European Radiocommunications Committee (ERC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

REPORT ON THE INTRODUCTION OF ECONOMIC CRITERIA IN SPECTRUM MANAGEMENT AND THE PRINCIPLES OF FEES AND CHARGING IN THE CEPT

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1 INTRODUCTION

The aim of this Report is to discuss an approach for CEPT administrations considering the introduction of economic criteria in spectrum management and to develop proposals on a possible fee structure for licences based on a proposed set of criteria. In both these areas the report examines the potential for developing a set of common rules and guidelines within the CEPT. The approach to economic criteria may take the form of new allocation procedures like auctions, or the form of incentive licensing systems like administrative pricing. In the area of charging the criteria and the relationship between individual elements of the licence fee could form the basis for further harmonisation work at a CEPT level. However it is acknowledged that the potential for harmonisation in the area of licensing and charging is limited because administrations different legislative systems, spectrum management requirements and wider political aims and policies, require a certain level of autonomy and flexibility in this process.

In preparing this ERC Report use is made of the information gathered and proposals made in two ERO studies prepared as Work Orders for the European Commission:

i) Licensing and Charging;

ii) PMR and PAMR Licensing.

1.1 Developments

Radiocommunications including the management of the radio spectrum has in recent years attained a high political profile. In part this is due to CEPT administration's policy of introducing "market forces" into various government controlled activities by the privatisation of state companies, putting them in the market place and creating competitors. The other major reason for the increase in radio's political profile has been a growth in demand for spectrum which has in some geographical areas, in some frequency bands and particularly for some services, exceeded the available supply. The latter development has been exacerbated by the liberalisation of telecommunications[1] and rapid changes in technology.

The experience of many CEPT administrations has shown the existing licensing mechanisms and charging policies are not sufficient to cater for these developments in the radiocommunications global environment. In particular the increased demand for spectrum and its scarcity have generated a requirement for greater transparency in the spectrum management process and its associated procedures.

The rising demand for spectrum has led to the development of new approaches to spectrum management. These new approaches have included, among other things, economic criteria as a new spectrum management tool for certain services and as an instrument for calculating licence fee structures. The economic criteria are used, together with other more traditional spectrum management tools, with the aim of improving spectrum management and allowing the radio spectrum to be managed on a more equitable basis for the benefit of all radio users. Economic criteria are not being introduced in order to create revenue for the administrations.

[1] Including the EU programme of liberalisation of telecommunications by 1 January 1998.

In most CEPT countries, licence fee structures are strictly controlled and to change the process may require significant legislative or even constitutional changes, and these constraints have influenced the approach taken by each country. Currently, several different licence fee regimes are in operation, or plans for their introduction are being made. In these regimes the fees are set:

i) at zero and the radio user is not charged at all;

ii) that do not reflect the cost of regulating the spectrum;

iii) to reflect the direct costs and/or the indirect costs of spectrum management;

iv) at a variable rate based on the service and a set of predefined criteria.

The operation of some of these systems may mean that the taxpayer subsidises spectrum management.

In some countries legislation is being prepared in order to introduce either the possibility of differentiation of fees for certain services according to a set number of criteria, or the introduction of spectrum auctions.

It is considered beneficial that exchange of information takes place within the CEPT to where harmonisation is possible and how this might be achieved.

1.2 Background

This report investigates the introduction of economic criteria into spectrum management and the licence fee structures used within the CEPT. The work is based on developments in spectrum management within CEPT countries and changes in the global telecommunications environment. In particular, the report examines CEPT Policy, Reports and Recommendations that are applicable to licence fee structures to determine:

i) any impact from changes in spectrum management within the CEPT countries;

ii) the extent to which they remain relevant.

The report also examines developments within the International Telecommunications Union (ITU) to ascertain the relevance of the ITU-R Report SM.2012 on "Economic Aspects of Spectrum Management" to the CEPT countries and the lessons that may be learned from the changes in the approach to spectrum management outside of the CEPT.

1.2.1 CEPT Policy, Reports and Recommendations

Some years ago the ERC developed policy goals for the long and short term[2]. Some of these goals dealt with the topic of fees and charges, for example the recommendation "to study new mechanisms for spectrum management and the exchange of information on the principles of financing the work of the administrations" with a view to finding a common basis for fees.

This recommendation was recently confirmed again by the ERC Reflection group[3], which examined the ERC PT8 policy goals and recommendations with the aim of bringing them up to date.

An extract of the ERC report dealing with the relevant policy goals and recommendations is included in **Annex 1**.

In the Detailed Spectrum Investigations[4], although primarily dealing with the harmonisation of certain frequency ranges, recommendations were also given with regard to regulatory issues regarding spectrum management and its funding.

[2] ERC Long Term Strategy and Policy, Nicosia March 1994 Annex 1 to Doc CEPT/ERC (94) 13.
[3] Final Report of the ERC Reflection Group CEPT/ERC(97)113.
[4] DSI I 3400 MHz - 105 GHz March 1993 ISBN 92-9135-001-3
DSI II 29.7 - 960 MHz March 1995 ISBN 92-9135-007-9.

The DSI I report concluded that currently in some countries major users do not contribute to the actual cost of spectrum management. The report recommended that in order to improve the efficiency of spectrum management in CEPT countries the direct and indirect costs involved should be reflected in licence fees and charges to all spectrum users, including those that still retain monopoly privileges. It further recommended that consideration be given to the establishment of radio regulatory agencies

DSI II raised the question of new methods of frequency management and touched upon the item of spectrum pricing including differential pricing where licensing is used as a tool to either encourage or discourage users and operators to apply for and/or operate in particular frequency bands.

Another item in the DSI II report is the reimbursement to users of a particular frequency band where that band needs to be recovered for another service or other users. It was proposed either to establish a fund raised from interested parties (industry and operators) or the new user of the spectrum should reimburse the old user.

The DSI II report further recommended that a time table with a date for transfer, to be confirmed by all parties, for major refarming projects be agreed on a European basis.

On new approaches to spectrum management DSI II recommended retaining the existing first come, first served system with some improvements like delegating responsibility for frequency planning to user groups. When competitive licensing is necessary because of lack of frequencies the administrative comparative approach should be used rather than lotteries or auctions.

A proposal for a differential licence fee structure was put forward and it was considered preferable to harmonise on the use of this fee structure. This was however recognised to be impractical but some merit was seen in agreeing the basic criteria on which a fee is based and the relationship between individual elements of the licence fee.

In the public consultation on DSI II the comments received supported, in general, the administrative pricing approach to licensing and the delegation of frequency planning to specialised interest groups. On the refarming proposals there were mixed opinions, specifically with regard to the practicalities of the proposed process and the possibility to harmonise this European wide. Alternatives to the financial mechanism proposed were suggested, such as fixed term licences and the early identification of new spectrum. Another suggestion was that the transfer process could be funded by all radio users.
The text of these recommendations can be found in **Annex II**.

The ERC, in its reaction to the DSI II recommendations concluded that the area these recommendations covered was subject to change and therefore no conclusions could be drawn.

All above mentioned reports call for further studies and investigations into the possibility of harmonisation in the areas of spectrum management and fee structures, together with the publication of guidelines by the ERC for member administrations.

1.2.2 ITU-R Report

The ITU-R report was developed to provide all administrations with a common understanding of economic criteria in spectrum management and guidance on the funding of the spectrum management process. Although the report was written in response to a specific request for information from the Development Sector of the ITU, the ITU-R had already recognised the need to provide information on this aspect of spectrum management and had started work in 1994. Work had commenced because administrations were concerned that changes in the telecommunications environment and rapid changes in technology, were impacting on management of the radio spectrum to the extent that it was necessary to investigate whether guidance on new spectrum management techniques needed to be developed. In presenting information on these new spectrum management techniques the ITU-R were concerned that some countries might assume that the report was attempting to promote the use of economic criteria. This concern (together with the recognition that all of the countries that were using economic criteria considered the methodology was still subject to rapid development) determined that the ITU-R report should not at this stage contain any specific conclusions for their use.

2 OVERVIEW OF THIS REPORT

There would be little point in repeating the work of the ITU-R Report SM.2012 on "Economic Aspects of Spectrum Management". This Report therefore concentrates on providing the background to these issues putting them into a CEPT context and attempting to identify a common approach to spectrum pricing. This report might therefore be read in conjunction with the ITU-R report to obtain the detailed information on the economic aspects. As the previous section indicated, there are many distinct but closely related subjects to be addressed in relation to charging principles. The Report will give an overview of existing charging principles, then deal with the principles of financing the radio administrations and lastly introduce the possibility of economic criteria in spectrum management.

The principles of financing spectrum management

Chapter 3 describes the various methods that have traditionally been used for funding spectrum management. These methods range from state funding to cost recovery and gives a breakdown of the distribution of fees across radio users. The Chapter also presents alternative methods, to charging fees, that are used by some administrations for providing spectrum management services and manpower resources.

Licensing mechanisms

Covering the licensing mechanisms that have been used with the funding methods described in **Chapter 4**. This includes the main licensing mechanisms like "first come first served" to the newer mechanisms.

Spectrum pricing

The difficulties facing a number of administrations from rising spectrum congestion and the increased competition for scarce spectrum has led to the introduction of spectrum pricing. Spectrum pricing is the term given to funding and licensing mechanisms that bring economic factors into spectrum management. This includes on one hand the possibility to use fees for influencing the behaviour of users (administrative pricing) and on the other hand the introduction of new frequency allocation procedures, like auctions (**Chapter 5**).

Spectrum rights

The introduction of spectrum pricing has raised a number of issues on the rights a licence confers on a licensee, the level of control retained by the administration and the licensee's spectral obligations to other radio users (**Chapter 6**).

Spectrum pricing - further considerations

The introduction of spectrum pricing allows some of the spectrum management problems caused by limitations in administrations funding to be resolved, allowing them to develop their spectrum management facilities. This Chapter examines some of the uses to which additional funding could be put and some of the associated spectrum management problems that spectrum pricing may help to resolve (**Chapter 7**).

Managing the transition.

All major changes to spectrum management need to be planned and implemented carefully. Spectrum pricing is no exception and this Chapter highlights some of the key areas administrations need to take into consideration when changing their funding or licensing methods, particularly if this leads to changes in the way radio administrations are financed (**Chapter 8**).

International perspective

Spectrum pricing and some of the problems it has been introduced to resolve are being studied in a variety of international fora. This Chapter presents reports from some of these debates and the work in progress (**Chapter 9**).

Conclusions and proposals for further work

Finally, **Chapter 10** presents conclusions on spectrum pricing and recommendations for further work, including identifying where further work on harmonisation may be possible and how this may be taken forward.

Glossary

In **Annex VII** a glossary of terms used in the area of spectrum pricing is included, as used in this Report. Since different meanings are often attached to different terms in this policy area, such a glossary was considered indispensable.

3 THE PRINCIPLES OF FINANCING SPECTRUM MANAGEMENT

The radio spectrum is a finite but reusable resource that cannot be fully utilised due to limitations in current technology. Use is further constrained by propagation effects and the requirement of some services for specific frequencies. In addition radio propagation is not limited by national or international borders. If the spectrum is to be used efficiently and effectively it is essential that it is effectively managed at both the national and international level for the overall benefit of the country, to avoid unwanted interference and ensure equitable access to the spectrum for all existing and potential users. To achieve this aim it is necessary to control access to the spectrum and this can be achieved by issuing licences to legitimate radio users - the issuing of a licence to all transmitting stations is a requirement of Article 24 of the Radio Regulations[5].

Licensing is only one aspect of managing the spectrum and it cannot function effectively without the support of other spectrum management activities e.g. monitoring (see **Annex III** for a list of spectrum management functions). Many spectrum management functions are inter-related and each needs to be performed to provide an overall management package for the radio spectrum - although it has to be recognised that the requirements of each administration may be different and the extent to which each function is performed may vary. If these functions are to be performed, then this activity will need to be funded and the administration will require a charging policy, this can be based on:

i) national budget financing;

ii) spectrum usage fees.

Administrations have used one or both of these methods to fund all their spectrum management functions. In most administrations the way licence charges are set is regulated by law. Further the way changes to the actual licence charges are made is also strictly regulated. Legislation has a major impact on radio usage and hence the operation of licensing. There is considerable variation between countries not only in terms of legislative content but also the number of different provisions that can apply. All CEPT countries have at least one law[6] relating to radiocommunications, however many have two or three (e.g. broadcasting, telecommunications) and some also have other legislation that is relevant (e.g. competition).

Providing the resources to perform all of the necessary spectrum management functions need not be confined to the administration national regulator, and some administrations are using private sector organisations to support specific spectrum management activities.

3.1 National budget financing budget

This is a probably the first method of spectrum management financing to be used by all administrations. In this system a portion of the state's annual budget is allocated to finance spectrum management and no fees are charged to the licensee. The level of funding provided will depend on the priorities of the national government and its total tax resources.

3.2 Spectrum usage fees

In many administrations the cost of providing adequate spectrum management and the unfairness of all tax payers funding the use of radio by a limited number of users, introduced the concept of charging a fee for the issuing of a licence. The fee may be applied to some or all radio users. There are two forms of spectrum usage fee:

i) simple fee;

ii) cost recovery.

In practice cost recovery might be considered as a variant of straight fee as the administration is setting the value, however a distinction needs to be made because its structure and operation are heavily influenced by national legislative and

[5] Article 24 to the Radio Regulations, Edition 1990 Revised 1994 (Article S18 of the revised Radio Regulations). In its current form this Article gives not much guidance and therefore CEPT has proposed that it will be reviewed at WRC 99.
[6] The ITU-R National Spectrum Management Handbook recommends that provision for spectrum management is enshrined in law.

constitutional requirements. Most CEPT countries fund their spectrum management programmes in whole or in part through the use of fees and many administrations operate a cost recovery system in some form or other.

3.2.1 Simple fee

In the case of a simple fee the administration only has to set a price for a license. The fee may be set at the same level for all licenses, or it may vary depending on the frequency band and service etc. The fee may be a completely arbitrary value and may not reflect the costs of the administration; consequently the fees recovered may be greater or less than the administration's costs.

3.2.2 Cost recovery

The purpose of a cost recovery system is limited to that of recovering the costs incurred by the administration, where the aim is to avoid overcharging the licensee and to avoid using the national budget to subsidise spectrum management. The charges for frequency usage, and hence the fees for a radio frequency licence, are set according to the costs incurred in issuing the licence and the associated frequency assignment process (for example: frequency assignment, site clearance, co-ordination) including any other necessary spectrum management functions. Licence fees are usually structured on the principle of recovering the costs directly and indirectly attributable to a licence category. In some countries the accounts are audited, by a national auditor, to ensure the costs, on which the licence fees are based, are appropriate and justifiable.

In practice, the exact definition and operation of cost recovery varies according to national spectrum management, legislative and constitutional requirements. These differences may have an impact on the implementation of cost recovery in each country and affect how the costs and fees are justified. There are several reasons for these differences:

i) In some countries a distinction is made between the administration's total income matching or simply approximating to its costs. In the former case the administration is not permitted to subsidise or overcharge the licensee with any excess having to be repaid. In the latter case it is recognised that fees are based on an estimate of the expected costs and therefore the income may exceed or not reach the administrations actual costs. Note: in those countries operating the latter system, strict audit control may still be applied.

ii) The fees set for cost recovery may be based on the work performed on an individual licence or the average for that licence category.

iii) The complexity of the frequency assignment process and the number of spectrum management functions that need to be performed to issue a licence may vary due to:

   a) national characteristics – for example the number of users, geographic features requiring the use of a detailed topographic database;

   b) international requirements – for example bilateral or multilateral treaties, footnotes in the Radio Regulations.

iv) How the costs of the individual spectrum management functions are attributed to a particular licence category may be different due to:

   a) the interpretation of whether the cost should be the responsibility of the licensee, should attract a fixed fee or should be the responsibility of the state (paid from the state budget);

   b) their allocation between direct and indirect costs, (see below).

