, the comments of Commissioner Harold Furchtgott-Roth in 2000 as the *Policy Statement on Secondary Markets* was released: " … every year the FCC processes thousands of license transfers, the consummation of secondary markets for spectrum rights. In many if not most instances, these licenses are transferred from one party to another in exchange for some form of consideration as a result of a contract."

80 FCC, *Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets: Report and Order and Further Notice of Proposed Rulemaking* (referred to in this report as the *First Report and Order*), WT Docket No. 00-230, Released: October 6, 2003.

81 The list from the *NPRM* is reproduced in the *First Report and Order*, footnote 181. The *First Report and Order* expands the applicability of the new procedures to additional bands at section 84.

82 First Report and Order, section 84.

Order[83] further expanded the categories. One particularly noteworthy inclusion was the addition of spectrum used for public safety; however, the FCC permitted leasing and transfers of public safety spectrum only to other public safety organisations, or to private organisations using their spectrum for public safety purposes.

As regards transfers of licenses, the primary effect of the *First Report and Order* was to accelerate the approval process. The *First Report and Order* committed to place applications for transfer on public notice promptly, and to act on any applications that did not trigger the need for a more intensive review within 21 days.

The *Second Report and Order* went significantly further by identifying a large category of license transfers and leases for which no *ex ante* FCC approval at all would be required. The *Second Report and Order* recognized that the FCC was routinely approving applications that raised no serious public policy concerns; consequently, the order established a fast track for cases " … where the parties certify that the proposed transaction meets specific criteria indicating the absence of potential public interest concerns relating to eligibility, use restrictions, foreign ownership, designated entity policies, and competition. Lease filings and transfer/assignment applications that meet these criteria [are now] eligible for overnight electronic processing."[84]

The absence of an obligation for *ex ante* approval arguably does not thwart effective checks and balances. The FCC committed in the *Second Report and Order* to put transfers granted on public notice, and to accept petitions for reconsideration from the public up to 30 days thereafter.[85] The order thus preserves the ability of any injured parties to appeal.

At the same time, these categories are not quite as expansive as might at first appear. The FCC's concern with competitive issues is primarily for spectrum that could be used to provide mobile services. Thanks to flexible spectrum usage rules, a lot of the spectrum that is most interesting for transfers and leasing falls in this category (see the discussion on competition issues in section 4.2.5). Paradoxically, the FCC's emphasis on flexibility actually reduces somewhat the scope of this particular initiative.

4.2.3.2.2 Leasing from existing licensees

FCC procedures for leasing of spectrum were substantially liberalized by the First Report and Order in October, 2003. That ruling enabled "…most wireless radio

---

83 FCC, *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* (referred to in this report as the *Second Report and Order*), WT Docket No. 00-230, Released: September 2, 2004.

84 FCC press release, *FCC Expands Spectrum Leasing Rules and Speeds Processing to Create Additional Opportunities for Access to Spectrum through Secondary Markets*, July 8, 2004.

85 *Second Report and Order*, section 31.

licensees with 'exclusive' rights to their assigned spectrum to enter into spectrum leasing arrangements. The policies affected "… both mobile and fixed services, including Cellular, Personal Communications Services (PCS), Specialized Mobile Radio (SMR), Local Multipoint Distribution Service (LMDS), fixed microwave, 24 GHz, and 39 GHz, among others."[86] The First Report and Order provided two modes of liberalized arrangements.

The order refers to the first of the two modes as *spectrum manager* licensing. Where the licensee retains both *de jure* control (i.e. legal control) and effective *de facto* control (i.e. working control) over the leased spectrum, the ruling enabled leases without prior FCC approval for any amount of spectrum, geography or term within the bounds of the license. In this mode, it is the licensee that is primarily accountable to the FCC for compliance with spectrum-relevant legal and regulatory obligations.

The second mode is the *de facto* transfer mode. Where the licensee retains *de jure* control but transfers *de facto* control to the lessee, the order creates a fast track approval process but still requires prior FCC approval. For transfers of less than a year's duration, expedited approval is available in 10 days; for longer term transfers, approval requires 21 days. In this mode, it is the lessee that is primarily responsible for legal and regulatory compliance.

In both modes, a longer review may be initiated where the transfer raises broader public policy issues. This might be the case where there are some combination of (1) foreign ownership; (2) questions about the eligibility of the lessee to hold a license; or (3) where the licensee obtained the license as a "designated entity" or "entrepreneur". This last category relates to auction preferences accorded to "small businesses, rural telephone companies, and businesses owned by women and members of minority groups"[87], or to relatively smaller firms. The intent is that the lease mechanism should not be used as a loophole to enable otherwise unqualified entities to benefit from auction preferences.

The *Second Report and Order* further liberalized the process. Most notably, it made overnight processing of lease applications available to a wide variety of lease arrangements where the parties certify that the arrangement does not raise any of a specified list of potential concerns (such as foreign ownership, license eligibility, or competition issues).

The scope of Wireless Radio Services (WRS), the defined category to which the order applies, was broadened (both for leases and for license transfers) to include Multichannel Video Distribution and Data Service, and the Automated Maritime

---

86 FCC press release, *FCC Adopts Spectrum Leasing Rules and Streamlined Processing for License Transfer and Assignment Applications, and Proposes Further Steps to Increase Access to Spectrum through Secondary Markets*, July 8, 2004.

87 47 U.S.C. section 309(j)(3)(B).

Telecommunications Systems Services, but not to include shared spectrum services, satellite services, or Cable Television Relay Services.

Notably, the *Second Report and Order* permits licensees of land mobile public safety services to lease their spectrum to "other public safety entities or entities that provide communications in support of public safety operations", but not to commercial entities.

The *Second Report and Order* also attempts to clear the way for Cognitive Radio and similar forms of opportunistic use of spectrum: "…we clarify that parties may enter into spectrum leasing arrangements in which licensees and spectrum lessees share use of the same spectrum, on a non-exclusive basis, during the term of the lease. For example, a licensee and spectrum lessee may enter into a spectrum manager or *de facto* transfer lease in which use of the same spectrum is shared with each other by employing opportunistic devices."[88] The FCC thus recognized that opportunistic use would be inconsistent with an obligation to formally lease spectrum any time that it is used.

The *Second Report and Order* goes a step further by establishing a *private commons* lease mechanism. The private commons is intended to provide interference protection to opportunistic mesh or peer-to-peer networks, and thus to complement license-exempt (in the U.S. context, *unlicensed*) spectrum. As an example, " … a private commons could be created by a licensee (or spectrum lessee), which may or may not otherwise have a network infrastructure to provide services, by granting access for a fee (e.g., on a transaction, usage, fixed, or other basis) to users who employ smart or opportunistic wireless devices that conform to the terms and conditions established by the licensee (or lessee), such as a requirement that devices operating in the licensed band use a particular technology, hardware, or software. The users' devices may be used to engage in peer-to-peer (device-to-device) communications, such as by becoming part of compatible *ad hoc* or "mesh" wireless networks.

Such users may need access to a particular licensed spectrum band in lieu of (or perhaps in addition to) gaining access to other bands that may be more heavily used or that do not allow for the quality of service necessary for a particular application. This type of private commons might be particularly valuable to users that find existing bands that provide for unlicensed operations to be crowded or otherwise less desirable."[89]

4.2.4 Interference issues

The FCC operates today with only very broad and general definitions of interference and of harmful interference. Interference is defined as: "The effect of unwanted energy

---

88 Section 88.
89 Second Report and Order, section 95.

due to one or a combination of emissions, radiations, or inductions upon reception in a radio-communications system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy."[90] Harmful interference is defined as "[i]nterference which endangers the functioning of a radionavigation service or other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [international] Radio Regulations."[91]

It should be immediately clear that these definitions are in varying degrees ambiguous, and moreover that embedded within them are additional terms that are themselves ambiguous. This is hardly a model of regulatory clarity.

4.2.4.1 Device standards

The FCC has substantial authority to regulate potentially RF-emitting devices manufactured, sold, or imported into the United States in order to reduce the risk of harmful interference. In the case if home electronic equipment, the FCC has similar legal authority to establish minimum performance standards in order to reduce their susceptibility to RF interference.[92] Today, the focus is on the transmitter, not the receiver.

Historically, the FCC tested equipment itself. Today, the manufacture or importer generally performs any necessary tests.[93]

4.2.4.2 The Nextel Order

The *Nextel Order* provides a fascinating window into both the strengths and the weaknesses of many of the FCC's methodologies.

As previously noted, flexibility in the 800 MHz band coupled with growth in Nextel's customer base led to intractable interference problems. The FCC initially dealt with these problems in its routine fashion: "Until now, the Commission's approach to

---

90 Defined in FCC rules at 47 C.F.R. § 2.1 (2002).
91 Ibid.
92 47 U.S.C. 302.
93 "Verification is a self-approval process. The verification procedure requires that tests be performed on the device to be authorized. The manufacturer (or importer for an imported device) is required to ensure that the measurements necessary to determine compliance with the technical standards are performed. A copy of the measurement report showing compliance with FCC standards must be retained by the manufacturer and, if requested, submitted to the Commission. Devices subject to verification include: business computer equipment (Class A); TV and FM receivers; and, non-consumer Industrial, Scientific and Medical Equipment. Once the report is on file, a compliance label must be affixed to the device. Also, an information statement regarding the interference potential of the device and information about any special accessories need to ensure FCC compliance must be included in the instruction manual …" See http://www.fcc.gov/oet/info/filing/ead/ver.html.

interference resolution in the 800 MHz band has been to urge the involved parties to make voluntary technical changes to prevent or reduce interference at particular sites. This is consistent with the policy reflected in current rules that require affected licensees to resolve interference through mutually satisfactory arrangements."[94]

In the *Nextel Order*, the FCC recognized the limitations inherent in dealing with the interference problems solely through its traditional mechanisms, or through reliance on best practices: "Addressing interference on a case-by-case basis is both labor-intensive and expensive. The transactional costs of applying Enhanced Best Practices as an exclusive remedy would increase as new public safety and other non-cellular systems were implemented and ESMR and cellular licensees increased the capacity of their systems by adding more cells. The increased costs and labor burden disproportionately affects public safety agencies, many of which operate with very limited human, technical, and financial resources. Some interference situations respond poorly, if at all, to the use of the techniques contained in the Enhanced Best Practices. ESMR and cellular systems will continue to expand. …"[95]

In the *Nextel Order*, the FCC adopted a new detailed methodology *solely* for the 800 MHz band as a short term fix, while migrating incumbents as a permanent fix. They established a new definition for "unacceptable interference", a term of art that does not otherwise appear in FCC rules. Of particular interest is the unique (for the United States) reliance on receiver performance standards:

> … In recognition of the role that receiver characteristics play in the interference calculus, we are affording full protection against unacceptable interference only to systems whose mobile or portable receivers are capable of satisfactory operation at the threshold signal power in the absence of interference. Other systems will receive lesser protection as a function of the degree to which their receivers exhibit inferior performance.[96]

4.2.4.3 The SPTF and the Interference Temperature

Among the many proposals put forward by the SPTF, one of the most controversial was for the use of *interference temperature* as a regulatory tool. This is a promising proposal, but in most respects it is more of a research project than a working regulatory methodology.

The Spectrum Policy Task Force advocated that the FCC instead evolve toward the use of explicit, quantitative standards based on the interference temperature. The *interference temperature* is a measure of energy, in degrees Kelvin, delivered to the

---

94 *Nextel Order*, section 14.
95 *Nextel Order*, section 17.
96 *Nextel Order*, section 19.

receiving system's antenna. Interference temperature is, in fact, synonymous with the antenna temperature.[97]

It is important to bear in mind that the interference temperature is a single metric of interference. In and of itself, it is not a regulatory methodology. It is potentially an enabler, a foundation on which one or more regulatory methodologies could perhaps be built.

Potential uses and applicability of the interference temperature include the following possibilities, which are closely interrelated:

1. As a rigorous means of expressing the amount of interference that is permissible, or impermissible, in a particular frequency band.

2. As a part of the technical underpinnings for fully automated systems that would dynamically sense the RF environment, and would transmit opportunistically only when the RF environment was sufficiently quiet.

3. As a means of enabling new services to operate as underlays in bands already licensed to others, to the extent that such operation would not exceed the permissible background noise level.

The SPTF Report provides surprisingly little detailed guidance as to how the interference temperature might in fact be used in any of these scenarios. In the discussion that follows, we seek to summarize key ideas from the SPTF report and from the more detailed discussion in the report of the SPTF's Interference Protection Working Group, and also to provide insights about the implications of these methodologies.

4.2.4.3.1 Expressing permissible interference

Again, the interference temperature is a single metric of RF interference. A regulatory methodology would need to address a wide range of complex technical and policy issues, among them:

- How is the interference temperature measured?
- From what locations must it be measured?
- Who measures it?

---

97 SPTF, *Report of the Interference Protection Working Group*, November 2002, page 13: "As conceptualized by the Working Group, the terms 'interference temperature' and 'antenna temperature' are synonymous. The term 'interference temperature' is more descriptive for interference management." See: http://www.fcc.gov/sptf/reports.html.

- How high a temperature is too high?
- When the temperature is too high, who should respond, and how?
- Is there a risk of willfully incorrect measurements, and if so, how can that risk be mitigated?
- Is it feasible to police the system so as to mitigate the risk of willful transmission in excess of permissible levels?

The interference temperature corresponds to a measurement at a single point in space, at a single instant in time. No single measurement is uniquely valid. Notably, a particular antenna might not "see" all of the transmitters in a given geographic area.

For most regulatory purposes, it would be necessary to develop some kind of averaged metric over a larger geographic area. An averaged metric might, for instance, provide a rational policy basis for permitting higher transmit power in remote areas with low teledensity. Doing so implies capturing data at multiple locations, and using that data to create some kind of overall figure of merit.

The SPTF Interference Protection Working Group does speak to this issue. They suggest that the data "… could be measured directly by the emitter; e.g., for low power devices with very small signal ranges. More generally, a grid of spectrum monitoring stations could be established that would continuously scan the RF environment for particular frequency bands, process the data and broadcast packetized interference temperature data from omni-directional antennas transmitting on dedicated frequencies. Data packets could also include the geographic location of the interference temperature measurement, the associated frequency or frequency band and the measurement bandwidth. As another means of data delivery, transmitters and receivers operating in the environment – for example, in 'an adaptive ad hoc wireless network' – could be equipped with interference temperature 'thermometers' and GPS sensors to determine measurement locations. The devices in the network would constantly measure interference temperature and route real-time data packets through the network. RF devices not in the network could also be equipped to measure and send this information."[98]

Needless to say, a great deal of work would be needed to operationalize such a system.

The next challenge would be to establish permissible levels of interference for each service in each band. The use of the interference temperature does not automatically determine this result. Paul Margie, former spectrum advisor to FCC Commissioner

---

98 *SPTF Interference Protection Working Group Report*, pages 17-18.

Copps, expressed it in this way: "… how would the Commission set these permissible levels of interference for each band, even if it uses the new interference temperature metric? The technical metric alone can tell us how much energy is present at a certain frequency at a certain time and at a certain place. But, alone, it cannot tell us if this amount of energy is acceptable or unacceptable as a policy matter."[99] Margie goes on to observe that it is useful to measure the speed of an automobile in miles per hour, but determining how fast an automobile may legally and safely be driven on a given road is a policy decision that is not uniquely determined by the choice of miles per hour as a metric.

If the interference temperature is above some predefined threshold, presumably some remedial action is required. But by whom? The interference temperature is a measurement of RF noise from all sources, as measured at a particular location in time and space. Did a single overly aggressive transmitter cause the threshold to be exceeded? A high temperature as measured by one or more receivers does not necessarily in and of itself tell us *which* transmitter should respond, unless perhaps it means that all transmitters must take action.

Once a transmitter determined a need to take action, responses might include "…reduction in transmitter power, antenna beam re-shaping, selection of a different transmitting frequency or a "stand down" decision to wait until the environment adjusted to permit a transmission that would not cause an acceptable interference level to be exceeded within the emitter's nominal signal range."[100]

Finally, protecting such a system from willful fraud, manipulation and abuse would appear to warrant a research project in its own right.

4.2.4.3.2 Fully automated systems

The thrust of the SPTF was largely toward future cognitive radios that would dynamically adapt to changes in the interference temperature.

In principle, the approach is very promising. Cognitive radios could dynamically find and utilize "white space", opportunistically capitalizing on bandwidth that would otherwise lay fallow.

These automated systems would need to address nearly all of the complexities discussed in the preceding section. How is the interference temperature measured? If too high, who responds, and how?

---

99 R. Paul Margie, "Efficiency, Predictability, and the Need for an Improved Interference Standard at the FCC", Telecommunications Policy Research Conference (TPRC), September 2003, page 12. See: http://tprc.org/papers/2003/214/HarmfulInterference.pdf.

100 *Report of the Interference Protection Working Group*, November 2002, page 18.

In addition, distributed control systems would presumably have to incorporate feedback mechanisms and possibly hysteresis loops to prevent oscillating behavior. This is not to suggest that any of these problems are insuperable; nonetheless, it is important to bear in mind that the use of the interference temperature is only one element of a complex systems design.

4.2.4.3.3 Underlays

Perhaps the most controversial aspect of the interference temperature proposal was the notion that it could be used to enable secondary use of spectrum within an existing licensee's band (a form of spectrum *easement*[101]), as long as the interference temperature remained within acceptable bounds. When U.S. incumbents express virulent opposition to the use of interference temperature, it is often the notion of underlays to which they are responding.

The concept is simple enough. As long as opportunistic secondary use results in an overall interference temperature to users of the primary service that is no higher than the permissible noise level, then it should be permitted.

Incumbents are understandably uncomfortable. First, underlays introduce uncertainties that would not otherwise exist into their business models. This is in part a function of the ambiguities inherent in the interference temperature model as defined in the SPTF Report, for reasons noted in the preceding sections. Second, the incumbents would observe that, as a practical matter, their networks are designed for the interference that they currently experience, not necessarily for the maximum permissible levels. And third, to the extent that underlays might make usable spectrum more abundant, and foster competitive entry, it potentially reduces the value of spectrum already held by the incumbents.

4.2.4.3.4 Concluding thoughts about interference temperature

Even though the concept is quite promising, the introduction of the notion of interference temperature in the SPTF was possibly premature and probably ill-advised. A great many important details are left as an exercise for the reader. At the same time, it is probably fortunate that this topic has now been introduced into the public discourse. Other countries can learn and benefit from the ongoing debate in the U.S.

---

101 An underlay is one type of easement (low powered non-interfering use). Another type of easement is high powered narrowband opportunistic use, often associated with cognitive radios.

4.2.5 Competition issues

The United States implements a number of measures to address competitive concerns through its spectrum management processes. Many of these relate to spectrum that is suitable for mobile telephony. Others relate to over-the-air broadcast. Fixed wireless access has not generally been subject to spectrum caps or other competition controls.

4.2.5.1 Introduction

In discussing spectrum auction methodologies, the Act specifically directs the FCC to "[promote] economic opportunity and competition and [ensure] that new and innovative technologies are readily accessible to the American people by avoiding excessive concentration of licenses and by disseminating licenses among a wide range of applicants, including small businesses, rural telephone companies, and businesses owned by members of minority groups and women…".[102]

4.2.5.2 Type of regulatory regime

As we have seen, transfers or leases that effectively may increase concentration are subject to review by the FCC. In practice at present, only spectrum licenses suitable for mobile telephony are deemed to raise concerns.[103]

4.2.5.2.1 Spectrum Caps

Historically, the FCC attempted to bound the risk of a provider achieving market power through the acquisition of all of the relevant spectrum for a geographic area by means of spectrum caps. These caps limited the maximum amount of spectrum available to a mobile provider to a maximum of 45 MHz in an urban serving area, and 55 MHz in a rural serving area. The cap applied to a range of bands that could be potentially suitable for wireless services. The caps were thus applicable to "120 MHz of broadband PCS spectrum, 50 MHz of cellular spectrum, and 10 MHz of attributable SMR spectrum."[104] If a provider had an interest of more than 20% in another entity with a license in the same geographic area, the latter's share was included in the former's attributable share for purposes of computing the maximum permissible spectrum in the area.

---

102 47 U.S.C. section 309(j)(3)(B).
103 The *Second Report on Secondary Markets*, document 04-167, September 2, 2004, sections 25-27.
104 FCC, *2000 Biennial Regulatory Review Spectrum Aggregation Limits For Commercial Mobile Radio Services*, WT Docket No. 01-14, Released: December 18, 2001.

The FCC phased these rules out effective January 1, 2003. They chose instead to evaluate potential competitive effects on a case-by-case basis.[105]

The elimination of spectrum caps was probably appropriate at the time, but whether it will ultimately prove to be problematic remains to be seen. Economist Peter Cramton of the University of Maryland once expressed the issue in this way: "The best policy on spectrum caps is a middle ground, where binding caps are imposed in initial auctions, but then these caps give way once it is believed that vigorous competition has been established. Then individual mergers can be reviewed on a case-by-case basis… If[, however,] concentration is viewed as a potential problem going into an auction, then spectrum caps, rather than case-by-case review, must be used, since only caps can provide an instantaneous determination of what is allowed and what is not. Such a rapid response is essential in a simultaneous ascending auction. Bids must be binding commitments until they are topped. Hence, at every point in the auction, the bidders must know what is allowed and what is not."[106] The market for mobile telephony in the United States was viewed as robustly competitive in 2001, perhaps excessively competitive, with six nationwide providers. Today, as mergers proceed apace,[107] the degree to which this competitiveness will be maintained is less clear.

4.2.5.2.2 Media ownership rules

The FCC historically has maintained a series of rules limiting the number of television or radio entities that a given entity could control in a given market, and preventing cross-ownership of newspapers in the same geographic market.

In June, 2003, the FCC approved an order that would have substantially liberalized these restrictions. A year later, in June 2004, the U.S. Appeals Court for the Third Circuit remanded large parts of the order to the FCC for reconsideration, thus blocking implementation. Implementation is still blocked, leaving media concentration rules in a serious state of disarray.[108] For the most part, rules adopted in the Seventies are effectively reinstated.

4.2.5.2.3 Merger reviews

In the past two years, there have been two major mergers in the mobile phone sector: Cingular/AT&T Wireless in 2004, and Sprint/Nextel in 2005. Both shed light on the U.S.

---

105 Ibid.
106 Testimony before the United States Senate Budget Committee, February 10, 2000.
107 AT&T Wireless and Cingular in 2004; Sprint and Nextel in 2005.
108 It is perhaps symptomatic that, as of this date in September 2005, the FCC's web page on media concentration appears not to have been substantively updated since 2003. See: http://www.fcc.gov/ownership/Welcome.html.

Government's response to competitive concentration as it relates to spectrum management.

In AT&T Wireless / Cingular, the FCC found potential competitive problems in only 22 of the 734 cellular geographic markets subject to FCC jurisdiction. They required that AT&T Wireless divest its holdings, including the spectrum associated with those holdings, in 16 of those markets. In the others, they required scaling back of spectrum: to 65 MHz in Detroit, to 70 MHz in Dallas, and to 80 MHz in all other markets.[109] Note that these levels are substantially in excess of the former spectrum cap of 45 MHz. In declining to impose stricter conditions, the FCC said: "We decline to require further limitation-based spectrum divestitures … because we believe such limitations too closely resemble our former cap on spectrum aggregation. In the analysis represented in this Order, we have fully taken account of the likely competitive effect of the aggregation of spectrum resulting from this transaction, and we have imposed remedies consistent with that analysis."[110]

The FCC also required the merged firm to agree to refrain from bidding for spectrum in any geographic market where Cingular held more than 70 MHz of spectrum in one particular auction.

In the Sprint/Nextel merger, only minimal conditions were imposed. No significant divestitures were required.[111] The Sprint/Nextel merger raised fewer issues because Sprint and Nextel are both considerably smaller than either AT&T Wireless or Cingular.

Commissioner Copps's comments in response to the Sprint/Nextel merger are nonetheless significant, and inevitably raise questions about the degree to which the FCC's deregulatory course will prove to be sustainable: "In less than a year mergers have reduced the number of national wireless competitors by one third. Only last year consumers could choose between six national carriers. There are now only four. The average US market's HHI score has grown from 2,900 (before the Cingular/AT&T merger) to 3,100 (after the Cingular/AT&T merger) to 3,300 (after the Nextel/Sprint merger). That means that consumers in the average community now have the equivalent of only 3.03 equal sized competitors—national, regional and local combined. While I am sensitive to the arguments that six national competitors could not have been forever sustained in the wireless market, I am also concerned about what this

---

109 FCC, "FCC Consents with Conditions to Cingular Wireless Acquisition of At&T Wireless Licenses and Authorizations", October 26, 2004.

110 FCC, *Applications of AT&T Wireless Services, Inc. and Cingular Wireless Corporation*, WT Docket No. 04-70, Released: October 26, 2004, section 257.

111 FCC, "FCC Consents to Sprint Corporation Acquisition of Nextel Communications Licenses and Authorizations", August 3, 2005.

substantial reduction in the number of competitors may mean for wireless consumers."[112]

4.2.5.2.4 Auction conditions

In the past, the FCC has sometimes used conditions in the auctions as a complement to spectrum caps. For example, in the A and B block PCS auction, incumbent cellular licenses were not permitted to bid on PCS licenses substantially overlapping their cellular service areas.

4.2.6 Economic pricing of frequencies

In the normal course of events, the FCC does not attempt to establish prices for spectrum as a regulatory matter. FCC application fees and regulatory fees are established by statute, by law. Broadly speaking, regulatory fees are intended to recover administrative costs. Auction prices are set by the market mechanisms.[113] In neither case does the FCC need to determine a price. As the FCC itself has observed, " … the valuing of spectrum is not an activity in which the Commission typically engages."[114]

4.2.6.1 General pricing mechanisms for licenses

A wide range of application and license fees are set explicitly by the Act, as adjusted every two years to compensate for inflation.[115] Application fees tend to be comparatively modest – for example, a "New or Major Change Construction Permit" for a commercial television station is just $2,535.

The Act directs the FCC to "… assess and collect regulatory fees to recover the costs of … enforcement activities, policy and rulemaking activities, user information services, and international activities".[116] Again, these fees are unrelated to the commercial value of the spectrum. Congress established an initial level for annual regulatory fees for VHF

---

112 Under the guidelines that the Department of Justice and the Federal Trade Commission nominally apply to horizontal mergers, a score of more than 1,800 on the Herfindahl-Hirschman Index (HHI) is worrisome. See: http://www.ftc.gov/bc/docs/horizmer.htm. For the Copps statement, see: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-148A3.pdf.

113 The FCC must, to be sure, estimate the value of spectrum when it sets a minimum opening bid for an auction; however, the estimate need not be precise, since the auction will effectively correct minor errors in the estimate.

114 *Nextel Order*, section 283.

115 47 U.S.C. section 158.

116 47 U.S.C. section 159(a).

commercial television to be in the range of $5,000 to $18,000, depending on the size of the market.[117]

4.2.6.2 Auctions

Legal authority for the FCC to conduct auctions rests in section 309(j) of the Act. Where mutually exclusive applications are accepted for spectrum, the FCC is to use competitive bidding to determine the winner.[118]

The money received must be deposited in the U.S. Treasury; however, the FCC may retain a portion of the money collected to offset salaries and expenses associated with the auction program itself.

The FCC is prohibited from considering the auction revenues in determining the benefits to the public that would accrue from allocating a particular band to a particular use.[119] Presumably, the Congress was concerned that the FCC might be tempted to allocate spectrum to the most profitable use, rather than to the use most valuable to society. Uses such as public safety or educational broadcasting might be valuable but not necessarily profitable.

4.2.6.3 Other instances where economic prices needed to be determined

Although the FCC does not need to establish spectrum prices as a routine matter, other than through auctions, the issue occasionally comes up in other contexts.

As a conspicuous example, the FCC arranged a spectrum swap with Nextel in order to address long-standing interference problems that were impacting public safety services. In so doing, they needed to establish a value for the old spectrum, and for the new, in order to respond to public criticism that Nextel might be unjustly enriched at public expense.[120]

In ascribing a value to the ten MHz of spectrum, the FCC began by evaluating the estimates that were provided to it by Nextel and by two other parties who opposed the transaction (CTIA and Verizon). Not surprisingly, the FCC found the Nextel estimate too low, and the CTIA and Verizon estimates too high.

---

117 47 U.S.C. section 159(f).

118 However, various statutes prevent the FCC from using auctions in conjunction with Public Safety Radio Services, Digital television licenses to replace analog licenses, Non-commercial educational and public broadcast stations, or international satellite usage.

119 47 U.S.C. section 309(j)(7).

120 The discussion that follows is based on the *Nextel Order*, sections 277-324 (especially 277-297).

The FCC ended up doing what a real estate broker or appraiser would typically do in analogous circumstances – they looked for the most nearly comparable transactions, and used those to develop a normalized estimate. In this case, the normalization was to a metric often used in this industry, a price per MHz per person (MHz-pop). They identified two highly relevant transactions at values that corresponded to $1.58 per MHz-pop and $1.66 per MHz-pop. They also identified a number of smaller transactions, mostly at significantly lower prices (which they attributed to the smaller transactions being associated with smaller cities or rural areas).

Having gone through this analysis, they then returned to the two highly relevant comparables, and simply averaged them to come up with an overall estimate of $1.62 per MHz-pop.