The factors will affect the composition of the licence fee and the mechanisms an administration put in place to monitor their income and costs. Differences between administrations is particularly evident in the division between direct and indirect costs and arises, despite general agreement on the definitions, due to different interpretations on the specific costs that should be allocated to each category. In general, the definition of direct and indirect costs are defined as follows.

- **Direct Costs**
  This covers the immediate and identifiable cost of issuing licences for specific applications. For example, they

include: the cost of staff time in the frequency assignment process, site clearance, interference analysis when it can be directly associated with a particular class of service - keeping the public news and entertainment channels clear, ITU and CEPT international consultation that is specific to a service. In some frequency bands and for some services or if transmitters are near neighbouring countries, the direct costs will include the cost of relevant international consultation.

- **Indirect Costs**
  This covers the cost of the spectrum management functions used to support the administration's frequency assignment process and the overhead of operating the administration's spectrum management procedures. They represent costs that cannot be identified as attributable to specific services or licensees such as general international consultation, for example with the ITU and CEPT, propagation research covering many frequency bands and services, general spectrum monitoring and interference investigations arising from the complaints of rightful users, and the cost of support staff and equipment

However in some administrations the definition of direct costs is very restrictive and is limited to the costs incurred for the individual licence applicant and not to the costs of the licence category and some administrations may not make any charge for indirect costs.

Further details and a description of the systems of some of the CEPT administrations can be found in **Annex IV**.

3.3 The difference between fees and taxes

Where there are discussions on the principles of charging and the setting of fees the differences between taxes, fees and contributions should be kept in mind. The difference between taxes, fees, and contributions may vary from country to country as it depends on national conventions relating to public expenditure and fiscal definitions and on constitutional considerations. Typically, a tax is a compulsory monetary contribution to governmental funds without any direct service in return, whereas a fee is a payment for a particular good or service received by an individual and a contribution payment for a particular good or service received by a certain group of people. An imposed monetary tribute without a direct service in return can however also be considered to be a fee or contribution if the purpose of such a charge is to fulfil a regulative purpose, i.e. spectrum management. In such a case the income of such a charge must, unencumbered, be conveyed back to the same sector of the economy from which it was charged and only be used for regulative purposes within that sector. Such a fee or contribution may only be levied when there are specific provisions regulating it.

3.4 Distribution of spectrum management costs across radio users

At the moment in most European countries the licence holders (of public and private radio systems) contribute to the costs of spectrum management, although this may not be the case in those countries where the public network operator or broadcaster is a government entity. Where government users and public broadcasters are charged, they do not contribute in a comparable way with private users for the spectrum they occupy. Indeed in many countries government users do not make any payment for the spectrum they use.

Private Mobile Radio (PMR) account in most European countries for the largest number of licences issued. A small number of these could be single licences for PMR operators whose networks have for example over 10, 50, 100, or a 1000 mobile units. Under the spectrum usage fees (see **Chapter 3.2**) PMR provide, in the majority of cases, the largest revenue to administrations irrespective of the method used.

3.5 Support in frequency management tasks

This section although not directly concerned with licensing and fees is relevant to financing spectrum management, as licence fees are often insufficient to adequately fund all spectrum management activities. It provides a brief introduction into alternative methods used by some administrations for researching spectrum management. Further information on this subject can be found in the ITU-R report 'Economic aspects of Spectrum Management' from which the following text is an extract.

Administrations often have limited financial and human resources that can be applied to spectrum management. In some cases, these limitations can delay or restrict the implementation of communications vital to the national economy, services, and security. Therefore, administrations need to consider alternatives to the traditional centralised, government operated and funded national spectrum management systems. Though national spectrum management remains a primarily governmental effort, alternative approaches using resources outside the national spectrum manager to perform or fund certain spectrum management functions can enhance the efficiency and effectiveness of the national effort.

A number of administrations have made use of spectrum management resources outside the national spectrum manager including:

i) communication groups with a direct interest in spectrum such as advisory committees, trade associations, professional organisations, and quasi-governmental associations;

ii) frequency co-ordinators (and co-ordination groups) and designated spectrum managers; and

iii) spectrum management consultants, and support contractors.

These alternatives can be used to support the national spectrum manager. Which approach is used may vary with frequency band, radio service, and/or specific radio application, the capability resident within the national spectrum management organisation, and the expertise available from other resources. The national spectrum manager can determine the limits of responsibility and authority granted these groups based on the function to be supported. Administrations may also find that a combination of approaches may be required to perform the overall spectrum management function.

The objectives of using groups outside the national spectrum manager to assist in the spectrum management process are:

- to save government financial or human resources;
- to increase the efficiency of spectrum use;
- to improve the efficiency of the frequency assignment and co-ordination processes;
- to supplement the expertise of the national spectrum manager[7].

3.6 Other fees and charges

In addition to the income and costs arising from the issuing of licences there are other functions of an administration associated with spectrum management activities that generate costs and income. These fees and charges may be based on a simple fee that does not recover the cost of the function or on a cost recovery basis. Some examples are given below.

- **Type approval fee:**

This is a fee charged by the administrations for the type approval of terminal or radio equipment. The equipment once it has been tested in an accredited test house receives a type approval certificate from the administration and thereafter the equipment can be placed on the market. In the immediate future more and more equipment will be approved once for the whole of the EU or CEPT market and more equipment will be covered by the manufacturers self declaration procedures.

[7] Extract from **Chapter 4** of Report ITU/R SM.2012 Economic aspects of spectrum management

This may imply that the income from these fees could diminish in future.

- **Accreditation fee**

In most countries testing of terminal and radio equipment is performed by independent accredited test laboratories which form no part of the administration, and even in some countries where the laboratories are still part of the administration, fees are collected for the accreditation of the laboratories. In most countries this is done by independent accreditation bodies, but in some countries it is done by the administration.

- **EMC fees and charges**

The introduction of European regulation in the area of EMC led to costs for the administrations in the area of market surveillance. Some administrations have therefore chosen to levy an EMC fee on the equipment that is covered by this regulation or in another way collect a contribution from manufacturers or others.

- **Inspection fees**

In some cases administrations inspect installations after the licence holder has taken the equipment into use. This can be done systematically or randomly. In some cases the fee for the inspection is covered by the normal licence fee, in some cases it is a separate fee.

- **Fees for dealing with interference complaints**

Administrations usually investigate interference complaints either from licence holders or other members of the public. In order to prevent that complaints are too easily made, a fee can be asked, either in all cases or only when the complaint turns out to be not justified.

- **Fees for examination certificates (radio amateurs, maritime examinations)**

In the cases of radio amateurs and maritime users applicants have to pass an examination in order to receive a certificate before they are allowed to operate their equipment. Administrations ask a fee for the issue of these certificates.

3.7 Discussion

The earlier mentioned ITU report is based on the position that globally many countries do not have a system for charging for issuing licences, whereas in the CEPT the majority of countries are recognised to charging for a licence. Of the countries that charge some use a simple fee system and other a cost recovery system.

In those countries that do not charge for licences the taxpayers pay for spectrum management, even if they get no benefit from the use of radio. This is considered unfair since radio users are then being subsidised and are not paying appropriately for the spectrum they use. Although the system of not charging is administratively simple, it is fairer to charge radio users for the issue of a licence. How this is achieved should depend on the requirements of the administration and of the two options, simple fee and cost recovery.

The simple fee (i.e. a flat rate fee) is easy to use and to operate, but it does not differentiate between users. Hence, small users of spectrum may be charged the same fee as large users. The fee may be varied between users based on the quantity of spectrum they occupy and even on the geographic area in which they are operating (which could be used to incorporate a charge for spectrum congestion). However as the fees charged for these elements are not based on the value of the spectrum, nor on any management costs, their introduction reduces the transparency of the charging system and can make the application of fees to different users purely arbitrary. There is also the potential, if the fee is too high, that it may force radio users to stop using the spectrum, removing the benefit the user gets from the use of radio and reducing the benefits the country receives from their use of radio (see **Chapter 8.1**).

From the point of view of licensees, cost recovery can be a fairer system, in that it apportions the cost of managing the spectrum to those that are using it and is transparent. However, cost recovery requires administrative resources to monitor and record the costs of spectrum management. To ensure maximum transparency of the licence fees, it is necessary to be able to produce independently validated -audited- accounts. Both of these points dramatically increases administrative overheads and may require substantial financial systems to be developed so that the costs can be matched to the fees. In

addition, the decision on how the charges are structured, whether they are direct or indirect costs and which should be charged to the licensee or to the state can cause further administrative complications.

Not surprisingly there are considerable variations throughout the CEPT on which spectrum management functions are charged and the category of costs in which they should be recorded. There are differences between the systems applied with regard to:

- the costs that are included, only direct or also indirect costs, partly or as a whole,
- the way the costs are divided over the users of the frequencies,
- which users have to contribute,
- how the direct costs are calculated, on the basis of costs made for the individual licensee or on the basis of the costs made for a category of licensees.

In a cost recovery system the precise distribution of costs to licensees will depend on the legislative requirements of the administration, the distribution of licensees across the spectrum and the licence structure. Costs based on licence categories may not take account of users' ability to pay, to the detriment of some users (e.g. users in remote rural areas) while other users do not have sufficient incentive to use the spectrum efficiently. Costs based on the individual licensee's costs are even more difficult to record and again offer no incentive to use the spectrum efficiently. Cost recovery's major disadvantage is that it inhibits charging users fees that are based on their proportionate use of the spectrum and the level of spectrum congestion that exists, which can have the effect that large spectrum users benefit to the detriment of the small users like for instance PMR users. This makes it very difficult to use fees to promote efficient use of spectrum by encouraging users to move to more efficient technologies or to less congested frequency bands.

The way radiocommunications are used and their level of development in a country will therefore have an impact on the way the spectrum is managed and fees are charged. In the beginning the best way to introduce spectrum management is probably to provide state funding but as the spectrum usage increases, the demands on spectrum management also increase until the cost eventually drives the administration to recover them from licensees. Simple fees (flat rate), although straightforward, are not transparent and there is a danger the administration may charge more than the market (spectrum users) can bear. Cost recovery prevents the administration overcharging users for spectrum and, particularly if the accounts are audited and published, is a more transparent process. However it also makes it difficult to set fees on the basis of spectrum used and virtually prevents the administration from using fees to promote efficient spectrum use.

4 TRADITIONAL LICENSING MECHANISMS

The previous Chapter discussed the funding of spectrum management and indirectly fee structures with only a brief mention of licensing mechanisms. Different licensing mechanisms are required to deal with the distinct needs of individual radio users and the time period that a frequency band may be open for assignment. The latter point is dependent on the spectrum available and perhaps the service concerned. For example it may take between two and ten years to fill a Fixed Link or PMR band; for public networks or broadcasting the demand may be such for the available spectrum that all the available licences are issued at the same time. How spectrum is made available and the method used to assess potential users will therefore depend on the circumstances.

4.1 First come first served

This is the licensing mechanism most frequently used by administrations. Licence applications are dealt with in the order of their receipt. The licence is granted when the frequency is available, the appropriate spectrum management functions have been completed and the applicant fulfils the application criteria. This mechanism is appropriate when there is no shortage of spectrum and licences have to be issued to a potentially large number of users. The first come first served frequency assignment mechanism can be used with any of the charging policies discussed under **Chapter 3**.

4.2 Tender procedures or beauty contests

This licensing mechanism has been used for a number of years by administrations to determine which applicant should have access to a limited quantity of spectrum. It has probably been used most frequently for broadcasting or public mobile systems. The mechanism is based on the competing applicants submitting their proposals for operating the service; these would then be assessed by the administration. The proposals would typically include information on population coverage, quality of service, speed of implementation, and the operators business plan. For broadcasting there would be information on programme content: number of hours of children's programmes; educational programming; news services. The applicants proposals are usually prepared in response to a set of established criteria that has been published by the administration.

The review of the proposals can be time consuming and resource intensive. There is no obligation on the part of the administration to issue a licence to any of the applicants if no applicant complies with the criteria. The review might be subjective and unless the reasons for the rejection of the losing applicants are clear and they conform to the administrations published criteria, the losing applicants may apply for a judicial review. Any legal challenge can have a significant impact on the administrations time scales for starting the service and may require the administration to repeat the whole tendering process.

Operating a tender procedure can be expensive and time consuming even without the threat of a legal challenge. Hence this licensing mechanism is only usable when there are a small number of applicants for a limited number of licences and is most likely to be used with national budget financing or a simple fee. Use with a cost recovery system is unlikely.

An advantage of the tender procedure is that it takes the qualifications of the future licensee into account and has the objective of issuing the licence to the organisation best equipped for fulfilling the licence requirements.

4.3 Comparative bidding

This licensing mechanism is gaining increasing currency for determining which applicants should have access to the spectrum. The mechanism is based on the tender procedure but instead of the administration issuing a licence free, or for a set fee, the applicants are invited to submit a cash bid in addition to meeting the requirements of the administrations published criteria. Thus, the bidders determine the cash value of the licence fee.

The introduction of the applicants cash valuation provides a limited indication of the spectrum's value but it is not a true market valuation as the aspects of the applicants submission included in response to the administrations published criteria may have a significant impact on the cash bid. To prevent applicants forming a cartel to reduce the monetary element of their submission it

is not unusual for the Government, having taken an administrative decision on the spectrum's value, to set a lower limit on the cash element of the submission.

Like tender procedures all submissions are reviewed by the administration. Again there is no obligation on the part of the administration to issue a licence to any of the applicants The review may be simplified if a number of applicants equal to the number of licences available, clearly present a submission that exceeds all of the administrations criteria and offers the best monetary valuation. However, in most cases the review procedure is more complicated as the cash bid is only one element of the submission and the highest cash bid is not guaranteed to win. In addition the introduction of the monetary element requires a more thorough evaluation of the applicants business and especially financial plans. The review process with comparative bidding can be similarly time consuming and resource intensive as the tender procedure. Unless there are clear winners, it is arguable that the administration's decision might be as subjective as the tender procedure and is even more open to legal challenge, because different elements (financial and other) are evaluated.

The comparative bidding procedure has the same drawbacks as the tender procedure but it can cope with a larger number of applicants (providing all of the bids are not similar). This licensing mechanism can be used under the simple fee approach or as a completely separate licensing procedure outside the cost recovery system and national budget financing. Operated within a cost recovery system, comparative bidding may present cost versus income problems under the legislative requirements of some countries.

An advantage of comparative bidding as with the tender procedure is that it takes the qualifications of the future licensee into account and has the objective of issuing the licence to the organisation best equipped for fulfilling the licence requirements. An additional advantage is that it partly takes the value of the spectrum into account.

4.4 Lotteries

This licensing mechanism is based on selecting the winners at random from the competing applicants. In its simplest form a lottery is simple, quick and transparent, and as there is no need for any review of the applicants there is little possibility of a legal challenge to the decision. However, unless there is some kind of entry fee the winners are given the spectrum free of charge. Consequently the administration may decide to impose a fee for entry to the lottery and possibly other entry criteria. Additional constraints may restrict the number of applicants and also recover some of the value of the spectrum, but they also slow the process down as each applicant will need to be evaluated. Entrance constraints also make the process more complicated and less transparent, opening up the possibility of a legal challenge.

In its simplest form lotteries can cope with a very large number of applicants. Lotteries can be used with any of the funding approaches discussed under **Chapter 3**.

There does not seem to be much interest in introducing lotteries in the CEPT. The only administration that is known to intend to introduce it is Hungary. They intend to introduce auctions and lotteries for limited categories, at this moment defined as MVDS and local or regional paging. The detailed procedures and organisation of these processes have not yet been established nor is it certain whether in future more services will be covered by these procedures.

4.5 Discussion

The licensing mechanism most commonly used with national budget financing or spectrum usage fees is first come first served (although it is not specifically addressed in the ITU report as it concentrates on economic principles behind the different mechanisms). The first come first served system is, as indicated earlier, a system that is most suitable when large numbers of similar licences are issued to applicants over a long period of time. For many licence categories, like radio amateurs, Private Mobile Radio, Fixed Links and other individual user groups, this licensing mechanism is expected to remain the most effective for the foreseeable future. Although the charging policy may need modification to include methods for regulating demand (e.g. administrative pricing).

Other mechanisms like tender procedures, comparative bidding and lotteries are however necessary when the number of applicants exceeds a limited number of available licences (e.g. where the number of licences are strictly limited by spectrum availability and there are potentially a large number of applicants) and particularly if they have to be assigned in a short time period. All of these mechanisms have their advantages and disadvantages. There is little difference between tender procedures and comparative bidding, both mechanisms require subjective decision making to decide the winning applicants and therefore suffer from a lack of transparency. They can also lead to a situation where the winning applicant has over enhanced the technical/quality elements to win the bid and then has to develop a service where, for example, the quality or capacity of the system are in excess of operational requirements.

Selecting the winning applicants on the basis of a subjective decision can cause concern among the losing applicants that the winning margin is not clearly defined and consequently they may mount a legal challenge based on the difficulty in applying the criteria and the relative merits of the winning and losing applicants bids. Depending on the complexity of the proceedings a judicial review can cause considerable delays in the introduction of the required service.

Lotteries can remove the problems of subjectivity and transparency and they enable a licence to be assigned quickly. However, they can cause speculative bidding in spectrum and may assign spectrum to someone who does not value it. In addition unless entrance criteria are used the winning applicant may not prove capable of providing a service.

To minimise the above mentioned negative effects of tender procedures, comparative bidding and lotteries, it is possible to use variations of the mentioned systems, like for instance a lottery in which applicants can only take part when they meet certain minimum criteria.

5 SPECTRUM PRICING

In recent years the liberalisation of telecommunications and ongoing technological developments have opened the door to a variety of new spectrum applications. These developments, though often making spectrum use more efficient, have spurred greater interest and demand for the limited spectrum resource. As a result in some geographical areas for some services and certain frequency bands, the demand for spectrum has exceeded the available supply. At the same time the increasing tendency for shorter development cycles, has increased the pressure on spectrum managers for quicker decisions on who and which technology should have access to the spectrum. In these circumstances the charging policies and licensing mechanisms, as described in **Chapters 3** and **4**, may not be the optimum solution for managing access to the spectrum. The charging policies and licensing mechanisms have a number of limitations as they cannot:

i) by themselves provide a transparent mechanism for promoting efficient use of spectrum;

ii) prevent users from stockpiling spectrum that they do not really need;

iii) provide any incentive to move to alternative bands when this would be desirable;

iv) provide a means of quickly assigning a limited quantity spectrum, when there is a high level of demand and strong competition between applicants.

In addition some of the licensing mechanisms are difficult to operate because of the number of applicants and more prone to legal challenge as the administration's decision making process (especially the comparative process) is not sufficiently transparent.

If the administration is to avoid the spectrum becoming congested and continue to be able to make spectrum available for new user services and technologies then new techniques are required to complement spectrum management's traditional management methods. New techniques enabling the administration to include incentives for radio users to use the spectrum efficiently, including new licensing mechanisms for deciding which applicants will receive a licence. The concerns have led to the development of economic methods, these include the use of fees for influencing the behaviour of users (administrative pricing - a differentiation in pricing with regard to set criteria) and a new licensing mechanism (auctions). The use of economic methods is not simply a matter of increasing the price charged for a licence, as this could lead to the spectrum being underused a situation all administrations want to avoid.

5.1 Administrative pricing

In a global context the term administrative pricing has a more extensive definition than in this CEPT Report. The term administrative pricing in this Report is equivalent to a version of administrative pricing called 'administrative incentive pricing'. It is a charging policy enabling administrations to differentiate fees in order to influence the behaviour of spectrum users. In this approach, administrations set their licence fees at levels which are not dependent on cost-based limitations and a fee structure is developed that approximates to the market value of the licence, thus attempting to capture for the public the economic rent for use of the spectrum. The aim of administrative pricing is to make the users use the spectrum more efficiently, with the intention of bringing the demand for spectrum into equilibrium with its supply by:

i) encouraging users to move to more spectrally efficient equipment;

ii) handing back spectrum they do not need;

iii) moving to a less congested part of the spectrum.

Administrative pricing may therefore also provide a mechanism to support a policy on spectrum refarming.

The licence fee is developed from a formula that attempts to reflect the scarcity value of the spectrum. Typically this formula may include a number of criteria:

- **Frequency Band**

The fee charged varies with the frequency band to encourage users to deploy new services in parts of the spectrum under less pressure or to move existing services to bands where there is spare capacity. The administration should also recognise that some services need specific frequencies or specific frequency ranges to function e.g. H.F communications, meteorological services.

- **Bandwidth Used**
  The fee varies with the amount of spectrum a user occupies and is used to persuade existing users to give up spectrum they do not need, and to persuade new users to seek only the minimum they require. It can also be used to persuade all users to utilise more spectrally efficient equipment. This is a method already employed in principle by charging per link in the Fixed Service or per channel for PMR.

- **Exclusive or shared use**
  The fee increases for users with access to an exclusive channel.

- **Geographical Location**
  The fee is higher for operators in highly congested areas (e.g. city centres) and is lower for those in less congested areas (e.g. rural areas). Note: in practice some rural areas are more congested than some cities and usage will vary with the type of service and the frequency band.

- **Coverage**
  The fee varies depending on the area covered by the transmission. (Strictly speaking, this refers to the sterilised area, meaning the area that cannot be used by others because of the use by the licence holder and equates to the coverage area plus a buffer zone). Coverage area is also used in the sense of the number of people reached (potential viewers or listeners).

- **Trunking**
  Differentiation of charges between the use of highly efficient trunking systems and individual radio systems.

In practice a combination of criteria would be used. Care would be needed to keep the system fair, transparent and consistent with prevailing market conditions. However, using a formula to simulate the market place is very difficult and although different feedback methods may be used no formula, no matter how complex, can take in all the variations of the market place.

Further information on administrative pricing measures (what services, which elements are to be taken into account in defining the fees) is contained in **Annex V**.

5.2 Auctions

Auctions represent a new form of licence mechanism where the applicants determine the value to be charged. In this way the price of spectrum is determined fully by market forces and the frequencies allotted to the winning bidder. Auctions allow the administration to capture for the public the full economic rent for the spectrum. An auction may be based purely on the price bid, but this is unusual for licensing spectrum. Typically the administration would set criteria that form the entrance conditions applicants have to meet to take part in the auction. These criteria may be similar to the type of conditions set in comparative bidding, except in the auction environment they are not used in determining the winner.

Auctions resolve some of the problems identified with tender procedures and comparative bidding. They are quick and efficient reducing the time and cost, and can cope with large numbers of applicants. In particular because the operation of auctions are transparent they considerably reduce the possibility of a legal challenge. However, the more criteria and conditions that are applied to an auction the greater possibility of reducing the value of the spectrum and possibly the competition. It also has to be born in mind that auctions need to be prepared carefully in order to create a good result, which is time consuming and resource intensive.

Auctions are not however a universal panacea and are only suitable for specific licences and conditions. They are not suitable for example for high volume, low value licences. In addition it may be necessary to impose safeguards to promote competition

to reduce the impact of dominant organisations. Auctions can take a number of forms, some examples are:

- **English auction**
  The auctioneer increases the price until a single bidder is left;

- **First-price sealed bid auction**
  Bidders submit sealed bids and the highest wins;

- **Second-price sealed bid auction**
  Bidders submit sealed bids and the highest bidder wins but pays the second highest amount bid;

- **Dutch auction**
  The auctioneer announces a high price and reduces it until a bidder shouts “mine”;

- **Simultaneous multiple round auction**
  As pioneered by the Federal Communications Commission in the USA. This involves multiple rounds of bidding for a number of lots that are offered simultaneously. The highest bid on each lot is revealed to all bidders before the next round when bids are again accepted on all lots. The identity of the high bidder may or may not be revealed after each round, but is revealed at the auction's close. The process continues until a round occurs in which no new bids are submitted on any lots. This variant is more complex than single-round auctions but offers bidders greater flexibility to combine lots in different ways, and, because it is more open than a sealed bid process, limits the impact of the winner’s curse, allowing bidders to bid with more confidence.

In all auctions a reserve price may be set, although so far the USA has not used a reserve price in their spectrum auctions.

5.2.1 Advantages of auctions

Auctions have a number of advantages over other licensing mechanisms by:

- promoting efficient use of the spectrum by providing the winning applicants with an incentive to use it efficiently;

- providing rational and transparent criteria for award of spectrum licences;

- auctions are administratively simple; the level of simplicity will depend on the use of any entry criteria but even where entry criteria are used the operation of an auction is still simpler than comparable licensing mechanisms, with the possible exception of lotteries.

- obtaining for the public the economic rent which accrues from a scarce public resource;

- reducing the opportunity for favouritism and corruption;

- allocating licences very quickly;

- charging those people who directly benefit from using the spectrum;

- providing for a mechanism for matching a limited number of licences to a large number of applicants and can be easily modified to handle different types of end user service.

It should be noted however, that a number of the mentioned advantages, as for example, obtaining the economic rent and providing a mechanism for matching a limited number of licences are valid also for the case of comparative bidding (both) or tender procedures (only the last mentioned advantage).

The main aim of an auction is to select the operators who will use the spectrum most valuably. Capturing rent is in fact secondary, although this is part of obtaining a fair return for the taxpayer for making the resource available.

5.2.2 Disadvantages of auctions

- the preparations of an auction for the first time is time consuming and resource intensive;
- the licensee expects more quality of service if having paid a considerable price ;
- auctions are not a universal cure for all spectrum management problems and are not suitable if:
    - there is no competition;
    - there are many small individual lots that are all different (e.g. Fixed Links);
    - the spectrum right cannot be defined properly;
    - providers of socially desirable service cannot put a financial value on the spectrum and this could lead to an under provision of these services to society if they faced auctions;
    - the cost of holding the auction are likely to exceed the revenues that could be obtained.

5.3 Discussion

Spectrum pricing can resolve some of the problems identified in **Chapter 3** by providing a charging policy (administrative pricing) for encouraging more efficient spectrum use and through the auction mechanism, a method of rapidly assigning licences that can remove the problem of transparency and judicial review.

The term administrative pricing has potential for causing some confusion as the global and CEPT understanding of the term varies. In the global sense administrative pricing includes incentive pricing, shadow pricing (where the spectrum manager tries to emulate market prices) and traditional charging policies like simple fees. However, in the CEPT the term administrative pricing means the specific use of an incentive mechanism (ITU definition: administrative incentive pricing) to encourage efficient use of spectrum. The incentive mechanism may be based on a number of criteria related to the frequency use, like area sterilised, radiated power, bandwidth, exclusive use etc.
In a way such systems have to some degree already been introduced in some countries in the CEPT for some services, like for instance in Finland, France and Hungary.

In some countries inside and outside Europe (UK, Canada) plans are being developed for the introduction of an overall system of “administrative incentive pricing”. The use of this charging policy is based on the development of formulae representing specified criteria (e.g. like the criteria listed in the previous paragraph) and taking into account the level of congestion in the geographical area at the specified frequency band. Different criteria and formula may need to be developed for each service included in the administrative pricing fee structure.

The use of auctions is currently being heavily debated in Europe by administrations as well as operators. Although there is little experience with spectrum auctions in Europe (only in the Netherlands), they have already been used in some cases for assigning telecommunications licences and their use in countries outside the CEPT have shown they can provide an addition to the current mechanisms for issuing licences and assigning spectrum. Consequently a number of administrations (Belgium, Germany, Hungary, The Netherlands, UK) have either revised or started to revise the necessary legislation to allow the introduction of auctions. While other administrations (Denmark, Finland, France, Norway, Poland, Sweden) have no current plans in this direction.

There are countries, like for instance Denmark, which feels that the instrument of auctions would raise the price of the telecommunications service provided on the basis of the frequencies in question, as it must be expected that the network and service providers would pass the increased costs on to the end-users. Spectrum management principles that may increase the price of service to end-users are considered inconsistent with Danish policy.

Many operators and potential operators of public mobile networks (terrestrial as well as satellite) are cautious about the introduction of auctions. This caution may be in part due to the limited information previously available on spectrum pricing in general and auctions in particular. This has led to negative opinions on the part of operators, for example, that the introduction of spectrum pricing will inflate costs, or that it places too large a burden on the operators at the start of the service. This type of opinion was one of the reasons for the development of the ITU-R Report SM.2012. There is no evidence to suggest that the fees obtained from an auction process would exceed the total bid price (the cash bid plus the total cost of the service provision including the "quality elements") from competitive bidding. The bid price will depend on the value of the lot and this will be based on many factors. Providing that competition exists, it is unlikely, that introducing auctions will push up the costs to the end user, in fact experiences in other areas indicate that prices to the end user will fall as the operators strive to maximise their market share. The single most important factor for auctioning a licence is that the winning applicants' services should face competition and a prerequisite for auctions is therefore that effective competition legislation exists to ensure the operators do not form price fixing arrangements.

In terms of the burden on the operators at the start of the service, obviously the operators would be aware of the cash flow requirements and any concerns they had in this direction would presumably be reflected in the size of their bid. However, in some cases there may be a requirement to open up the auction to a wider range of potential operators and one way to allow smaller operators to compete with big players could be to permit the staged payment of the winning bid (and is no different from the payment facilities currently operated under comparative bidding procedures). This variation in payment is in many respects a secondary issue as it is far more important that the auction is properly designed so they can provide certainty, stability and security of tenure for the winner applicants. The efficiency of auctions and the benefits they can provide will therefore depend on the conditions placed on them. These conditions are likely to vary for each auction, although there is likely to be a common set of criteria (specific conditions will be dependent on individual administrations national legislation) for every auction to ensure that the winning applicant conforms to the requirements of the licence.

A further factor in the caution shown by operators may be due to concern that auctions might be introduced for satellite systems. It is not impossible to auction satellite services but, as recognised in ITU-R Report SM.2012, auctions in multiple countries would be difficult and resource intensive and "such a cumbersome process could lead to delays in implementing new and innovative services". These problems would make the auctioning of international services extremely difficult. The only possible exception is where a satellite footprint is wholly within the territory of the originating country (i.e. a purely national service).

6 SPECTRUM RIGHTS

The introduction of spectrum pricing has raised a number of issues on the rights a licence confers on a licensee, the level of control retained by the administration and the licensee's spectral obligations to other radio users. These issues are likely to be country dependent as the licence in most countries has a basis in national legislation and as previously noted in this report, there are variations between CEPT member states legislation. Consequently there is unlikely to be a single model equally suitable for all countries and not all of the issues raised in this Chapter will be relevant in all cases. It should also be noted that the relationship with national legislation may mean that unexpected issues could emerge in countries that have not introduced spectrum pricing.

6.1 Security of tenure and licence duration

Licence duration and security of tenure are two separate issues that are linked through the conditions attached to a licence.