Curiously, they then noted that the spectrum that they were providing might command a slight premium, since it was a coherent national block, unlike the ostensibly otherwise comparable transactions. So they took their $1.62 per MHz-pop figure and added a 5% premium to it, with no particular justification as to the specific choice of 5%.

A few generalizations emerge from studying this exercise:

- First, the FCC does not routinely attempt to ascribe a value to spectrum, as they themselves observed in this order.
- Second, even though the FCC has the ability to subpoena documents (i.e. to use compulsory process), they apparently based this entire analysis on publicly available information.
- Third, the analytic methodology is no more sophisticated than one might find in a typical article in the financial section of a non-specialist newspaper or magazine.
- Fourth, the application of the 5% correction at the end – which might be viewed as “Kentucky windage”, i.e. a heuristic adjustment to one’s aim with a rifle – seems rather arbitrary.

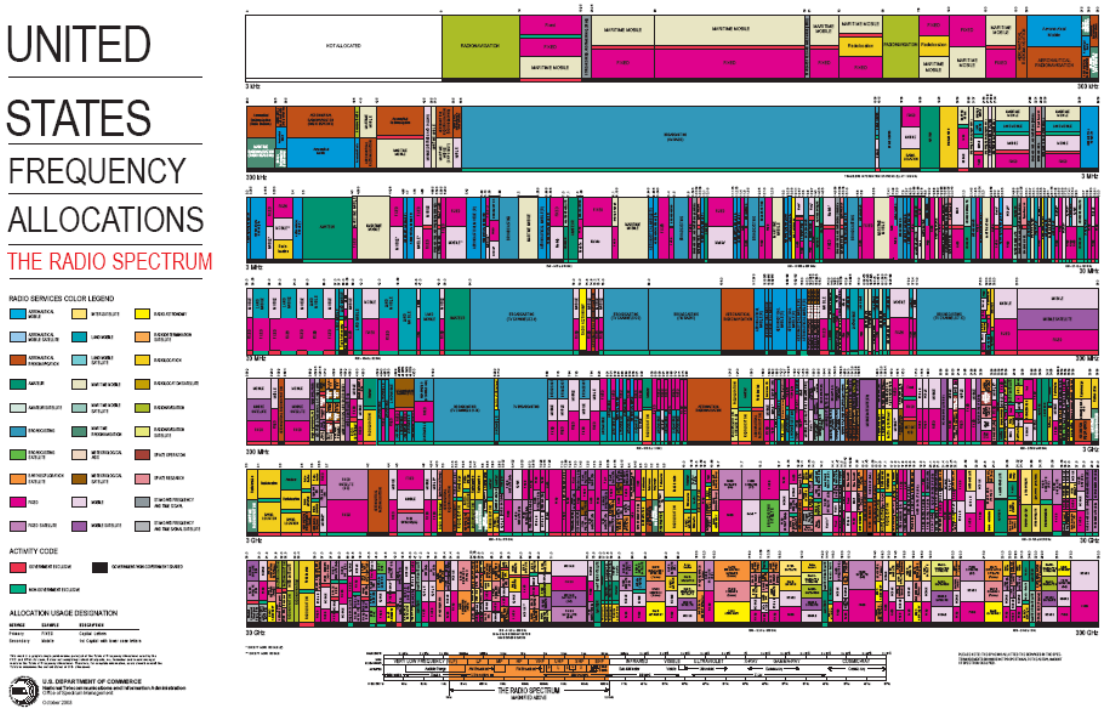
4.2.7 Implications of frequency trading and liberalisation for selected areas

This section serves primarily to expand somewhat on points about specific spectrum bands that for the most part appeared earlier in this report.

No United States document provides an overall view of strategic planning for spectrum management on a band-by-band basis. The NTIA maintains a chart of current allocations, which is reproduced below. Unfortunately, the chart (see Figure 2) is too

cluttered to be of much benefit to anyone other than a dyed-in the-wool specialist spectrum warrior.

Figure 2: NTIA chart of United States Frequency Allocations

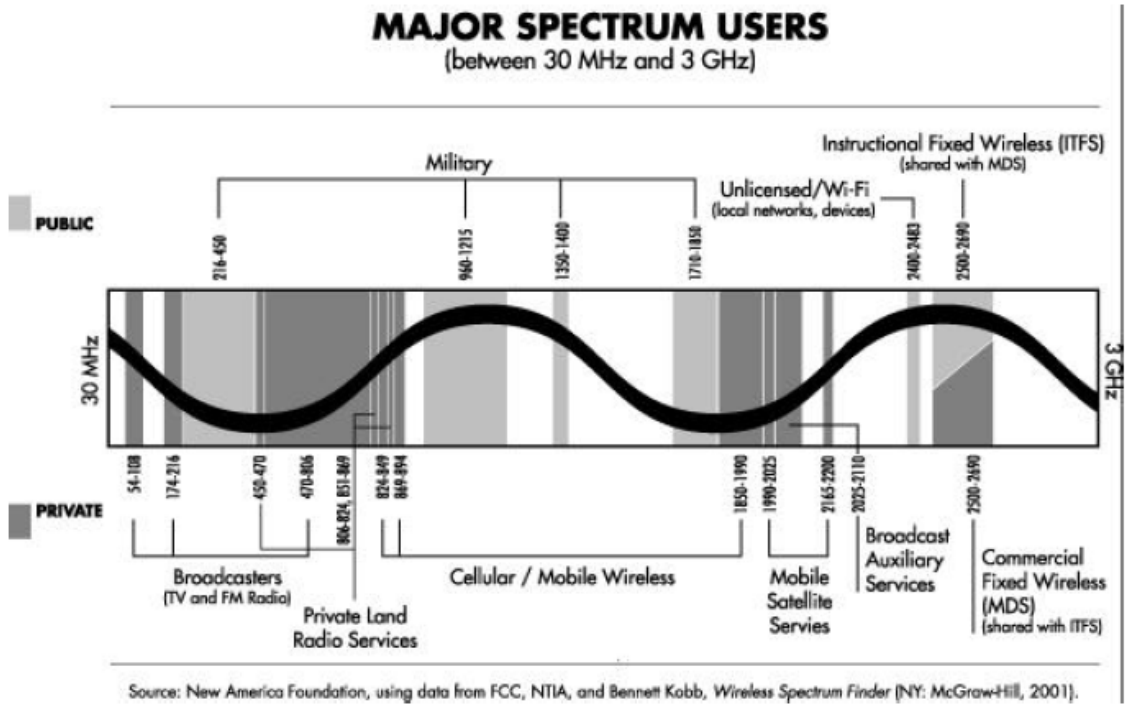


Source:

Michael Calabrese of the New America Foundation has provided a simplified chart,[121] at a lower level of detail, which is more readable and more helpful to the non-specialist reader (see Figure 3).

121 Michael Calabrese, *Battle Over the Airwaves: Principles for Spectrum Policy Reform*, New America Foundation, October 2001, page 3.

Figure 3: Calabrese's abstracted chart of United States Frequency Allocations



Source:

4.2.7.1 Broadcast frequencies

It is widely anticipated that the migration to *Digital Television (DTV)* will generate a large "digital dividend", since digital transmission can utilize spectrum as much as six times more efficiently than current U.S. analogue usage. The migration to DTV will not only enable more over-the-air broadcast content, of better visual quality,[122] but will also make spectrum available for other uses.

122 DTV permits any of a number of transmission formats. *High Definition Television (HDTV),* delivered over DTV, enables dramatic improvements in image quality and sound. HDTV uses a widescreen aspect ratio of 16:9, compared to the North American standard aspect ratio of 4:3, with greatly improved image resolution and Dolby Digital surround sound. All of this is implemented in roughly the same bandwidth as a current analogue channel. Alternatively, DTV can enable "*multicasting*", or the transmission of several *Standard Definition Television (SDTV)* programs at once. Other formats can also be supported.

The FCC has assigned a second channel to traditional broadcasters to enable them to continue analogue broadcasting while migrating to DTV. At the end of an extended transition period, they must return the analogue channel.

The spectrum that will be freed up is attractive “beachfront property”. It has excellent propagation and penetration characteristics.

The current expectation is that some of the spectrum will be used for public safety, and particularly to facilitate interoperability among public safety organisations. The remainder is to be auctioned off under provisions that are already established in the Telecommunications Act of 1996.[123]

The Act directs the FCC to stop issuing license extensions to analogue television broadcasters once fewer than 15% of the “television households” in that market would lose service as a result of the transition. The issue has been hotly lobbied, and the statutory language is not altogether clear. As a result, the FCC has been unable to bring the matter to closure.

At present, Congressional action is widely anticipated, probably this year. It is likely that the Congress will set a firm date for analogue television shut-off. Pressure for a resolution has mounted in the wake of the devastating hurricanes that the United States experienced this year (2005), given public safety interest in the returned spectrum. There is much speculation that Congress will mandate analogue shut-off at the end of 2008. Much of the debate within the Congress has revolved around possible subsidies for consumers to purchase set-top boxes to enable existing analogue television to process the new digital signals. How much money should the U.S. Government provide, how should the subsidies find their way to needy consumers, and where should the money come from?

4.2.7.2 2G versus 3G frequencies

As previously noted, the U.S. makes no distinction in general between 2G and 3G usage. Allocations for mobile telephony are generally technologically neutral; moreover, they often permit the deployment of other services as well, subject to interference constraints.

The bands that are already allocated for Commercial Mobile Radio Services (CMRS), or mobile phone usage, are thus generally available for either 2G or 3G usage as desired. Conversely, there is no need to address any phase-out of 2G bands, since the spectrum is available for alternative use as the licensee sees fit. The recent

---

123 47 U.S.C. section 309(j)(14).

proceedings for the AWS (Advanced Wireless Service) bands[124] – new spectrum that licensees will most likely use for 3G/4G services – make this clear by proposing to "permit any use of this spectrum that is consistent with the bands' fixed and mobile allocations".

4.2.7.3 Fixed wireless access (FWA) frequencies

Two trends are particularly noteworthy as regards fixed access. The first is that licensees of spectrum intended primarily for other use, notably including mobile services, are in many cases free to use their licensed spectrum for fixed access. This is also true of a number of other bands, including the 2500-2690 MHz MMDS/ITFS band (previously discussed in section 4.2.2.2 of this report), and also the 746-806 MHz band allocated to analog television channels 52-69.

A second trend relates to self-provisioning. The FCC issued two orders, in 2003 and 2005, relating to the use of the high frequency "millimetre wave" bands at 71-76 GHz, 81-86 GHz, and 92-95 GHz.[125] These bands were historically used exclusively by the U.S. Government; indeed, there are significant technical challenges associated with their commercial use. The FCC and NTIA agreed to open these bands to enable commercial use on a shared basis with Federal Government operations.

The FCC noted that these bands were "…essentially undeveloped and available for use in a broad range of new products and services, including high-speed, point-to-point wireless local area networks … Highly directional, 'pencil-beam' signal characteristics permit systems in these bands to be engineered in close proximity to one another without causing interference."[126] In fact, there is some question as to whether licensing is needed at all.

In light of the fairly low risk of interference, the FCC and NTIA jointly developed an automated web-based licensing system. The FCC describes the operation as follows:

> Starting on February 8, 2005, [a permanent link registration process was established] where third-party database managers are responsible for recording each proposed non-Federal link in the third-party database link system and coordinating with NTIA's automated "green light/yellow light" mechanism to determine the potential for harmful interference with Federal operations. … A "green light" response indicates that the link is coordinated with the Federal Government; a "yellow light" response indicates a potential for interference to Federal Government or certain other operations … In the case of a "yellow light," the licensee must file an application for the requested link with the

---

124 Specifically, 1915-1920 MHz, 1995-2000 MHz, 2020-2025 MHz, and 2175-2180 MHz. See the FCC's AWS NPRM, FCC document 04-218, at 1.
125 See http://wireless.fcc.gov/services/millimeterwave/.
126 Ibid.

> Commission, which in turn will submit the application to the IRAC for individual coordination. … This automated process is designed to streamline the administrative process for non-Federal users in the bands. … Database managers will not be responsible for assigning frequencies but will be responsible for establishing and maintaining the database. However, they are not precluded from offering additional services, such as frequency coordination, which will assist a licensee in designing a link.[127]

4.2.7.4 Unlicensed spectrum

The FCC's initiatives to open up unlicensed spectrum (known in other countries as license-exempt) have been very popular with industry and with the general public.[128] The FCC is likely to look for ways to make more unlicensed spectrum available in the years to come.

4.2.8 Conclusions and Recommendations for Germany based on experiences in the United States

The United States has introduced many valuable spectrum management innovations to the world. Some U.S. spectrum management practices that may have seemed *avant garde* at the time of their introduction now are generally accepted globally as representing regulatory best practice. The best example of this is the pioneering use of auctions to achieve market-based spectrum assignments in order to bring spectrum to its best and highest-valued use; moreover, the broad underlying principle that market mechanisms should be relied on where feasible is now widely accepted.

The United States continues to be a hotbed of innovation as regards spectrum management techniques. Some of these innovations will ultimately prove themselves out, just as spectrum auctions did. At all events, however, a note of caution is in order: there is no need to imitate United States innovations here in Germany *before* they have demonstrated their worth. It also bears mentioning that the U.S. is for the most part a large contiguous country, with only two land neighbours (Canada and Mexico), and with a very substantial internal market. In a number of instances, the U.S. was able to undertake novel approaches unilaterally, where a country like Germany would need to coordinate with multiple close neighbours.

---

127 FCC, *In the Matter of Allocations and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands: Memorandum Opinion and Order*, WT Docket No. 02-146, Released: March 3, 2005, footnote 12.

128 See, for instance, Kenneth R. Carter, Ahmed Lahjouji, and Neal McNeil, *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, OSP Working Paper 39, May 2003.

With all of that said, we consider the potential applicability to Germany of a number of specific U.S. spectrum innovations. The major elements of our recommended approach, as elaborated in the discussion that follows, are:

- Gradual simplification of license transfer and lease mechanisms;
- Recognition of the benefits that North America has achieved with flexible mobile telephony spectrum, and initiation of a planning process to determine the feasibility of migration to a similar system in Germany;
- Expansion of unlicensed spectrum as circumstances permit;
- Consideration of selective use of receiver performance guidelines if circumstances warrant; and
- Continued observation from afar of North American progress with other innovative interference management tools and approaches.

License transfers and leases

The various regulatory changes that the United States has made in order to simplify license transfers have arguably brought some gain in efficiency, and do not in and of themselves appear to have caused adverse side effects.

License transfers should tend to improve the efficiency of spectrum usage, allowing corrections over time to the initial allocations achieved through auctions. License transfers are permitted in Germany, but they are rarely undertaken. Reducing regulatory barriers to transfers, and thus reducing transaction costs and increasing regulatory certainty, should improve the effectiveness of this process.

U.S. experience in defining a category of transfers suitable for fast-track handling provides valuable guidance to the Federal Network Agency. The FCC defined criteria sufficient to identify certain proposed license transfers as not being problematic, they permitted parties to a proposed transfer to self-certify that the conditions were met, and they committed to approve such transfers in a specified, brief period of time absent some specific reason to do otherwise.[129] The Federal Network Agency could take similar steps, while holding in reserve as a potential future enhancement the possibility of defining a category of transactions that are so routine as to require no regulatory approval at all.

---

129 See section 4.2.3 of this report, „Frequency Trading“, and especially section 4.2.3.2.1, „Transfer of Licenses“.

Spectrum leases should also improve the efficiency of spectrum usage. At the same time, leases are significantly more complex than outright transfers. There is still some question as to the degree to which the benefits exceed the regulatory costs, all things considered.

With that in mind, we recommend that the Federal Network Agency continues the spectrum leasing arrangements already in place, and consider incremental improvements over time. In general, measures that reduce transaction costs and that increase the confidence of parties to a prospective lease that it will be granted will tend to improve the effectiveness of the system.

The FCC has implemented at least four distinct forms of spectrum leasing, each with its own regulatory challenges: spectrum manager leasing, short-term *de facto* transfers, long-term *de facto* transfers, and the private commons. Several interviewees were of the opinion that the more novel forms of spectrum leasing are still not being used very much in the United States. Rather than duplicating this considerable complexity, we recommend that the Federal Network Agency continue at this time to implement only a single form of leasing, which corresponds the simplest and most basic U.S. form of spectrum leasing: *spectrum manager leasing*.

In the spectrum manager form of leasing, the licensee retains working control of the spectrum, and the FCC looks to the licensee to take responsibility for compliance with spectrum-relevant obligations (e.g. interference) and also for general regulatory compliance.

The FCC requires timely notification by the parties of the intent to enter into a spectrum manager lease, but these leases are automatically granted within the term and the geographic scope of an existing exclusive license in an eligible band.

In sum, we recommend that the Federal Network Agency take steps in the near term (1) to simplify spectrum transfers and leases by establishing an FCC-like fast track mechanism, and (2) continue to explore any options that might reduce transaction costs to the parties and thereby increase use of these mechanisms.

Liberalisation of use

In the United States (and also in Canada), there is widespread agreement that the flexibility that mobile operators have enjoyed has been both effective and appropriate. There is a general consensus among stakeholders that this is the preferred model of spectrum management going forward. Liberalised use is also expected to simplify any 2G-3G transition issues, and to avoid artificial spectrum scarcity.

This form of flexibility can no longer be viewed as radical. It is unquestionably working well in the North American context.

We recommend that the Federal Network Agency initiates a planning process to seriously consider the applicability of such a model to Germany. Given the criticality and the commercial significance of these bands, we believe that any German implementation would need significant and careful prior planning, both in terms of transition planning and in terms of mitigating possible side effects.

Spectrum auctions for mobile telephony in Germany distinguished explicitly between 2G and 3G usage, and companies made large investments based on assumptions about how they and their competitors would be able to use that spectrum. Any change in rights would need to consider the potential impact on those firms, and any explicit and implicit commitments that were made to them.

Unlicensed spectrum

The use of unlicensed spectrum has been a great success in the United States. It has served as a spur to innovation. More spectrum is likely to be allocated to unlicensed use over time.

For Germany (as for Canada) it will typically be inadvisable to allocate uniquely German unharmonised bands to unlicensed use. Manufacturing economies of scale, as well as the ability to take gear across borders, argue for international harmonisation.

As new internationalized bands are agreed, the Federal Network Agency should look for opportunities to expand unlicensed spectrum in Germany.

Interference management

Many aspects of the U.S. program have worked very effectively; at the same time, the example of Nextel shows that it is possible to take flexibility too far.[130]

As with many of the U.S. spectrum management institutions, the rather relaxed approach to interference management seems to work satisfactorily most of the time in the context of the United States. There is much to be said for the U.S. perspective that overly aggressive interference management can needlessly impede market entry. At the same time, the U.S. experience does not directly equate to circumstances in Germany.

In the mobile bands, the FCC has imposed only three simple restrictions: (1) radiated power into adjacent bands; (2) radiated power into adjacent geographies; and (3) total radiated power. This appears to have been a very successful model, and one that Germany could well wish to emulate where appropriate.

---

130 The *Nextel Order* is discussed in sections 4.2.2.3, 4.2.4.1, and 4.2.6.3 of this report.

A number of emerging U.S. innovations bear continued watching:[131]

- The ultimate emergence of cognitive radio and Software Defined Radio holds great promise – it is important that regulation not get in the way.

- It is clear that the selective imposition of receiver standards has the potential to improve overall welfare. There are many interference problems that could most appropriately and most cost-effectively be addressed by means of a modest improvement in receiver quality, rather than by the traditional method of imposing restrictions on the transmitter. At the same time, manufacturers in the U.S. and Canada have understandably been uncomfortable with the prospect of new regulatory impositions. Nonetheless, it may be possible to make progress. In the Nextel proceeding, the U.S. FCC did not mandate overall receiver quality standards, but it committed to provide protection from interference only for receivers that met certain quality standards.[132] Experience to date is limited, but this approach seems sensible and could be considered for use where circumstances warrant.

- The U.S. work on interference temperature might in time lead to important advances, but it is not yet clear if this single metric is sufficient for regulatory purposes, nor is it altogether clear exactly how to apply the interference temperature to regulation. It would be appropriate to monitor further developments in the U.S. and elsewhere to see if this concept makes progress.

- An additional observation that flows from the U.S. exploration of the interference temperature is the notion that it would be useful to have a better understanding of the overall interference environment. Two approaches that were considered but not implemented to date in the U.S. are (1) the use of a monitoring network, and (2) the "enlisting" of a group of cognitive radios to function as an *ad hoc* monitoring mesh as an adjunct to their primary function. For the former approach, it has not been clear that the benefits would exceed the costs. The latter approach must be viewed today as being futuristic, but it has the potential to provide a very inexpensive yet rich data source on the overall interference environment. If solutions of this type were to emerge, they might be of interest.

---

131 See section 4.2.1.2.3, „The Spectrum Policy Task Force Report", and section 4.2.4, „Interference Issues".

132 See Section 4.2.4.2 of this report.

4.3 Canada

Canada's spectrum policy is powerfully influenced and impacted by the United States. That is hardly surprising – most of the Canadian populace lives in a strip 100 Kilometers north of their southern border with the United States. The need for spectrum coordination is manifest in order to avoid interference.[133] Beyond that, the U.S. population is about ten times larger than that of Canada; consequently, coordination is necessary in order to achieve manufacturing economies of scale and also to enable portability of products and services (for example, roaming for mobile phones).

All of this notwithstanding, Canada's spectrum management arrangements are not merely a wan shadow of those of the United States.[134] Canada, like the United States, is clearly moving in a progressively more market-oriented direction, but this trend is tempered somewhat by Canadian attitudes. The Canadians tend to have a different perception of the role of government – in some ways, a perception that is less *laissez-faire* and more *dirigiste* than that of the United States. There is a visibly greater emphasis on the role of government in promoting public welfare. In terms of spectrum management, these Canadian predilections manifest themselves in a somewhat greater propensity than in the U.S. for the government to intervene to achieve societally desirable outcomes.

From a German perspective, Canada may represent a particularly interesting case study. Canada represents something of a middle way – a more cautious and more controlled realization of U.S. market-oriented ideals.

4.3.1 Overview of spectrum management in Canada

Canadian spectrum management is much easier to decipher than that of the United States. The Canadians have periodically issued short, omnibus documents that describe the overall principles to which they adhere in spectrum management. The most recent approved document is *A Spectrum Policy Framework for Canada (2002 Revised Edition).*[135]

The Canadians embarked on a significant overhaul of the framework just a few months ago, with the *Consultation on a Renewed Spectrum Policy Framework for Canada and*

---

133 This is not to say that coordination is *unimportant* to the United States – about a third of the U.S. population lives in areas where coordination is necessary, mostly with Canada. But the United States simply pays less attention to spectrum coordination – the issue gets less mind space.

134 Having said this, the author somewhat apologetically notes that this report will frequently and perhaps inevitably compare Canadian spectrum management practices to those of its more populous neighbour to the south.

135 Published as revision notice DGTP-004-02 – *Revision to the 1992 Spectrum Policy Framework for Canada* (referred to in this report as the *2002 Framework*), June 2002. Relevant Canadian documents are publicly available at http://strategis.gc.ca/spectrum.

Continued Advancements in Spectrum Management.[136] In just 37 concise and highly readable pages, the Canadians lay out all of the core elements of the directions in which they hope to take their spectrum management program.

4.3.1.1 Institutions of frequency regulation

Canadian spectrum is managed by *Industry Canada*. The Minister has expansive powers, but many of those powers are – prudently, perhaps – exercised only rarely, when the need arises.

Industry Canada is the Ministry, not the regulator. The *Canadian Radio-television and Telecommunications Commission (CRTC)* is the regulatory body for telecommunications and broadcasting. The CRTC does not manage spectrum nor issue spectrum licenses, but licensees must in practice register with the CRTC.

The centralization of spectrum allocation and assignment in a single agency is greatly superior to the bifurcation of responsibilities that we see in the United States. At the same time, there is some question whether this spectrum licensing function most appropriately belongs with the Ministry rather than the regulator. The *Organisation for Economic Cooperation and Development (OECD)* prepared a comprehensive review of regulation of the telecommunications in Canada in 2002.[137] In that report, they observed: "The powers of Industry Canada are a mixture of policy and regulation. It would be more efficient in the context of future streamlining of regulations to transfer the licensing of spectrum … to the CRTC, which has the responsibility for market entry in fixed telecommunication services and the responsibility for regulating market entrants in all the telecommunication markets. Such a transfer of powers would also more clearly separate the policy functions from regulatory functions. Industry Canada should, however, retain its responsibilities for spectrum planning which is a policy function. … Such transfer of powers would also ensure that industry policy obligations are not included in licences (e.g. R&D contributions, roll-out obligations)."

4.3.1.2 Frequency management regime

Canada has historically used *First-Come, First-Served (FCFS)* assignment of licenses wherever "… the Department believes spectrum supply is adequate to meet demand."

---

136 Notice DGTP-001-05 -- *Consultation on a Renewed Spectrum Policy Framework for Canada and Continued Advancements in Spectrum Management* (referred to in this report as the *2005 Consultation*), May 2005.

137 Dimitri Ypsilanti, *Regulatory Reform in Canada: From Transition to New Regulation Challenges: Regulatory Reform in the Telecommunications Industry* (referred to in this report as *OECD*), OECD, 2002, available at: http://www.oecd.org/dataoecd/48/28/1960562.pdf?channelId=37421&homeChannelId=37361&fileTitle=Regulatory+Reform+in+the+Telecommunications+Industry+in+Canada.

More than 95% of all current licenses were granted on an FCFS basis,[138] and they expect FCFS licenses to continue to play a large role going forward.[139] Canada comprises large geographic areas with very low population density, in marked contrast to the strip along the southern border that includes densely populated areas. They do not attempt a one-size-fits-all solution.

Wherever demand exceeds supply for an exclusive license, the Department would need to somehow make a choice. The *2002 Framework* envisions two alternative mechanisms: *comparative review*, or *auctions*. "Auctions may be used where the Minister of Industry is confident that market forces can be relied upon to select licensees consistent with the public interest. Where such reliance on market forces alone may not be sufficient to achieve public policy objectives, the Minister may consider other policy factors in the public interest such as spectrum set-aside, or spectrum caps, to foster competition and the delivery of services to Canadians."[140]

There is a subtle shift of emphasis in the *2005 Consultation*. In the *2002 Framework*, the burden is on the Minister to determine whether market forces can be relied on. The new consultation states instead that "[a]n auction *will* be used [emphasis added] when government policy objectives can be fully met through the various means available and where reliance on market forces to select licences is deemed to be in the public interest."[141] In both the 2002 and the 2005 documents, auctions are a permissible approach. What has changed is that auctions have become the default in the 2005 document.

Shared use has steadily grown in importance in Canada from the time of the 1992 framework. The 2002 Framework notes various examples: for example, fixed terrestrial satellite service and terrestrial radio relay service (both using directional ground-based antennae). They also describe various forms of sharing in the time domain.[142]

Canada has also made spectrum available for licence-exempt ("unlicensed") use, and they intend to continue to do so. At the same time, they are of the opinion that any licence-exempt bands must be coordinated internationally – the Canadian market is not large enough "to support the design, manufacture and deployment of products for unique Canadian licence-exempt bands."[143]

The Ministry retains the right to "refarm" frequency assignments whenever it sees fit, and specifically disclaims any obligation to compensate displaced licensees. Canadian

---

138 *2005 Consultation*, page 21.
139 See the *2005 Consultation*, New Policy Guideline 5, page 9; also, the *2002 Framework*, page 13.
140 Page 13.
141 Page 9.
142 Page 10.
143 *2005 Consultation*, page 17.

law is said to prohibit direct compensation. In practice, the Ministry may implicitly compensate displaced licensees by granting replacement licenses for long terms.

4.3.2 Liberalisation of frequency usage

Canadian liberalisation of usage has largely followed the U.S. model. The Canadians seek to gradually expand flexbility of usage; at the same time, they are trying to minimize the risk that different and incompatible uses of spectrum might cause harmful interference.

4.3.2.1 Introduction

Canadian practice is to *allocate* a band to a *use* rather than to a *user*. Within a band, *assignments* may then be made to individual users. The allocations are reflected in the *Canadian Table of Frequency Allocations*, and generally correspond to a subset of the services specified in the ITU's *Table of Frequency Allocations*.

Regulations and technical standards are intended to be technologically neutral.

4.3.2.2 Extent of liberalisation

Canada has provided progressively greater flexibility in the use of allocated bands. "Over the past few years, the Department has made decisions in spectrum policy and the Table that generally broaden the permitted uses of the radiofrequency spectrum. Multiple services may be allocated in a band and greater latitude in the use of the spectrum granted. As an example, the spectrum used for Personal Communications Services (PCS)[144] has no limitations on the nature of the type of mobile or fixed communications aside from meeting minimal technical criteria designed to deal with adjacent band interference. The policy concerning cellular systems has retroactively been modified to make it consistent with that of PCS."

As a case in point, consider the licensing procedures for the WCS and FWA bands, 2300 MHz and 3500 MHz respectively. As regards WCS, Industry Canada recognized "… that the defining line between fixed and mobile services is becoming less distinct in some scenarios which are envisaged for local broadband networks. Provision for applications which have elements of both services, depending on the user location or situation, are included in several broadband requirements. The Department will provide full flexibility for the development of local broadband networks in this band and does not

---

144 In Canada, as in the United States, PCS is a band that was intended primarily to expand mobile telephone competition. In both countries, the corresponding licenses are exceedingly flexible.

want to predetermine or prescribe what types of commercial services should be offered. However, due to current technical restrictions, Industry Canada envisages that the spectrum designated for WCS services will be used predominantly for the provision of one-way and/or two-way, local broadband access services in digital, fixed, point-to-multipoint configurations."[145]

4.3.3 Frequency trading

Canada has been moving to permit progressively greater frequency trading, but these systems are not yet nearly so evolved as in the United States. Frequency trading is routine in a limited number of bands. Frequency leasing is not formally supported at all.

4.3.3.1 Introduction

Canada has granted transferability and divisibility privileges, in conjunction with long ten-year license terms, to licensees in a number of bands,[146] as shown in Table 26 below.

Table 26: Transferability and divisibility granted to Canadian licensees

Band	Frequency	Year
Fixed wireless broadband	24/38 GHz	1999
MCS	2500 MHz	1999
PCS	2 GHz	2001
WCS/FWA	2.3/3.5 GHz	2004
Incumbent cellular and PCS providers	(various)	2003

Leases are not officially accommodated within the Canadian system. Where a licensee wishes to effectively lease its licensed spectrum to some other party, the two parties can jointly apply to the Ministry for a license transfer for a defined period of time.[147]

---

145 Industry Canada, *Policy and Licensing Procedures for the Auction of Spectrum Licences in the 2300 MHz and 3500 MHz Bands*, published September 2003, revised July 2004. See: http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/vwapj/policy-2300-3500e-july2004.pdf/$FILE/policy-2300-3500e-july2004.pdf.

146 *2005 Consultation*, page 20.

147 *2005 Consultation*, page 20.

4.3.3.2 Extent of trading

Trading is conspicuously less advanced in Canada than in the United States. For most allocations, there is no need for market mechanisms, as supply of spectrum in much of the geographic expanse of the country typically exceeds demand. Market mechanisms are primarily of interest in urban areas close to the southern border, where spectrum can be extremely congested.

4.3.4 Interference issues

The Canadians are acutely aware of the tension of objectives between interference management and increased flexibility of use. They try to strike a balance. “By grouping compatible radio services, the utilization of the spectrum can be increased and the probability of interference reduced. Nevertheless, the Department also recognizes the benefit of enabling licensees and potential users to adapt their communications systems to meet changing requirements. The Department will generally adopt measures which provide the greatest degree of flexibility feasible in the use of allocated spectrum, within the bounds of promoting orderly and efficient use and also adhering to sound technical considerations.”[148]

4.3.4.1 Introduction

The Ministry’s overall objectives as regards interference management are clearly expressed in a proposed new guideline in the *2005 Consultation*: “New Policy Guideline 13 - Interference Mitigation and Frequency Coordination: The Department will strive to ensure that the effects of interference are minimized or managed to acceptable limits. Coordination will normally be required for licensees to permit service availability to users in adjacent service areas or in adjacent spectrum. The Department generally encourages the holders of area licences and certain site-specific licences to coordinate amongst themselves.”[149]

This approach is akin to that of the United States inasmuch as it encourages licensees to sort problems out for themselves, and to ask the government to intervene only if they are unable to resolve matters on their own.

---

148 *2005 Consultation*, page 7.

149 This text differs in small but important ways from the corresponding text on page 7 of the *2002 Framework*: “The effects of interference are minimized or managed to acceptable limits. Coordination is normally required for licensees such as to permit service availability to users in adjacent service areas. The Department encourages the holders of area licences to coordinate amongst themselves.”

4.3.4.2 Type of regulatory regime

The Canadians continue to maintain all of the traditional interference management techniques, but they are also exploring many of the same initiatives that the United States is looking at.[150]

They are optimistic that Software Defined Radio (SDR) and cognitive radio may revolutionize spectrum management, and they note that a few leading-edge examples already exist; at the same time, they recognize that comprehensive implementations of these capabilities are unlikely to exist for at least five to ten years.

In February 2005, they issued an initial consultation on Ultra-wideband (UWB).[151]

The *2005 Consultation* discusses the U.S. notion of an interference temperature, but they seem rather cool to it.

Canada employed radio receiver standards for mobile services for many years, but removed them in two stages culminating in 1993, primarily to facilitate harmonisation with the United States.[152] There has been occasional consideration of possibly reintroducing them; however, Canadian industry tends to be strongly opposed.

4.3.5 Competition issues

The Ministry has considerable authority to intervene to achieve policy goals, notably including competition goals, but it wisely avoids doing so needlessly. The OECD, in its 2002 review, observed that the CRTC "has forborne from regulating the wireless industry as it considers the industry to be sufficiently competitive."[153]

4.3.5.1 Introduction

In the auction process, the Minister has significant authority to address potential competitive harms by

1. limiting eligibility to bid;
2. creating spectrum set-asides; or
3. establishing maximum aggregation limits.

---

150 The discussion in this section is based on the *2005 Consultation*, pages 24-26.
151 "Consultation Paper on the Introduction of Wireless Systems Using Ultra-wideband Technology". See http://strategis.ic.gc.ca/epic/internet/insmt-gst.nsf/en/sf08285e.html.
152 *2005 Consultation*, page 25.
153 *OECD,* pages 29-30.

4.3.5.2 Type of regulatory regime

The licensing procedures that the Ministry followed in the licensing of the 2300 MHz and 3500 MHz bands illustrate these themes clearly.[154] The principles that the Ministry articulated for limits to eligibility were to restrict an entity if:

(i) that entity possesses market power in the supply of one or more telecommunications service in a region covered by the licence to be auctioned;

(ii) a new entrant is likely to use the licence to provide services in competition with that entity's existing services; and

(iii) the anti-competitive effects of that entity's acquisition of a licence are not outweighed by the potential economies of scope arising from the integration of the spectrum in question into that company's existing network.

Spectrum aggregation limits might be appropriate if:

(i) a bidder that acquires a significant amount of spectrum would not face effective competition from providers of services that use infrastructure other than the spectrum being auctioned; and,

(ii) the anti-competitive effects arising from the acquisition of a significant amount of spectrum by a single bidder would not be offset by lower costs or higher valued services resulting from holding this amount of spectrum.

In that proceeding, the Ministry considered but rejected eligibility restrictions (on incumbent operators of local exchange telephony service [ILECs] and on incumbent cable operators) because the relevant markets were fully open to effective competition. It did, however, impose "…a spectrum aggregation limit of 100 MHz per service area, to participating companies, their Affiliates and Associated Entities."

4.3.6 Economic pricing of frequencies

The Canadian position on license fees is clearly expressed in policy guideline 9 of the *2002 Framework*: "Licence fees will be based on spectrum management costs where resource rents do not exist. When resource rents do exist, fees will ensure a fair economic return to the public in addition to recovering spectrum management costs."[155]

Where Industry Canada conducts an auction, it is easy to see how this is met. In the case of applications that are met on a First-Come, First-Served basis, perhaps the

---

154 Industry Canada, *Policy and Licensing Procedures for the Auction of Spectrum Licences in the 2300 MHz and 3500 MHz Bands*, op. cit.

155 Page 15.

absence of more than one application suggests that there are no rents. In general, however, it is difficult to see how Industry Canada would determine the appropriate fee, or for that matter determine whether rents were present, solely through the procedures identified through the consultation.

In the past, the Treasury Board provided limited guidance as to the setting of fees in order to recover the rents associated with the market value of assets such as spectrum.[156] More recently, Canada enacted a User Fees Act[157] that established a broad and over-arching set of mechanisms for user fees, but at the same time superseded the Treasury Board guidelines. Unfortunately, the new law provides no meaningful guidance as to how the market value is to be calculated.[158]

Ministry sources note that economic rents almost invariably exceed the Ministry's costs, and therefore drive user fees in nearly all cases. The Ministry bases its proposed user fees on appropriate market indicators and on the level of demand for the band in question. They conduct public consultations on all fee proposals, and they often adjust the fees as a result of the feedback that they receive.

4.3.7 Implications of frequency trading and liberalisation for selected areas

In many specific areas, Canadian policies strongly reflect the need for harmonisation with their larger neighbour to the south.

4.3.7.1 Broadcast frequencies

Canadian implementation of Digital Television is generally coordinated with that of the United States. Industry Canada and the FCC signed an accord on spectrum harmonisation in regard to Digital TV implementation in September, 2000.[159] The accord specifically "…paves the way for the introduction of public safety and other non-broadcast operations on channels 60-69 as the deployment of DTV services progresses."[160]

---

156 See http://www.tbs-sct.gc.ca/archives/opepubs/tb_h/2004/CRP1_e.asp#statement.
157 See http://laws.justice.gc.ca/en/U-3.7/108815.html.
158 The relevant guidelines are much more procedurally oriented. See http://www.tbs-sct.gc.ca/pubs_pol/opepubs/tb_h/crp1_e.asp#_Toc90296906.
159 It relates to spectrum use in a zone extending 400 Km on both sides of the U.S. – Canada border. See: http://www.fcc.gov/Bureaus/Miscellaneous/News_Releases/2000/nrmc0042.html.
160 Ibid., statement of FCC Chairman Kennard.

Coordination is also important in terms of achieving manufacturing economies of scale for DTV-capable equipment. The U.S. and Canada have settled on identical technical standards.[161]

There are, however, noteworthy differences at the policy level. Canada has taken more of a voluntary approach to DTV migration, and they have not mandated a specific cut-off date for analogue broadcast.

4.3.7.2 2G versus 3G frequencies

The bands used for cellular mobile and PCS services in Canada are fully liberalised. Incumbents have full rights of transferability and divisibility of their licenses, and significant freedom as to the services that they can provide.

Consequently, considerations for these bands are generally the same in Canada as in the United States. Incumbents can generally manage their own individual transitions from 2G to 3G, and for that matter to 4G. Spectrum management policies did not generate a “false scarcity” of 3G spectrum.

4.3.7.3 Fixed wireless access (FWA) frequencies

Canada has been introducing progressively more licence-exempt spectrum in support of fixed wireless access. In addition, a number of bands have been opened up for licenced use in recent years, notably including the 3500 MHz and the 24/38 GHz bands.

The 38 GHz band is particularly interesting. The Ministry initially auctioned portions of the spectrum on a regional basis (rather than site by site). For blocks that had been assigned other than by means of an auction, the Ministry subsequently withdrew the assurance of exclusivity, making the assignments suitable for sharing. Starting in 2001, they would issue only shared licences in this band.[162] The licences are generally for a geographic area (a hexagonal “grid cell”) – individual station licences are not required.

The Ministry maintains a database of point-to-point links and multipoint links in this band. Licensees are responsible for coordinating directly with other licensees, presumably using the database information to identify potentially impacted licensees. The role of the Ministry is in effect limited to conflict resolution.

---

161 „The new over-the-air digital television (DTV) system will be based on the Advanced Television Systems Committee A/53 transmission standard that has been adopted for use in Canada as well as in the U.S. The standard defines a number of digital television formats ranging from narrow screen to wide screen, and from ‘low definition’ to ‘high definition’ television, or HDTV.” See Broadcasting Public Notice CRTC 2002-32, Ottawa, June 12, 2002, available at: http://www.crtc.gc.ca/archive/ENG/Notices/2002/pb2002-32.htm.

162 “38 GHz Licensing Process and Application Procedure”, CPC-2-1-17 Issue 3, February 1, 2001.

4.3.8 Conclusions and Recommendations for Germany based on experience in Canada

The spectrum management system in Canada is strongly influenced by the United States; consequently, the recommendations derived from Canadian experience largely parallel those proposed in connection with the United States.

Those recommendations are elaborated in section 4.2.8, “Conclusions and Recommendations for Germany based on experience in the United States”. They include:

- Gradual simplification of license transfer and lease mechanisms;
- Recognition of the benefits that North America has achieved with flexible mobile telephony spectrum, and initiation of a planning process to determine the feasibility of migration to a similar system in Germany;
- Expansion of unlicensed spectrum as circumstances permit;
- Consideration of selective use of receiver performance guidelines if circumstances warrant; and
- Continued observation from afar of North American progress with innovative interference management tools and approaches.

In the United States, there is a strong tendency for government to withdraw from spectrum management as much as possible, leaving everything up to market mechanisms. Canada chooses instead to retain substantial government power over spectrum management, but then to step back as much as possible in order to allow market mechanisms to do what they do best. Government refrains from inappropriate exercise of its rather expansive powers.

The Canadian model would appear to have advantages in comparison with that of the United States. During this period of rapid transition, the Canadian government has far more ability to intervene if necessary to correct any problems that might emerge.

4.4 Australia[163,164]

4.4.1 Overview of Spectrum Management in Australia

4.4.1.1 Institutions of Frequency Regulation

Until 1 July 1993 when the 1992 Radio Communications Act (RC Act) came into effect, radio frequency in Australia was managed through a command and control system centred around apparatus licenses. These licenses authorised users to operate certain equipment at a specified location according to limitations on power and other technical specifications.

The RC Act introduced an economic approach to spectrum management through the use of market based reforms. The main feature of the reforms was the creation of *spectrum licenses* which were to be assigned by competition and which could be traded in a secondary market.[165] Spectrum licenses are discussed further in section 4.4.1.2.3 below.

In 2005 when the Australian Broadcasting Authority (ABA) and Australian Communications Authority (ACA) were combined to form a single entity in charge of managing the radio spectrum in Australia. Prior to this spectrum that was identified by the Minister as being for broadcasting had been managed by the ABA under the Broadcasting Services Act 1992, with all other spectrum managed by the ACA.

Today there are four main players involved in spectrum management and spectrum management policy developments. These are:

- The Australian Communications and Media Authority (ACMA),
- The Department of Communications, Information and the Arts (DCITA),
- The Australian Competition and Consumer Commission (ACCC),
- The Minister of Communications, IT and the Arts.

---

163 WIK-Consult is grateful to the staff of the ACMA, the Department of Communications, Information Technology and the Arts, and the Australian Competition and Consumer Commission, for interviews and for follow up information they provided us.

164 1€=AUS$1.5828 on 1-10-2005

165 These reforms were recommended in a report to government by the Bureau of Transport and Communications Economics (BTCE), a federal government research and advisory agency. This was the first Government report which employed an economic focus to spectrum management. BTCE report was followed by a Parliamentary Committee Report and this became the template from which the RA was drafted.

The ACMA is the agency in charge of spectrum management.[166] It also has a policy advisory role for government which it shares with DCITA. Regional offices provide access to the radiofrequency spectrum through licensing and frequency assignment services, and undertake interference investigations and audits to ensure compliance with regulatory requirements.

It is not possible to review the effectiveness of the forerunner to the ACMA, the ACA, without reference to the role of the Minister. Many activities require actions by both parties before they can proceed. The Minister's powers include the designation of spectrum bands for broadcasting purposes, the determination of competition limits to apply in the primary assignment of spectrum, for both spectrum licenses and for apparatus licenses (i.e. to specify the amount of spectrum that specific bidders could acquire), to order a re-allocation of spectrum, and to deem that certain spectrum licenses can be renewed, although this can also be done by ACMA. The Australian Communications Authority Act 1997 (ACA Act) also empowers the Minister to direct the ACA (now the ACMA) in the administration of its duties.[167]

The ACCC is the competition law authority which is also responsible for the regulation of access to *essential facilities* that are of national importance – principally the utility network industries. The ACCC's merger rules contained in the Trade Practices Act 1974 (TPA) are applicable to primary and secondary purchases of spectrum.

DCITA is a government department headed by the Minister. It provides the normal range of support and policy advice to government, including advice on any proposed amendments and recommendations concerning future reforms of spectrum management that would involve either the Minister or statutory changes by parliament.

4.4.1.2 The Frequency Management Regime

The ACMA is the frequency manager in Australia. It accomplishes its frequency management functions through a system of fees, rules and activities applied to different types of licenses. These include: market based competitions for spectrum, setting license fee levels and fee structures, spectrum planning and interference management, and the imposition of secondary trading rules.

---

166 The ACMA came into being on 1 July 2005. It was formed through a merger of the Australian Communications Authority and the Australian Broadcasting Authority (ABA). The ACA had been in charge of non-broadcast spectrum since it was created by merger between the Spectrum Management Agency (SMA) and the Australia Telecommunications Authority (ATA). The SMA was established along with the market-based spectrum management reforms that were introduced in 1992 with the passing of the RC Act.

167 The Government has accepted that some of the Minister's powers should be modified or past onto the ACMA, following recommendations made in the Productivity Commission's *"Radiocommunication Inquiry Report"* (2002); referred to from here as the "PC Report".

4.4.1.2.1 Overview of License types

There 3 types of license in use in Australia:

- Apparatus licenses
- Spectrum Licenses, and
- Class licensed spectrum

All spectrum is allocated using one of these three types of license. This includes spectrum that is designated by the Minister for either broadcasting or defence, in which case bands of spectrum have been assigned under apparatus licenses for equipment using spectrum within those bands.

Both spectrum licenses and apparatus licenses may be assigned using market based techniques. According to the RC Act market based pricing can include auctions, tenders, pre-determined prices and negotiated prices for the sale of spectrum licenses. The RC Act also allows for market based pricing methods to assign apparatus licenses. Except where it involved the conversion of an apparatus license, all market-based allocations of spectrum and apparatus licenses have so far occurred through auction.

A comparative summary of the characteristics of the three license types is shown in Table 27.

Table 27: Characteristics of license types

Attribute	*Apparatus licence*	*Spectrum licence*	*Class licence*
Licence period	≤ 5 years	≤ 15 years	Ongoing[a]
Renewable	Yes	No[b]	No
Tradeable	Yes	Yes	No
Divisible	No	Yes	No
Combinable	No	Yes	No
Third party use	Yes	Yes	na
Compensation	No[c]	Yes	No
Enforceable	Yes	Yes	Yes

[a] Until revoked. [b] Spectrum licences can be renewed where it is deemed by the Minister or ACA to be in the public interest (RC Act, s. 82). [c] Apparatus licensees may receive a partial refund of their licence fees. **na** Not applicable.

Source: PC Report

4.4.1.2.2 Apparatus licenses

Apparatus licenses represent a traditional command and control system aimed at managing interference from transmitters and receivers. Since 1997 apparatus licenses may be assigned using market based techniques.[168] Usually, however, apparatus licenses are issued on a first come first served basis, except where there is an excess of demand for the available spectrum. Close to 70% of the spectrum between 9 kHz and 40 GHz is either apparatus licensed or unlicensed. This figure is expected to drop as the ACMA converts more apparatus to spectrum licenses, and possibly allocates spectrum for management by private band managers – a new type of license which is still the subject of public consultation. These changes follow recommendations in the PC Report.

An apparatus license authorises the holder to use a specific type of radio transmitter or receiver at a certain location and to provide a certain category of service e.g. maritime radio-based services, broadcasting etc. Included with the license will be technical conditions that the licensee must abide by, including specified frequencies, the type of emissions, and other technical measures that enable interference management.

Within the apparatus license system there are 17 types of transmitter license and 5 types of receiver license.[169] They are based on definitions in the Australian Radiofrequency Spectrum Plan that are drawn from definitions used by the International Telecommunication Union (ITU). Different kinds of radiocommunications applications are identified separately within the various license types. There are differences in: licensing procedures; license conditions, and fees. These differences are usually related to the kind of service or station or use.

The main features of the apparatus licensing regime include:

- broad apparatus license categories;
- a system where apparatus licenses are either ‘assigned’ or ‘non assigned’ (see below).
- an equitable and relatively transparent if complex approach to apparatus license fees (see section 4.4.6.2.1);
- apparatus license periods of up to 5 years, with renewal likely;

---

168 In practice, we understand that price-based allocation of apparatus licences has only occurred for the MDS bands for Pay TV, the last two blocks of 5 channels in Melbourne for TLMS at 800 MHz, space services associated with the geostationary orbit, and low power open narrowcasting (LPON) licences.

169 For a list of these see Table 1 - License Types and Licensing Options at: http://www.acma.gov.au/ACMAINTER.2490560:STANDARD:1267586855:pc=PC_1292

- no compensation paid where apparatus licensees are cleared from bands designated for spectrum licensing;
- a range of options giving flexibility in fee payment;
- freedom to transfer apparatus licenses between parties (with some exceptions), and
- license tax exemptions and concessions for certain types of licensee e.g. organisations providing emergency or safety of human life functions.

Assigned licenses are issued where a licensee requires frequencies to be allocated for the licensee's particular use. A non assigned license will be issued when an individual frequency assignment is not required, or if a frequency can be selected from a predefined suite which has been engineered according to general requirements.[170]

Apparatus licensing employs a systematic approach which in most cases authorises a single licensee to operate many devices. Under the Land Mobile System licensing option, for example, individual licenses are not issued for devises where they are within the operational range of the main base station. Such devises may, for example, include mobile stations; remote control stations of 1 watt or less; standby base stations or supplementary base stations.

While, under the RC Act licenses are not generally required for receivers, some receiver licenses are necessary to accommodate the requirement of some operators that receivers are afforded interference protection through frequency coordination. In such cases receivers are licensed and included in the ACMA's computerised database.

By far the majority of licenses and usable spectrum in Australia are assigned as apparatus licenses. Indeed, there were approximately 147,000 such licenses in mid 2004.

Since 1993 the Spectrum Management Agency (SMA) and its successor, the ACA (succeeded by the ACMA in July 2005), undertook changes to apparatus licensing which made them more flexible. The number of categories of apparatus license were reduced[171], short term assignments were introduced, secondary trading was permitted,

---

170 An assigned license provides a unique frequency for exclusive use at a site. A frequency assignment is performed before the issue of each assigned license to ensure the frequency can be used without interference. Assigned licenses must therefore have one or more spectrum accesses (see section 4.4.6.2.1.1.3). For a non assigned license, each licensee has non-exclusive access to a defined set of frequencies. For example, ships are allowed to use standard maritime frequencies with a non assigned license. Non assigned licenses do not have spectrum accesses as frequency coordination is unnecessary.

171 The types of license categories are based on the definitions in the Radiofrequency Spectrum Plan (the Spectrum Plan). The subsequent use of apparatus licenses need to be consistent with this Plan.

and the licensees could pay for licences up to 5 years in advance or by instalments.[172] Within 6 months of expiry a licensee may apply for renewal. The regime now provides a presumption that licenses are renewable (although there is no statutory basis for it). However the ACMA's right to manage spectrum for the public benefit can result in renewal requests being turned down, or renewal license periods being relatively brief.

Once issued, changing the designated usage of an apparatus license would require the agreement of all affected licensees in a given band. As this is likely to be difficult, changes in spectrum use would mainly occur through administrative changes to frequency band plans and re-allocation, either initiated through the ACMA or possibly even through the ITU.

Spectrum re-allocation from apparatus licenses to spectrum licences first requires the Minister to issue a spectrum re-allocation declaration although not before the ACMA has consulted with the affected licensees. Following a period of notice, licensees would have to vacate the spectrum they occupy. Controversially, there is no compensation payable, although licensees can obtain a refund of their annual fees for the unused license period.[173]

4.4.1.2.3 Spectrum licenses

Spectrum Licenses are where Australian spectrum management has been scored highly by international commentators. Spectrum Licenses define the rights and obligations for accessing and using a given 'parcel' of spectrum. They provide licensees with flexibility in the types of services they can provide (i.e. they are as far is possible technologically and service neutral, i.e. the traditional allocation to use stage has been by-passed). Instead, spectrum is allocated to users who then determine the use, although the interference parameters of the license (developed with interested industry players), will limit this flexibility to a degree. Spectrum licenses can be traded or leased, and can be combined or broken up and sold as individual 'parcels'. Spectrum licenses mainly occur in the UHF band, where they account for about 12% per cent of the frequencies. The maximum and usual license period is 15 years. There are approximately 600 spectrum licenses issued.

In practice, the technical framework for the band which helps define the license, does impose constraints on licensees which affect their usage choices. Spectrum licenses are thus not entirely technology neutral but are designed with ITU allocations and available technologies in mind. Moreover, the international coordination which results in

---

172 PC Report, p 94.

173 The PC Report urged government to require the ACMA to pay compensation but government declined to do so. In its response the Government drew attention to the divergence of views among the industry about compensation, (see *Review of Apparatus License Tenure and Associated Issues*, http://auction.aca.gov.au/tenure/tenure_report.pdf)

certain frequencies ranges being matched to certain types of usage, results in there being little or no equipment available internationally for uses other than those envisaged by the ACMA when designing the technical framework for Spectrum License. For these reasons spectrum licenses in Australia have largely (but not entirely) been used for the same types of services as those frequencies are used for in Europe where assignments have in general been service and sometimes technology specific.

The RC Act requires that spectrum licenses must be issued according to a price-based method.[174] There is no presumption of renewal of spectrum licenses. This can only be done by the Minister when it is shown to be in the public interest.

For spectrum licenses to be issued, either existing users must be cleared and the spectrum re-allocated by auction, the re-allocation occurs with existing apparatus licensees protected until an expiry date (generally 2 years), or existing apparatus licenses are converted into spectrum licenses.

4.4.1.2.4 Class licenses

Class licensing (some times described as “general authorisations”) provides for efficient spectrum management for services where a limited set of common frequencies are employed, and equipment is operated under a common set of conditions. A class license sets out the conditions under which any person is permitted to operate. A class license is not issued to an individual user and does not involve license fees or license conditions applied to individuals.

Class licenses authorise users of designated segments of spectrum to operate on a shared basis. The licenses are issued by ACMA by a notice published in the Commonwealth of Australia Gazette.

ACMA has issued the following class licenses:

- Radiocommunications (27 MHz Handphone Stations) Class License 2002
- Radiocommunications (Aircraft Station) Class License 2001
- Radiocommunications (Cellular Mobile Telecommunications Devices) Class License 2002
- Radiocommunications (Citizen Band Radio Stations) Class License 2002
- Radiocommunications (Cordless Telecommunications Devices) Class License 2001
- Radiocommunications (Infrared Devices) Class License 2002
- Radiocommunications (861-865 MHz Land Stations and Handsets) Class License 1996

---

174 There are only 3 possibilities permitted by the Act: “(a) by auction; or (b) by tender; or (c) by allocation for a pre-determined price or a negotiated price” (RC Act s 60).

- Radiocommunications (Low Interference Potential Devices) Class License 2000
- Radiocommunications (Maritime Ship Station - 27 MHz and VHF) Class License 2001
- Radiocommunications Miscellaneous Devices Class License 1999
- Radiocommunications (Radio-controlled Models) Class License 2002
- Radiocommunications (Spread Spectrum Devices) Class License 2002
- Radiocommunications (Communication with Space Object) Class License 1998

4.4.1.2.5 Broadcasting and Defence

The Minister reserves spectrum in the Australian Radiofrequency Spectrum Plan (the Spectrum Plan) for free-to-air broadcasters and the Department of Defence (Defence).

Most spectrum that is used for broadcasting is managed differently compared to spectrum used for telecommunications purposes. Firstly, the spectrum is designated as being for broadcasting purposes by the Minister and until the recent merger of the ACA and ABA, the planning needed to complete Section 31 allocations was conducted by the ABA and not the ACA as occurred with other spectrum. The recent merger to form the ACMA would appear to have addressed the difference in planning. However, differences in treatment remain including license fee/taxes, obligations, and conditions of license renewal. Conditions applicable under the Broadcasting Services Act 1992 require a licensee to commence broadcasting services within a year of being allocated a license or within such longer period as is notified in writing by ACMA. Such rules have so far not been applied to non broadcast spectrum licenses with two recent exceptions (see 4.4.7.2.4).

There are a number of licenses that can be applied regarding access to spectrum reserved for broadcasting. These are: Commercial, Community, International broadcasting, Subscription Class (includes narrowcasting[175]), Datacasting, Apparatus (transmitter), and Special events. Broadcast spectrum can not be traded separately from the broadcast service license.

Spectrum is set aside for Defence in the Australian Radiofrequency Spectrum Plan.[176]

---

175 Open narrowcasting services are broadcasting services whose reception is limited in at least one of a number of ways specified in the Broadcasting Services Act 1992 (targeted to special interest groups; intended for limited locations (e.g. arenas or business premises); being provided during a limited period (special event); because they provide programs of limited appeal.

176 In terms of bandwidth occupied, Defence is the largest single user of spectrum in Australia. In the VHF band Defence has about 28% of frequencies, and in the EHF band it has about 33%. Defence also has rights to about 25% of the most congested bands (those below 5 GHz) For frequencies below 40 GHz, the spectrum allocated to Defence amounts to approximately 21 per cent of the bandwidth.

4.4.2 Liberalisation of Frequency Usage

4.4.2.1 Main Changes in the Frequency User Plan in Recent Years

The main change in the frequency user plan (FUP) in recent years has been: (i) as a result of the heightened policy focus on getting broad band out to rural areas, and (ii) to move from apparatus to spectrum licenses.

The ACA re-farmed several bands in and around 2000 to make way for mobile communications services and many hundreds of fixed services were required to relocate. ACMA is also looking into reducing the thresholds around certain bands.