6.1.1 Security of tenure

The issuing of a licence provides a licensee with some security of tenure for a stated period of time. The extent of this security will depend on the licence duration and the revocation procedures associated with the licence. Revocation procedures are required to safeguard against instances of the licensee repeatedly ignoring the conditions of the licence (for example, transmitting at higher radiated power levels, operating over a wider bandwidth) or for the administration to recover the frequency if that area of the spectrum needs to be re planned. The ease with which the revocation procedures can be implemented, the level of justification required to support the revocation procedures, any form of redress open to a licensee (for example: an appeal against the revocation for a licence, a claim for compensation) and the licence duration determines the security of tenure of a licensee. Of course, security of tenure may be increased by the administration stating they have no intentions to replan the frequency band for the next "X" years, where "X" is equal to, or less, than the licence duration. In this respect an increase in security of tenure may also require an increase in licence duration, indeed it is difficult to imagine any extensive transferable or flexible spectrum rights system based on a yearly licence.

Whether licensees view their security of tenure in the same way as the administration is not clear, but it is likely they will approach the issue from a different perspective. A licensee's view of security of tenure is likely to be based on their level of confidence in retaining their licence and the pressure that failure to retain it will bring to their business. Licences that are for a single year or have to be renewed annually may therefore decrease the security. In addition, to the licensee, a radio licence represents an asset[8], even without the introduction of transferable or tradable spectrum rights, as it may be used to increase the value of the company. In these cases the increased value of the company will be based on the fact that the number of licences available is limited, i.e. they have a licence and others therefore do not. For small companies this can be used as a means for borrowing money from banks, and for large companies, like broadcasters or telecommunication providers, as a means of raising capital in the market. However, irrespective of how funding to a company is provided, the greater the level of investment in radio systems or the greater the dependency of the business on the use of radio then the greater the requirement for security of tenure. This requirement applies to both spectrum pricing and traditional methods for funding spectrum management.

6.1.2 Licence Duration

The licence period varies between countries. Normally the licence period lies in the range 1, 5 or 10 years, although some special licences may be shorter and in some countries licences may be issued for an indefinite period subject to the annual payment of a fee. The annual payment of a fee does not make a licence an annual licence, but this may not be the way it is viewed by licensees who may regard the annual payment element as a reminder of the limited nature of the licence. Longer licence periods do not automatically imply any greater security of tenure, as this is dependent on the conditions attached to the licence. However, annual renewal may make it easier, or more convenient, for the administration to terminate a licence, as opposed to the use of revocation procedures with several years of a licence remaining.

[8] In this section asset is not used in its standard accountancy form.

6.1.3 Licence fees

The period for payment of licence fees does not have to be linked to the renewal date or the licence period. Payments can be structured so that even for annual licences, payments are made at i.e. quarterly intervals, which would provide a more regular source of income for the administrations, particularly under a cost recovery system and allow the licensee to stagger payment. For operators with a large number of licences, or as licence fee payments increase under auctions or administrative pricing, then payment by instalment may provide greater financial flexibility.

6.2 Spectrum Rights

Spectrum pricing has led some administrations and licensees to reconsider the rights or permissions associated with a licence, what they include, how they should be defined and whether they should be tradable. There are two alternatives; one a licence to use equipment, the other spectrum rights. In practice there are many permutations of spectrum pricing/traditional charging policies, spectrum right/equipment licence but some are unlikely in practice. For example there is little point in introducing spectrum rights without spectrum pricing and a non-tradable spectrum right may have little advantage over an equipment licence.

6.2.1 Spectrum Rights obtained by the Licensee

In some respects spectrum may be analogous to land in that it can be divided into "lots" that may be conveyed or leased. However, spectrum is not as easily defined or delineated as land since radio propagation is not limited by physical or political boundaries. In addition although the "sale of spectrum" is a term that is often used in connection with auctions, it is really only a conceptual idea. In practice it is the licence that is sold and an auction is simply a market mechanism used to assign it.

The spectrum rights a licensee obtains depends on the individual licence and its associated conditions and exclusions. These rights are conferred on the licensee when the licence is assigned. Spectrum rights normally cover details stating the precise technical, or operational characteristics, of the radio system that will be used from a specified location, or within a specified area. They may also include requirements on, for example, the periods of operation or frequency sharing.

Under traditional licensing mechanisms it has been accepted that the administration has, amongst other things, retained the rights to modify the conditions of the licence, resolve interference complaints and take responsibility for related international spectrum issues. The introduction of spectrum pricing, i.e. auctions, has led competing licence applicants to question the extent of the conditions to which they will be subject. These questions have arisen because:

- to the licensee, the licence represents an asset[9] (irrespective of the licence period but the longer the period the greater the value of the licence) that, may be used to finance their development programmes. The fewer restrictions that are imposed on the use of the spectrum the greater the value of the licence and conversely the more restrictions the lower its value.

- each auction normally has a set of criteria specifying the conditions under which the spectrum licence will be put on offer, these may be in addition to a statement of the spectrum rights granted by the licence, and those retained by the administration. If the criteria contradict the statement of spectrum rights, or do not accurately reflect the spectrum rights associated with the licence, then they may:

    i) inhibit the operation of the auction or,

    ii) if at some later date they are the subject of a dispute between the licensee and administration, raise doubts on the value of the licence - this may also result in a legal challenge to the administration or a claim for compensation.

[9] In this section asset is not used in its standard accountancy form.

6.2.2 The Spectrum Rights Retained by an Administration

The spectrum rights retained by an administration are important to it and any applicants competing for spectrum. They are also important to the administration's neighbours[10]. From the international perspective the administration should retain the spectrum rights necessary to:

i) provide the international contact point for radiocommunications issues;

ii) take responsibility for all radio signals originating on its territory

iii) meet its obligations under international agreements and treaties (for example the ITU Constitution) and should include the right to reclaim the spectrum before the licence has expired, if it should be necessary to meet, for example, the requirements of an international agreement to reallocate the spectrum on a regional or global basis.

The spectrum rights listed above are likely to be the minimum an administration would wish to retain and in practice there may be additional requirements. These additional requirements will depend on the specifics of the auction and its associated legislation. The additional requirements could vary for each auction as they may include, amongst other things, control of the service, the type of radio system, its coverage area, frequency band, exclusive or shared use and how the radio system will be used.

6.3 Transferable or Flexible Spectrum Rights

An auction could be the licensing mechanism most capable of providing an economically efficient allocation of spectrum at one point in time, but it cannot allow for someone coming along at a later date who can make better use of the spectrum. Therefore other means must be found to ensure the spectrum continues to be used efficiently and two, non-mutually exclusive, solutions have been examined in several countries.

i) Transferable spectrum rights - the transfer of a licensee's spectrum rights either in whole or in part, to a third party.

ii) Flexible spectrum rights - the permission for a licensee to modify their spectrum rights and so allow for changes in modulation techniques, population densities, transmission powers, frequencies etc.

In some countries some form of transferability or flexibility of spectrum rights may be possible with the permission of the administration under their existing legislation. However, this brings the administration directly into the decision making process, and that is likely to introduce delays and constraints on the whole process.

To avoid unnecessary constraints on the operation of these spectrum rights and to ensure they are completely economically effective, the definition of the spectrum rights needs to be flexible. The least restrictive definition would allow the licensee to choose the end user services they provide, but this is most probably unacceptable to administrations. There have at least to be limits to the flexibility in the sense that the existing end users are sufficiently protected and that no interference is caused to other users of the spectrum. At the other end of the scale, the most restrictive form of spectrum rights limits transferability within a specific allocation and a set of tightly defined technical parameters, but this might not provide sufficient flexibility to achieve economic efficiency. An acceptable solution lies somewhere between these two extremes in achieving an acceptable balance between economic efficiency and restrictive technical parameters. Essentially it is a problem of the greater the flexibility, the greater the possibility of interference which would in turn require greater input from the administration. One solution to this problem of increased interference might be, in some circumstances, to permit licensees to negotiate their emission rights - effectively one licensee accepts greater interference in exchange for compensation - but this idea has not been properly examined.

6.4 Secondary Market

[10] In this respect neighbouring countries will depend on propagation distances and may extend up to a 1000 miles or possibly more depending on frequency and whether the propagation path is over land or sea.

The introduction of transferable spectrum rights does not provide any significant benefits unless it can be traded and this requires an enabling mechanism - a secondary market - for openly trading this type of spectrum licence. If a secondary market does not exist, then small users with transferable spectrum rights could find it difficult to attain the current market value for their spectrum and may be at a disadvantage compared to large users. At present, most frequency licences throughout the world are not transferable and a secondary market would clearly need both transferable spectrum rights and a licence with adequate security of tenure and duration to operate. The ability to trade spectrum would encourage its efficient use by providing a mechanism for licensees to obtain an economic return on their investment in any spectrum they no longer require. This might be particularly appropriate in the mobile and fixed link areas.

Any transfer of rights would need to be registered with the spectrum management authorities and the spectrum market, like any other market, would need to be regulated to avoid abuses. In particular there would be a need for competition legislation to prevent hoarding of spectrum and price fixing. If a market in spectrum were to develop then it is likely there would be a need to help establish new organisations to provide frequency resale and, perhaps, spectrum marketing services.

6.5 Discussion

Spectrum rights and related issues seem to be frequently referenced as integral elements of spectrum pricing. This is not correct, the introduction of spectrum rights should be seen as an additional and separate step that may follow the introduction of spectrum pricing. Spectrum rights are not necessary for the introduction of spectrum pricing, as spectrum pricing can operate with traditional license conditions (i.e. permission to operate). Whereas spectrum pricing is a prerequisite if spectrum rights are to be introduced and are to operate correctly. Even with spectrum pricing there is limited benefit in introducing spectrum rights unless it is possible to trade them. For this reason it is assumed that the introduction of spectrum rights would be a precursor to establishing a secondary market that would allow them to be traded.

If an administration proposes to introduce spectrum rights, their definition and the legal basis for the trading process are very important. In giving the licensee greater rights and perhaps the ability to change aspects of the service they provide or its technical characteristics, the administration needs to ensure that they retain adequate control of the spectrum and have the capability of recovering it should the necessity arise.

A degree of flexibility in the definition of a licensee's spectrum rights is clearly desirable although there are limitations. In particular, the ability of the licensee to change the service they provide does raise problems, particularly where there are a number of countries with many close borders, concerning:

i) the potential technical and interference problems of having different types of service operating in the same frequency band or on the same frequency;

ii) the impact of the licensee changing the service they provide (to take advantage of changes in the market conditions) on the users of their existing service.

In the former case, although it may be possible to operate some services in the same frequency band, there are potential difficulties seen with mixing, for example, mobile with broadcasting; personal mobile (e.g. pager, phones) with aeronautical mobile or radio navigation. There is also the question of protection from cross border interference that would arise from a national allocation that differed from Article S5 of the Radio Regulations. In the latter case, the licensee may also face practical problems in changing the service they provide. Presumably it would be necessary for the licensee to recover any investment in their initial service/system and any change to a new service would need to take this into consideration together with the number of years remaining on the licence. In addition other factors may affect the recovery of investment (both in the existing service and planned for the replacement service), like the availability of any new equipment for provision of the replacement service, the time required to roll out the replacement service and any new equipment to users.

7 SPECTRUM PRICING - FURTHER CONSIDERATIONS

The introduction of spectrum pricing needs careful consideration but it can provide an opportunity for resolving recurring spectrum management problems. This Chapter examines some of the implications of implementing a spectrum pricing regime and the scope for developing and improving spectrum management.

7.1 Spectrum pricing income and its potential use

If an administration intends to implement spectrum pricing, then consideration should be given to its operation, the generation of any income in excess of their spectrum management costs, and the purposes for which this surplus could be used. The implementation of spectrum pricing does not mean that an administration will automatically produce a surplus and this needs to be recognised by those administrations that fund their spectrum management activities from licence fees as:

i) spectrum pricing may require the expansion of some spectrum management activities to provide necessary information for its operation, (e.g. monitoring services);

ii) there is a need to consider the type of spectrum pricing introduced, its purpose and its long term operation.

Administrative pricing is expected to alleviate spectrum congestion and persuade users to move to more spectrally efficient equipment, or new frequency bands, which attract a lower licence fee. It is a pricing policy that can be used in the long term for regulating access to a block of spectrum. If administrative pricing is to be successful then the surplus in any frequency band may only be temporary as the users will change their habits and move to new equipment or frequency bands. In addition if the demand for the band decreases its market value and hence the licence fee may also decrease.

Auctions were introduced to decide quickly who from a large number of applicants will have access to a limited quantity of spectrum. It is a licensing mechanism that can be used for a number of services, but only at very infrequent intervals for the same frequency band. The size of any bid will be dependent on the conditions imposed at the auction, the "lot" for sale and any limitations, or conditions, attached to its use (e.g. coverage requirements, interference limitations). A winning bid may therefore be high or low[11] which makes it an unreliable and possibly impractical source of spectrum management funding.

In both cases it is possible a surplus will be generated but the nature of any surplus will depend on the administration's pricing policy and the version of spectrum pricing implemented. How a surplus might be used therefore depends not only on its size in the terms of the overall cost of spectrum management but the variation in the level of the surplus with time. Further, the variability of any surplus from year to year may limit the purposes for which it might be used. The following list provides some examples of the potential use for any surplus.

- **international co-operation**

- **research**

One of the more realistic uses of any surplus as the level of research performed could be varied to suit the available funding; e.g. propagation studies in new frequency bands,

- **reallocating spectrum to new applications (refarming fund)**

This may be possible for a small number of users or low value equipment, however the variability of the surplus is likely to make the management of a fund difficult. An alternative would be to allow the winning applicant from an auction process to compensate the previous tenants of the band – this would form part of the conditions of the auction. Using administrative pricing then the current tenants would be given a time period for vacating the band and would be encouraged by differential pricing.

[11] In the US the winning bids at recent auctions have been considerably below the pre-auction valuation

- **new software and technology**

Any surplus could be used for the development of new spectrum management software or test equipment. Any long term development projects would have to consider the stability of the funding. For example: interference analysis software, licensing software; monitoring equipment.

- **sharing studies**

A reasonable use of any surplus as sharing scenarios between services are increasing particularly with space and as new technology is developed.

- **training of personnel**

There is a general shortage of radio engineers and courses could be funded to attract more applicants.

This is only possible when there is no obligation to transfer the whole of the surplus to the public government funds or arrangements exist for the government to hold funds in lieu of their requirement by the spectrum management authority.

7.2 Spectrum refarming

Spectrum refarming is a spectrum management function and is the physical process by which a spectrum management authority recovers spectrum from its existing users for the purpose of reassignment, either for new uses, or for the introduction of new spectrally efficient technology. It is required for several reasons, for example:

i) spectrum allocations have been made over a considerable period of time and they currently no longer match the demands of users, or the capabilities of modern systems;

ii) an allocation within a specific range of frequencies is required by a new radio service and these frequencies are occupied by services with whom the new service cannot share;

iii) a decision by a WRC to allocate a currently occupied frequency band to a different service on a regional, or global basis.

The importance of spectrum refarming to spectrum planners is inversely proportional to the amount of unused spectrum they have available and their ability to move services, or groups of users to different frequency bands. Spectrum refarming is therefore important for all countries in which the demand for spectrum is greater than their ability to make suitable spectrum available for new users, or uses, within the limits set by the availability and cost of current technology.

7.2.1 Why spectrum refarming is important

Delays in introducing new services are undesirable as they can make a proposed solution obsolete before it can be implemented. In the case of a proposed change affecting one, or more, frequency bands, a delay with one service[12] may affect several other bands and services. Studies[13] have shown that delays in introducing new services are capable of causing a significant loss to a countries economy. However for a variety of reasons (see **Annex VIII** Spectrum Refarming Issues for further information) operating a spectrum refarming is difficult. For example, users are not aware of the value of the spectrum to the country and the problems of the administrations, but are aware of the benefits that it provides their business. The concerns raised by limited spectral availability and the timescales required for making a frequency band available to new users, have led some countries to consider ways they can further improve awareness of the value of the radio spectrum. The problems arising from spectrum congestion and refarming are among the main reasons for many countries considering the proposed introduction of spectrum pricing.