4.4.2.2 Spectrum Partition

In Australia all spectrum between 9 kHz and 300 GHz is allocated to different spectrum uses according to the Spectrum Plan). Allocation is according to 3 different sharing arrangements:

(i) an exclusive use (the band is allocated to a single spectrum use),

(ii) primary use (the band is allocated to more than 1 use but one of the specified uses is designated as 'primary'. The other uses are classified as secondary, and are unable to claim protection from interference from the primary use, or to cause interference, or

(iii) co-primary use basis (the band is allocated to several uses with at least 2 of them defined as co-primary uses who must share primary 'rights'. Remaining uses are secondary uses and are unable to claim protection from interference with co-primary uses, or the cause interference.

Spectrum is not allocated to secondary uses, rather secondary uses operate on a 'shared basis' in bands allocated to primary and co-primary uses.[177] Even exclusive allocations are, however, open to a range of identified uses meaning that spectrum partition in Australia does not have the same rigidity as it has traditionally had in Europe.

177 PC Report (2002) pp 15-18.

4.4.2.3 Spectrum Reserved for Broadcasting

Spectrum is the dominant platform for delivering broadcasting services in Australia. Spectrum is set aside for broadcasting (both commercial and non-commercial) by the Minister. Broadcasters are allocated exclusive use of spectrum in this range. They also use significant amounts of spectrum from outside this range, such as for outside broadcasting, providing fixed links, and when using satellites.

Spectrum that is dedicated to broadcasting services accounts for approximately:

- 38% of the frequencies allocated in the VHF band.
- 15 % of the frequencies allocated below 30 MHz,
- 15% of the frequencies allocated in the UHF band, and
- 17% of frequencies allocated in the congested VHF and UHF bands.[178]

Table 28: Broadcasting services bands

Band	*Use*
526.5–1606.5 kHz (inclusive)	MF–AM radio band
45–52 MHz (inclusive)	VHF television band I (channel 0)
56–70 MHz (inclusive)	VHF television band I (channels 1 and 2)
85–108 MHz (inclusive)	The VHF–FM radio band in 87.5–108 MHz.
137–144 MHz (inclusive)	VHF television band III (channel 5A)
174–230 MHz (inclusive)	VHF television band III (channels 6, 7, 8, 9, 9A, 10, 11 and 12)
520–820 MHz (inclusive)	UHF television bands IV and V (channels 28–69)

Source: PC Report 2002 Annex 2E

4.4.2.4 Evolution of Class Licensing (common usage)[179]

Under current class licensing arrangements, the ACMA allows operation in the 5.8 GHz band with EIRP levels of up to 4 watts. The ACMA is considering increasing EIRP levels as requested by wireless broadband service providers who want to use 5.8 GHz band (and 2.4 GHz) band spectrum to provide backhaul links for broadband services in low population regional and rural areas.[180] These links will require apparatus licences however.

---

178 PC Report (2002), Annex 2E
179 For further information see the Chapter on class licensing at, http://www.acma.gov.au/ACMAINTER.2163012:STANDARD:2111527420:pc=PC_1612
180 For more information see The ACMA's Spectrum Strategy Report.

Class licensing has also been employed to facilitate the implementation for WLANs at 2.4 GHz and the expansion of general computer networking applications. There is 83 MHz of spectrum used by WLANs in the 2.4 GHz range, and as at mid 2004 there was a total of 350 MHz of class-licensed spectrum in the 5 GHz band. In addition, 255 MHz in the 5 GHz band was added at WRC-03 and this could be made available for WLAN applications. In Australia the 5 GHz band appears to be readily able to accommodate additional users which is not the case with the 2.4 GHz band, which in some cases is already showing signs of congestion.

4.4.2.5 Future Liberalisation Plans

4.4.2.5.1 Converting Apparatus Licenses to Spectrum Licenses

Reforms in spectrum management in Australia in the 1990s made Australia a world leader in spectrum management. In recent years, however, it appears that reform has been too slow. Initial problems appear to have been due to the legislation which required the then SMA to undertake a very drawn out re-farming process. In response the government amending the RC Act in 1997. When clearing spectrum of existing users the ACMA usually finds alternative spectrum for ejected incumbent apparatus licensees.

By mid 2002 only 13 of 84 bands that the SMA considered were suitable for conversion to spectrum licenses, had been converted to spectrum licenses. Criticism in the PC Report has resulted in the ACMA consulting on a more aggressive license conversion policy. In addition, the ACMA is planning to convert some bands to spectrum licenses where there will be numbers of sitting incumbent apparatus licensees. It is also consulting on the allocation of spectrum under a private band manager license. We discuss these issues further below.

The ACMA expects growth in demand for bands in the 1 to 5 GHz range for new services, e.g. for mobile satellite service (MSS) in the 1 to 2 GHz and 2 to 4 GHz range. It expects to re-locate users in the medium and longer term in the following bands:

- The 1.5 GHz band, which may be re-farmed to allow for digital sound broadcasting (DSB) and MSS. New assignments have therefore been restricted in parts of this band;
- In the case of the 3.8 GHz band, the ACMA is monitoring international trends. Continuing demand for spectrum below 5 GHz for a range of services may eventually lead to re-allocation pressures on this band. The ACMA is providing advice about these developments to stakeholders, but does not believe that an

embargo on new assignments is warranted.[181] There is presently an embargo at 3.6 GHz.

The ACMA is also looking into converting most wide area apparatus licenses held by Defence to spectrum licenses.

4.4.2.5.2 Private Management of Encumbered Spectrum Bands

In February 2005 the then ACA released a discussion paper as a response to PC Report which considers implementing a scheme of private band management. The proposals contained in the discussion paper outline the case in some detail. Under the existing proposal the ACMA's role would be changed to one where it:

- Allocates band management spectrum licenses;
- Manages registration and international agreements and provides coordination in relation to the band;
- Manages out of band unauthorised interference;
- Ensures compliance of the band manager with the band management license, and
- Agrees conditions with the band manager regarding access by fee-exempt users.

All other functions would pass to the band manger.[182] There appears to be only lukewarm response from industry on the proposal and its future is unclear.

4.4.2.5.3 The digital dividend

There has been no decision about what would be done with spectrum that becomes available when analogue TV converts to digital.

---

181 From DC to Daylight – Accounting for Use of the Spectrum in Australia: A Spectrum Management Strategy". ACMA, June 2004.

182 See, "Private Management of Encumbered Spectrum Bands", ACA Discussion Paper (February 2005). A link to this report is provide at, http://www.acma.gov.au/ACMAINTER.2490560:STANDARD:226505777:pc=PC_6124

4.4.2.5.4 The 3G extension Band

The 2500–2690 MHz band is currently used by broadcasters for electronic news gathering. It involves point to point terrestrial links for live news events or sports outside broadcasting.

4.4.3 Frequency Trading

4.4.3.1 Frequency Bands Currently Open for Frequency Trading

All bands that have been allocated as Spectrum Licenses or are used by apparatus licensees not being in reserved defence or broadcast bands, are open to trading (broadcast licences can be traded but as a package see above). Class licenses are not issued to individual users and do not involve license fees or license conditions being applied to individuals. Class licenses can not therefore be traded.

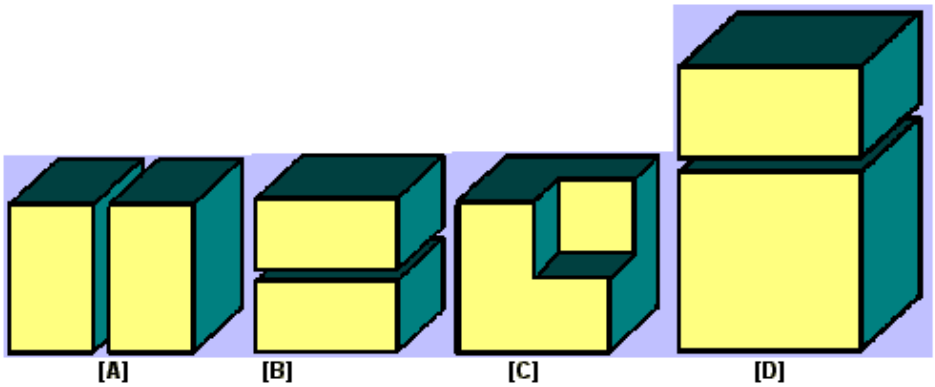
4.4.3.2 Trading Spectrum Licenses

4.4.3.2.1 Design of Spectrum Licenses

Spectrum Licenses are designed to be traded. Trading in spectrum licenses in Australia is unavoidably linked to the concept of Spectrum Trading Units (STUs). STUs are defined in terms of the following 4-dimensional units of spectrum space:

- The area they occupy (2 dimensions);
- The bandwidth (or frequency range), and
- The time during which they exist.

Figure 4: Aggregating Spectrum Trading Units



Source: ACA report on Spectrum Licensing and Trading, at:
http://www.acma.gov.au/ACMAINTER.2163012:STANDARD:2111527420:pc=PC_1620

For pedagogical reasons the SMA conceived of STUs as cubes (see Figure 4), with area coverage on the horizontal plane and frequency bandwidth on the vertical axis – a *'spectrum map grid'*. Time is in order to focus on a depiction of possible ways that spectrum space can be altered under STU trading rules. These cells can be aggregated [A] by geography, [B] by bandwidth, [C] by both geography and bandwidth, and [D] by extending geographic coverage and/or bandwidth by acquiring adjacent spectrum license(s) from another licensee. STUs are the smallest spectrum unit that can be traded – they are indivisible. STUs may be combined with neighbouring STUs to form larger spectrum spaces. Conversely, where licensed spectrum is comprised of numerous STUs (the usual case), the rights holder can trade multiple or individual STUs as desired.[183] In some bands there are additional rules which set the minimum contiguous bandwidth of a spectrum license, and prevent trading down to a single STU.

STUs come in 3 different sizes, depending on population density:

- 3 degrees of arc in remote areas;
- 1 degree of arc in rural areas, and
- 5 minutes of arc in metropolitan and regional areas.

The area of every spectrum license is defined in terms of these cells with the smallest 'parcels' being 7-9 km (5 minutes of arc), and the larger parcels can be 200 km (3 degrees of arc). The basic dimension depends on the frequency band. For example, in the 500 MHz band this is 12.5 kHz. Licenses are then created by aggregating STUs

183 ACA report on Spectrum Licensing and Trading, at:
http://www.acma.gov.au/ACMAINTER.2163012:STANDARD:2111527420:pc=PC_1620

acquired by individual operators.[184] Australian spectrum space is thus made up of a grid of latitudinal parallels and longitudinal meridians that defines 21,998 cells.[185], [186]

All auctions of spectrum licenses have involved the ACA pre-defining STUs into lots following consultation with industry. For frequency used to provide mobile telecommunications services, for example, these lots were city-wide. Industry consultation would also allow the ACA to set the minimum bandwidth that the technology would realistically be able to operate with.

4.4.3.3 Restrictions imposed on frequency trading by Spectrum Licensees

The Radiocommunications Determination of 1998 specified the following rules for assignments of spectrum licenses:[187]

1) A licensee may not trade a part of his or her license that is less than a whole STU or a multiple of whole STUs.

2) A licensee must not trade a part of the license if any of the resulting licenses would contain less than a minimum contiguous bandwidth.

3) A licensee may not transfer his or her license for the purpose of providing security for a loan.[188]

Any spectrum license that is traded must be notified to the ACMA, including information on: the license traded; the parties involved in the trade; the sale price (new); the bands traded; the geographic area, and the nature of trade (whole or part of the license). The information is included in the ACMA's License Register.

---

184 Cave (2002).

185 Ian Hayne, (1997), "Spectrum property rights and practical auction design: the Australian experience". *Industry Economics Conference Proceedings*: Melbourne.

186 When spectrum licenses are divided and traded, the devices operating under the original license must be allocated to each part of the license before the trade is registered. Before the trade, all the devices will be set to a status of either(i) Passed; (ii) Failed Guard Band; (iii) Failed Guard Area; (iv) Failed IIC (Effective Occupied Bandwidth outside the Frequency Band of the License); or (v) Confirm agreement to share spectrum with adjacent licensees.

187 The document can be found at: http://www.acma.gov.au/ACMAINTER.2163012:STANDARD:314280411:pc=PC_346

188 Note that a licensee is able to authorise other persons to operate devices under the license.

4.4.3.4 Apparatus Licenses

4.4.3.4.1 Transfers of Apparatus Licenses

Apparatus licenses may be transferred. An application to transfer a license may be made only when it is proposed that another person be substituted for the licensee. Applicants are required to pay a transfer charge to cover the ACMA's administrative expenses. A device authorised by the transferred license is still required to operate under the same technical conditions (including transmission site) as specified on the original license. When an apparatus license is transferred, it will remain in force for the balance of the original term of the license and remains subject to the possibility of later administrative action by the ACMA.

The licensee must apply to the ACMA for approval to transfer a license to another party. There are a number of limitations the ACMA applies to applications to transfer apparatus licenses.

4.4.3.5 Broadcasting licenses

Most broadcasting licenses carry an entitlement to spectrum. In cases involving the transfer of commercial licences relating to broadcast services, broadcasting licences and transmitter licences must be transferred as a complete package. It is not possible under the current regulations to transfer a licence to transmit a service at a certain frequency separately from the license to broadcast.

4.4.3.6 Experience with Frequency Trading

4.4.3.6.1 Spectrum Licenses

The PC estimates from 2002 suggested that the turnover rate (see Table 29 note (b)) for spectrum licenses was around four times that for apparatus licenses and similar to that of the residential property market.[189] It found that some commercial leasing arrangements existed within both spectrum and apparatus licenses, but a lack of data meant that little more could be said about it.

---

189 PC Report p. 152

Table 29: Trading in Spectrum Licenses 1998 to 2004

Year	Total Licenses traded (a)	Percentage turnover rate (b)
1998 - 1999	50	13.8
1999 - 2000	22	5.4
2000 - 2001	47	7.7
2001 - 2002	51	8.4
2002 - 2003	54	8.8
2003 - 2004	22	3.6
Total trades	**246**	

Notes: (a) Note that a high proportion of these trading figures represent license transfers between related companies (includes mergers, acquisitions and restructuring).

(b) The turnover rate is the number of licenses traded each year compared to the total number of spectrum licenses on issue.

Very few trades have been other than transfers between different entities under similar financial control, or that occurred as a result of a sale, merger, or takeover of the company which holds the spectrum license.[190] A major trade between licensees at 2.3 GHz and 3.4 GHz was recently undertaken and more may take place as unused spectrum licenses move towards their 15 year expiry.

There appear to have been some 'rationality' type issues with spectrum purchased at a market peak being withheld from sale by company bankruptcy administrators. The ACMA's view is that administrators remain unwilling to sell the spectrum for a large loss, and appear to be waiting for a miracle. There are significant amounts of spectrum in this situation which have been unused since allocation.

4.4.3.6.2 Apparatus Licenses

As with trades of spectrum licenses, while there have been many trades in apparatus licenses, few of them involve a genuine trade between separately controlled entities. Trades have occurred in land mobile radio licenses and quasi-broadcasting licenses such as those for open narrowcasting services which use broadcasting services bands.

190 ACMA, personal communication

4.4.4 Interference Issues

4.4.4.1 Technical Interference Management

There are two primary means by which interference is managed: (i) Core conditions and (ii) device registration

4.4.4.1.1 Core Conditions

Spectrum licences are designed as far as is efficient, to be technology and use independent. However, in managing the potential for interference to other spectrum users the ACMA does tend to assume a certain use when setting core conditions for spectrum licences. Core conditions are binding on licensees. They establish the background noise that other licensee should expect at the boundary. Differences in core conditions thus imply differences in what adjacent licensees can do with their own spectrum. Setting core conditions according to an assumed use enables narrower guard bands and greater spectral efficiency, but at the cost of neutrality.

There has been discussion in Australia as to whether core conditions have not been over specified in some cases and could have been generic and in so doing obtained a greater potential license value and liquidity.[191] However, to date, these technical constraints do not appear to have been a major problem and there is evidence of different technologies being planned for spectrum licences in the same band.

4.4.4.1.2 Device Registration

Following liberalisation the original spectrum management agency, the SMA, decided that ensuring compliance by policing boundaries was impractical. Instead it relied on device registration to ensure that spectrum licensees did not breach the conditions of their licences. Today, the ACMA will only register devices if a licensee can demonstrate that he or she would not create unacceptable levels of interference. This is most often done by accredited experts reporting on the emission characteristics of devices.

---

191 PC pp204-05

4.4.4.2 Institutional Arrangements – Accreditation[192]

The RC Act provides for the Australian Communications and Media Authority (ACMA) to accredit persons to perform certain activities regarding the use of the radiofrequency spectrum. Such activities include frequency coordination and emission level management.

The ACMA currently accredits persons to issue two kinds of certificates:

- Frequency assignment certificates (FACs) relating to the operation of radiocommunications transmitters and receivers covered under apparatus licensing arrangements; and
- Interference impact certificates (IICs), relating to the operation of radiocommunications transmitters in spectrum subject to spectrum licensing.

4.4.5 Competition Issues

4.4.5.1 Ministerial Directions

The Minister is empowered to give written directions to the ACMA in relation to the performance of its functions and the exercise of its powers. Such directions are recorded in a register by the ACMA. These powers have enabled the Minister to set limits regarding the participation of certain bidders in auctions and to specify the amount of spectrum that bidders could acquire at auction. Advice is sought from the competition authority (the ACCC) although the Minister is not bound by it.[193]

These "imposed limits" appear to be concerned with the wish to avoid undue concentration and any market participant acquiring a level of market power that would not be in the public interest. There is, however, no express relationship between limits imposed by the Minister and limits implied by section 50 of the Trade Practices (TP) Act which addresses mergers and acquisitions that are not in the public interest. The experience to date suggests that on the margin, spectrum caps have prevented firms from acquiring spectrum that would have been permitted under the TP Act.

The Minister's powers under the ACMA Act apply to primary allocations or assignments, and do not affect the operation of secondary markets for spectrum. A firm excluded

---

192 This section has drawn heavily on "The Role of Accredited Persons in Radiocommunications" at http://www.acma.gov.au/ACMAINTER.2490560:STANDARD::pc=PC_500

193 In regard to spectrum allocations or assignments, these powers are further clarified by s. 60(5)(b) and (10) which states that the Minister may *"impose limits on the aggregate of the parts of the spectrum that, as a result of the allocation of spectrum licenses under this Subdivision, may, in total, be used by the members of a specified group of persons*".

from an auction or prevented from bidding for all the spectrum it wanted, could later purchase the spectrum on the secondary market. In this case the only regulation that may limit its ability to do this would be competition law, primarily the merger provisions of the TP Act. This was not considered a problem in regard to the "imposed limits" *per se* since their main aim is to foster new entry and not as a substitute to the TP Act.[194]

According to Grant (2004) in all the key spectrum auctions the Minister has used powers to impose limits on the amount of spectrum bidders can obtain.[195] In 2000–2001 which was an important year for spectrum auctions, the Minister gave 9 directions to the ACA, covering use of radiocommunications devices, spectrum licenses and spectrum allocations.[196] We understand that these limits have usually involved Telstra. However, in one 1999 case both Telstra and Optus were excluded from the auction. It appears that the intention of the "imposed limits" may have been used to foster new entry rather than simply as a competition safeguard which is more conservative than that provided by the TP Act, i.e. a type of active industry policy.[197]

4.4.5.2 The Role of and Competition Authorities

The RC Amendment Act of 1997 defined the issue of a license as the purchase of an asset for the purposes of section 50 of the Trade Practices (TP) Act 1974, which addresses the competitive effects of mergers and acquisitions. Both primary and secondary market allocations are subject to the TP Act. No entity can acquire shares assets of a person or corporation if the acquisition would have the effect, or be likely to have the effect, of substantially lessening competition in a market.[198]

4.4.6 Economic Pricing of Frequencies

4.4.6.1 Introduction

Australia uses auctions and market-based administrative pricing to allocate or assign spectrum among competing users. Most spectrum, however, continues to be priced administratively, albeit with the intention of setting allocation and holding costs for licensees that promote the efficient use of spectrum. An exception to this occurs where spectrum licenses result from the conversion of apparatus licenses, in which case the sale price has to date been negotiated.

---

194 DCITA personal communication
195 Grant (2004), p 207.
196 PC Report (2002), p 50.
197 ACMA personal communication.
198 The term "substantially lessening competition" is in practice little different in its meaning than is the term "dominance" in European Community competition law.

Australia's first auction was conducted by the ABA in 1993. It was for two satellite pay television licenses. A first-price, sealed-bid auction was used, but the rules were in practice naïve: bidding was in predetermined multiples, deposits were not required and multiple bids by a single bidder were not excluded. This resulted in some bidders employing a strategy of defaulting on their winning bid, secure in the knowledge that they also held the next-highest bid. The bids cascaded, with the prices ultimately paid for the licenses being less than half of the initial bids placed by the eventual winners (McMillan 1994, and PC Report p 240).

Open outcry auctions were used by the ACA in 1994-95 to allocate multipoint distribution system (MDS) apparatus licenses. With the exception of one open outcry auction for 2 land mobile licences in 2001, since 1997 all auctions have been simultaneous multi-round (SMR) ascending bid auctions. Spectrum license auctions were based on predetermined regional zones. The zones (a combination of numerous STUs) were developed following consultation with the industry. Details of these auctions can be found in Annex 4.4.1.[199] The ACMA is presently studying the possibility of designing and using combinatorial auctions in future rather than an SMR design but is unlikely to change in the near-term.

4.4.6.2 Administrative Pricing

The range of license fees for spectrum users determined by the administration are:

(i) Reserve prices at auction, or the price paid when an auction is not used;[200]

(ii) A charge for issuing a license - to cover issuing costs (the minimum charge is $81.40);

(iii) License (spectrum usage) fees which recur annually (although these may also be paid upfront for the duration of the license);

(iv) Fees payable for license transfers, and

(v) Fees payable for the administrative cost for license issue or renewal.

---

199 The success of Australian spectrum auctions in raising revenue is apparent from the $3 billion plus raised since 1994. Two particular auctions stand out: the PCS 2000 auction (41 per cent of the overall revenue) and the 3G auction (37 per cent). For prices paid at both auction were not high by international standards measured on basis of megahertz x the maximum population covered by the licenses. One likely reason for this is because the spectrum was not reserved for any particular service.

200 The approach to setting a reserve price would be based on an assessment of the opportunity cost of the spectrum, as occurs with administrative incentive pricing (AIP). Such assessments tend to be prone to significant error, such that the spectrum management agency will need to take care that its reserve price is not greater than the market's willingness-to-pay for the spectrum.

Table 30: Annual license fees and the distribution of spectrum by use (or user), 1999-2000[a]

Spectrum use	*Licence fees*	*Share of total licence fees*	*Share of spectrum allocations*[b]
	$ million	%	%
Broadcasting[c]	232.1	71	2
Mobile[d]	39.0	12	20
Defence	8.1	2	10
Fixed[e]	39.0	12	38
Amateur	0.7	0	0
Other[f]	7.2	2	30
Total[g]	**326.1**	**100**	**100**

Notes: [a] License fees exclude revenue from auctions. [b] Includes spectrum allocated on an exclusive use, primary use and co-primary use basis (see final column in table 2.2). [c] Relates to dedicated broadcasting services bands. Broadcasting license fees are based on the amount of revenue earned by broadcasters, not on the amount of spectrum they use. [d] Includes license fees from cellular mobile and land mobile systems. [e] Includes license fees from point-to-point, point-to-multipoint and multipoint distribution systems. [f] Includes license fees from satellite, meteorology, radioastronomy, standard time and frequency signals; industrial, scientific and medical uses; and non-assigned licenses for amateur, maritime, aircraft and outpost uses. [g] Columns may not add to total due to rounding.

Source: PC Report (2002) p 25, ACA (unpublished).

In Table 30 we provide information about the latter three: recurring license fees and transfer and renewal fees, for both apparatus and spectrum licenses.

4.4.6.2.1 Apparatus License Fees

Most license fees determined by the administration are calculated by a formula that is intended to approximately reflect the market value of the licensed spectrum: that is, higher fees apply in areas and for frequencies where there is high demand (congestion). A summary of imputed fees for apparatus licenses and the number of assigned licenses by industry in November 2001 appears in Table 31.

The revised system of apparatus license fees (the previous formula was introduced in 1995) has operated since 4 April 2005 in response to the PC Report that the earlier fee setting methodology sometimes diverged from good economic practice. The ACMA's modified system of apparatus license fees relies on apparatus license types to apply common license conditions to categories of radiocommunications services. Within license types there are usually several licensing options suitable for specific purposes, including assigned and non-assigned licenses. Fees charged vary according to the licensing option.

Table 31: Fees for access to spectrum not designated for broadcasting or defence

Industry	*Licence fees*	*Share of total licence fees*	*Assigned licences*	*Share of total licences*
	$ million	%	No.	%
Telecommunications	80.7	71	27 001	26
General government	12.7	11	18 829	18
Broadcasting	5.2	5	4796	5
Transport and storage	3.4	3	9809	9
Manufacturing	3.1	3	5954	6
Electricity, gas or water supply	1.4	1	4999	5
Education	1.0	1	1103	1
Health services	0.7	1	2998	3
Mining	0.5	0	4450	4
Safety services	0.5	0	4376	4
Wholesale or retail trade	0.4	0	2338	2
Recreational and amateur activities	0.4	0	4958	5
Agriculture, forestry and fishing	0.2	0	2790	3
Construction	0.2	0	1461	1
Finance and insurance	0.1	0	125	0
Other	3.3	3	9328	9
Total[b]	**113.7**	**100**	**105 315**	**100**

a License fees are imputed by applying current ACA methods of charging for apparatus licenses to the stock of apparatus licenses held in November 2001, assuming all licenses had a duration of one year. **b** Columns may not add to total due to rounding.

Source: PC Report (2002) and ACA (unpublished).

4.4.6.2.1.1 Assigned License Fees

There are two components to apparatus license fees:

(i) an administrative charge to recover the direct costs of spectrum management, plus

(ii) a transmitter or receiver license tax, which is intended to cover the indirect costs of spectrum management (those which are not directly attributable to an applicant), plus a component to reflect the opportunity cost of the spectrum.

Determining the license tax is where most of the complexity lies.[201] Annual transmitter or receiver apparatus license taxes are determined by a formula which has 4 main drivers: These are:

- the band in which a service operates;
- the geographic area in which a service is entitled to operate;
- the bandwidth of a service; and
- the authorised power level (low power services get a discount).

The minimum tax levied is $A29.39.

4.4.6.2.1.1.1 License Tax Formula

The revised apparatus license fee schedule dates from April 2005. It aims to provide more information to license holders, specifically to ensure that all elements required to calculate fees are available in a clear and accessible format.[202],[203]

4.4.6.2.1.1.2 Fee Exemptions and Concessions[204]

The ACMA has the power to provide license fee exemptions, concessions and discounts to some licensees in certain circumstances. Exemptions from license fees apply to the annual license tax and the ACMA administrative charge. License fee exemptions apply to:

(i) diplomatic and consular missions; or

(ii) bodies, the principal purpose of which is to provide surf life saving and remote area ambulance services or;

(iii) bodies, the principal purpose of which is to provide emergency services or services for the safe-guarding of human life - where the body is staffed principally by volunteers and is exempt from paying income tax.

---

201 For an extensive report of these fees see, ACA "Apparatus License Fee Schedule" (April 2004).

202 The main changes would appear to be a shift to continuous bandwidth pricing as was recommended by the PC Report. Other changes include: Spectrum frequency ranges increased from 8 ranges to 11, spectrum location and geographic location weightings updated; changes to the application of the low power discount; the introduction of a remote density area; fee increase for fixed services in bands below 960 MHz, and new licensing options. These changes can be found on URL: http://www.acma.gov.au/ACMAINTER.2163012:STANDARD:1208947544:pc=PC_2941#CBP

203 The schedule along with table and an explanation about how to calculate fees can be found at URL: http://www.acma.gov.au/ACMAINTER.2883838:STANDARD:1336714429:pc=PC_1614

204 Further detail can be found at: http://www.acma.gov.au/ACMAINTER.2163012:STANDARD:2111527420:pc=PC_1272

4.4.6.2.1.1.3 License Renewal Fee

A renewal charge of $6.60 is payable for each chargeable spectrum access.[205]

4.4.6.2.1.1.4 License Transfer Fee

Applicants are required to pay a transfer charge to cover the ACMA's administrative expenses. Licensees who qualify for license fee exemption are not required to pay the transfer fee.

4.4.6.2.2 Spectrum License Fees

In addition to any assignment fee (i.e. an amount bid at auction or an administered allocation fee), there are three types of fee levied on spectrum licensees:

- an auction entry fee, refundable for those not winning licenses;
- a spectrum access charge[206], and
- an annual tax on spectrum license holders.

The first two are administrative charges permitted by the RC Act (s. 60). Spectrum access charges are applied once only when an apparatus license is converted to a spectrum license. These taxes are intended to cover the direct costs borne by the ACMA in issuing and managing licenses.

The annual tax on Spectrum License holders is authorised under the Radiocoms Act 1997.[207] The tax is generally smaller than for equivalent apparatus licenses because the rental element of a spectrum license is already captured by the auction price. The tax represents the contribution of spectrum licensees to international coordination, domestic planning, interference investigation and policy development carried out by the ACMA.[208] It is complex to calculate but it is the cost recovery part (roughly 40%) of the fee that would be payable by an apparatus licensee for the same spectrum. As an example, if the licence covers 10% of the spectrum in band that is Spectrum Licensed

---

205 If a license includes both a transmit and a receive spectrum access, fees are only charged for the transmit spectrum access. If a license only includes a receive spectrum access then this attracts a fee. Spectrum accesses for which fees are charged are called chargeable spectrum accesses.

206 A spectrum access charge is quite different from a 'chargeable spectrum access'. When an apparatus license is converted to a spectrum license, the licensee must pay the value of the spectrum license over the term of 15 years, up-front. This up-front payment is called the spectrum access charge.

207 In 2001 the Minister for Communications, increased the annual apparatus license fees charged for GSM spectrum in the 900-MHz band to Optus and Vodafone, by 150%. Both operators had purchased through tender carrier licenses in 1991 and 1992 for a period of 25 years. The PC pointed out that this amounted to a "hold-up" given that the prices offered at tender would have been lower had the bidders know there was going to be such a large tax rise in future.

208 See the Government response to the PC's recommendation 8.2.

(say, 10MHz of 100 MHz) in the five major state capitals (say, 70% of the population) then the licensee would pay 7% (10x 70) of the cost recovery part (40%) of the equivalent Apparatus License fee for that band.

The ACMA is considering scrapping the administrative fee for new Spectrum Licenses. Licensees would pay the auction price, which if all else remained the same might increase by the present value of the future stream of expected recurring administrative fees no longer charged.

4.4.6.2.3 Broadcasting License Fees

The fees broadcasters must pay are based on the revenue they earned, not on the value of the spectrum they use.[209] The annual license fees commercial broadcasters must pay (both radio and television) are derived as a percentage of their gross earnings. The percentage that each licensee pays varies according to a sliding scale (0.5% to 9.0% for television licensees and 0.25% to 3.25% for radio licensees.[210] Non-commercial broadcasters be they national or community broadcasters, do not pay any fees for the spectrum they use which is in the broadcasting services bands. For spectrum they use which is outside the bands reserved for broadcasting, the fees broadcasters pay are not influenced by their broadcasting status.

In 1999–2000 (Table 30) the Federal Government collected approximately $A232 million in license fees from commercial broadcasters, 94% of which came from television broadcasters. These fees appear to be only a fraction of the market values of the spectrum (or the amounts commercial broadcasters are willing to pay). No fees are paid for spectrum that broadcasters have been temporarily lent in order to simulcast in both digital and analogue form, unless that spectrum is used for datacasting. In 2001 fees paid by broadcasters to use spectrum outside the broadcasting bands totalled $A5.2 million.

The need to reform the fee system for broadcasting spectrum was one of the main recommendations of the PC Report. The government is yet to make a decision about it.

4.4.6.2.4 Fees Paid by Defence

Government, including the military, has to pay spectrum usage fees. The Department of Defence (Defence) is a large user of spectrum in Australia. In the VHF and EHF bands Defence uses 28% and 33% of the frequencies respectively. The Minister allocates

---

209 Under the BS Act (1992) new commercial television and radio licenses are to be auctioned to the highest bidder. Three commercial television and 25 commercial radio licenses have been auctioned since 1992, raising $A358 million.

210 Annex 2E, PC Report (2002).

spectrum to Defence on an exclusive use or primary use basis. Defence must pay license fees for apparatus licenses, calculated on the same basis as apparatus licenses possessed by private users. In 2001 Defence paid approximately $A8.4 million for reserved spectrum, a further $A979,000 for spectrum used outside the reserved bands, and $245,000 for classified assignments.[211]

4.4.7 More Detailed Analysis of Frequency User Rights in Selected Bands

4.4.7.1 Introduction

This section addresses FWA. In Australia in the last couple of years the focus of the wireless access discussion has tended toward WLANs and broadband wireless access (BWA). Both of these are considered below under the superior heading of FWA.

4.4.7.2 Fixed Wireless Access

The primary interest in FWA in Australia is in its potential to provide telephone and internet access in rural areas. In October 2000 the then ACA auctioned 2 by 33 MHz of spectrum in the 3.4 GHz range in regional lots to facilitate local telephone services.

Where spectrum is labelled as FWA and is allocated as a spectrum license, the license is not assigned to any particular use, as is the case for all spectrum licenses. If a 'spectrum license' licensee wanted to use FWA spectrum to provide mobile services (i.e. with call handover between cell sites), and was able to obtain suitable network equipment for doing so, the licensee would be free to do this provided it met the interference limits of the license. If the licensee wished to change any of the interference related parameter that apply to the license, he or she would need the agreement of surrounding licensees.

Below we provide a brief discussion outlining further the authority's policies toward licensing this spectrum.

4.4.7.2.1 FWA Allocations and Future Developments

The ACA held auctions for 3.4 GHz FWA spectrum in late 2000. Numerous licenses were eventually purchased with licenses covering a pre-defined urban area. As with

---

211 PC Report (2002).

virtually all Spectrum Licenses they are for 15 years.[212] These auctions raised $A112 million. Licenses to spectrum in the 3.4GHz range not taken up in 2000, are offered every 3 months with 4 having been sold to date (October 05), but as there was only one bidder in each case they each sold for their reserve prices. Table 32 provides an overview of apparatus-licensed and spectrum-licensed spectrum that is currently used for FWA.

Table 32: Overview of apparatus-licensed and spectrum-licensed spectrum that is currently used for FWA

Band	Current use	Comments
400 MHz & 1.5 GHz	Digital radio concentrator systems (DRCS) and high capacity radio concentrator (HCRC) systems—used by Telstra to provide an FWA	Increase in demand for high data transmission rates will move beyond the capabilities of these bands. system in remote and rural Australia.
1.9 GHz (1880–1900 MHz)	Provision for FWA services—must be coordinated with existing fixed links and co-exist with class-licensed cordless telecommunication systems.	FWA services must be in rural and remote areas of Australia, and must use DECT technology.
1900–1920 MHz	Spectrum-licensed for 3G services in capital cities; apparatus-licensed fixed links and some BWA services in regional areas.	BWA services have commenced from 2004 in Sydney.
3.4 GHz	Spectrum-licensed and apparatus-licensed FWA services.	

4.4.7.2.2 WLANS

The ACMA makes spectrum available to WLANs under a class license. This provides a ‘public park’ regulatory environment. Users receive no guarantee of protection from interference from other services and must not cause interference to other services. The design and restricted power of the devices used keeps interference to acceptable levels.

212 The PC Report (2002) urged the government to enable Spectrum Licenses to be issue in perpetuity, primarily for the benefit it would have on the operation of the secondary market. The government did not accept this recommendation.

Table 33: Summary description of the frequency ranges and current EIRP limits for the deployment of WLANs

Band	Summary
900 MHz	band limits: 915–928 MHz max EIRP: 1 watt—frequency hopping, direct sequence and other complex digital modulation schemes
2 GHz	band limits: 2.4–2.4835 GHz max EIRP: 500 milliwatts—'wideband' frequency hoppers (hopper bandwidth > 1 MHz) 4 watts—'narrowband' frequency hopping (hopper bandwidth < 1 MHz), direct sequence and other complex digital modulation schemes
5 GHz	band limits: 5.150–5.350 GHz max EIRP: 200 milliwatts, indoor use only
	band limits: 5.725–5.850 GHz max EIRP: 4 watts—complex digital modulation schemes, including direct sequence spread spectrum
	band limits: 5.725–5.875 GHz max EIRP: 1 watt—frequency hopping

Source: "From DC to Daylight – Accounting for Use of the Spectrum in Australia: A Spectrum Management Strategy". ACMA, June 2004

The ACMA has stated its commitment to support WLANs in the 900 MHz, 2.4 GHz and 5 GHz bands, specifically to:

- continue to support WLAN operations in the 5150–5250 MHz band;
- consider various WLAN and FWA options for 5250–5350 MHz range following industry consultation;
- introduce WLAN operation under a class license for the 5470–5725 MHz range; and
- continue to support WLAN operations in the 5725–5875 MHz band.

The ACMA is planning to use of the 5.8 GHz band to provide BWA services, as well as backhaul for such services, and is likely to raise EIRP limits in rural areas to assist licensees who wish to provide such services. The ACMA is also intending to support the use of WLANs in the 60 GHz band which is used for high data rate short-range communication.[213]

213 http://www.acma.gov.au/ACMAINTER.2490560:STANDARD:1768857331:pc=PC_2848

4.4.7.2.3 Broadband Wireless Access (BWA)

The ACMA has already allocated spectrum licenses suitable for BWA in the 1.9 GHz, 2.3 GHz, 3.4 GHz, 27 GHz and 28–31 GHz bands. In addition, the ACMA has facilitated spectrum access for BWA through apparatus licensing in several bands. In areas where apparatus licensing opportunities in the 3.4 GHz band exist, there has been continuing interest.

There is perhaps more interest in BWA in Australia due to its potential for delivering competitive data services to households and small business in regional and rural areas. The ACMA will make spectrum available in the 2010–2025 MHz band in 2006. The ITU has identified this band for IMT-2000 time division duplex (TDD) applications.

Other possibilities included 1785–1805 MHz and 1880–1900 MHz, although interference with GSM and DECT devices would need to be addressed. There is an Australia-wide embargo on the 3.6 GHz band and 40–42.5 GHz band (identified for LMDS applications in Europe) pending discussions about future use of the band.[214]

The ACMA is also intending to increase permitted radiated power levels in the class-licensed 5.8 GHz band in rural and less populated regional areas. Higher power levels could potentially make it more economic to deploy WLAN and BWA services and would be likely to reduce the costs of backhaul for such services.

4.4.7.2.4 Roll-out or Coverage Obligations

Following public consultation it has been decided that for the 1900-1920 MHz band and the 2010-2025 MHz band (in remote areas), roll-out obligations would be imposed. This is the first time such obligations have been used in Australia. The ACMA has stated that the intention of the policy is to deter spectrum hoarding or anti-competitive activity.

4.4.8 Lessons learned from Australia that are relevant to the implementation of a flexible frequency management system in Germany

4.4.8.1 Overview

Australia has been a World leader in spectrum management. Liberalisation of spectrum usage and spectrum trading began in Australia in 1992. Australia has managed to keep at the forefront of spectrum management through self review and occasional

---

214 For more information see, “From DC to Daylight – Accounting for Use of the Spectrum in Australia: A Spectrum Management Strategy”. ACMA, June 2004

independent review at the behest of government. These institutional characteristics appear to be an important factor in explaining Australia's maintenance of it reputation for spectrum management.

4.4.8.2 Spectrum liberalisation

In Australia, Spectrum Licenses can be used with any technology and for any use so long as emission limits are observed. Licenses are not completely neutral as emission limits are designed with the likely use in mind. Spectrum licensing began in the mid 1990s in Australia

Australia is still struggling with the conversion of the old style Apparatus License to Spectrum Licenses. It is increasing looking to allocate Spectrum Licenses with sitting incumbents. It may also allocate Spectrum Licenses to the military as the sitting wide-area Apparatus License incumbent. This would put some responsibilities onto the licensee and away from the ACMA. The Federal Network Agency may also find scope for a level of spectrum license reform which is able to transfer some of its existing responsibilities for interference onto licensees, freeing it to use its resources in other aspects of spectrum regulation.

4.4.8.3 Spectrum Trading

Licenses in Australia are specifically designed to be traded. Licenses are comprised of Spectrum Trading Units (STUs) which are defined in terms of 4-dimensional units of spectrum space: the area they occupy (2 dimensions); the bandwidth (or frequency range), and the time during which they exist. STUs come in 3 different sizes, depending on population density: 3 degrees of arc in remote areas; 1 degree of arc in rural areas, and 5 minutes of arc in metropolitan and regional areas. 22,000 STUs are needed to cover Australia. Auctions typically involve regional bundles of STUs being offered, these having been previously determined by industry consultation.

The spectrum management agency (the ACMA) maintains an online and comprehensive database of licenses which it considers essential for the operation of a secondary market in spectrum.

There have been very few trades, however, that have not been transfers between different entities under similar financial control, or that occurred as a result of a sale, merger, or takeover of the company which holds the spectrum license. There are a range of possible reasons for this, knowledge of which may be of relevance to The Federal Network Agency:

- In Australia there is no presumption of renewal of spectrum licenses. This can only be done by the Minister when it is shown to be in the public interest. We believe this may be a significant impediment to spectrum trading in Australia. We commend to the Federal Network Agency the investment benefits of statutory renewal rights to be granted several years prior to expiry, with very specific and limited exceptions. A system of rights in perpetuity can also work under certain conditions, the main ones being those we noted in the next bullet point;

- Existing 15 year licenses are thought to be a significant impediment to secondary trading. Peer review has recommended that spectrum licenses be awarded in perpetuity. WIK notes, that a well functioning secondary market where substitutable spectrum is dispersed among many users, is required before we could recommend this to the Federal Network Agency;

- Where taxes apply to traded spectrum they can prevent trades of spectrum to a marginally higher value users. *Ad valorem* taxes payable on secondary trades fit this description, and may be one factor detracting from the liquidity of spectrum in Australia. We recommend that the Federal Network Agency keep this in mind when reviewing future changes to the secondary trading regime in Germany.

4.4.8.4 Interference issues

Following initial liberalisation in Australia it was decided that trying to ensure compliance by policing license boundaries was impractical. The ACMA now relies on device registration to ensure that spectrum licensees do not breach the conditions of their licences. The ACMA will only register devices if licensees demonstrate that they would not create unacceptable levels of interference. Assurances on the emission characteristics of licensees' devices are mainly done by private accredited engineers. While we understand that EU law prevents any NRA from checking a firm's equipment, there is a larger issue here that BNetsA may want to consider further; are there technical/interference functions that are able to be equally well performed by private engineers?

In Australia, as occurred in New Zealand, some observers have called the ACMA to look again into whether it can provide more neutral core license conditions as this will increase the degree of usage neutrality. We suggest that the Federal Network Agency look out for any future developments in Australia (and perhaps also New Zealand) concerning core license conditions, as these will have evolved following a lengthy experience and may have practical implications for spectrum liberalisation and spectrum trading.

4.4.8.5 Class License Bands

The ACMA consults on an ongoing basis with industry in order to have spectrum available for license exempt uses. Australia follows closely low power hardware developments (especially in the USA and Europe) in order that the must useful spectrum is available for unlicensed uses.

4.4.8.6 Competition issues

The telecoms law in Australia expressly refers to the applicability of competition law (merger and takeover rules) to the acquisition of radio spectrum. In additional to this, however, spectrum caps, and sometimes even auction exclusions, have been imposed by the Minister for certain auctions. The caps do not operated in the secondary market and there is no analysis tabled to support the cap in any particular case. Caps appear to represent a form of government industry policy to encourage new entrants. We can not recommend the Australian approach to the Federal Network Agency. Rather, we would recommend that any cap be included in the auction consultation and then included as an element in the auction rules. This will prevent accusations of arbitrariness and non transparency that can be claimed about the Australia spectrum caps. It will also mean that a cap can be applied to spectrum auctions and also to later spectrum trading.

4.4.8.7 Annex

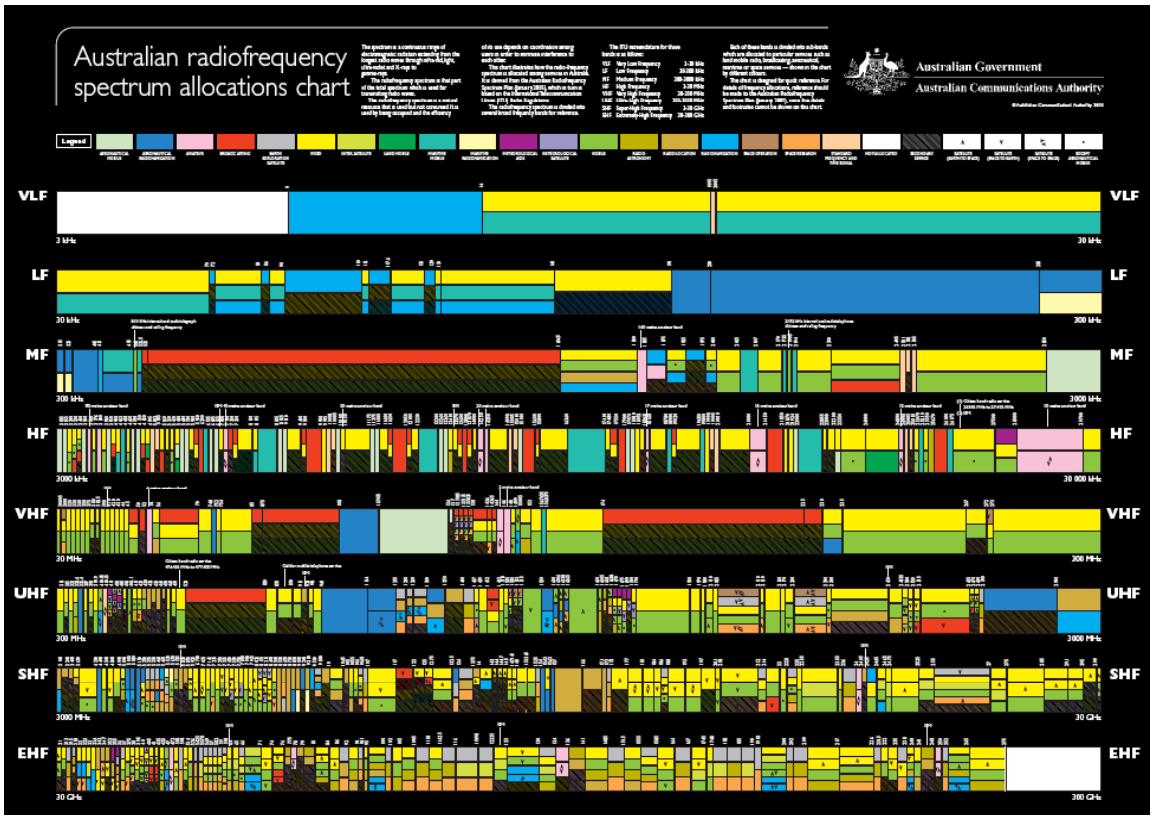
Table 34: Overview of Australian spectrum auctions

Auction	Licence type	No. of licences/lots	Date	Rounds	Bidders	Auction type	Amount raised	($/MHz) /pop (mean)	Annualised figure[m]	Typical service
							$m	$	$	
Multipoint distribution station (MDS) (2.3 GHz)[a]	5 yr apparatus	471 licences	1994 and 1995	na	20	Open outcry	101.0	na	na	Pay television
500 MHz[b]	10 yr spectrum	834 lots	3 Feb–24 Mar 1997	63	13	Simultaneous ascending	1.0	0.05	0.0062	Land mobile and point-to-point
PCS (800 MHz and 1.8 GHz)[c]	15 yr spectrum	230 lots	20 Apr–25 May 1998	89	9	Simultaneous ascending	347.4	0.11	0.0113	Land mobile and mobile phones
Second PCS (unsold lots) (800 MHz and 1.8 GHz)	15 yr spectrum	18 lots	15 Sep 1998	na	5	Open outcry	30.6	0.10	0.0105	As above
Broadband wireless access (28/31 GHz)[d]	15 yr spectrum	29 lots	1–8 Feb 1999	37	5	Simultaneous ascending	66.2	0.0008	0.0001	Fixed wireless
Third PCS (unsold lot) (800 MHz)	15 yr spectrum	1 lot	29 Apr 1999	na	1	Open outcry	0.02	0.02	0.0016	
800 MHz TLMS[e]	5 yr apparatus	2 lots	30 Apr 1999	na	2	Open outcry	0.05	na	na	Trunked land mobile
PCS 2000 (1.8 GHz)[f]	15 yr spectrum	60 lots	24 Jan–5 Mar 2000	138	7	Simultaneous ascending	1 327.7	1.26	0.1295	Mobile phones
3.4 GHz[g]	15 yr spectrum	482 lots	3–24 Oct 2000	53	8	Simultaneous ascending	114.8	0.04	0.0040	Wireless local loop
Broadband wireless access (27 GHz)[h]	15 yr spectrum	126 lots	28 Nov 2000	3	2	Simultaneous ascending	37.6	0.002	0.0003	Fixed wireless
800 MHz residual PCS[i]	13 yr spectrum	2 lots	22 Feb 2001	na	na	Open outcry	na	na	na	Mobile phones
3G mobiles (2.1 GHz)[j]	15-yr spectrum	58 lots	15–22 Mar 2001	19	7	Simultaneous ascending	1 169.0	0.61	0.0627	Mobile phones
Space licences[k]	5 yr apparatus	2 licences	30 Oct 2001	..	1	Simultaneous ascending	1	na	na	Broadcasting
Low power open narrowcasting licences[l]	5 yr apparatus	19 licences; 25 licences	December 2001; March 2002	..	na	Open outcry	0.009; 0.0125	..	na	Niche radio
							3 196.4			

Notes: [a] Licenses in the B band (2302–2400 MHz) were converted to 15 year spectrum licenses in 2000. Licenses in the A band (2076–2110 MHz) will terminate in 2002 and the spectrum will be re-planned. [b] First simultaneous ascending spectrum auction in Australia. First auction of a spectrum license in the world. Parts of the band were sold encumbered. [c] Parts of the spectrum were encumbered. Competition limits were in force, regarding the maximum bandwidth available to a single bidder and the identity of bidders for some lots. [d] AAPT won all 29 licenses, covering the whole of Australia. Competition limits prevented Optus and Telstra from bidding. [e] Lots only in Melbourne. Motorola won both. [f] Lots only available in capital cities. Winning bidders were Hutchison, OneTel, Telstra, and Vodafone. Competition limits applied to all bidders. [g] Subject to competition limits applying to all bidders and, in some cases, to Telstra only. Telstra withdrew from the auction. Lots were unpaired. [h] Two winning bidders: Agility Networks (owned by Optus) and Shin Satellite Co. [i] All lots allocated to the only bidder, Telstra. The license term was timed to coincide with that of the previously allocated 800 MHz licenses and therefore was equivalent to about 13 years. [j] Winners were Telstra, Vodafone, Optus, Hutchison, 3G Investments (Qualcomm) and CKW Wireless (ArrayComm). Some paired and some unpaired lots. Competition limits were in force, applying to all bidders. [k] Competition limit of one license per bidder. Only Foxtel entered the auction, so the ACA sold one license to this firm at the reserve price. [l] Subject to a 'use it or lose it' condition. Licenses were allocated at their reserve price. [m] Discount rate is 6 per cent per annum, equal to the average daily yield on 10-year Treasury bond rates between 1997 and 2001. **na** : not available; not applicable.

Source: Productivity Commission estimates based on ACA data (PC Report 2002).

Figure 5: Australian Radiofrequency Spectrum Allocations Chart



4.5 New Zealand[215]

4.5.1 Overview of spectrum management in New Zealand

4.5.1.1 Institutions of Frequency Regulation

Including separately the Ministry in charge of spectrum management, there are 3 main players involved in spectrum management and spectrum management policy development in New Zealand. These are:

- The Ministry of Economic Development (MED), which is where Radio Spectrum Management Unit is placed,
- The Government, especially
    - The Minister of Communications
    - The Cabinet – all spectrum allocations are subject to Cabinet approval
    - The Minister of Broadcasting
    - The Ministry of Culture and Heritage
    - Te Puni Kokiri (The Ministry of Māori Development)
- The Commerce Commission (the competition law authority).

The MED's functions in relation to spectrum policy and spectrum management are performed by:

- The IT and Telecommunications Policy Group
- The Radio Spectrum Policy and Planning Group,
- The Radio Spectrum Management Group

Together, the latter two constitute the spectrum management authority in New Zealand. We refer to them as the SMA. Their tasks are to:

- Advise on policy, spectrum planning and allocation;
- Administer radio apparatus licences pursuant to Part XIII of the Act;

---

215 1€ = 1.73982 NZD: 1 NZD = 0.574773€ (1 October 2005).

- Advise the Government on what spectrum should be allocated under the spectrum rights regime (SRR) and, where it is to be allocated to private interests, the means by which this should be done;
- Allocate spectrum on the basis determined by the Government;
- Manage certain spectrum blocks that are allocated to Government;
- Maintain and control the Register of Radio Frequencies that holds information on all radio and spectrum licences;
- Represent New Zealand at international meetings e.g. the ITU;
- Mediate in some disputes between private right holders over interference matters, and
- Advise the Government on competition law.

The Chief Executive of the Ministry of Economic Development (MED) administers the Radiocommunications Act (1989). The SMA performs its tasks (summarised above) under authority delegated by the Chief Executive (known as the Secretary of Commerce until public sector reforms in 1999).

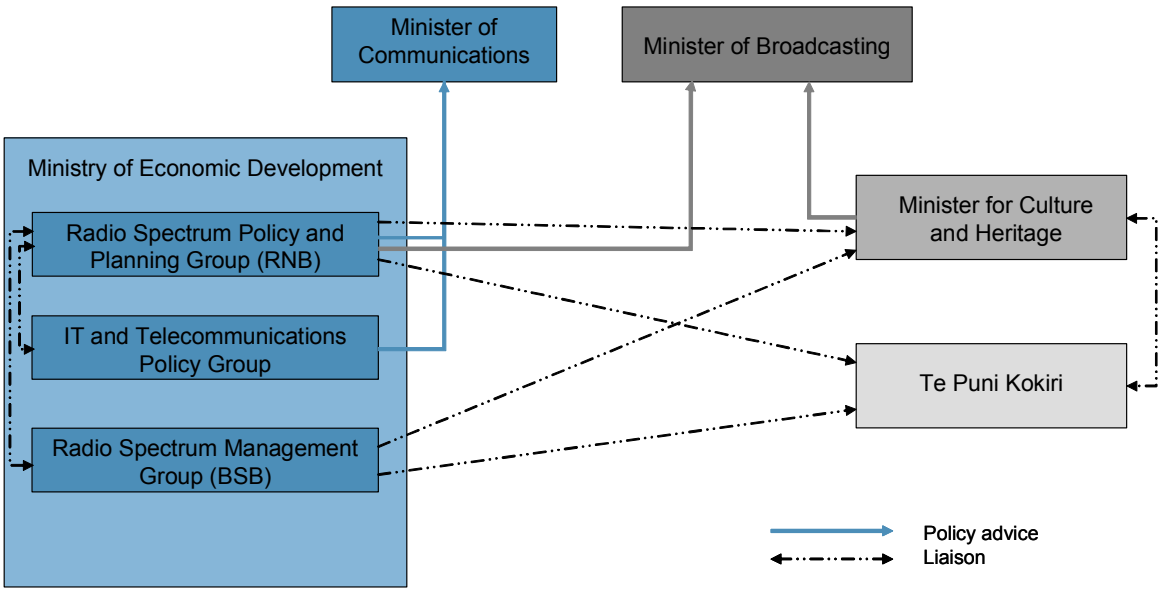
The Minister of Communications and the Minister of Broadcasting sit at the top of the decision-making process. Together, and where appropriate in consultation with the Ministry of Māori Development, and with Cabinet approval, they:

- approve all primary allocations
- determine the spectrum which is to be reserved for:
    - Social and cultural outcomes (broadcasting or telecommunications), or
    - Allocated for defence purposes.

The Minister of Communications is, however, where the primary authority resides as far as the Radiocommunications Act is concerned. The Chief Executive of MED may be directed by the Minister in regard to aspects of spectrum management contained in the Act. Any such direction given by the Ministry must be published in the Gazette. Previous orders include a cap being placed on the acquisition of 3G spectrum and on the 3.5 GHz bands – discussed further in section 4.5.5. We note, however, that the SMA is a unit within the Ministry of Economic Development and the Ministry is headed by a Cabinet Minister. There will presumably be opportunities for other aspects of government policy to be communicated to the SMA which are not published in the Gazette.

The Commerce Commission is jointly the Competition law authority (under the 1986 Commerce Act) and regulator of the telecommunications sector (under the 2001 Telecommunications Act). Merger rules and rules governing unilaterally anticompetitive practices by dominant firms, are administered by the Commerce Commission. Such rules apply to primary and secondary sales of spectrum.