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[12] Whether delays occur will depend on the difficulty an administration has in getting users to agree to the change. Assessment of the difficulty experienced by administrations should be based on their ability to make all users, both public and private, large and small release spectrum when it is required.

[13] Radiocommunications services have been shown in various studies to contribute to a nation's economy (In the UK £ bn & 100,000s of jobs) and may also facilitate the development of other areas of the economy. (The Economic Impact of the Use of Radio in the UK; Study into the Use of Spectrum Pricing both by NERA and Smith Engineering Ltd.

7.2.2 Potential solutions

For the above reasons administrations have considered the creation of a refarming fund that could be used to compensate users if the administration reclaims the frequencies they are using. The proposal for a refarming fund has always been a difficult issue because of the requirement for state funding. However, the introduction of spectrum pricing provides a number of opportunities to resolve this problem and provide compensation to users either by:

i) all spectrum users contributing to a fund through some form of levy;

ii) using the surplus from spectrum pricing.

Which of these options should be used in any particular spectrum refarming scenario may depend on the circumstances involved, for example timescales, the service, number of users. Although the development of a fund may have many attractions, to use it as the sole means of compensated refarmed users could raise a number of problems. These are:

fees raised from spectrum pricing may fluctuate raising the question of what would happen if there were insufficient funds to compensate users.

that users to be refarmed, seeing that a fund existed, might inflate their claims for compensation, thus earning windfall profits and distorting the market.

Although spectrum pricing may provide an approach to resolving one of the main problems in implementing spectrum refarming, the direction the approach should take and the precise mechanism to be used in each instance requires further careful consideration.

7.3 Discussion

The decision on the use to be made of any surplus funding arising from spectrum pricing is a matter for individual governments. However, there are a variety of ways in which increased funding could benefit spectrum management. Of these probably the most frequently discussed option is the development of a refarming fund. Although this proposal has many attractions and a refarming fund would be particularly suitable for compensating many small users when the frequency band is allocated to another group of small users, it could be the case that in some countries there would be legislative problems with licensees contributing to a fund from which they would not gain benefit. In some cases it may therefore be more appropriate to let the winning applicants of licences compensate the existing users of the spectrum. However, there would be a need for clear rules to be established regarding the compensation procedure as it would be generally undesirable:

i) for existing users to assume there was an automatic right to compensation;

ii) if no time limits were set to remove existing users as this may result in their holding the winning applicants to ransom;

iii) if time limits were set irrespective of the need to pay compensation, the winning applicants may then avoid paying compensation and, if the compensation package had been taken into consideration by the competing applicants during bidding for the licence, result in the winning applicant effectively reducing the total value of their bid for the licence.

It should be realised however that compensating licensees is not always necessary. In many cases there will be ample time for the administrations to clear the band from existing users without financial compensation.

8 MANAGING THE TRANSITION

Implementation of any significant change in the operation or structure of an organisation needs to be planned and the transition managed to avoid any unnecessary disruption to the business. However, even if the administration does not consider the move to spectrum pricing, or the introduction of spectrum rights to be a significant change, it is still advisable that it should be managed due to its potential implications for the country's economy, administration, industry and radio users. In particular it is necessary to consider the impact of any change in the existing level of spectrum management funding, both in the short and long term. The type of implications that may arise will depend on the:

i) administration's spectrum management operation and their organisational structure;

ii) the extent and type of radiocommunications and telecommunications services in the country;

iii) the proposed changes;

iv) the country's radiocommunications legislation.

8.1 Why managing the transition is important

Use of radio brings a number of benefits[14] to a country, including improved communications between businesses, the expansion of manufacturing capability and the creation of new radio industries and services. Development of new industries, manufacturing capability and jobs are generally recognised to bring economic benefits to a country. In the same way improvements in the performance of business arising, for example, from improved communications also generates economic benefits. Therefore the more radio is used the greater the value of the economic benefits that can be generated, (for example a study[15] to evaluate the economic impact of the use of radio in the UK equated this to approximately 2 % of GDP or £13,000m and 410,000 jobs; with radio's contribution to the economy growing at 11% per year in terms of GDP and at 1000 jobs per week). Conversely unused spectrum generates no economic benefits and congested spectrum may fail to deliver any improvement in communications reducing the potential value of the benefits. Whether the level of economic benefits grows or diminish depends on the spectrum being used effectively and managed efficiently.

8.2 Issues for consideration

Although the details of the issues is likely to vary with the administration and spectrum pricing procedure they can be grouped into a limited series of categories.

8.2.1 Legal

Whether or not administrations need to develop new legislation to introduce spectrum pricing, it is essential that they ensure their existing legislation is effective. If the administration plans to introduce auctions, transferable spectrum rights or a secondary market it is also essential that they have appropriate competition legislation in place. If effective competition legislation and any organisations required to implement it have not been created then this could inhibit the operation of spectrum pricing.

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[14] Here the term benefits is not used in its standard economic sense.

[15] From "A study to evaluate the economic impact of the use of radio in the UK" by NERA/Smith System Engineering Limited in 1997, commissioned by the Radiocommunications Agency (RA) - estimates based on the 1995/96 Financial Year.

8.2.2 International obligations

Where an administration introduces spectrum pricing and particularly transferable spectrum rights, it is important that it should retain responsibility for the country's international obligations. However, they may need to consider establishing a mechanism for representing the users views in the relevant international fora, especially if the user is permitted to take on any of the management responsibilities for their spectrum that is normally associated with the administration (see **Chapter 3.5**). In most countries these mechanisms may already exist, whether they would need modification to reflect users different levels of spectrum management responsibility may depend on their structure and organisation.

8.2.3 Formula development

Administrative pricing requires the development of formulae to operate effectively. In developing these formulae it is advisable that the administration should consult the radio industry on the parameters to be used. The spectrum pricing formulae need to be fair, objective, transparent and simple. Simplicity is particularly important, otherwise there could be difficulty in operating and maintaining the formulae. Consultation can also help to ensure the parameters are appropriate for the service any disputes on the definition of the areas of high usage are resolved and so that users can see the spectrum pricing procedures are transparent.

If the introduction of spectrum pricing requires the development of new software this may need to be tested and staff trained in its use. This is particularly important if the administration has previously never charged for a spectrum licence. The setting of the fee level is critical to the operation of spectrum pricing and it is necessary to have a suitable differentiation, in terms of the fee value, between areas with high and low levels of spectrum usage. Fee levels also need to be set at an appropriate level. If fees are too low, they may encourage misallocation of resources; if they are too high, they may act as a disincentive on enabling technologies. In addition high fee levels may result in frequency bands becoming vacant, reducing the benefits the country's economy receives from the use of radio.

To ensure an orderly migration to new frequency bands or more spectrally efficient equipment administrative pricing may need to be introduced gradually, perhaps over a period of two or three years, so that users can get used to the new price structure. From the administration's and users an orderly change is necessary to avoid problems in equipment supply causing an increase in equipment prices, the overloading of the frequency assignment mechanisms and disruption to the administration's funding.

8.2.4 Funding implications

Any administration that has previously operated a cost recovery system, or been dependent on fees for funding their spectrum management operations, needs to consider the implications of a change in spectrum management funding mechanisms on their overall income as:

i) auctions cannot be held on a continuous basis, since there is a limited quantity of spectrum available and only certain end user services are suitable to be auctioned;

ii) administrative pricing is intended to relieve congestion not to increase the levels of the administration's funding.

While in the short term funding levels may increase, as the spectrum pricing mechanisms take effect, the levels of funding may fluctuate with time and adjustments to the level of supply and demand. This issue is particularly relevant for PMR, which currently is probably one of the most important sources of income within CEPT administrations.

8.3 Discussion

Managing the transition is probably the most important aspect of making changes in spectrum management. This is particularly true in the case of spectrum pricing where not only is it necessary to consider the impact that radio can have on the economy, but also the implications the changes necessary for the introduction of spectrum pricing may have for the administration, its funding, national legislation requirements and its obligations to all radio users.

The introduction of administrative pricing requires administrations to consider how they will structure licence fees to encourage licensees to use spectrum more efficiently. This will require a thorough presentation to licensees on precisely what will be happening and the timescales for the introduction of administrative pricing. There will also be a need for a consultation process between the administration and users to determine the appropriate technical parameters to be used in the pricing formulae and the definition of the criteria to be used, for example, highly congested geographic areas and frequency bands.

The introduction of auctions, if required, may be expected to resolve some of the difficult problems in assigning those licences that would otherwise have to have been issued through the use of comparative procedures and tenders. However, it is unlikely to reduce the workload of the administration as the effort, that previously were used for comparative bidding procedures or tenders would have been expended in judging the applicants bids, will now be required to prepare the auction process and determining the interference scenario in the spectrum concerned. In some cases to clearly define the operational limitations of the licence, administrations may need to develop the type of spectrum management facilities they had previously considered unnecessary, e.g. monitoring, terrain databases, automated interference analysis capabilities. In addition there are the legal requirements. Comprehensive competition legislation is important to the setting up and operation of spectrum pricing, and is essential if spectrum rights are to be introduced and the trading of spectrum rights permitted.

In any change it is perhaps important to remember that unused spectrum generates no benefits for anybody and it is therefore to the administrations and users benefit that any changes are developed through a comprehensive consultation process. In this process, users need to recognise that although they may oppose the changes for a variety of reasons (e.g. concern that it may increase the price required for access to the spectrum) only the administration has the responsibility of having to maintain the ability to provide spectrum access to all new users, technologies and services on demand.

9 INTERNATIONAL PERSPECTIVE

9.1 The European Union

The EU has directly entered the debate on different methods for awarding licences, like comparative bidding, lotteries and auctions. This item was first addressed in the Mobile Green Paper[16], where it was stated that licence fees must be based on objective facts, be proportionate and be justifiable. And further that: Whichever method is used to award licences -first come first served, comparative bidding, auctioning, lottery- licence award procedures must be based on open, non-discriminatory and transparent procedures. Reliance on auctions should not lead to an excessive transfer to the public budget or for other purposes to the detriment of low tariffs for the users. Lotteries do not seem to guarantee the achievement of the criteria in particular concerning efficient use of frequencies, technical competence and financial resources. In the Directive on Licensing [17]this topic was also touched on. Article 11 states:

> "Member States shall ensure that any fees imposed on undertakings as part of authorisation procedures seek only to cover the administrative costs incurred in the issue, management and enforcement of the applicable individual licence. Such fees shall be published in an appropriate and sufficiently detailed manner, so as to be readily accessible.
>
> In addition, where resources are scarce, Member States may allow their national regulatory authorities to collect additional charges, which reflect the need to ensure the optimal use of this resource. Those charges shall be non-discriminatory and take into account the need to foster the development of innovative services and competition."

With regard to this directive there are differences of opinion whether this directive is applicable to individual radio licences, since it seems more directed towards licences to operate a service. Whether this is the case or not, radio licences are an authorisation to use scarce resources and will therefore be covered by the second part of the article where it says that additional charges may be collected.

There is thus scope within the context of EU developments for Member States to embrace either cost-based, administrative or market-based pricing systems.

9.2 ITU developments

The ITU-R report on "Economic Aspects of Spectrum Management" represents a first step in covering this subject. This report was presented to the ITU-D (the Development Sector of the ITU) and feedback from administrations has been requested. In the future it is expected that the report will be updated and the material gathered to answer the original questions, agreed by the Radio Assembly, in the form of new recommendations. Further work however needs to be completed before any recommendations can be agreed and there is a need to collect feedback from more administrations on their use of market and non-market methods of spectrum management. At the next ITU-R Study Group 1 meeting it is intended to produce a simplified version of the report (one or two pages) that would be more suitable for use as introductory text on the subject.

9.3 Developments in individual CEPT countries

In a large number of CEPT administrations there are developments in the area of licensing and charging and frequency assignment systems. Some administrations intend to broadly keep to the existing methods of funding spectrum management with the existing first come first served licensing mechanism, in some cases with the exclusion of public mobile systems. While other administrations want to introduce spectrum pricing in all its different facets as described in **Chapter 5**. Detailed information is given in **Annex VI**.

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[16] Green Paper on a common approach on Mobile and Personal Communications in the European Union, April 1994.
[17] Directive 97/13/EC of the European Parliament and of the Council on a common framework for general Authorisations and individual licences in the field of telecommunications services.

9.4 Opinions of user groups

In this section of the Report opinions of some of the user groups on spectrum pricing and/or administrative pricing are quoted.

9.4.1 UMTS forum

In its Report "A regulatory Framework for UMTS" published on the 25th of June 1997, the UMTS forum laid down the following opinion on Spectrum pricing.
"Selection is justified only if all applicants cannot be authorised due to the limitation of scarce resources such as frequency spectrum. Therefore selection can only be made on certain parts of a UMTS system, which use frequency spectrum or any other scarce resource. Any selection process must be fair and transparent.

The selection process may differ for each type of UMTS component. Two main types of selection procedures can be employed:

- auction or competitive bidding
- comparative bidding.

In both types of selection process, the applicants may be required to satisfy certain minimum entrance requirements as to their ability to set up and run such a service.

The relative advantages and disadvantages need to be carefully considered before deciding on the procedure for a selection process. One aspect of such a process is its influence on spectrum pricing.

Properly designed and applied spectrum pricing would encourage operators to maximise the spectrum efficiency of their systems to reduce spectrum cost overheads and encourage them not to hoard spectrum.

Too high spectrum pricing would add to the operators' cost and lead to higher tariffs and reduce the number of users. Spectrum prices may also have implication for the market for UMTS equipment. If spectrum prices are higher for UMTS than for competing technologies, then the UMTS technology may become more expensive compared to what other competitors can offer. Therefore, the impacts on the competitiveness of UMTS standards when enforcing higher spectrum efficiency than other international standards have to be studied carefully.

Properly designed auctions provide certainty, stability and security of tenure for the winners. Auctions also have the advantage that they are transparent and the winning criterion is objective, which can prevent possible legal challenge. Comparative bidding can cause difficulties when there are more applicants for licences than the spectrum can support. Auctions are an effective means of determining the market value of the spectrum.

Among the negative aspects of auctions, if not properly designed, is that they more easily lead to excessive spectrum pricing. Another negative aspect is the possible fragmentation of the coverage and problems in roaming that may be the result of a spectrum auction. This is particularly serious for a satellite system. The access to spectrum for use by satellite is subject to international regulations in the ITU, in addition to any national regulation. If however a selection process for the satellite component of UMTS is to be considered, auctions may be inappropriate due to the pan-national nature of satellite coverage.

It is for the NRAs to determine which selection process to adopt, within the framework of the Licensing Directive. However, a decision to impose very high prices for UMTS spectrum usage, which may be motivated by fiscal reasons and the scarcity of spectrum, will have adverse effects on market success. This will mean higher tariffs and would be against the best interests of the end users.

If spectrum pricing is introduced for UMTS frequencies, it is important that this pricing does not hinder the uptake of UMTS services."

The UMTS Forum established subsequently the Task Group for Licensing Costs and Spectrum Pricing to study the charges for granting licences and to formulate recommendations from industry to national regulators concerning the use of charges and prepare a report.

The industry members of the Forum have formulated in their report the following recommendation to regulators concerning the use of spectrum pricing:

- Spectrum pricing may be used as an incentive for efficient spectrum use, provided that these charges are fair, proportionate, transparent and competition neutral. They should mainly be motivated by cost-recovery and not by maximisation of revenue. The benefits, however, should be carefully weighed against the potential damage on the service.