Figure 6: Inter-Ministerial and agency spectrum management relationships



Source: Review of Radio Spectrum Policy in New Zealand (2005)

4.5.1.2 The 1989 frequency management regime

New Zealand was the first country to liberalise radio frequency management and use auctions to assign licenses. This was made possible with the adoption of far-reaching reforms contained in the 1989 Radiocommunications Act. The main features of the Act are described below:

- It enabled relatively technology and use neutral, freely tradable spectrum management rights to be allocated using market mechanisms;
- It required the registration of spectrum management rights, following a similar model to that used to register rights in real estate;
- It permitted the mortgage of spectrum management rights, and

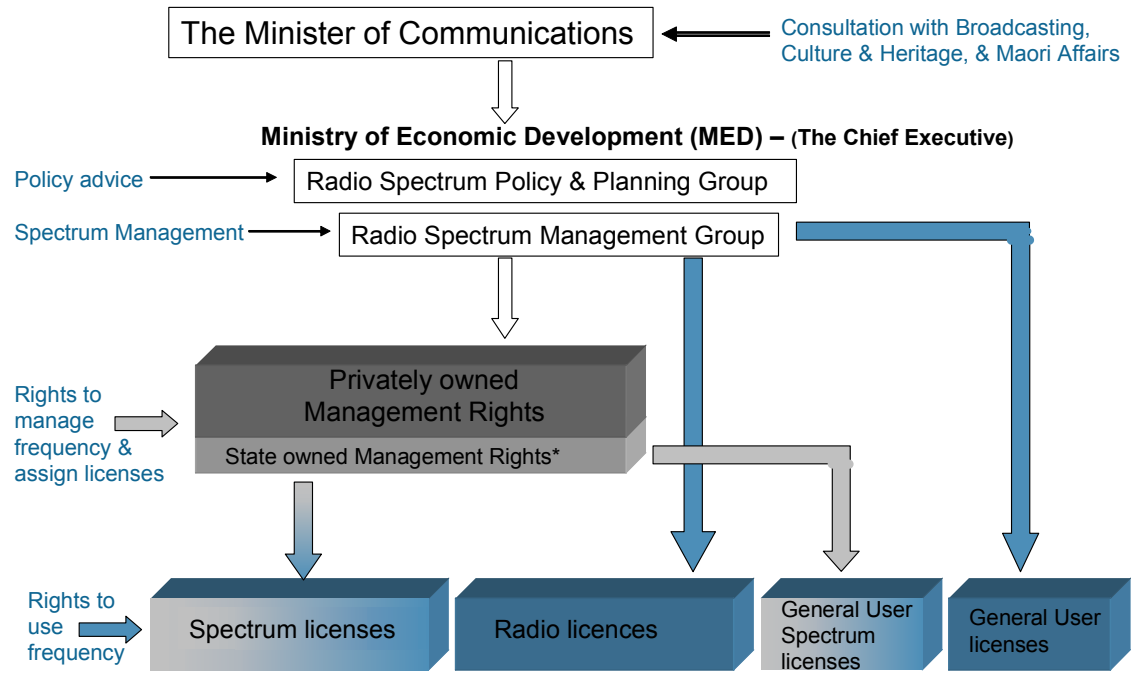
- It empowered spectrum management right holders to assign Spectrum Licenses under their management right.[216]

4.5.1.2.1 Overview of Management Rights and Licensing Systems

There are three licensing systems that apply to spectrum in New Zealand:

- The management rights regime (MRR);
- The radio license regime (RLR), previously known as apparatus licensing, and
- General user licenses (GULs)

Figure 7: The New Zealand Licensing Regime



Notes: *These are managed by the Chief Executive of MED through RSM. Radio licences, Spectrum Licences in State owned MRs, GULs and GUSLs, are all created by RSM.

Source: WIK-Consult

216 Review of Radio Spectrum Policy in New Zealand (2005), Ministry of Economic Development: p 11

4.5.1.2.1.1 The Management Rights Regime

The creation of licenses to spectrum management rights was pioneered in New Zealand. The MRR involves a two tier market based system for managing spectrum access through the creation of tradable property rights:

- Spectrum *management rights* represent the upper tier. Those acquiring these rights would have unencumbered use of a nationwide block of spectrum, including the sole authority to assign to others, *spectrum licences* within that block.

- Beneath management rights (MR) are *spectrum licences.* These can only be assigned under an MR, and may specify conditions of use, but are otherwise fully tradable.

Radio spectrum MRs are created by the State with the approval of the Cabinet. MRs define a technical envelope concerned with interference management.[217] They are not defined in terms of use although there have been claims that the interference targets that constitute the technical envelop, overly constrain the use/technology choices of licensees. MRs do not in themselves confer the right to make any transmissions. This is done through the MR holder allocating spectrum licenses, and is done using prescribed forms which must be registered with the RSM.

About 30% of the spectrum used for telecommunications or broadcasting has been converted to MRs. The Sate is the major MR holder of broadcast spectrum. RSA policy is to offer spectrum under the MRR system whenever appropriate, but as spectrum not already under the MRR is characterised as either heavily encumbered and considered not suitable for allocation as an MR, or has no competing demand, the 30% figured is not expected to change much in the next few years.[218]

MRs have to date only been allocated nationally. Rights holders are then free to assign spectrum licenses locally or regionally as they choose.[219] About 17% of spectrum below 30 GHz is controlled by MR band managers. There are 88 MR licenses. The Government holds 18 of these MRs, specifically where the use has been specified for

---

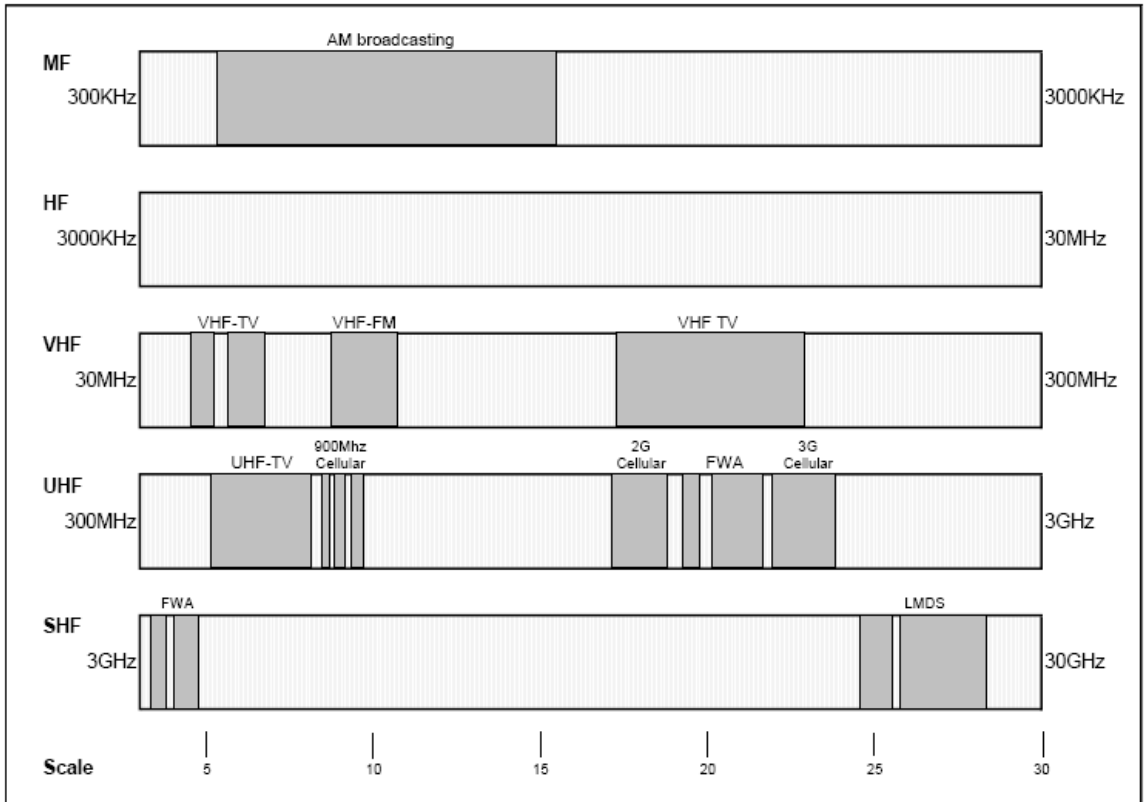
217 Each MR has a defined set of characteristics but those characteristics vary with the frequency and envisaged use of the MR e.g. Cellular FM broadcasting. Except for the edges of the MR, RSM is unconcerned with most interference parameters within an MR; this is the MR owners concern.

218 Spectrum congestion and interference problems in New Zealand are relatively less than for most countries. New Zealand has a population of 4 million and an area of 75% of Germany. Its closest neighbour, Australia, is 2,000 Km to the west. About two fifths of the population live in Auckland or around the Auckland region.

219 It has been argued by consultants that the allocation of these rights on a regional basis would aid in the development of regionally based innovative start-ups, and would likely enhance the tradability of spectrum on the secondary market (see Market Dynamics Pty Ltd and Moore Wright Associates Pty Ltd, (2003), *Allocation and Acquisition of Radio Spectrum*. Report to the New Zealand Ministry of Economic Development).

public broadcasting, and also where spectrum has been reserved for use according to culture and heritage objectives.

Figure 8: Spectrum Allocation under Management Rights



Source: "Review of Radio Spectrum Policy in New Zealand" (2005), Ministry of Economic Development.

Except for frequencies reserved to meet specific social, cultural or security obligations, MRs, and Spectrum Licences that are held under a Crown-retained MR, are allocated by public spectrum auction or tender.[220]

In some cases MRs have been allocated along with sitting incumbents who have been protected from eviction for at least the period of their license.

220 In practice, auctions are used whenever there is excess demand for an MR. New Zealand used 4 different auction mechanism starting with a Second Price Sealed Bid Tender, replaced by a First Price Sealed Bid Tender, replaced by a Fax-based Simultaneous Ascending bid Auction, and the method presently used – Internet-based Simultaneous Ascending bid Auctions.

In practice MRs appear to have been acquired by those who want to use the spectrum to transmit rather than to run a business managing licensees (tenants) operating on the block of spectrum.

4.5.1.2.1.2 Types of license which allow radio transmissions

There are three types of license which enable licensees to make transmissions:

- Spectrum Licenses
- Radio licenses
- General users licenses

4.5.1.2.1.3 Radio Licenses

The RLR is an administrative system providing for the licensing of sites and transmitters.[221] Under this system licences usually specify the equipment and methods to be used. Licences must be renewed yearly. The majority of radiocommunications services (both mobile and fixed) are licensed as Radio Licences i.e. the transmitters are licensed and the types of services that can be provided are also specified. Radio Licenses are issued under the delegated authority of the Chief Executive of the MED. The remainder of radiocommunications and broadcasting services are licensed under a tradable spectrum rights framework in accordance with Part II of the Act.

4.5.1.2.1.4 Spectrum Licenses

Spectrum Licenses are issued by MR holders. Spectrum Licenses involve the creation of long term and tradable property rights for the use of the radio spectrum. Licence rights granted under this scheme confer the right to cause radio transmissions and the right for those transmissions to be freely receivable (without interference). Spectrum licenses are not use specified, except where the MR holder is the State. In this case the MED as its agent has not so far allowed a use change from the original Spectrum License assignment. As MRs are limited to 20 years, Spectrum Licenses are also limited to a maximum of 20 years.

4.5.1.2.1.5 General User Licensing and General User Spectrum Licenses

Under the provisions of General User Licences (GULs), various uses of radio spectrum are exempt from individual licensing and licence fees. The bands covered by GULs are commonly known as “spectrum public parks”, and sometimes as “class licence bands”.

---

221 The type of licensing is not ‘Type Approval’, but the recording of transmitters in place.

General User Spectrum Licences (GUSLs) are granted pursuant to section 55A of the Radiocommunications Act 1989. GUSLs have only been created in MR's held by the State in order to allow free and easy access to spectrum for low powered devices. The Chief Executive of MED assigns GUSLs on behalf of the state (Crown).

For GULs and GUSLs, certain classes of radio transmitter are able to be used without the need for the transmitter to obtain a licence in his or her own name.

The main stages of Management Right and license allocation are shown diagrammatically in Annex 4.5.1.

4.5.1.2.2 Broadcasting and Defence

4.5.1.2.2.1 Broadcasting

Responsibility for policy on non-commercial broadcasting, including *New Zealand On Air*, is with the Ministry for Culture and Heritage. Māori broadcasting, including Te Māngai Pāho (Māori Broadcasting Funding Agency), is the responsibility of Te Puni Kōkiri (the Ministry of Māori Development). The Ministry for Culture and Heritage also has responsibility for the Broadcasting Standards [content] Authority.

Not-for-profit broadcasting Radio Licences are awarded in certain reserved bands i.e. the HF (short-wave band) and the UHF-TV frequencies in the reserved block (Māori & Non-commercial). The frequencies assigned in this range are engineered by RSMG.

Fees relating to non-commercial broadcasting spectrum apply on a service by service basis. Within each service a fee is payable per location (irrespective of the number of frequencies applying). Fees are applicable to all new services. Spectrum is assigned to such services by administrative rather than commercial means, incurring only a cost-recovery fee.

Organisations that wish to engage in commercial broadcasting will have to obtain suitable spectrum via auction.

4.5.1.2.2.2 Defence

The State has retained ownership of certain rights to spectrum bands and products used to meet defence obligations. The 235-405 MHz range is reserved for defence purposes, although with NZMD's approval some of this frequency has been assigned to non-military uses including for aircraft navigation and short-range civilian devices such as automatic garage doors. The 235-405 MHz range is administered by MED with Defence operating under a technically non-specific radio license. MED is, however,

debating the possibility of moving this spectrum to Defence under a management rights license.

4.5.2 Liberalisation of frequency usage

4.5.2.1 Main changes in the frequency user plan in recent years

The main policy drivers have been:

- To get broadband out to schools in rural areas
- To convert Radio Licenses to Spectrum Licenses

Broadcasting spectrum has changed little except for the introduction of 'public park' broadcast space. The Ministry has opened a low power FM space (less than ½ Watt) in the 88-108 MHz range to General User status. There have been broadband auctions of Management Rights at 2.3 GHz, 3.5 GHz, and 2.5-2.7 GHz – all aimed at broadband and other higher bandwidth services, including 3G.

4.5.2.2 Spectrum Partition

Spectrum that is allocated to private spectrum MRs is not assigned to any particular use. MRs are able to decide what they will do with the spectrum, limited only by the interference conditions that apply to the MR. Assuming the MR holder's behaviour is not being influenced by market power, such as could arise if too much spectrum is concentrated in too hands, the rights manager has an incentive to assign the spectrum to the highest value user.

We understand that much of the usable spectrum in New Zealand remains unallocated or is allocated to the State as MRs. In many cases the State's policy for allocating this spectrum to licensees is to auction Spectrum Licenses. These licenses are use-specific and typically contain certain service requirements. In other cases the spectrum is assigned under a Radio License. All spectrum that falls under the RLR is specific to a device (which must be registered), and to a specific use. Thus, for spectrum held under State MRs, or for spectrum assigned under RLR, the spectrum is use specific and/or assigned with a high degree of technical specification. Spectrum which is held by the State or assigned as radio licenses thus appears to be more or less partitioned from spectrum that is allocated to the private sector MRs which is relatively technology and use independent. The State's MRs are mainly in the broadcasting spectrum, although government also managers some 'telecommunications' spectrum.

Spectrum that is under government control includes:

- 521-1 612 kHz MF-AM Sound Broadcasting under MR regime (MR15) 525-1705 kHz under Ministerial Directive
- 44-51 MHz VHF television broadcasting under MR regime (MR47) Radio Spectrum Auctions
- 54-68 MHz VHF television broadcasting under MR regime (MR48)
- 88.8 – 106.63 MHz VHF-FM Sound Broadcasting (band II) Under MR regime (MR143) 88-108 MHz under Ministerial Directive
- 174-230 MHz Under MR regime (MR49) VHF Television (Band III) Radiomicrophones
- 1710 - 1880 MHz Private Management Rights - suitable for 2nd and 3rd Generation cellular technologies and fixed services.
- 1920 - 1980 MHz Private Management Rights - suitable for 2nd and 3rd Generation cellular technologies and fixed services.
- 2200 - 2300 MHz Private Management Rights - suitable for FWA and fixed services.
- 2300 - 2396 MHz 12 x 8 MHz Private Management Rights suitable for MMDS, FWA or Fixed services
- 3410-3487 MHz Under MR regime Crown and private MRs
- 3510-3587 MHz Under MR regime Crown and private MRs

Present New Zealand Band Usage: fixed service use between 30 and 1000 MHz

4.5.2.3 Spectrum reserved for public usage (military, broadcasting etc.)

4.5.2.3.1 Defence

- Aeronautical mobile (OR) >30 MHz
- 230 MHz – 328.6 MHz
- 335.4 MHz – 399.9 MHz

Information about Defence usage is not published in the Radio Spectrum Usage Table.

4.5.2.3.2 Broadcasting

- AM and FM Radio broadcasting bands
- VHF and UHF television broadcasting bands

See Figure 8 for a visual presentation of frequency held under broadcast Management Rights.

- 521-1 612 kHz, MF-AM Sound Broadcasting under MR regime (MR15)
- 525-1705 kHz under Ministerial Directive
- 44-51 MHz VHF television broadcasting under MR regime (MR47)
- 54-68 MHz VHF television broadcasting under MR regime (MR48)
- 88.8 – 106.63 MHz VHF-FM Sound Broadcasting (band II). Under MR regime (MR143).
- 88-108 MHz under Ministerial Directive.
- 100 - 106.63 MHz extension to FM sound broadcasting band. Under MR regime.
- 174-230 MHz Under MR regime (MR49) VHF Television (Band III), Radiomicrophones
- UHF Television (BAND IV) 28 x 8 MHz Channels in 7 Blocks under the Management Right Regime
  518 - 550 MHz: Block 1
  550 - 582 MHz: Block 2
  MR1
- UHF Television (BAND V) 582 - 614 MHz: Block 3 Māori Television Service MR195
- UHF Television (BAND V)
  646 - 678 MHz: Block 5
  678 - 710 MHz: Block 6
  710 - 742 MHz: Block 7
  742 - 774 MHz: Block 8
  774 - 806 MHz: Block 9
  Radiomicrophones

4.5.2.4 Licence exempt frequency bands (common usage)

Frequency has been allocated or is to be allocated in the following range for general users.[222]

Wireless LANs

- 915 to 921 MHz (SMU still considering)
- 5150 to 5250 MHz
- 5250 to 5350 MHz
- 5470 to 5725 MHz (SMU still considering)
- 5725 to 5875 MHz

Radio Frequency Identification Devices

- < 500 MHz
- 9 to 30 kHz
- 860 to 960 MHz (SMU still considering)
- 2400 to 2483.5 MHz

Medical Telemetry

- 402 to 406 MHz
- 869 to 870 MHz

Very Low Power Audio Senders

- 88 to 108 MHz

Audio Video Senders

- 614 to 646 MHz

Ultra Wideband Applications

- UWB

---

222 http://www.med.govt.nz/rsm/planning/srd/submissions-summary/submissions-summary.pdf

Low Power FM Broadcasting Short Range Devices

Additional Information on the operation of broadcasting stations under the Low-Power FM Broadcasting (LPFM) General User Radio Licence (GURL)

- Radio Microphones 174 - 230 MHz:
- Radio Microphones 646 - 806 MHz:

Other General User Licences:

- Aeronautical Purposes
- Visiting Amateurs
- Citizen Band Radio
- Cordless Telephones
- Differential GPS (Itinerant)
- Emergency Transmitters
- Fixed Radio Link Devices
- Mobile satellite
- Maritime

4.5.2.5 Registration

The Register of Radio Frequencies has always been open for public search. However, until 2001 this database only contained records of MRs (both State and privately held) and the associated Spectrum Licences. The Ministry had historically maintained a separate non-public Radio Licence database which constituted the bulk of its licence records. As the majority of the usable spectrum is managed via the RLR system, until recently the public system only covered a minority of the spectrum in use.

The amended Act provided for a new merged system where all except personal details and those relating to radiocommunications affecting the security or defence of New Zealand, are now publicly available online. The new system about to be implemented, is known as the Spectrum Management and Registration Technology (SMART). It allows members of the public to do the following, online:

- search the Register of Radio Frequencies in real time;
- apply and pay for a radio or spectrum licence;
- pay engineering and annual fees;
- engineer a licence externally – externally engineered licences will require a policy check only;
- register legal instruments, and
- modify contact details.[223]

Two important things the computerised registration system facilitates are (i) the trading of spectrum rights and (ii) spectrum/license engineering. The system is managed by the Registrar of Radio Frequencies, whose task is to maintain the register for use by the public.

4.5.2.6 The Reallocation of Commercial Spectrum Rights at Expiry

In December 2004, the Cabinet agreed a framework for renewal of licenses for MRs. It rejected a call for rights to be awarded in perpetuity and instead established a system where there was an right of renewal following Cabinet approval. While such structural arrangements raise concerns, the Cabinet's involvement appears to be non-political, The licensee will be asked to pay a fee (discussed in section 4.5.6) for this renewal.

In December 2004 the Government announced a decision on renewal of commercial UHF television licences. The government decided on a renewal time of 10 years rather than 20 years because of the likelihood of technology changes, including digital television.

4.5.2.7 Future Liberalisation Plans

Below we outline plans regarding future spectrum use according to 3 classes:

- Fixed Services
- Mobile Services
- Space Services[224]

---

223 Review of Radio Spectrum Policy in New Zealand, pp12-13.

Table 35: Future spectrum use – Fixed Services

Class of Fixed service	Nature of Change	Change for 2001-2006	Change for 2006-2011
Below 30 MHz	Continuous Improvement	Small reduction in number of licences and some new short range devices (SRD) applications	Introduction of HF digital linking likely with frequency congestion problems below 10 MHz.
30 MHz TO 1000 MHz.	Continuous Improvement	Continued expansion of analogue systems with some new digital services being brought into use.	Continual upgrading of existing services to digital formats in particular in support of ICT needs.
Above 1000 MHz	Significant technology changes.	Emphasis will be on higher data rates and higher frequency bands. Introduction of new wireless local network technologies	New FS requirements below 3 GHz in support of TVOB, continued expansion of FWA and the microwave main trunk capacity.
Low Power Applications (SRD)	Large expansion in numbers with a trend towards spread spectrum techniques.	Increase in usage is expected until interference restricts performance.	Some rationalisation of SRD activities may be required in face of demand and lack of spectrum.

224 FUTURE SPECTRUM USAGE, A FORECAST OF TECHNICAL ISSUES FOR THE PERIODS 2001-2006 2006-2011: Ministry of Economic Development.

Table 36: Future spectrum use – Mobile Services

Class of Mobile service	Nature of Change	Change for 2001-2006	Change for 2006-2011
Aeronautical Mobile	Some technology changes within existing spectrum	Continued HF dependence with some digital system augmentation. Expansion of MSS usage and new wide band MSS usage for IP uses. Little change to VHF services	Some reduction in HF dependence due to MSS take up leading to MSS congestion issues. Proliferation of wide band MSS IP usage. Some rationalisation of VHF usage
Land Mobile other than emergency services	Below 30 MHz little change, Above 30 MHz change to more trunked and digital services	Little change below 30 MHz and with conventional two frequency services. Considerable growth in trunked services.	Some experimental HF digital services with some migration to digital services in the VHF and UHF bands.
Emergency Services	Gradual national and international harmonisation	Domestic harmonisation of analogue services with the start of digital services	Start of the international harmonisation process, along with growth, of digital services.
Maritime Services	Slow uptake of digital and satellite technologies	Little change to HF requirements with some MSS and VHF growth. Reliance on cellphones for close to shore operations will grow.	Some new digital HF systems are expected as well as high MSS growth.
Cellular Radio.	Quantum leaps to advanced digital platforms	Significant technology changes within the existing 800/900 MHz cellular bands.	Start of 3G services at 2 GHz as well as upgrades at 800/900 MHz.
Low power mobile devices.	Technology shift including spread spectrum with a huge increase in numbers.	Large expansion in existing users in support of cordless and Wireless LAN operations. Major interference problems are to be expected.	New global applications will come into use that could cause problems to existing users in the same band.

Table 37: Future spectrum use – Space Services

Class of Space Service	Nature of Change	Change for 2001-2006	Change for 2006-2011
Geostationary Fixed Satellite	Constant growth and improvement	The growth in new networks will be linked to broadband data applications. There will also be upgrades of existing networks using new digital techniques to improve efficiency.	Growth in the number of high bandwidth, high power of networks is expected in support of ICT activities.
Geostationary Mobile Satellite	Constant expansion of global and regional networks to meet the demand.	It is expected that the MSS bands will be full by the end of this period.	Introduction of new bands and sharing arrangements.
Non Geostationary Fixed Satellite	Implementation of this service	Some experimental networks will be launched this period.	The bringing into service of NGSO FSS constellations, is expected in 2008.
Non Geostationary Mobile Satellite	Improvements and demise of some existing networks and some new entrants.	The continuation of the commercial sorting out of these networks can be expected this period.	NGSO MSS will increase bandwidth and power to challenge NGSO FSS operations.

4.5.3 Frequency trading

4.5.3.1 Legal and operational framework

Trading in management rights and spectrum licences has been permitted since the passage of the 1989 law. Trading is not permitted for Radio Licenses, and clearly is not relevant to GULs since these are not allocated to any individual or organisation. Spectrum MRs held by the State are use specific and carry other obligations, such as

those that apply to public broadcasting. Such licenses would therefore appear to be significantly less tradable compared to spectrum held in private MR bands.

4.5.3.2 Experience with spectrum trading

The has been very little activity in the secondary market for telecommunications spectrum. Some rationalisation occurred regarding MDS spectrum, with most MRs now owned by TCNZ (the incumbent), with TelstraClear being the predominant owner of the LMDS spectrum. The MDS and LMDS spectrum is however, apparently largely 'idle'. The allocated 3G spectrum is also largely unused, although TCNZ is due to begin a 3G service in the near future. Two other firms have voiced their intention to offer 3G services. Telstra sold its GSM spectrum to Bell South which later sold its New Zealand mobile business to Vodafone. The original buyers of LMDS 28 GHz spectrum have all sold it on.[225]

The part of the spectrum in which MRs have been allocated has been limited to that used by commercial broadcasting and telecommunications. The level of trading has been low and mainly confined to FM and AM radio broadcasting where there has been a great deal of consolidation through takeover. The initial liberalisation of spectrum resulted in a considerable increase in the number of broadcasting licenses. This appears to have resulted in the price radio broadcasters could charge for advertising declining sharply leading to consolidation which resulted in 15 stations being owned by two operators, with 84% of the listening public.[226] Trades have not involved a change in use.

The 2 GHz band had existing users but was nevertheless auctioned in several MR lots, with existing users being given 2 years notice to vacate the band, or they could compete at auction for the right to stay for a further 3 years. Following the auction, new management right holders bought out some sitting incumbents, while others negotiated rights to extend their stay.

Several possible reasons have been suggested for the low level of trading, with each likely to have had some influence. These are outlined below:

- Initial allocations may have been efficient and market and technology changes have not been such as to alter this;
- Management rights in New Zealand are not specifically designed to be traded as they are in Australia. They are allocated nationally not regional, resulting in a smaller number of potential buyers. Indeed, it appears that there are more

---

225 Analysys, •Econ and Hogan and Hartson, Study on the conditions and options in introducing secondary trading of radio spectrum in the European Union: p 50.

226 Ibid p 54.

geographic license transfers than transfers in national management rights, suggesting that if MRs were regional there would be more trades than is occurring under the present system.[227] Moreover, licences in New Zealand are tailored to specific users on a case-by-case basis. This would appear to make a change in use difficult, reducing the liquidity of the spectrum. A recent decision, to assign spectrum for 3.5 GHz fixed wireless access by means of area licences based on administrative boundaries may facilitate increased flexibility;

- In many cases there is unused spectrum available from RSMG;
- MRs have been taken up by firms wanting to transmit on the frequency themselves, i.e. we gather most spectrum licenses are held by rights holder.[228]
- Allocated spectrum differs in terms of license period termination dates and the technical parameters relating to interference. This tends to make it impractical to combine rights or licenses;[229]
- A 20 year license period will result in the license value falling over time, such that any buyer on the secondary market would have a shorter period within which to recover his or her investment in the spectrum and perhaps more importantly, would have a shorter payback period in which to recover associated network investments. This will reduce spectrum trading opportunities. It has recently been agreed to allow license renewal 5 years before expiry if Cabinet approval is given. In cases where cabinet approval is not given no compensation is envisaged;
- The pool of tradable rights is more limited than it might be due to the substantial amount of spectrum for which the MRs are allocated to the State, and licenses it issues are usually use specific.

4.5.3.3 Frequency which is open to trading

All spectrum held under a private MRs and some which is held by State MRs, is tradable. RLs are not tradable.

---

227 This point was noted by consultants Market Dynamics Pty Ltd and MooreWright Associates.

228 The lack of firms operating a spectrum MR business may in part be explained by the low level of demand for spectrum in New Zealand and the existence of scale economies in setting up and operating an MR business.

229 Where licenses are defined according to *n* dimensions, *n*-1 of those dimensions need to be the same in order for spectrum to be joinable. This is not the usual case in New Zealand. This point was noted by consultants Market Dynamics Pty Ltd and Moore Wright Associates.

4.5.4 Interference issues

4.5.4.1 Accreditation

Accredited private persons are permitted to engineer Spectrum Licences in MR bands, and also Radio Licences in the fixed and land mobile service categories. They must then log onto SMART and enter the licence details. The External Engineering and Certification system allows most licence applicants to choose who will perform the engineering certification of their licence application, with most now being engineered privately.[230]

4.5.4.2 Interference management regime

Spectrum Licenses are not concerned with the equipment or transmission methods used. Rather, they define a technical envelope within which the licence holder is free to operate. If there is interference it is the concern of the management right holder if it is occurring within bands the management right holder has been allocated.

There is a three-stage test for interference practised in New Zealand for spectrum held under Management Right. The test checks whether:

(1) If the emission is in the right holder's band and area then no further action is required by the authorities (It is up to the right holder to address the problem), otherwise the authorities will check whether:

(2) The emission is below a specified background noise level. If it is then no further action is required, otherwise this would imply that:

(3) A third party user suffers from interference, and in this case the RSMG will take up an interference problem as it emanates from outside of the spectrum allocated to the right holder.

Valletti considers that this approach can work in a market for spectrum because it is not too difficult to identify the source of interference problems. He notes that when this is not true, a case could be made for a third role for the regulator; as a co-ordinator rather than an arbitrator.[231]

---

230 The New Zealand system does not use standard "building blocks" as in Australia. Rather area and frequency parameters are defined on a case-by-case basis for lots that are to be auctioned. Licensees are then able to partition/disaggregate spectrum as they wish subject to meeting specified overall interference constraints.