- When selection of licensees is necessary because of lack of frequencies the administrative comparative approach should be preferred over lotteries or auctions. Auctions lead to high up-front fees, which will increase the tariffs for the consumers, slow down the development of new, innovative services, such as UMTS services, diminish the infrastructure investments and harm competition. Lotteries provide no assurance that a competent operator will be awarded a licence.

- Spectrum pricing as an instrument of taxation must be avoided, as it will have a direct negative impact on the growth of the telecommunications market and the general economy. Such taxation will in the long run diminish the total income for the State. High market values should be an incentive for regulators to find more spectrum, which will benefit the public more than excessive transfers of money to the public funds.

- Taking into account that the UMTS market still is in a very early stage of development, any regulatory actions regarding UMTS spectrum should be aimed at encouraging investments in UMTS systems. The calculations of the UMTS business case indicate that high fees will have a negative impact. Large down-payments in the beginning of the licence period should be avoided, in favour of charges related to the use of the system, like royalty or annual fees.

- Due consideration should be given to the particular global nature of satellite systems when seeking to establish a suitable mechanism for defining licensing costs and spectrum pricing for the UMTS satellite component.

9.4.2 EBU

The EBU formulated an opinion on spectrum pricing for this Report as follows:

In principle, spectrum pricing is a potentially important tool for management of the radio spectrum. It could encourage the early adoption of technologies giving more efficient use of the radio spectrum, for example for mobile radio services or point-to-point fixed links. In such cases, users of the spectrum will be able to make their decisions on a strictly financial basis by comparing their costs of new equipment with their reduced charges for use of the spectrum.

However, it is unlikely to be applicable in broadcasting because the general public's investment in TV and radio receivers is huge compared with the investment by broadcasters in transmitter networks. As spectrum pricing would have an impact only on broadcasters, rather than the public, there would be no financial linkage to accelerate replacement of TV and radio receivers. Thus, broadcasters would be penalised by increased costs for use of the spectrum with no opportunity for them to reduce these costs.

In the absence of spectrum pricing, many broadcasters have already introduced, or are planning to introduce, spectrum-efficient technologies, such as DAB and digital terrestrial TV. However, the speed of the transition from analogue to digital broadcasting will be constrained by the fact that no broadcaster (or a Government) would risk upsetting millions of people by premature withdrawal of analogue broadcasting services. It is difficult to see how spectrum pricing could solve this intractable problem.

Furthermore it should be noted that public broadcasters rely upon licence fees levied upon users of broadcasting receivers to provide a significant part of their operating revenue. Any additional charges upon such broadcasters, as a result of spectrum pricing would normally need to be passed on directly to the public in the form of an increased license fee.
The application of spectrum pricing to public broadcasters should therefore be seen as a tax on the entire population.

9.4.3 ECTEL

The ECTEL PMR Working Group has the following comments regarding charging in relation to the ERO study on PMR

and PAMR licensing and charging as well as the further work to be undertaken in the RR Working Group on this topic:

- the level of charging for PMR in most European countries is quite disproportionate in comparison with other mobile radio uses.

- it should be emphasised that charging is not a tax but a fee for a service encompassing:
    - costs of the spectrum management administration
    - costs for spectrum refarming (i.e. financing of moving networks to other frequency bands)
    - costs for spectrum monitoring

9.4.4 International Amateur Radio Union (IARU)

This ERC Report has been drafted to provide a common policy for CEPT Administrations to introduce economic criteria in the spectrum management field. As a user, the Amateur Service has closely followed these discussions.

Currently the Amateur Service Licence fees are based on an Administrative cost basis, whereby expenses incurred in the issue of licences, allocation of call-signs; collection of fees and the cost of consultative meetings are used to assess the licence fee.

A considerable amount of spectrum management and administration is carried out through the International Amateur Radio Union (**IARU**)
Regional Meetings to ensure that, maximum and efficient use is made of spectrum allocated to The Amateur Service.

Amateurs, by the experimental nature of The Service, are free within the above constraints, to select operating frequencies depending on propagation conditions and allocated spectrum occupancy.

Administrations are receptive to IARU Conference decisions applicable to VHF/UHF repeaters, packet relay stations and propagation beacons that require specific frequencies allocating within IARU criteria to enable an orderly use of the spectrum for these purposes.

Amateur Satellite frequencies are International and are co-ordinated through IARU in consultation with Amateur Satellite Services (**AMSAT**) [18]

IARU has actively pursued a policy of assisting Administrations whenever possible in the detailed work of frequency management and supervision of our allocations to ensure that the cost involved is kept to an absolute minimum. We believe that this arrangement should continue to our mutual benefit.

9.4.5 AirTouch Communications

The “Report on the introduction of economic criteria in spectrum management and the principles of fees and charging in the CEPT” (“Report”) addresses both financing systems for radio administrations (generally cost-related fees) and spectrum pricing issues related to frequency allocation and assignment of licenses. AirTouch respectfully submits the following comments related to the Report’s discussion of the use of auctions as a frequency allocation tool.

AirTouch has extensive experience with cellular, PCS, paging, and mobile satellite joint ventures in over twelve countries around the world. Our comments are focused upon the spectrum pricing issues applicable to assigning licenses for commercial mobile services, which may raise different issues than those relevant to individual radio licenses, broadcast licenses, or other spectrum based services. Mobile services share common attributes including rapidly increasing demand, large capital investments needed to offer service, and vigorous competition.

The Report identifies a number of advantages and disadvantages of auctions. Advantages identified include that auctions promote efficient use of spectrum, provide rational and transparent criteria, are administratively simple, and obtain economic rent for a scarce public resource. Disadvantages are listed as restricting the number and size of potential bidders, increasing consumer prices, and impacting government ownership and control over spectrum.

18 The Amateur Satellite Services AMSAT represent national member societies through liaison with IARU.

Below are some important additional arguments against the use of auctions to assign mobile licenses. Many of these arguments support those provisions in the EU's Mobile Green Paper and Directive on Licensing which caution against charges which increase tariffs for users, slow the development of innovative services and harm competition.

Consumer charges: Auction fees are a cost, which must be recovered from users, and result in higher prices. The Report notes in Section 4.5 that because service providers may charge what the market will bear, license bids do not dictate service prices. However, spectrum based services are highly competitive, and mobile operators must manage costs and profits or risk market failure. Mobile system operators compete for scarce capital and must offer investors economic returns. The market "may bear" higher prices but at the cost of slower growth, poorer quality service and higher financing costs.

Investment and infrastructure: Auctions increase investor uncertainty. Network build-out may be less robust as profits will be under more pressure. Technology choices may also be impacted as operators focus on short-term recovery of up-front fees rather than longer term growth. Reliance on bid price minimises criteria such as strong customer service, information systems, and marketing plans, which spur more competitive development of the market.

Competitive impact: Auctions can add complexity by distorting competition among licensees. Later entrants to a market may be faced with sizeable entry fees not paid by current operators, leading to severe anti-competitive consequences. Where licenses are awarded serially, as is generally the case for mobile licenses, auctions are not a competition-neutral method to obtain revenue.

Additionally, mobile services offer potential competition to existing fixed services. High auction fees handicap the ability of wireless providers to compete with wireline providers. High fees will suppress demand for mobile services, particularly for the residential market most sensitive to price.

Transparency: Open and rapid licensing processes can be devised using qualitative criteria that more closely reflect important government objectives. As long as an assignment method emphasises clear, objective criteria - such as specific weightings for such items as user tariffs and coverage commitments - the benefits of an open process can be achieved.

Administrative simplicity: Auctions are least necessary where there are very few, large (e.g. national) licenses available because strict qualification effectively limit the pool of qualified bidders to those with sufficient capital and expertise to meet license conditions. The alleged simplicity of competitive bids as an allocation tool are often undermined by litigation, e.g. from current operators opposed to retroactive fees imposed to level the playing field, from governments seeking to collect from license winners facing bankruptcy, and pending investigations into allegations of bid rigging, collusion, or bidding information leaks.

Fairness: Competitive license awards frequently involve both private enterprises and state owned enterprises who are increasingly crossing borders to invest in wireless licenses. Because state owned enterprises may not be subject to the same financial considerations as private investors, they may bid "above market" in order to expand their investments. Elimination of the financial bid reduces the risks of cross-subsidisation, which can distort competition in the market.

Efficient spectrum usage: Proponents of auctions argue that competitive bids ensure that licensees develop their services quickly in order to recover their up-front investments. Other methods can accomplish this as well, including strict build-out requirements and coverage commitments. Financial resources dedicated to marketing programs, high quality systems, robust networks and employee training will result in more effective use of spectrum than government fees.

Resource compensation: A government's interest in receiving appropriate compensation for public resources may be addressed through secondary benefits such as higher tax revenues and broader economic growth from a more efficient telecommunications sector. The level of up front fees may provide less economic rent from spectrum resources than would otherwise be obtained through faster spectrum exploitation. Because auction fees can increase prices and reduce demand, licenses awarded on the basis of service criteria without financial bids may generate more taxes from operators and equipment suppliers, create more jobs, and increase PSTN interconnect revenues.

In light of these consideration, AirTouch encourages revision of the Report's conclusions that auctions are efficient assignment systems for cellular telephony. Other tools such as a beauty contest systems combined with reasonable spectrum usage fees should be favoured in order to ensure the strongest development for this sector.

10 CONCLUSIONS AND PROPOSALS FOR FURTHER WORK

10.1 Summing-up

In many European countries, administrations are facing increasing demand for radio services. This has led, in some countries, to varying degrees of spectrum congestion that at best is causing increased levels of interference and at its worst is limiting the administration's ability to provide access for new users of existing services and spectrum for the development of these services or the provision of new services. While it is extremely unlikely that spectrum congestion will occur in some countries, there is for example a shortage of broadcast channels using the existing broadcast formats in all countries. Further a change to new more spectrally efficient equipment is hampered by the administration's ability to provide suitable spectrum. Where spectrum congestion has occurred, the increasing demand is putting pressure on the administration's existing spectrum assignment mechanisms. As the responsibility for continuing to be able to provide spectrum for new users and uses rests with the administration, they also have the responsibility for developing new spectrum assignment mechanisms to resolve the problems of spectrum access. Changes in spectrum management functions are not new. The use of radio has developed considerably over the last 30 years, raising a variety of different problems and requiring many administrations to adapt existing, or introduce new, spectrum management functions or techniques.

The approach to licensing among administrations can be divided into the charging policy they have for the licence fees and the assignment mechanism used to distribute the licences. Charging policies currently in operation are state funding, a simple fee (flat rate fee) and cost recovery. Some administrations are also in the process of introducing administrative pricing. In terms of licensing mechanisms there are a number of options including first come first served, tender procedures, comparative bidding, lotteries and auctions. There are also a number of variations on these mechanisms e.g. the use of entrance criteria for competing applicants at auctions. It is unlikely that any one of the described licence mechanisms could be used in all circumstances and for all licence categories. Administrations therefore need to select the licensing mechanism most suitable for the characteristics of the radio system and their national circumstances at the time. For example, for the large majority of licences like PMR, radio amateurs, fixed services etc., the first come first served licensing system might remain the most appropriate, although it may need to be supplemented with a new charging policy like administrative pricing to regulate user demand.

When a large number of applicants are expected to apply for a limited number of licences that are to be issued at one occasion, then auctions, tender procedures, comparative bidding or lotteries (or a variant e.g. entrance criteria for entrants to a lottery) are the most appropriate mechanisms. These mechanisms are generally applied to public service systems like public telephony, paging, PAMR broadcasting etc. Again the mechanism used will depend on the provisions of national legislation in addition to the circumstances surrounding the process, like the expected number of applicants.

Problems of spectrum access have caused some administrations to re-evaluate the traditional methods of charging for licences and their assignment. This re-evaluation process has led them to consider implementing, or to start implementing, new charging policies to support spectrum management objectives such as balancing the demand for spectrum with the amount of spectrum available and new assignment mechanisms to reduce the delays and lack of transparency in selecting winning applicants where there is a strictly limited number of licences available. In order to apply administrative spectrum pricing, administrations will need data to estimate future demand for spectrum by service as well as robust definitions of spectrum congestion.

10.2 Conclusions

Administrations that have never charged for the use of spectrum, should consider charging for its use and to pay for the administration's spectrum management activities (see DSI 1). In developing charging policies administrations must charge both national and foreign licence applicants equally to avoid creating artificial trade barriers. To support this policy of equal charging it is necessary to recognise administrations right to subsidiarity in determining the actual price level or the assignment mechanism. Administrations will therefore need to be aware that the spectrum management functions performed by individual administrations may vary due to national circumstances and that there is a legitimate range of spectrum management functions administrations may need to perform. These spectrum management functions are documented in the International Telecommunication Union Spectrum Management Handbook.

The current proposals from administrations for additional charging policies and licensing mechanisms to resolve the problems of spectrum access are administrative pricing and auctions, although public tendering, administrative redistribution, requirements for changeover to more frequency effective methods of utilisation or technologies, requirements for reduced usage, and administrative withdrawal are also used and considered adequate mechanisms also in the future.

Administrative pricing and auctions, in the future, may be supplemented by the introduction of spectrum rights. However, for the immediate future there is a need to identify the requirements necessary for administrative pricing and auctions.

The introduction of spectrum pricing will depend on a number of factors, such as spectrum conditions (i.e. existence of congestion), spectrum management objectives and government policy and may depend on the existing legislative framework. Administrative pricing needs simple and transparent formulae in addition to a clearly identifiable step in the level of pricing between areas of low and high congestion. Although the pricing policy may be based on broadly the same factors in each country, the actual value of the step may vary considerably depending on several factors, including the users' expectations of fair value for a licence and the general costs in country. Developing simple and transparent formulae is also important to avoid maintenance problems caused by the necessity for complex revisions at regular intervals. Administrative pricing is intended to be used to regulate demand for spectrum and as a mechanism to promote improved spectral efficiency through either the use of more spectrally efficient equipment or the transfer of existing services to less crowded frequency bands. However the introduction of spectrum pricing may not be possible without introducing changes to national legislation when the administration's existing charging policy is based on cost recovery.

Auctions may provide the ability to reduce the delay in frequency assignment and may alter or in some cases reduce the problems associated with a judicial review of frequency assignment decisions. It is unlikely that auctions would be used for satellite services but for a number of terrestrial services they can provide the opportunity to resolve a number of assignment problems. Some organisations and countries have raised concerns over auctions. Auctions can only be used when there is competition, there are clear spectrum rights to be defined and the costs of holding the auction can be recovered. Also, providers of socially desirable service cannot put a financial value on the spectrum and this could lead to an under provision of these services to society if they faced auctions;

The decision to compete in an auction is a commercial decision for each applicant as is the size of his or her bid. The auction process does provide the opportunity to prove to competing applicants that the winner(s) have been unambiguously decided, thus removing the possibility of subjective decision making introducing anti competitive activities that affect the selection of the winning applicant.

In introducing auctions, administrations want to maximise the efficient use of the frequency spectrum and to obtain a fair valuation for the licence. However future or existing operators have expressed concerns over the operation of the auction procedures and therefore currently seem to favour tender procedures with a fixed fee attached. In the case of auctions typically the administration would set criteria that form the entrance conditions applicants have to meet to take part in the auction. These criteria may be similar to the type of conditions set in comparative bidding, except in the auction environment they are not used in determining the winner.

In considering spectrum pricing in its entirety, there seems little scope for harmonisation, apart from the development of a common understanding of the concepts and requirements of spectrum management and administrations licensing requirements. This process would benefit from a regular exchange of information with regard to the experiences of administrations. Although it is not possible to harmonise the actual licence fee values due to:

- available frequency management functions,
- different legislative requirements,
- number of users,
- the state of development of the administration's radiocommunication infrastructure,

the development of a common understanding of the different spectrum management functions that may be legitimately used by administrations would be beneficial.

10.3 Proposals for further work

There is concern at the extent of confusion over spectrum rights and auctions both within administrations and amongst operators. In order to develop the debate on spectrum pricing and to diffuse unnecessary concerns it is considered important that more accurate information on the operation and implications of spectrum pricing should be made available to both administrations and operators.

In changing their approach to charging for spectrum use, whether this represents a move from state funding to simple fees, or from cost recovery to administrative pricing, it is important that administrations should consider the transitional arrangements. There may be benefit in the CEPT developing guidance perhaps through mapping out and identifying the important steps and issues for consideration involved in initiating a major change in charging policy or licensing mechanism. In particular the move from state funding to charging for spectral use.

Considering all administrations currently using or considering spectrum pricing recognise that this particular spectrum management technique is still in the early stages of development, it would be appropriate for a review of any changes in the implementation of spectrum pricing together with a collation of these administration's experiences to be made available at yearly intervals. This could provide a source of updated information to all administrations and operators.

If spectrum refarming is to provide a useful mechanism for redeveloping the spectrum, particularly in view of the additional resources that may result from the introduction of spectrum pricing, there is a need for an investigation to determine how it would operate in practice. **Chapter 7.3** identifies some of the concerns and clearly there should be no automatic right to compensation. However, where there is a need for compensation, how the qualifying point is identified and the proportionate level of compensation over a particular period needs further study and the basic philosophy defined.

Administrative pricing is at the moment introduced in a number of countries with the aim of making users use the spectrum more efficiently. The introduction of an overall administrative pricing system is a complicated matter which needs considerable adjustments to the administration's existing licensing procedures. This report has touched upon these matters but further study of the different options and the experiences of the individual countries is useful for those administrations that have plans to introduce these pricing systems.

ANNEX 1

RECOMMENDATIONS ERC PT 8 REPORT

ERC long term policy and strategy, Annex of ERC (94)13

3.2.1 Frequency planning

The radio frequency spectrum is a scarce natural resource like minerals, ground space etc. In economic theory it is common to give a (money) value to scarce resources. So far this is not a common practice in most European countries, although there is a growing tendency to introduce economic criteria in frequency management. The introduction of these criteria is an answer to the criticism from outside the area of frequency managers, that there is a lack of transparency and objective criteria and insufficient weight to economical criteria. The ERC should not shut its eyes for this criticism, but should try to find "harmonised answers".

Recommendation 2: The ERC should study new mechanisms for frequency planning and harmonise - as far as possible and necessary - the principles of these new mechanisms.

3.4.3 Principles of financing

In many countries the legislation as well as government policies require that the radio regulatory authority covers the cost of its work by fees collected from the users. Manufacturers, importers or sale of radio equipment. This policy also implies that it is unacceptable to subsidise the work of such specialised government services as the radio regulatory function with "taxpayers money", i.e. directly with state income raised through taxes.

There may be a further requirement that the fees should cover fully but with no excess the particular costs which may be attributed to a given class of transmitter or a given type of administrative act.

An important general policy in any government service is that the administrative routines and costs should be kept to the minimum for meeting the essential objectives of the service concerned.

In this sense, maintaining a licensing system for the main purpose of collecting yearly licensing fees is not acceptable. Nevertheless, any administrative costs, such as those caused by standardisation, harmonisation of frequency allocations, solving cases of interference etc. still should be borne by those users of radio, which enjoy the benefits.

Furthermore it is the policy of most administrations in Europe to facilitate border crossing of radio transmitters, even for use, whenever this may happen without causing undue risks of harmful interference or of otherwise inappropriate use of the spectrum.

A simultaneous application of wide-ranging exempting from licensing and common Europe-wide type approval together with free border crossing of radio equipment is desirable for many reasons but may hamper the proper covering of administrative costs caused by these equipment for the regulatory authorities.

It should be noted that the principles of covering the administrative costs caused by "free of licence" equipment to radio regulatory authorities may have implications for free and equitable opportunities for trade. If some countries only very small fees or none at all and thereby in fact indirectly subsidise the sales and use the retail price level in these countries could consequently be somewhat lower.

Last but not least it is of major importance that unnecessary administrative restrictions should not hinder free trade in radio equipment. Restrictions which are not well justified by the aim of guaranteeing efficient and interference -free use of radio frequencies should therefore not be imposed.

Recommendation 30: The ERC should encourage the approximation of the principles of the fees charged from the users, manufacturers, importers or trade of radio equipment in CEPT member countries, giving guidance to the administrations concerned.

This would facilitate meeting the objectives of the radio frequency management function in each country efficiently and

economically, whilst avoiding the risk that vastly different fees in different countries might distort the trade of radio equipment.

ANNEX II

RECOMMENDATIONS DSI I AND II

DSI I

6.2.2 Cost recovery and resource limitations

Many of the ills identified in the course of the DSI in respect of frequency management can be attributed to resource limitations within administrations. This is not however a complete picture since even the customers of the best resourced administrations have complained of technically questionable planning models, too much bureaucracy and long delays in answering correspondence. Most importantly there appears to be a need for good "front offices".

As a first step in preparing for any change it seems essential that frequency management authorities should have an accurate knowledge of their costs and overheads. It seems to follow logically that licence fees should be based on the costs of regulating the spectrum in an efficient and effective manner and that all users of the spectrum should contribute to the work undertaken by the administration on their behalf.

Several users commented that they would be prepared to pay more for a better service. The DSI was encouraged by the United Kingdom example the frequency management function from other governmental activities as a consequence of its cost recovery capability. A warning was however sounded that although licence fees could in many cases be raised, they should not be seen as just another mechanism for raising government income, although surplus revenue raised as a consequence of supply and demand policies could be transferred to the Finance Ministries, or be used to sponsor research into various telecommunications activities.

Such "ring fencing" of the radio regulatory body could then ensure that adequate staff resources and budgets are available to fulfil national objectives. There must however be safeguards in order to avoid any abuse, such as the setting of unrealistic and unjustified fee levels. Agreed quality and efficiency criteria would also have to be established.

In addition there was a certain degree of interest in the initiation of a CEPT study that analysed the views of administrations in respect of the licensing process in order to identify common themes and concepts.

8.8 Resource management

To effect many of the concepts and changes identified in this document will require dynamic and efficient radio regulatory regimes in CEPT countries. It is believed that European governments should consider seriously whether radio regulatory authorities can be removed from the normal governmental constraints on budget and staffing levels. It is further suggested that all bodies benefiting from the work of the radio regulatory administration should pay for the services received (6.2.2).

9.13 Resourcing administrations

The DSI team noted that in some cases licence fees do not reflect the costs involved in related regulatory activities. Moreover, in some CEPT countries major users of the spectrum, such as PTOs or broadcasters, contribute nothing to the actual costs of spectrum management. It is with some trepidation that the following recommendation is made, knowing that in many cases political decisions and primary legislation may be required.

It is recommended that, in order to improve the efficiency of spectrum management in CEPT countries, the direct and indirect costs involved should be reflected in licence fees and charges to the spectrum users. It is further recommended that consideration be given to the establishment of radio regulatory agencies with sufficient freedom to enable them to provide a quality service to their customers and to implement the necessary staff levels and setting of adequate budgets. The financing of such agencies should be recovered from spectrum users.

Regulatory organisations are in the process of being established as a consequence of separating regulatory and operational functions. It is therefore suggested that governments review how radio regulatory matters should be handled and resourced. To facilitate this task, it might prove beneficial to conduct a study amongst CEPT administrations on the arrangements for licensing radiocommunications services and the actual fee structures that are in place (6.2.2).

DSI II

4.4 Compliance with ERC Decisions

A recurring theme from industry has been the fear that administrations, who have committed themselves to implement an ERC Decision, will not take the final step of transferring the Decision into national law or implementing other administrative provisions which will ensure compliance with the terms of the Decision.

On the other hand the Management Team were equally concerned about situations arising where spectrum is requested for an application, political support is secured, existing spectrum users are inconvenienced and transferred, yet equipment is not manufactured or new users are not forthcoming and the spectrum in question lies dormant.

There therefore needs to be a change of attitude in Europe. Firstly from administrations to apply objective criteria to frequency management considerations in CEPT meetings, particularly where spectrum is to be refarmed for new applications. Currently important frequency allocation decisions are made after administrations have been invited to express their opinions in a meeting of the Frequency Management Working Group. Often only a few countries take the floor and a decision is taken on the preferred solution by a simple majority. Such decisions take no account of the overall economics of the various frequency options, for example the number of users affected or the investment in equipment in a specific frequency band. Thus a few countries with little or no use of a frequency allocation can outvote a country with a major network, which has perhaps been implemented only recently. Once appropriate criteria for determining frequency allocation questions have been developed and implemented, appropriate decisions can be taken in specific cases. The next step would then be for administrations to take the necessary administrative steps to free the spectrum in question and if necessary transfer existing users.

Ideally changes should be based on firm market information relating to the new application and should take place over a long time period in order to reduce the impact on existing users. However where short term (under 10 years) refarming is required the problem of the financial burden on existing users must be addressed by administrations.

In input material to the DSI, and in discussion, a number of funding options were mentioned, for example national spectrum funds managed by administrations and financed by various indirect taxation methods (special sales tax category for telecommunications equipment, an element in the station licence fee etc.) Some contributors were of the opinion that incoming users should finance the transfer of existing users, whilst others raised the point that industry should also be involved in the financing of transfers since if type approved equipment was to be manufactured and sold, companies' shareholders would directly benefit from equipment sales. Another option was presented which proposed that for EU member states the EC might finance or partially finance changes, which favour the implementation of trans European networks.

It should also be borne in mind that even in the short term, refarming may not require the complete replacement of an existing users' system or equipment. Changing operational needs may make it possible to share or reduce the spectrum requirements of an existing user.

On the funding question the Management Team believe that the financial burden should be shared in freeing any spectrum identified for a new pan-European application. A funding mechanism should therefore be developed to facilitate refarming involving interested parties concerned with both incoming and outgoing radio systems. However it is believed that this mechanism can only apply to professional radio users. It would for example not appear practicable to compensate individual broadcasting users and amateur radio or model control enthusiasts for any change, incurring cost penalties, which may affect an existing frequency allocation. The funding process should extend to all CEPT countries where the new service shall be introduced.

Administrations might also offer incentives through reduced fees for professional spectrum users transferred as a consequence of any refarming exercise designed to improve spectral efficiency.

This matter will no doubt be debated in detail, but one possibility that has occurred to the Management Team is described as follows. Individual national CEPT administrations would announce their intention of introducing the new service and would invite all interested parties, including existing users, operators seeking licences, equipment manufacturers of both incoming and outgoing radio systems and members of the relevant national industry association(s) to a formal meeting. It would be a condition on the issue of a licence that the interested parties had negotiated the terms of a funding agreement, which was satisfactory for the existing spectrum user, based on a standard costing formula to be agreed at the European level. It is believed that such an arrangement could sit within the legal framework of most CEPT countries since administrations would not be directly involved in the raising of revenue.

Even with such procedures in place, it seems appropriate to establish the timetable for change at an early stage, one milestone in such a timetable would be a date when a consensus shall be reached on the refarming proposal. After this date, existing users would become subject to the transfer process. The process for developing the timetable through consensus will require particular attention, but might be determined through a series of open meetings held under the auspices of CEPT. Although not a legal document, all parties present when the timetable is approved would be invited to commit themselves through signature of a position statement.

To encourage compliance with CEPT ERC Decisions and to seek a commitment from all interested parties the DSI Management Team recommend:

- the development of objective criteria to determine suitable frequency bands for new requirements. Such criteria should be based on the existing economic investment and occupancy of the candidate spectrum,
- that all new major requirements shall be the subject of market analysis before a decision is taken to allocate spectrum,
- that all involved parties shall be invited to commit themselves to the timetable by signature of an agreed position statement,
- the continuation of the ERC Decision process for major European projects involving spectral resources,
- that administrations initiate the administrative procedures necessary to free spectrum within the required time frame following their commitment to an ERC Decision,

The following is a process the DSI Management Team would recommend for further consideration in the commitment process:

- that the transfer of existing professional radio users from a frequency band which is required for a new application in the short term (within 10 years) be jointly funded by interested parties for example industry and operators (where appropriate) of the new system to a value based on a standard costing formula to be developed at the European level,
- that licensing would be conditional on successfully concluded negotiations,
- that CEPT administrations be encouraged to introduce incentive licensing regimes to encourage such transfers,
- that a timetable for each major spectrum refarming project be established on a European basis which shall be determined by consensus with all involved parties but in particular with administrations, equipment manufacturers and operators (where appropriate) of the new system,
- that the timetable mentioned above shall contain a date which shall be confirmed by all parties after which the transfer process of existing users shall be initiated. (Section 4.4)

CEPT administrations that have not already actioned the relevant DSI Phase I recommendation should reflect the direct and indirect costs of spectrum management in licence fees and charges to all spectrum users, including those still retaining monopoly privileges. (Section 12.9)

12.9 How licence fee structures are established is a difficult and complicated matter, but a possible differential licensing philosophy is described below. This should have the objective of ensuring that small users (regardless of the radio service) are not disadvantaged by the spectrum management process. Ideally fees should be established according to a logical set of criteria for example:

- the global cost of the CEPT radio regulatory administration to be recovered,
- the amount of administrative work involved in regulating the radio service in question,
- the characteristic (low VHF, high VHF, UHF etc.) of the spectrum used,
- the amount of spectrum required by the individual operators radio system,
- the number of additional users and their fees contributing to the administrative costs of the administration,
- the geographical area covered by the individual users' radio systems,
- any incentive licensing factor (see Section 4.4),
- an anomaly factor to avoid unrealistic distortions if the per MHz per square kilometre factor predominates,
- a channelling load factor and
- a factor reflecting the efficiency of 'in house' frequency management expertise.

Although it is considered preferable to harmonise fee structures on a European basis to avoid the significant price discrepancies that now occur, the DSI Management Team considered this an impractical proposition, but would however see merit in agreeing basic criteria and the relationship between individual elements of the licence fee at the European level.

Studies already in progress on establishing licence fee structures within CEPT countries should be accelerated and the elements which are used to formulate fees should be harmonised on a European basis.
In order to facilitate the spectrum management process in CEPT countries the following policy guidelines are also recommended by the DSI Management Team:

- in general radio licensing policies for assigning radio frequencies and authorising radio systems should continue on a 'first-come, first-served' basis with appropriate consideration and responsiveness to new service demands and overall objectives,
- once radio systems have been licensed, administrations should ensure that they are implemented within a reasonable time and radio frequencies are efficiently utilised,
- where existing users have to be transferred to alternative spectrum, the refarming strategy and compensation mechanism recommended in Section 4.4 be implemented, the incentive licensing element to be considered part of the overall fee criteria,
- for competitive licensing, where the available spectrum is inadequate to satisfy all demands, or where it is necessary to limit the number of new entrants, the administrative comparative approach (beauty contests) should be used to select licensees from qualified applicants,
- if other market based approaches are eventually considered necessary, an appropriate mechanism should be established after full public consultation, preferably on a European basis,
- the radio spectrum should continue to be managed by agencies (see section 13.8) directly responsible to government Ministers but delegated responsibility for planning and frequency assignments could be considered for specialised user groups, for example police and fire, defence, ancillary broadcasting etc. where such delegation is seen to be in the public interest,
- emphasis should be placed on efficient spectrum utilisation, by applying adequate planning techniques and spectrum efficient technologies,
- the research and development of efficient spectrum usage should be encouraged. (Section 12.9)

ANNEX III

SPECTRUM MANAGEMENT FUNCTIONS

Introduction

If an administration is seeking to assess the cost of spectrum management, it has to consider the range of the work, the equipment required to support it and the overall cost of the staff required to perform them.