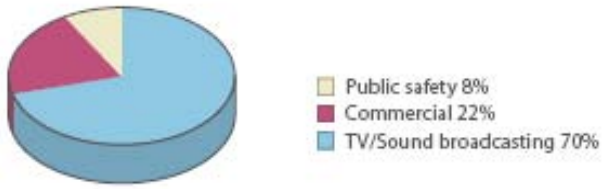
231 Tommaso Valletti (2001), "Spectrum trading", *Telecommunications Policy*, 25 pp 655–670.

Spectrum Licenses provide rights or entitlements to transmit. Consultants have criticised the interference management regime for not focussing on protecting the rights to receive. The consultants consider that usual spectrum management practice licences transmitters to permit their operation, but with the primary goal of protecting receivers. In their view a licensing system which focuses on creating rights to transmit is not consistent with effective spectrum management. They recommend that interference management focuses on the protection of receivers, especially their boundary right.[232]

New Zealand operates a duel system of registration of devices operating under management rights which also define license interference avoidance obligations. The later may be considered necessary if the courts are thought likely not to provide especially efficient solutions to interference disputes.

In 2003-04 there were 1138 interference complaints, 70% required a visit to identify the cause. Interference cases completed are shown in Figure 9.

Figure 9: Interference Cases Completed by RSMG in 2003-04



4.5.5 Competition Issues

4.5.5.1 The Role of Competition authorities

In allocating spectrum, the Government traditionally relied on the Commerce Act to prevent undue market power from developing through the acquisition of spectrum at auction or through the secondary market. Section 47 of the Commerce Act (the competition law) prohibits acquisitions of business assets that are likely to result in a *substantial lessening of competition* in a market.[233] The Radiocommunications Act deems MRs and Spectrum Licences to be assets of a business for the purposes of section 47.

232 Market Dynamics Pty Ltd and Moore Wright Associates Pty Ltd, (2003).
233 The threshold has recently been lowered from *dominance*.

Historically, competition law in New Zealand defined dominance with the same words as the European Courts have used, however, in practice the interpretation of dominance has involved a significantly higher threshold than has been adopted in the EU. The “dominance” threshold in New Zealand competition law was recently amended to a “substantial lessening of competition”, which are the same words as used in Australian Competition law, and which in practice has been interpreted by Australian courts in a way that is virtually identical to the “dominance” threshold used in the EU.

4.5.5.2 Ministerial directions

The Ministry’s advise until recently was to rely on the Merger rules of the Competition law to prevent any firm attaining a dominant position through spectrum acquisition. If anything needed changing to accomplish this it would be the market power threshold in the Merger section of the competition law.

In the event Government chose to reduce the market power threshold bringing it in line with the Australian competition law, and to adopt spectrum caps in certain cases.[234]

Following takeover activity in private radio broadcasting, which ended with two operators ended up with 84% of the listening public (as was outlined in section 4.5.3.2), the Government decided to introduce spectrum cap of 15 MHz for the 2 GHz band, which would run for 3 years. The Government also decided to withhold from allocation 2 x 15 MHz of a total of 2 x 60 MHz and designate this as a special block, with reserved preferential bidding for Māori, leaving spectrum sufficient for a maximum of 3 licensees. In January 2004 the Minister announced the Government's decision to continue the 2 GHz spectrum cap until May 2007 in order to facilitate future competition in the market for 3G mobile services.

The 2002 auction of the 3.5 GHz spectrum band was for 9 management right pairs of 7 MHz, and for spectrum licenses in the two further management right pairs to be retained by the State. A spectrum cap was applied for the 9 private management rights which limited a bidder to win 2 x 21 MHz.[235] This was to ensure there would be at least three successful bidders. The cap only lasted 1 year.[236] Competition law was assumed to provide the most effective means of ensuring effective competition once the cap ended.

A form of spectrum cap also applied in Spectrum License auctions in the two State retained MR bands. These Spectrum Licenses were constructed for specific geographic

---

234 See http://www.med.govt.nz/rsm/spp/3g-spectrum-cap/index.html

235 http://www.med.govt.nz/rsm/auctions/auction05/a5catalogue-15jul02.pdf

236 Consultants Market Dynamics and Moore Wright Associates considered that the cap imposed an additional cost on new entrants by necessitating base station deployment as opposed to additional radio deployment to satisfy capacity needs.

areas.[237] Applicants were not eligible if they had access to alternative spectrum rights, such as spectrum in the 1098, MDS or 3.5GHz bands through direct ownership or an association.

4.5.6 Economic pricing of frequencies

4.5.6.1 Allocation and recurring fees

MRs are allocated by auction. They are also tradable on the secondary market. In bands that are 'reserved' by Government, the rights are held by the State, with use specified Spectrum Licenses usually assigned by auction. MR holders do not pay any additional fees. All their fees are upfront.

There is an annual fee payable to the Chief Executive of the Ministry of Economic Development on all registered licences (Spectrum and Radio Licenses). The fee payable by registered licensees for each frequency is set out in the Radiocommunications (Fees) Regulations. There are different fees for different service classes, and within each class the fee may vary according to the maximum transmission power (E.I.R.P.) permitted by a given licence. These fees can be seen in Table 38.

The RSMG's annual costs and the planning costs of RSPP are met by these fees. Fees are allocated roughly in accordance with cost-drivers.[238] Broadcasters operating according to Government social/cultural guidelines, and not for profit broadcasters, appear to face only licence fees relating to transmission power.[239] Fees are not payable by those operating under GULs. Fees can be waived for a limited range of reasons, including where existing users are re-farmed. The present fee structure followed a public consultation process and resulted in a number of changes compared to previously.

Licence fee revenue accrues to the government, which keeps a year-to-year memorandum account so that revenue and costs can be balanced in the long term. The new fee schedule appears in Table 38.

RSM's 2002-2003 budget was $11.3 million. Following organisational restructuring in that year it was reduced to $9.5 million and, in the 2004-2005, to $8.7 million, of which $7.2 million is recovered in fees and charges.

---

237 See Ministry of Economic Development, Radio Frequency Auction No. 5, Auction Catalogue, 15 July 2002, available at http://www.med.govt.nz/rsm/auctions/previous.html

238 See Radio Spectrum Management (RSM) Fees Review 2004, at http://www.med.govt.nz/rsm/formsfees/review/costingmodel/costingmodel.pdf

239 "Review of Radio Spectrum Policy in New Zealand" (2005), *Ministry of Economic Development*, p 42

Table 38: Fees Payable to the Chief Executive of Ministry of Economic Development for Radio and Spectrum Licenses from 1 July 2005 (GST inclusive)

Class of Licence Code	Class of Radio or Spectrum Licence	Engineering Certification Fee ($)	Annual Administration Fee ($)
	LAND MOBILE SERVICES (Radio Licences only)		
	Repeaters (Two-frequency)		
LR1	Multiple repeaters on a common channel throughout New Zealand with bandwidth 12.5 kHz or less	400	1300
LR2	Multiple repeaters on a common channel throughout New Zealand with bandwidth more than 12.5 kHz	400	2500
LR3	Single repeater 7 dBW (5 watts) e.i.r.p. or less	400	150
LR4	Single repeater more than 7 dBW (5 watts) e.i.r.p.	400	250
	Simplex (Single frequency)		
LS1	Multiple transmitters on a common frequency throughout New Zealand with bandwidth 12.5 kHz or less	400	800
LS2	Multiple transmitters on a common frequency throughout New Zealand with bandwidth more than 12.5 kHz but less than or equal to 25 kHz	400	1500
LS3	Multiple transmitters on a common frequency throughout New Zealand with bandwidth more than 25 kHz	400	2000
LS4	Other transmitters (per licence)	400	100
	Paging:		
LP1	Multiple transmitters on a common frequency throughout New Zealand	400	2500
LP2	Transmitters 7 dBW (5 watts) e.i.r.p. or less	400	100
LP3	Transmitters more than 7 dBW (5 watts) e.i.r.p. but less than or equal to 14 dBW (25 watts) e.i.r.p.	400	200
LP4	Transmitters more than 14 dBW (25 watts) e.i.r.p.	400	400
	FIXED SERVICES (Radio Licences only – per transmitter)		
FP1	Point-to-point - Frequency less than 1 GHz	400	75
FP2	Point-to-point - Frequency more than 1 GHz	400	200
FM1	Point-to-Multipoint and Multipoint-to-Point (Note 3)	400	100
	BROADCASTING SERVICES (Radio and Spectrum Licences)		
	Sound Broadcasting below 30 MHz (MF/HF)		
BA1	Transmitters less than 30 dBW e.i.r.p.	850	200
BA2	Transmitters 30 dBW e.i.r.p. or more but less than 36 dBW e.i.r.p.	850	900
BA3	Transmitters 36 dBW e.i.r.p. or more but less than 40 dBW e.i.r.p.	850	1800

Class of Licence Code	Class of Radio or Spectrum Licence	Engineering Certification Fee ($)	Annual Administration Fee ($)
BA4	Transmitters 40 dBW e.i.r.p. or more	850	3500
	Sound Broadcasting above 30 MHz (VHF/UHF)		
BF1	Transmitters less than 10 dBW e.i.r.p.	1100	200
BF2	Transmitters 10 dBW e.i.r.p. or more but less than 20 dBW e.i.r.p.	1100	300
BF3	Transmitters 20 dBW e.i.r.p. or more but less than 30 dBW e.i.r.p.	1100	500
BF4	Transmitters 30 dBW e.i.r.p. or more but less than 40 dBW e.i.r.p.	1100	1700
BF5	Transmitters 40 dBW e.i.r.p. or more	1100	3000
	Television Broadcasting below 300 MHz (VHF)		
BV1	Transmitters less than 10 dBW e.i.r.p.	2000	100
BV2	Transmitters 10 dBW e.i.r.p. or more but less than 30 dBW e.i.r.p.	2000	900
BV3	Transmitters 30 BW e.i.r.p. or more but less than 50 dBW e.i.r.p.	2000	3300
BV4	Transmitters 50 dBW e.i.r.p. or more	2000	18000
	Television Broadcasting above 300 MHz (UHF)		
BU1	Transmitters less than 10 dBW e.i.r.p.	900	100
BU2	Transmitters 10 dBW e.i.r.p. or more but less than 30 dBW e.i.r.p.	900	150
BU3	Transmitters 30 dBW e.i.r.p. or more but less than 40 dBW e.i.r.p.	900	250
BU4	Transmitters 40 dBW e.i.r.p. or more but less than 50 dBW e.i.r.p.	900	500
BU5	Transmitters 50 dBW e.i.r.p. or more	900	1500
	OTHER SERVICES (Radio and Spectrum Licences)		
	Maritime and Aeronautical (Radio Licences only)		
OM1	Ship, aircraft or mobile	-	100
OM2	Land (including Maritime Coast stations)	350	100
OM3	Repeater (two-frequency)	400	200
	Amateur (Radio and Spectrum Licences)		
OA1	Beacon, Repeater or Fixed Link	300	50
	Radiodetermination (Radio Licences only)		
OR1	Radiodetermination (including radiolocation and radionavigation)	400	200
	Satellite (Radio Licences only)		
OS1	Fixed-satellite service (per transponder accessed)	550	200
OS2	Other satellite services (non-shared with Fixed Services)	550	150
OS3	Other satellite services (shared with Fixed Services)	550	1200

Class of Licence Code	Class of Radio or Spectrum Licence	Engineering Certification Fee ($)	Annual Administration Fee ($)
	Telemetry and Telecommand (Radio Licences only)		
OT1	Telemetry and Telecommand (including space telecommand)	200	50
	Reception Protection (Radio Licences only)		
OP1	Co-channel reception protection from terrestrial transmissions	550	1400
	Miscellaneous Services (Radio and Spectrum Licences)		
OZ1	Transmitters less than 20 dBW (100 watts) e.i.r.p.	200	100
OZ2	Transmitters 20 dBW (100 watts) e.i.r.p. or more but less than 30 dBW (1000 watts) e.i.r.p.	200	200
OZ3	Transmitters 30 dBW (1000 watts) e.i.r.p. or more	200	300

Notes to Fees
1. From 1 December 2005, payment of annual fees by due date, by direct debit or credit card through a Ministry of Economic Development web page service, will be subject to a 10% discount.
2. Engineering certification fees apply to both new licence applications, and any re-engineering required in regard to existing licences.
3. For the Fixed class of licence FM1, the engineering certification fee includes the first 4 transmitters. Each additional transmitter will attract an engineering fee of $50.

The State faces annual fees for its licensed spectrum as contained in Table 38, but does not pay a lump sum amount for its MRs. This spectrum is reserved and not purchased at auction. There is thus rather little incentive for the State to acquire and use this spectrum economically. Given that it holds a large amount of valuable spectrum as MRs, correcting this situation may well provide the best opportunity for New Zealand to improve its management of the spectrum resource. At present there is a lack of consistency and transparency in spectrum management, especially in regard to rights held by government compared to non-government entities.

Spectrum access fees may be charged by private MR holdings although the level and structure of such fees are for them to determine. Note however, that private MR holders allocate most of the spectrum as Spectrum Licenses to themselves.

4.5.6.2 Renewal fees for License

In mid 2003, following a public consultation, Cabinet agreed that the reallocation of commercial MRs should:

- Occur 5 years before expiry for a further 20 years, subject to review on a case-by-case basis to ensure consistency with New Zealand's international radio obligations and with the general objective of maximising the value of the spectrum to society as a whole;

- The State should receive a fair financial return for the use of spectrum in the future period; and

- That spectrum rights be reallocated to existing rightholders based on a price setting formulae that estimates the market value of the rights, with the proviso that if existing right-holders do not wish to pay the price requested the spectrum would be reallocated by auction.

Fees for the renewal of licenses are to be determined according to the following a price setting formula

$$V2 = (1+z)^n \times V1$$

where:

V1 = original acquisition price of spectrum right
V2 = renewal price
z = population growth factor
n = term of right (maximum 20 years).

The price-setting formula calculates the renewal price for a spectrum right (V2) by taking the acquisition price (V1) and applying a compound growth factor ('z'). The growth factor represents an estimate of how much the net cashflows from the use of rights in the renewal period compare to the net cashflows from the current period. The 'z' value is based on population growth by license area averaging the results of two different but equally valid econometric methods applied by consultants.[240]

4.5.6.2.1 Fees paid by Defence and Broadcasting

We gather NZDF, public broadcasters and special interest broadcasters, pay administrative fees as do other Radio Licensees. There is support from MED to assign to NZDF an MR for spectrum in the 230-400 MHz range.

---

240 Various reports on this topic by consultants and the Ministry can be found at: http://www.med.govt.nz/rsm/publications/dps.html

4.5.7 Implications of frequency trading and liberalisation for selected areas

4.5.7.1 FWA

4.5.7.1.1 Private bands and State reserved bands

FWA is available in a number of frequency bands which have been allocated in the form of MRs, including spectrum in the 2 GHz and 3.5 GHz bands (known as '1098 bands' and 'MDDS bands').

In December 2001 Cabinet agreed to auction nine management right pairs of 9 MHz in the 3.4 - 3.6 GHz ("3.5 GHz") spectrum band. Two further management right pairs were created and retained by the State. Cabinet agreed that licences in the retained pairs were to be made available for specific geographic areas and would be specified for FWA services. Priority was given when granting licenses in State retained MRs to Project PROBE proposals.

Project PROBE (Provincial Broadband Extension) was developed jointly by the Ministry of Education and MED in order to foster the roll-out of high speed internet access, or broadband, to all schools (the priority) and provincial communities, that would otherwise be unlikely to obtain affordable access through commercial provision. A beauty contest for Spectrum Licenses in the reserved bands included firms specifying the amount of money they required in order to provide the services to rural schools, although preference was to be given to bidders offering to not only connect schools but also rural communities.[241] The subsidy 'bid' was not binding on the State but subject to a profitability review. Users subscribe to and pay suppliers for the provision of broadband services.

4.5.7.1.2 Roll-out obligations and tradability restrictions

Licences in the reserved 3.4-3.6 GHz bands are tradable but only after 2 years. This restriction was considered appropriate to ensure that applicants apply for licences with the intention of implementing a service within two years.

Licensees are required to implement a FWA service in accordance with the licence(s) to the Ministry's satisfaction within 2 years of the license being issued. This requirement is apparently specified in the agreement with licensees. The Ministry will hold a cancellation authority for the licence. The Ministry states that the cancellation authority could be removed following implementation, thereby increasing certainty and value.

---

241 This appears very similar to the Auctioning of USO subsidies, which is recognised to be problematic.

4.5.7.2 Digital dividend

There has been relatively little political interest to date in switching to digital. No plans have been made as to what to do with the spectrum released from a future digital switchover. The Ministry has advised that switchover may be coordinated with the end of the TV spectrum license periods, the first of which occurs in 2010.

4.5.7.3 3G extension band

The 2.5 GHz band is presently encumbered by Television Outside Broadcasting. A change in use of this band would thus not seem likely in the 2001 - 2011 timeframe.

Frequency Range	International Region 3 Allocation	New Zealand Allocation	Summary of Usage	References and Policies
2 500-2 520 MHz	FIXED 5.409 5.411 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A MOBILE-SATELLITE (space-to-Earth)5.351A 5.403 5.414	FIXED	2500 - 2690 MHz "O" Band Itinerant fixed linking for Television outside broadcast operations Spectrum identified for possible expansion of 3rd Generation Cellular services.	PIB22: Fixed Service Bands in New Zealand PIB 37 Linking for Television Outside broadcast
2 520-2 535 MHz	FIXED 5.409 5.411 FIXED-SATELLITE (space-to-Earth) 5.415 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 5.403			
2 535-2 655 MHz	FIXED 5.409 5.411 MOBILE except aeronautical mobile 5.384A BROADCASTING-SATELLITE 5.413 5.416 5.339 5.417C 5.417D 5.418A 5.418B 5.418C	FIXED (continued)	2500 - 2690 MHz "O" Band Itinerant fixed linking for Television outside broadcast operations Spectrum identified for possible expansion of 3rd Generation Cellular services.	PIB22: Fixed Service Bands in New Zealand PIB 37 Linking for Television Outside broadcast

4.5.8 Lessons learned from New Zealand that are relevant to the implementation of a flexible frequency management system in Germany

4.5.8.1 Overview

New Zealand was the first country to implement a market-based system of spectrum allocation and secondary trading and was for several years the World leader in spectrum management.[242] The main feature associated with spectrum management in

---

242 These reforms occurred in a period of far reaching reform in New Zealand which included the removal of import tariffs, agricultural subsidies, labour market and tax reform, the adoption of a freely floating currency, the introduction of tradable quotas for the purpose of fisheries management, and a program

New Zealand is the licensing of property rights in spectrum to private band managers. Management Right (MR) holders may then allocate Spectrum Licenses in their bands.

While its spectrum resource is more easily manageable than is the case in Germany, due to New Zealand's isolation and low population density, there are several aspects of the New Zealand experience that are of relevance to Germany. We discuss them under the following topics: Spectrum liberalisation; spectrum trading; interference issues, and competition issues.

4.5.8.2 Spectrum Liberalisation

Spectrum liberalisation in New Zealand has not caused problems, even if it has not yet been completed. Liberalisation is tied up with the design of licenses, including interference rules. The less these rules make licenses liquid, the less able spectrum is to gravitate to its most valuable use. Liberalisation is thus inextricably tied up with factors that influence the tradability of spectrum. With less effective liberalisation there is less tradability, which may be one factor explain the low level of genuine spectrum trading in New Zealand. Spectrum liberalisation is a complex problem that may need to be revisited many times in order to complete a program of spectrum liberalisation.

The implication of this for Germany is that it may be best to approach spectrum liberalisation as an ongoing issue, rather than one that can be completed at some moment. This is also suggested by that fact that a great deal of spectrum in Germany has already been assigned on a use-specific basis. Moving to a situation where spectrum is very largely liberalised will unavoidably take time.[243]

4.5.8.3 Spectrum Trading

In new Zealand few trades have been other than transfers between different entities under similar financial control, or that occurred as a result of a sale, merger, or takeover of the company which holds the spectrum license. It is apparent from the New Zealand experience that a system that provides for spectrum to be traded is more difficult to implement than originally anticipated. Not that is has caused problems, but it appears not to have worked well. There are several issues of possible relevance to Germany:

---

of privatisation of State own utilities and enterprises. This reform period began with the newly elected government in 1984 and concluded in the early 1990s.

243 Note that in Germany at present it is possible to expand the use through public consultation, although if the expanded use clashes with the Frequency User Plan (FUP) it would require the FUP to also be changed.

- There may be an issue of critical mass regarding the performance of secondary markets:
    - The concept of private band managers who allocate spectrum licenses has not worked as intended in New Zealand. It appears to have resulted in too few firms holding the most valuable spectrum, and this may be one reason why he level of genuine secondary trading of spectrum in New Zealand has been low;
    - Perhaps also contributing to the low level of trading is that government retains a significant share of the most valuable spectrum which is not available for trading. The reduced pool of tradable spectrum may detract from the level of trading.
- Issues of license 'joinability' and liquidity
    - Management rights and spectrum licenses in New Zealand are not specifically designed to be traded as they are in Australia. They are allocated nationally and moreover may be tailored to specific users on a case-by-case basis. This would appear to detract more than enhance their tradability. It also makes a change of use more difficult;
    - Similarly, allocated spectrum differs in terms of the date of license period termination and the technical parameters relating to interference. This appears to have reduced the combinability of licenses; [244]
    - A 20 year license period without statutory right to renewal will undermine investment incentives as the license gets closer to its expiry date, and reduce the value of the license on the secondary market, and reduce its tradability.

These are relevant issues for the Federal Network Agency as it progresses to an increasingly liberal spectrum management regime. One possible feature that we draw the Federal Network Agency's attention to is that private band management may need to be done on a broad scale, perhaps with band management rights fragmented regionally, if spectrum is to be sufficient liquid for spectrum allocations to remain efficient. However, the experience in New Zealand is insufficient for us to draw firm conclusions.

We suggest that while we would not rule out the possible efficacy of private band management in Germany, the Federal Network Agency should first observe the

---

244 The more the dimensions along which licenses are defined differ, the less joinable (tradable) are the license. Where licenses are defined according to *n* dimensions, *n*-1 of those dimensions need to be the same in order for spectrum to be purely joinable.

outcome of further developments in New Zealand (should these occur) and any other country which adopts the private band manager model.

4.5.8.4 Interference issues

New Zealand, like Australia, is using accredited engineers to engineer Spectrum Licences and Radio Licences. In both countries it appears to have been a success in reducing the demands on the spectrum management agency so that it can focus on more important aspects of spectrum management. We recommend that the Federal Network Agency explores the scope for adopting a similar scheme in Germany.

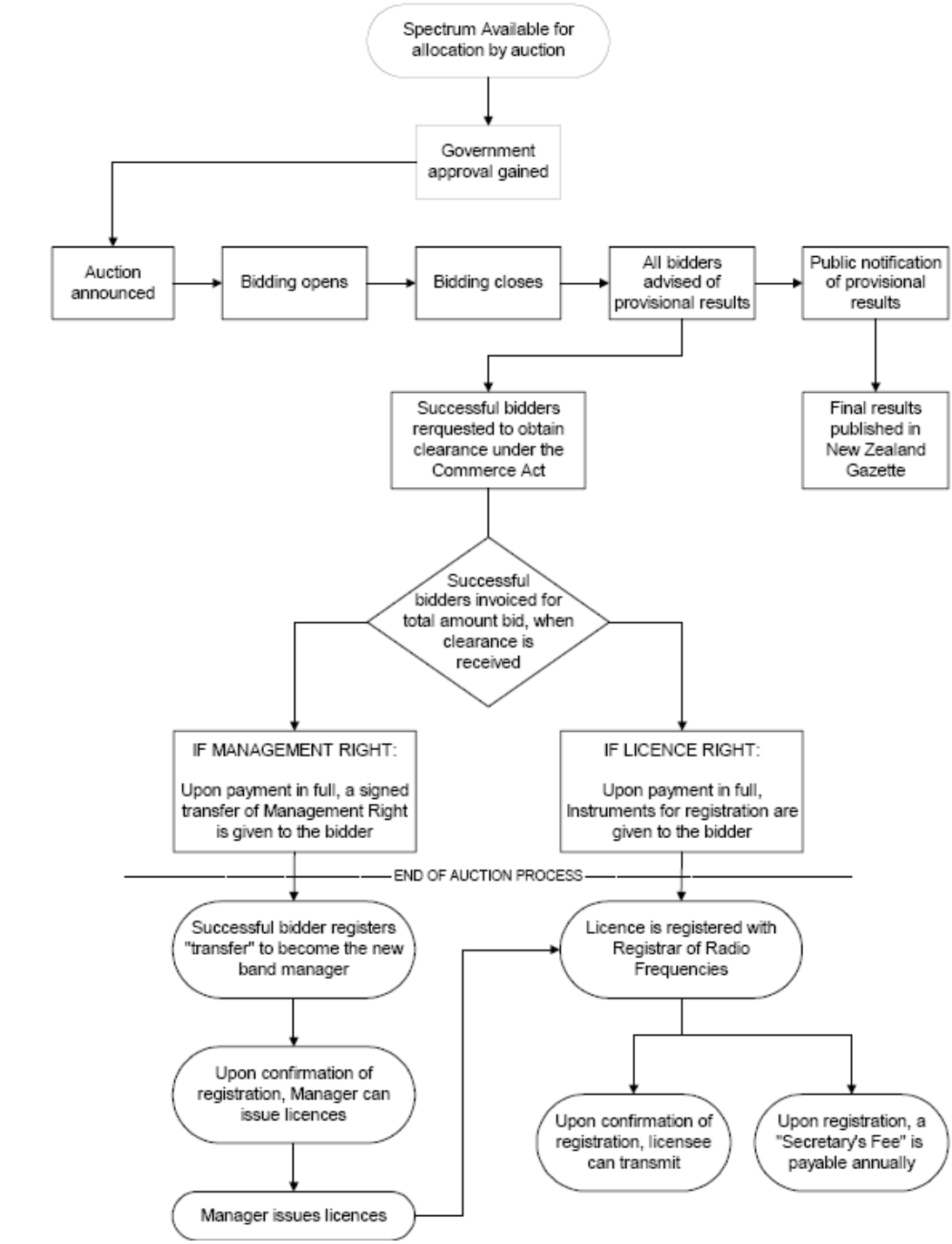
Liberalisation of spectrum in New Zealand has not resulted in the interference problems that some industry commentators continue to say it does. We can not be sure that the same would be true in Germany given the more intense use of spectrum in Germany compared to New Zealand or other countries that can claim a similar result, such as Australia and Guatemala. Our suspicion is, however, that a similar system would work relatively well in Germany.

4.5.8.5 Competition issues

In New Zealand there is a slightly worrying concentration of spectrum in certain bands. To avoid this occurring in some other bands New Zealand has included spectrum caps which extend over a several year period thus preventing circumvention of the cap through secondary market trading. Rather than the cap being decided in an arbitrary way or according to a non-transparent rationale, as may be accused in New Zealand, we suggest that the Federal Network Agency considers the possibility of including any cap in the consultation on the auction, and include the cap as one of the conditions of the auction.

4.5.9 Annex

Figure 10: Main Stages of Management Right and license allocation



Source: http://www.med.govt.nz/rsm/publications/pibs/pib28.pdf

4.6 Guatemala

4.6.1 Overview of spectrum management in Guatemala

4.6.1.1 Institutions of Frequency Regulation

The institutions of spectrum management in Guatemala are relatively weak, as is usually the case in emerging economies. The head of the authority (SIT) is a political appointment. We are told that the first superintendent who occupied the post between 1996 and 1998 was captured by interests apposed to the pace of liberalisation. Foreseeing that this would likely occur, US advisors convinced the government to give the regulator and spectrum authority few powers, these being mainly limited to adjudication over interference disputes that the parties can not resolve through a resolution process, and in regard to certain bands being reserved for state use. Rather, a system which relies primarily on individuals to solve these disputes, where appeal to the courts is the final act, was preferred.[245]

4.6.1.2 The pre-1997 Spectrum Management Regime

Prior to the new law coming into effect in 1996, and which included a new spectrum management regime, all spectrum was owned and licensed by the state. Indeed, the radio spectrum was managed by a branch of the military from within the state owned telephone company. Spectrum was earmarked for certain sectors and then large blocks of bandwidth were allocated for particular uses. Individual licenses were then assigned for which a specific technology was usually specified. Licenses also specified the location of the transmission equipment, and the type of antennas.

Only Guatemalans were able to obtain licenses and these were assigned by beauty contest without any fee legally payable. Licenses were not transferable. Apparently, as demand outstripped supply, some secondary market trading occurred with the illegal involvement and assurances of the spectrum authorities.[246] Licenses were issued for periods of up to 25 years but in practice could be repossessed by government at any time without compensation.

---

245 In 1996 the Government of Guatemala retained economics Professors Thomas Hazlett and Pablo Spiller, of the *American Enterprise Institute* and *UC Berkeley* respectively, to advise it on telecommunication legislative reform.

246 See *The Wall Street Journal*, "What Guatemala Can Teach the FCC", December 27, 2002

4.6.1.3 The 1996 frequency management regime

Far reaching reform began in 1996 with a new telecommunications law. Under the new law all spectrum not currently assigned to the government, or to radio or TV stations, or to existing license holders, or defined as "free" (spectrum commons), can be requested by any person.

The novelty in the Guatemalan approach is that the regulator and spectrum authority is largely bypassed. This was only possible because the spectrum being allocated was as fully liberalised as possible, i.e. licensees could do what they liked with it with the proviso that they met interference guidelines.

The powers of the regulator (SIT) are limited to adjudication over interference disputes that the parties can not resolve through a resolution process, and in regard to certain bands being reserved for state use.

The initiation of an allocation process begins with a request for certain spectrum from a Guatemalan or foreign company or person. The process is described as follows:

1. An interest firm or person views the spectrum registry of SIT to see if there is spectrum in the range they want which is not allocated;

2. If suitable spectrum is available the firm or person applies to SIT for the right to use this frequency;

3. SIT evaluates the spectrum application and within 3 days of receiving it must either reject it, accept it, or class it as incomplete.

   Grounds for rejection are:

   - use of the spectrum would cause interference;
   - the band has been requested or is reserved for amateur users;
   - the frequency is reserved for government use.

4. A public notice is issued if the application is accepted;

5. Third parties are then able to note their objection, although these can only be based on interference. Where objections occur, a binding arbitration process occurs which can last no longer than 10 days.

6. Third parties can file counter claims for the spectrum;

7. If no competing claim is made the applicant will receive rights to the spectrum without payment.

8. If competing claims are filed then SIT must auction the spectrum within 35 days after the end of the objection period (5 above).[247]

If the opinion of SIT is that subdivision of the spectrum requested would promote competition then the auction should be for multiple lots. The law says that in this case a simultaneous, ascending bid multiple round auction format should be used.

The theoretical maximum time from request to license allocation is 4 months but as the law does not penalizes the agency for delays the process has often taken a little longer.

The spectrum that is assigned under the 1996 law is according to a usufruct title with no limitation placed as to the technology or service that can be provided using the spectrum, so long as interference limits are met. Frequency usage titles (*Títulos de Uso de Frecuencias*, or TUFs) are essentially a property right and may be leased, sold, subdivided or consolidated at any time over the 15 year license period.[248] This period can be extended by request and without a fee for an additional 15 years. TUFs can be used as security in the same way as other company property. TUFs are subject to technical restrictions regarding interference, with limits set for transmission power, and max interference specified at the border of coverage area.

A TUF is a security certificate which specifies 6 variables:

- The frequency band;
- The hours of operation;
- The maximum power that can be transmitted;
- The maximum power that can emitted at the border of adjacent frequencies;
- The geographic coverage;
- The duration of right (beginning and ending).[249]

The SIT issued approximately 5,000 TUFs between 1996 and 2002. There are over 1,050 different owners of TUFs in Guatemala who acquired spectrum during this period. The spectrum auctions have generated over $US100 million in revenue. Apparently,

---

247 Giancarlo Ibarguen (2003), Liberating the radio spectrum in Guatemala; *Telecommunications Policy* 27, pp 543-554.

248 This is very similar to the allocation of rights in New Zealand, except there the licenses are less easily renewable but last for 20 years.

249 Ibarguen (2004), "Spectrum Management for a Converging World: Case Study on Guatemala". International Telecommunication Union, Geneva, Switzerland.

70% of these auction receipts have been allocated by the state to subsidise rural telephone services.[250]

In practice the system has not always worked as intended. In the first two years after the new law came into effect there was only a modest release of spectrum onto the market. It seems that the Superintendent's private agenda can explain the rate at which TUFs are sold to market participants.[251]

SIT is responsible for the computerised TUF registry or database. It is easily accessible to the public; an excel copy can be obtained for $US25. The database can be searched according to several different fields. Images of the front and back of TUFs are recorded. The back of the TUF is for endorsements which are required whenever the license is transferred (traded).

4.6.1.3.1 Broadcasting

Until 1997 broadcasters received TUFs for free. Additional parties could apply for TUFs, subject to the non-interference rules.

For TV and radio, guard bands appear to be minimal. There are 50 TUFs in the FM bands: that is 88.1 MHz, 88.5 to 107.7 MHz.

The second round of auctions started in August 1997. Auctions occurred In 3 stages, each two weeks apart. In total, 33 regional and city FM radio licenses were auctioned, A total of 37 bidders registered, and 19 won TUFs paying a total of $US 3 million.

There remain problems with unauthorized use of spectrum, especially for pirate radio. At their height it was estimated that there were 400 pirate users in Guatemala. It has been suggested that SIT faces political pressure not to investigate and close down pirate broadcasters.

---

250 Ibarguen (2003).

251 Ibarguen (2004), says (endnote 44 p 25) that the peak in licensing which occurred in 1999 can be explained by the 'aggressiveness' of the Superintendent.
"The government of President Alvaro Arzú (1996-1999) had the political incentive to limit radio spectrum supply to hike up the price for the State telephone company (TELGUA), which was finally privatized in 1998 after a failed attempt ten months earlier".
Such a strategy, however, is not likely to work with sophisticated bidders who are unlikely to accept the low rate of spectrum licensing as a commitment not to later release much more spectrum once TELGUA had been sold, or once a new superintendent is appointed, as in fact occurred following the appointment of José Toledo in 1999.
"Toledo indicated that he received considerable pressure to stop the auctions from key figures of the ruling party; however President Arzú supported his actions".

4.6.2 Liberalisation of frequency usage

4.6.2.1 Spectrum Partition

Spectrum was partitioned into 3 categories under the 1996 regime:

- reserved for government use, which comes to 1,335 MHz in total [1000 MHz reserved from 3 MHz to 3000 MHz]
- reserved for amateurs, which comes to 4,761 MHz in total [about 12 MHz reserved from 3 MHz to 3000 MHz].
- 'regulated' (liberalized) bands

Users in the first two groups receive an AUF - *autorización de uso de frequencia* - which cannot be sold or transferred.

4.6.2.2 Licence exempt frequency bands (common usage)

Eyeballing the frequency user table suggests that there are no unlicensed bands for low power transmitters (spectrum commons) in Guatemala. The 2.4 GHz is owned privately. Primarily by two major TUF holders. The situation is similar at 5.8 GHz but with 3 main TUF holders. Due to the relative concentration of ownership in these bands there is clearly the potential for a 'hold-up' problem should the State wish to buy the spectrum back so that it can provide spectrum for unlicensed low power services.

4.6.3 Future Liberalisation Plans

All frequencies that are not allocated to the State or to amateurs, have been liberalised since 1996.

4.6.4 Frequency trading

Considerable trading in TUFs appears to have taken place. From 1996 until mid 2001 about 26% of TUFs issued had been endorsed, although this does not include spectrum leases. By 2004 TUFs traded totalled 1,621 (or 41% of total TUFs in existence).

As in the case of Australia and New Zealand we understand that many of these secondary trades were either transfers between different entities under the same financial control, or occurred as a result of a sale, merger, or takeover of the company which holds the spectrum license. However, we were also told that genuine trading has

been common, especially in regard to spectrum used for radio broadcasting.[252] Our overall impression is that there has been a greater degree of secondary trading of spectrum in Guatemala than in either Australia or New Zealand.[253]

4.6.5 Interference issues

4.6.5.1 Interference management regime

The interference management system in Guatemala is designed to enable effective dispute resolution to occur privately. Where this fails the telecommunications regulatory authority (SIT) enforces specified rules, although ultimately the injured party may go to court and sue for damages.

Private companies are used by aggrieved parties to gather evidence of prejudicial interference. Apparently, spectrum right holders monitor themselves and others who transmit around them, using readily-available equipment. If a right holder suffers from interference, the issue is usually brought to a private arbitration office; either one established by the *Cámara de Radio Difusión de Guatemala*, a private association of broadcasters, or the *Centro de Arbitraje y Conciliación* (CENAC). These entities apparently have sophisticated equipment to monitor the radio spectrum.[254]

In the event that an interference dispute can not be resolved or arbitrated privately, aggrieved parties can appeal to SIT to put a stop to the interference. A pseudo trial ensues in which the plaintiff must show the existence of prejudicial interference and also its source. Assuming this is done the violator must desist and pay a pre-specified fine. In order for this system to work all transmission devices must be registered with SIT, so that any illegal interference can be traced to a TUF right holder.[255]

SIT also has authority to initiate its own radio emission investigations. SIT's technical unit monitors the radio spectrum with the help of a number of receiving and control stations. Approximately 50% of SIT's radio spectrum investigations are self initiated, the other 50% being at the request of an aggrieved rights holder. In year 2000 there were 28 investigations by SIT, and 38 in 2001.[256] It has, however, been suggested that the number of interference problems reported is relatively small considering the number of

---

252 Giancarlo Ibarguen, personal communication, 15-11-2005

253 It may be of value to investigate and compared country trading data in more detail as it may help us understand what elements in a licensing regime undermine the liquidity of 'tradable' spectrum.

254 Ibarguen (2004).

255 Ibarguen (2004), and Spiller, P. and Cardilli C., (1997), Toward a Property Rights Approach to Communications Spectrum. Later published in the *Yale Journal of Regulation*.

256 Hazlett, T. and Ibarguen G., (2002). "An Experiment in Airwave Ownership: Spectrum Liberalization in Guatemala". *Paper delivered to the Association of Private Enterprise Annual Meetings*, Cancun, Mexico (April 9).

TUF's issued and the large number of competitors and different technologies in use (see Table 39).[257]

Table 39: Official number of Interference Conflicts

Type of Conflict	*No. of cases reported*
Commercial radios operating without usufruct title	83
Administrative proceedings	83
Administrative appeals presented to date	4
Administrative proceedings with fines	68
Fines charged to date	1
Collection actions by the state	3
Cases pending suit filing	27

Note: Data from enactment of the 1996 Telecom Law up to March 8, 2002.

Source: Hazlett and Ibarguen (2002)

The data suggests that since 1996 when the liberal regime began, interference complaints are not greater or more complex than in the years proceeding 1996. Most of the problems appear to have been resolved without much difficulty through bilateral negotiations.

The vast majority of the interference cases appear to have concerned commercial AM and FM radio spectrum. Indeed, there are also a number of unresolved interference problems associated with transmissions by pirate radio stations. Investigation by the Cámara have located 341 illegal commercial radios operating in the FM range. Pirate radio commonly has a religious focus but have also broadcast political advertising for the present party of government. This is suggested as the likely reason explaining why SIT have not actively sought to trace them and shut them down. SIT's engineers have unofficially suggested there are about 400 community radios stations operating without TUF's, while officially reporting just 83 cases publicly.

257 According to Ibarguen (2004) only 14 cases of interferences had been disputed in the courts between 1996 and the date of the ITU report (2004). Indeed, the intention of the Guatemalan Government's US advisers was to provide a system that would lead to effective resolution without having to go to court, since one of the advisers considered the Guatemalan courts were not likely to be very effective in resolving interference disputes. More recently, however, the advisers wrote, "We believe the responsibility for adjudicating spectrum property rights should lie with the judiciary." Spiller and Cardilli (1997), and Hazlett and Ibarguen (2002).

4.6.6 Competition Issues

Guatemala is quirky in its approach to spectrum and antitrust. It has involved getting to rights holders as many rights out as possible, believing that this would promote competition. The 1996 act does not address anticompetitive concerns expressly. This is to say that there is nothing in telecom law that restricts firms from buying up many TUFs. In practice, we are told that there is no evidence of undue concentration, at least not at this point.[258]

4.6.7 Economic pricing of frequencies

The economic pricing of spectrum is reserved for spectrum allocated under the TUF rights system. This spectrum is auctioned wherever there is competing demand, and what appears to be a functioning secondary market suggests that at any time rights holders face an opportunity cost equivalent to the spectrum's highest alternative use.

It has been suggested that auction prices for the high value 'mobile' spectrum were lower in Guatemala than other south and central American countries because TUF spectrum is liberalised. This was in spite of the much broader property right granted in Guatemala compared to the other south and central American countries, something that would tend to push spectrum prices higher. Income differences were also accounted for by the authors.[259]

Spectrum that is allocated to government or to amateurs (*funk Amateuren*), however, is neither acquired at auction or tradable on a secondary market. Moreover, there are no administratively determined holding fees. Thus, at no time is this spectrum subject to economic pricing.

4.6.8 More detailed analysis of frequency user rights in selected bands

4.6.8.1 Fixed Wireless Access

As all spectrum that is not allocated to government or for amateurs is liberalised, it is up to the TUF right holders to decide whether to use the spectrum for FWA or some other service platform.

---

258 Wayne Leighton, personal communication 24th October 2005.
259 Hazlett and Ibarguen (2002).

There appear to be relatively low barriers to entry for new entrants wanting to provide wireless access services. There are no regulatory mandates such as coverage, investment, or build out obligations that are commonly found in other jurisdictions.

4.6.9 Conclusions

Except for spectrum allocated to government and amateurs, all spectrum in Guatemala is allocated according to a tradable property right system. In this regard Guatemala has gone further than other countries with liberal spectrum management regimes, and with very successful results. Whether in Germany the more intense demand for the downstream services that spectrum enables organisations to supply, would be achievable by Germany similarly allocating only liberalised and tradable spectrum, is an open question.

The interference management regime which relies heavily on a procedure designed to enable spectrum rights holders to solve their inference problems privately, appears to function effectively. It is unclear whether in Germany the private and public costs of a similar interference regime may be higher than one that relies on an authority empowered to address interference problems. This option was deliberately avoided in Guatemala due to its meagre institutional endowments.

Radical reform which includes liberalisation of most spectrum, and the licensing of tradable rights involving most spectrum, has not thrown up the range of problems some commentators predicted. There remain problems with capture and political interference, but these are primarily confined to broadcasting, an area where most countries face similar problems.

5 Guiding principles for a flexible system of spectrum regulation

In designing a flexible system of spectrum regulation, the Federal Network Agency should always have the interests of the end user in mind. The goal is to create a framework for assigning spectrum that permits market forces to act for the benefit of the end user. Assignment mechanisms should be selected with the aim of boosting competition; one of the primary tasks of the Federal Network Agency is to create or guarantee effective competition. Greater flexibility is a means to achieving this goal and not an end in itself. In certain cases, it may in fact be necessary to limit flexibility, notably as a means of addressing issues of market power or interference.

In the following section we present our recommendations for implementing a more flexible spectrum policy in Germany. These are based on our analysis of spectrum policy in selected countries and on the fundamental considerations examined at the beginning of this study. The first point to note is that spectrum policy is not only a domestic matter, it also requires corresponding agreements and coordination at international level. A more flexible regulatory regime in Germany will only realise its full potential if the principle of greater flexibility is also applied in the international arena.

On a national level, flexibility means a further liberalisation of spectrum usage rights as defined by the National Table of Frequency Allocations, the Frequency Usage Plan and the mechanisms for assigning spectrum. As far as possible, usage rights should be both technology- and service-neutral. Ideally, spectrum should be assigned using either the commons model or market-based assignment mechanisms. Under the latter approach, comprehensively defined rights of use for scarce spectrum are assigned by means of an auction. After the primary assignment, it should be possible to trade these usage rights or transfer them to third parties at any time. This is different to a command-and-control approach, in which spectrum usage rights may not be sold to third parties and spectrum is initially assigned by means of a beauty contest. External effects, however, mean that spectrum regulation must be accompanied by a suitable system for regulating interference. Care must also be taken of factors that have a distorting effect on competition.

The international context and harmonisation

Frequency Usage Plans should continue to be drawn up and implemented at national level, taking account of international – and in particular European – efforts at harmonisation. Through its participation in international bodies, the Federal Republic of Germany should seek to create an environment that allows each country the greatest possible flexibility in regulating spectrum usage rights. The goal should be to ensure that the resource of spectrum is utilised as efficiently and effectively as possible, and in the interests of end users (private households and companies).

This further implies that countries should agree to harmonise spectrum usage if this would result in considerable economic benefits. On the one hand, harmonisation restricts the ways in which individual frequencies can be used and thereby excludes certain applications that might be economically attractive. On the other hand, harmonising pan-European usage (including international roaming) makes it easier for services to be marketed and used throughout Europe. Harmonisation allows manufacturers of terminal equipment to plan for the future with greater confidence and makes it possible for them to benefit from economies of scale in production. This is particularly true in the case of equipment and infrastructure components that can only be developed once a critical mass is reached. It is therefore necessary to examine the particular circumstances of each case before proceeding with harmonisation.

Liberalisation of the National Table of Frequency Allocations and the Frequency Usage Plan

The National Table of Frequency Allocations and the Frequency Usage Plan should be designed so as to impose as few restrictions as possible. We recommend in particular a technology- and service-neutral approach. Lifting restrictions on spectrum access for emerging radio technologies will promote innovation and technological progress. In order to ensure that the Frequency Usage Plan can be changed as flexibly and quickly as possible, the formal procedure for drawing up the plan should be streamlined and simplified, whilst retaining the element of public participation. In addition, the provisions governing the range of applications permitted in particular frequency bands should be expanded and gradually liberalised.

- The WAPECS initiative from the RSPG is a pioneering example of this approach. The object of the initiative is to open up frequency bands that had previously been reserved for one specific application such as mobile communications, fixed radio services or some other type of wireless access. These frequency bands are now to be opened up for all services. Moreover, WAPECS operates on a technology-neutral basis. Nevertheless, questions of market power and interference also have to be taken into account.

- The principle of liberalisation should also guide decisions about the assignment of the UMTS expansion band. It is conceivable, for instance, that these frequencies might also be opened to broadband wireless access (BWA) applications. Any assignment mechanism should therefore include not just the current UMTS licence holders but other qualified operators as well, for example companies that wish to use this spectrum for BWA. If the UMTS licence holders are indeed in a position to use the spectrum more efficiently than the competitors, then they shall also emerge victorious in any auction of usage rights. And if they are not the most efficient of the prospective users, then it

makes sound economic sense for the usage rights to go elsewhere. The fact that the UMTS licence holders were promised so-called complementary spectrum does not give them an automatic right to use particular frequency bands. From a regulatory standpoint, this merely means that they have the option of participating in a competitive process in order to acquire this right.

- The "digital dividend" spectrum, i.e. those frequencies that will be freed up by the switchover from analogue to digital terrestrial TV, should also be made available for as many applications as possible.

- Ofcom's Implementation Plan describes how conditions of use can be gradually liberalised.

Frequency assignment

Frequency assignment mechanisms should be designed with the greatest possible degree of flexibility. When deciding on a system it is important to take a range of factors into consideration: For example, the speed at which applications arrive on the market, the protection needed from interference, the quality of services, the strengthening of the domestic market and the encouragement of innovation. The mechanisms for assigning spectrum should be designed so as to take account of market power issues as well as the goal of avoiding interference.

- The commons model should be employed wherever this promises an efficient use of spectrum, taking into account the issue of interference. This means that multiple users share access to a frequency band reserved for certain types of services. These will mainly be short-range applications such as Bluetooth or WiFi and, providing that certain criteria are met, it will be possible to use devices without the need to obtain a licence (these will typically be low-power devices for end users). Of course, it is still imperative to define clearly the rights of use for such applications.

- In the remaining frequency bands there should be clearly defined spectrum usage rights, which are then distributed to users by means of market mechanisms. Spectrum usage rights should be acquired in a commercial transaction (primary assignment by way of an auction) with the right to resell them at a later date (secondary markets). Market participants are in a far better position to ascertain the economic value of alternative applications in a spectrum market. This is a quicker and more effective way of achieving economically efficient usage.

- The auction of IMT-2000 licences/spectrum in Germany, at which it was to some extent possible for market players to shape the 3G standard, the size of the

frequency blocks to be acquired and the market structure are a good example of a more flexible regulatory regime. The mechanism currently under consideration at the Federal Network Agency for assigning 3.5 GHz frequencies is also an example of a more flexible approach to regulating spectrum. Both approaches abide by the principle of keeping restrictions to a minimum.

Characteristics of a market-based model

Where it is appropriate for spectrum usage rights to be distributed by means of a market mechanism, the following elements should be in place:

- If spectrum is scarce, the Federal Network Agency should hold an auction to either assign frequencies for the first time or re-assign them.
- It should be possible to resell spectrum usage rights by transferring them (whereby usage does not change) and by means of spectrum trading (whereby usage does change).
- Spectrum usage rights should be clearly and comprehensively defined.
- There should be as few restrictions as possible on how spectrum may be used.
    - As far as possible, usage rights should be technology- and service-neutral.
    - It should be possible to partition frequency bands (particularly with regard to spectrum trading) in terms of both spectrum and geography, in so far as this constitutes an efficient use of spectrum.
    - It should only be possible to specify coverage requirements or quality standards for the intended services in exceptional cases and with good reason. For example, coverage requirements would be justified if the services in question were classified as universal services. In particular situations, however, such obligations are rendered superfluous, notably when the spectrum usage charge reflects the opportunity cost of spectrum use (this is known as administrative incentive pricing and has been partially implemented in the UK). The existence of secondary markets is a further safeguard against the hoarding of unused spectrum, as the price that the spectrum would potentially fetch in the market reflects the corresponding opportunity cost.
    - Spectrum usage rights should include clear rules designed to prevent interference (specifying, for example, spectrum masks).

Spectrum trading regime

Spectrum trading and transfer should be possible in nearly all bands. A trade should only be prohibited if there are overriding reasons of social and economic policy for doing so.

The spectrum trading regime should be designed so that, in principle, the spectrum user is able to change the spectrum usage rights.

It should be possible to transfer usage rights quickly and easily. To this end, the regulatory authority should generally refrain from specifying particular trading mechanisms, such as a specific type of auction for secondary trading.

However, the regulator may justifiably reserve the right to approve or block a transfer of spectrum usage rights in advance. In order to keep down transaction costs for users and prevent the process from becoming a barrier to trading, approval should generally be given as swiftly as possible. In particular, it should only be possible to block a trade if a significant distortion of competition or significant interference might result.

It should be possible to transfer spectrum usage rights for a temporary period (leasing). The parties to the arrangement should sign a contract agreeing a fixed date on which all property rights revert to the lessor.

Central register of spectrum use

There should be a central register of spectrum use that allows existing and prospective spectrum users to find out as quickly as possible what they need to know about the spectrum available, who is using it at present and the associated rights of use. The register should contain sufficient information to facilitate transactions, and might include additional information consistent with a cost/benefits analysis. It should not contain information that is confidential. Ideally, the information should be made available via an electronic interface. The Federal Network Agency is responsible for the assignment of spectrum and possesses all the relevant information. It would therefore seem logical for the Federal Network Agency to take responsibility for preparing this register.

At a minimum, the register should contain the following information:

- Name of the person or company holding the spectrum usage right
- Postal address, e-mail address, phone number or contact details of the agent
- Band of spectrum and geographic area covered by the spectrum usage right
- Description of all relevant rights of use

Interference management regime

The Federal Network Agency should provide reasonable interference guidelines for each band. It should be possible to deviate from the thresholds specified by the regulator. If all those affected are in agreement, the regulatory authority should allow a departure from the interference threshold. This means that the regulatory authority only intervenes in the event of a dispute

In addition, a number of the innovative interference management approaches that are under study in the United States are promising and bear watching.

It is clear that the selective imposition of receiver standards has the potential to improve overall welfare. There are many interference problems that could most appropriately and most cost-effectively be addressed by means of a modest improvement in receiver quality, rather than by the traditional method of imposing restrictions on the transmitter. At the same time, manufacturers in the U.S. and Canada have understandably been uncomfortable with the prospect of new regulatory impositions. Nonetheless, it may be possible to make progress. In the Nextel proceeding, the U.S. FCC did not mandate overall receiver quality standards, but it committed to provide protection from interference only for receivers that met certain quality standards. Experience to date is limited, but this approach seems sensible and could be considered for use where circumstances warrant.

The U.S. work on interference temperature might in time lead to important advances, but it is not yet clear if this single metric is sufficient for regulatory purposes, nor is it altogether clear exactly how to apply the interference temperature to regulation. It would be appropriate to monitor further developments in the U.S. and elsewhere to see if this concept makes progress.

An additional observation that flows from the U.S. exploration of the interference temperature is the notion that it would be useful to have a better understanding of the overall interference environment. Two approaches that were considered but not implemented to date in the U.S. are (1) the use of a monitoring network, and (2) the “enlisting” of a group of cognitive radios to function as an *ad hoc* monitoring mesh as an adjunct to their primary function. For the former approach, it has not been clear that the benefits would exceed the costs. The latter approach must be viewed today as being futuristic, but it has the potential to provide a very inexpensive yet rich data source on the overall interference environment. If solutions of this type were to emerge, they might be of interest.

Spectrum pricing

Spectrum charges should cover not only the administrative costs of spectrum use; they should also be levied at regular intervals and reflect the economic value associated with the best alternative use of the spectrum (opportunity cost). This approach is known as administrative incentive pricing (AIP) and has already been used in the UK, for example.

- AIP is effectively an indirect tax that reflects the economic value of spectrum use. It consequently tends to make it more difficult for spectrum users to make windfall profits. AIP can therefore make a flexible approach to spectrum regulation more acceptable from a political standpoint.
- AIP can be used in concert with auctions, spectrum trading and the liberalisation of spectrum usage in order to ensure that spectrum is used efficiently.
- AIP reduces the risk of spectrum usage rights being held for speculative reasons.

Implementing a more flexible regime

A more flexible regulatory regime should be implemented as quickly and extensively as possible, yet also with due care. It is important to ensure that it is still possible to manage issues of interference, that there are no distorting effects on competition and that spectrum is not fragmented or used inefficiently.

A gradual approach, one frequency band at a time, would be appropriate, including consultations with all those affected in order to discuss the specific issues associated with each band. It would also be expedient to set up pilot projects in order to test different approaches, for example with regard to a new interference management regime.

The national regulatory regime is designed against the backdrop of international agreements. Therefore, in order to introduce greater flexibility at national level, a degree of flexibility at international level is required. It is consequently important to prepare for this in advance by paving the way in the international arena for possible approaches to greater flexibility. This will require German representatives to lobby international bodies to this end.

Issues of competition policy

It is expected that the introduction of liberalisation and spectrum trading will be gradual and may therefore differ in detail for each frequency band.

As long as liberalisation is still imperfect, it can be assumed that there will still be a noticeable “artificial” scarcity of available spectrum for certain applications, with the result that tight oligopolies may emerge and competition may be inhibited. Consequently, in such a situation it is imperative that the regulator evaluates the competitive implications of spectrum transfers or trades, either by *ex ante* review or by predefining categories of trades that are permissible.

In the long term, competition law may provide sufficient means of addressing competition concerns. This assumes that spectrum usage rights are almost completely liberalised, spectrum trading is possible and spectrum charges are set according to AIP.

Expanding spectrum usage rights of current users

Expanding the usage rights of current users presents the difficulty of how to introduce a more flexible regulatory regime in a non-discriminatory fashion. This applies both to a broadening of the conditions of use and to liberalisation. It may be the case that, by expanding spectrum usage rights, the regulator is discriminating against those who were unsuccessful at the time the spectrum was originally assigned, regardless of whether this took place via an auction or a beauty contest. It must be emphasised, however, that an expansion of existing spectrum usage rights does not automatically constitute discrimination. Irrespective of these considerations, there are various tools that can be used to counter potential discrimination.

- The user whose existing right of use is being expanded can make a payment to the government that is commensurate with the increase in value.
- The spectrum in question can be distributed in a big-bang auction restricted to that frequency band. This means that all the frequencies within that band are re-distributed by means of an auction, including those that have already been assigned. If the current user is the highest bidder, they will receive the expanded usage right without having to make any further payment. If a different bidder enters a higher bid, they acquire the usage right and pay the bid price to the previous user by way of compensation. This method gives all prospective users another opportunity to acquire the spectrum usage rights in a competitive process.
- Discrimination can also be ruled out if spectrum usage charges are set according to the principle of AIP and already take account of the possibility of expanded use.

If properly designed and appropriately used, such tools can be employed to ensure a non-discriminatory transition. This is especially true if they are combined with spectrum

trading. It is therefore indeed possible to expand existing usage rights if this is done by pursuing one of the approaches outlined above.

Implementing liberalisation, spectrum trading and AIP in parallel

In the long term, it will only be possible to reap the full benefits of more flexible spectrum regulation if the restrictions on spectrum usage rights are relaxed as far as possible, if users are able to transfer rights of use (both permanently and temporarily) and if AIP is the guiding principle behind spectrum usage charges.

- Without a liberalisation of the conditions of use, spectrum trading will have little impact, as any new rights holder would have to use the spectrum in the same way. However, in view of the benefits of harmonisation, any steps towards liberalisation must also take careful account of all the relevant regulatory factors.

- Without spectrum trading, a liberalisation of conditions of use would at best allow present rights holders to use the spectrum more effectively. However, there would be no market mechanism for re-distributing spectrum to more efficient users.

- Without AIP, and even if spectrum trading is possible, there still may be an incentive for rights holders to retain spectrum for strategic reasons. AIP can also be used to reduce windfall profits and thereby make spectrum trading more acceptable from a political standpoint.

- *Ex ante* regulation of spectrum markets is only likely to become superfluous when spectrum usage rights are completely liberalised.

Ultimately, the full impact of a more flexible approach will only be felt if all tools are employed together.