A national spectrum management authority will have a number of aims and objectives for management of the radio spectrum. These will reflect national policy and may favour public use or private enterprise. Stability in national policy is important to spectrum users for investment decisions and consistency. These policies and objectives will, inter alia, determine the shape of the spectrum management authority within the available resources and legislative requirements. The spectrum management activities can be divided into a basic set of spectrum management functions[19] although the precise tasks within each function group may vary. These functions are as follows.

Spectrum management policy and planning/allocation of spectrum

Determination of existing and future public/national spectrum requirements;
Development of long and short term spectrum management strategies;
Allocation of spectrum considering, technical aspects and equipment limitations;
Development of spectrum policy
Organisation and structuring of specific systems and services.

Frequency Assignment and Licensing

Development of licensing policy
Examination of licence applications;
Authorisation for use (including instances where licences may not be issued);
Assigning call signs;
Issuing licences and collecting fees;
Renewal and cancellation of licences;
Conducting examination of operator competence and issuing operator certificates.

Standards, Specifications and Type Approval

Type approval of radio equipment;
Maintenance and calibration of test equipment;
Acceptance testing and evaluation of equipment purchased for inspections and monitoring;
Equipping special purpose monitoring vehicles and the calibration of its equipment.

Enforcement

Required to enforce national and international statutory and regulatory requirements the work includes:
Investigating interference complaints;
Investigating illegal operation, including operations not in keeping with the terms of the radio station licences;
Collecting information for prosecution cases and assisting law enforcement agencies;
Ensuring radio station operators comply with national and international statutory and regulatory requirements;
Taking technical measurements, e.g. measurements impossible to assess through monitoring - output noise power, distortion at the transmitter.

[19] See the ITU-R National Spectrum Management Handbook

Monitoring

Monitoring performs tasks to aid enforcement, frequency planning and licensing
Determination of interference and its source;
Participation in international co-operation to identify interference sources affecting several countries;
Gathering information on usage and channel occupation in support of frequency planning and licensing.

International Co-ordination/Co-operation

Radiocommunications operates in an international environment, because radio waves are not limited by political boundaries. Administrations requirement for participation in international fora is recognition of the role of international regulation and co-ordination of services that originate outside their borders. Specific areas are:

Participation in International standardisation and Regulatory organisations;
Participation in International planning conferences and meetings.

Liaison and Consultation

Development of national radiocommunications, the preparation of long term strategies, the introduction of new technologies and changes in the management and licensing of the spectrum, require communication with the radio industry, user groups, the general public and other government departments if they are to be effective. Some of this can be achieved by the production of information sheets, publications on major developments, proposed long term strategy and annual reports on the operation and performance of the spectrum management authority. However for this to be successful it has to be two way process that enables feedback on the spectrum management authorities performance which requires a more direct approach:

Establishment of advisory committees;
Encouragement for creation of user associations;
Spectrum management seminars;
Presentations at radiocommunication meetings;
Participation at radio industry “shows”.

Spectrum Engineering Support

Spectrum management and frequency assignment require engineering support to provide analysis of technical information:

EMC assessment;
Assessment of technical developments;
Systems capabilities;
Interference assessment.

In addition the provision of accurate planning models requires a certain level of research. Although research may be performed by any number of organisations the more specialised areas of investigation are covered by specialist research centres or Universities, where the work may be funded by the spectrum management authority. To ensure the research projects meets its objectives and that the level of funding can be justified, the spectrum management authority will need to provide a level of project management and monitoring.

Computer Support

The development of planning tools, interference analysis models, database development; electronic notification systems, licensing systems, financial management systems, etc. all require computer support. As sharing scenarios become more complicated and use of the spectrum increases, greater dependence is put on interference analysis and planning tools. Hardware and software systems require maintenance

Administrative and Legal Support

Administrative and legal support is required for many organisations, but legal support is also of particular interest to licensing, frequency policy and enforcement operations.

ANNEX IV

EXAMPLES OF CHARGING SYSTEMS IN CERTAIN ADMINISTRATIONS

Germany

Only Directly Attributable Costs in a limited way

There are administrations where the directly attributable costs are defined very narrowly and can only relate to the costs made for the individual licence applicant and not to the costs made for the licence category.

The German fee system for instance only allows in a restricted way directly attributable costs to be recovered by fees.

Users of frequencies are charged in two different ways for two different categories of costs.

Costs that can be directly attributed to an individual:

The applicant pays a single fee in return for the frequency assignment. The single fee has to be calculated in such a way that there is a reasonable relation between the administrative cost of that process and the importance, economic or other value for the applicant. In any case the fee must not be so high that it deters the applicant from asking for a service.

This principle can lead to fees that are higher than the administrative costs when the frequency is of high economic value for the applicant (for example mobile phone operator). On the other hand the fees for some frequency assignments do not cover the administrative costs because the frequency does not have a high value for the applicant or a fee covering those costs would be so high that it would deter the applicant from applying for it.

As this principle (called Principle of Equivalence in German law) does not necessarily lead to cost recovery, a deficit would have to be covered by the state budget while a surplus would flow back into the state budget.

Costs that cannot be directly attributed to an individual:

As those costs cannot be recovered by fees, the user of a frequency has to pay an annual contribution to cover those general costs of spectrum management that can be attributed to user groups such as PMR, mobile phone operators, amateur radio etc. The specific costs of a user group are broken down to the individual user of a frequency by certain criteria. The Principle of Equivalence does not apply to contributions. Therefore the value of the frequency cannot be taken into account.

General costs that cannot be attributed to a user group have to be covered by the state budget.

While the Principle of Equivalence allows fees to be determined not only on the basis of cost recovery, contributions do not leave any room for administrative pricing at all. Another disadvantage is the fact that general costs that cannot be attributed to a user group have to be covered by the state budget. Therefore the German system is not strictly cost recovery, but a mixture between cost recovery and a system with no relation between costs and income.

Sweden

Attributable as well as not attributable costs

Some administrations administer a cost recovery system for licensing and charging for radio equipment and spectrum management including attributable and non attributable costs. An example is for instance Sweden.
Sweden administers a cost recovery system for licensing and charging for radio equipment and spectrum management. The Swedish view is that any licensee or any other undertaking in a licensing procedure - who uses the resources of the administrative authority and thereby causes costs to it shall be charged an appropriate charge/fee enabling the administrative authority to recover its costs for granting the claimed resources.

According to the Swedish view an appropriate charge/fee must be cost based rather than cost-oriented. The charge/fee should however be determined in such a way that it not only enables the administrative authority to recover directly attributable costs caused by a certain inquiry or application, but also other, for the administrative authority, necessary costs, unattributable costs. Such other costs may be costs for having technical expertise and know-how within the administration, costs for regulatory obligations, costs for supervisory obligations etc. The reasoning behind this is that the duties carried out by the administrative authority must be considered to be for the benefit of any licensee. Each licensee or applicant - concerned undertaking - shall therefore be obligated to carry a reasonable share of the total costs of the administration for fulfilling any duty relevant to its terms of reference. A charge/fee ought not to become a tool used for policy or administrative purposes or for generating a profit.

ANNEX V

ADMINISTRATIVE PRICING APPLIED TO DIFFERENT SERVICES

The UK Spectrum Pricing Model foreseen for the fixed services[20]

For the fixed service the UK spectrum pricing policy has a number of aims including:

i) overcoming spectrum congestion;

ii) promoting spectrum efficiency;

iii) promoting competition and innovation.

The parameters used in the proposed pricing model to establish the basic pricing elements are:

- Bandwidth
- Area sterilised
- Exclusivity
- Frequency bands
- Site location: 2 regions are envisaged, region 1 (congested) and 2 (not congested)

The bandwidth element has been used to calculate the reference fees for different bit rates and/or bandwidths for links using optimum equipment (itself a function of modulation technique, cost and assessment of present day technologies).

The examples shown in Table 4 are proposals for two frequency bands (7.5 and 13 GHz) and at bit rates of 8 Mbit/s and 34/51 Mbit/s corresponding to 7 and 28 MHz channelling arrangements.

Frequency Band (GHz)	Channel Bandwidth (MHz)	Reference Bit Rate (Mbit/s)	Category A Equipment Licence Fees (ECU)		Category B Equipment Licence Fees (ECU)	
			Region 1	Region 2	Region 1	Region 2
7.5 & 13	7	8	690	470	1381	470
7.5 & 13	28	34/51	1426	939	2853	939
38*	7	8	-	300	-	300
38*	28	34	-	601	-	601

* Currently the RA (UK) does not consider that the 38 GHz band has congestion problems.

Notes

Category A equipment = spectrally efficient

Category B equipment = less spectrally efficient

Region 1: Areas where assignments cannot be made or where there are only a limited number of possible frequencies available.

Region 2: All other areas.

[20] The information on fixed and mobile services is an extract from the Consultation Document on Administrative Pricing, May 1997 from the Radio Agency, UK. Comments have been sought on the document, therefore final proposals might be different than the ones quoted here.

Table 4. Examples of Proposed Spectrum Pricing Structures in the UK.[21]
Pricing considerations for Preferred (National) Channels

The aforementioned proposals on spectrum pricing include the concept of preferred or national channels. According to the consultation document[16] this covers two situations:

i) where operators have access to spectrum which they currently self-manage; and
ii) where operators and users have access to preferred channels in a frequency band where the frequency assignments are undertaken by the RA. (A preferred channel is where an operator or user is allocated, on a national basis, a channel in which all applications for assignments will be met, by the Agency, provided there are sufficient frequencies available. In general other operators or users will not be assigned spectrum in the preferred channel except in cases of spectrum congestion.)

In both cases, unless the spectrum is utilised effectively, the use of these bands could effectively limit the availability of suitable frequencies to others and is considered to be contributing now or potentially at a future date, to congestion in other similar bands. The Agency considers that operators and users should pay a fee for national channels that reflects the value of the spectrum occupied regardless of how intensely it is used.

The RA is proposing that the fee for each national channel is based on a spectrum re-use factor multiplied by the standard fee for a link providing the bandwidth required. In congested bands the standard fee would be the reference fee for a Category A equipment link of the required bandwidth in Region 1 for the number of links assumed to be in Region 1 plus the reference fee for the number of links assumed to be in Region 2. In non-congested bands the standard fee would be the normal per-link fee for a link of the required bandwidth. This would be applied to all self managed and preferred bands regardless of link bandwidth and utilisation to provide the necessary pressures to maximise the use of the spectrum.

In its consultation document the RA acknowledges that at present it will only be feasible to provide new operators and users with national channels (preferred channels) in the 38 GHz band. Where a new preferred (national) channel is made available to an operator or user, the RA recognises that it will not be possible for the operator/user to achieve the standard reuse factor immediately. Therefore it proposes that when a new preferred channel is made available the full fee would be phased in over time - i.e. 25% charged in year 1, 50% in year 2, 75% in year 3 and the full national channel charge in year 4 onwards.

Spectrum Efficiency Norm

If administrations are to assess how efficiently an operator is using the frequencies it has been assigned or if they need to establish a base price for implementing spectrum pricing then it is essential that they should devise a spectrum efficiency norm. This “norm” should obviously take account of key parameters, which affect channel occupancy. In the context of fixed services these are likely to include antennas, circuit availability, transmitter power, bandwidth threshold, antenna height, automatic power control, cross-polar operation, optimal path length, etc. A more direct and simplified approach, e.g., in order to set a spectrum pricing reference fee, would be to base the efficiency norm on the two prime elements in this respect; namely bandwidth and transmitter power. Once this has been established then the economic spectral efficiency model can be defined by studying present technology trends. Based on such an approach the UK made their decision that it was quite reasonable to expect 34Mbit/s equipment to occupy a bandwidth of 14 MHz and that a 140/155Mbit/s equipment should be capable of operating in a 28 MHz channel. Such a definition will obviously impact on factors such as the modulation technology, which the equipment designer should implement.

The UK Spectrum Pricing Model foreseen for the mobile services

For the mobile services the UK spectrum pricing policy has a number of aims including:

1. promoting spectrum efficiency;

2. encourage users to consider the alternatives available to them (both in terms of service and frequency band);
3. promote the use of new more spectrum efficient technology (especially the capability to handle the same or more traffic

[21] Implementing Spectrum Pricing. A Consultation Document on Administrative Pricing. May 1997. Radiocommunications Agency, United Kingdom.

within a narrower effective bandwidth).

The parameters used in the proposed pricing model to establish the basic pricing elements are:

- Bandwidth
- Area sterilised
- Exclusivity
- Frequency bands
- Location (is the station operating in an area of congestion or not)

Although the same pricing principles are used to calculate the prices a distinction is made between:

- Private Business Radio Systems (PBR) and Common Base Station services(CBS);
- PAMR services
- Cellular services; and
- PCN services.

The values proposed at the end of the 3 years transitional period for national channels in the 1996 consultation were:

Service	**Channel**	**Proposed Fee**	**Spectrum Unit**	**Tariff**	**Total Allocation**
					50MHz
PMR/CBS	2 x 12.5 kHz	ECU 24,160	ECU 4.03		
					25 MHz
PAMR	2 x 12.5 kHz	ECU 14,194	ECU 2.39		
					82 MHz
Cellular	2 x 200 kHz	ECU 267,270	ECU 2.76		
					100 MHz
PCN	2 x 200 kHz	ECU 144,960	ECU 1.51		

The Spectrum Tariff Unit (STU) is a calculated figure based on the value of 1 MHz of spectrum covering 1km^2. From the above figures, and taking account of the total allocations to each service, an average STU for all mobile communications spectrum of ECU 2.49 can be derived. That is the figure, which has been, used her.

Congestion by frequency bands and location

Congestion can be encountered when users are either denied access or perceive significant degradation in the service that is offered to them. More technically, congestion is found when the traffic offered to the channel exceeds the capacity of the channel. In order to derive the criteria to determine the presence of congestion, account needs to be taken of the difference between exclusive and shared users of the spectrum.

In respect to exclusive users, the criteria for congestion will be based on the availability of spectrum to meet current and expected demand without any regard as to the actual use/capacity of the channels except for some minimum loading. For CBS and regional PAMR, the availability of spectrum is based on the number of channels that are not yet in use in the required coverage area. For national PBR, PAMR (including public mobile data operators), cellular and PCN, the availability of spectrum is based on the number of channels available for national use but, it should also be noted, that the total need for spectrum for national networks is determined by the requirements in the busiest areas of the country.

For the providers of public communications services, the concept of congestion also needs to take account of the fact that the limited availability of spectrum inevitably means that the numbers of such operators is also limited and that there may well be others who would wish to compete in the market place if spectrum were available. Moreover, public operators occupy spectrum, which could be utilised by other mobile services (such as private business radio) where the pressures on spectrum are more visible and quantifiable.

The spectrum that has been allocated for cellular and PCN services at 900MHz and 1.8 GHz has all been assigned for national use to the four national operators. The Agency therefore considers that these frequency bands are congested.

For national and regional channels for other mobile communications services, it is proposed to determine whether the fee should reflect congestion by reference to whether the band in which the service operates is itself congested (see Table 1). This suggests that PAMR national and regional services operating in Band III will pay a fee of less than ECU 14,949 (the national channel charge for 2 x 12.5 kHz). The fee for Band III spectrum has not yet been determined and will be the subject of further consultation with the industry. In addition, account will also be taken of the desirability of encouraging the introduction of new more spectrum efficient technologies such as TETRA.

In respect to shared users - i.e. most PBR users -the criteria need be more detailed. The determination of congestion at the end of the transitional period needs to take account of a number of factors:

- Determine a threshold channel loading (by reference to the Erlang rate that can be accommodated in the busy hour in the sterilised area at an acceptable grade of service) and compare it with channel monitoring information. A 70% loading has been suggested as the threshold loading level for single-channel wide area shared PBR. For VHF high band, it was found that 40% of all channels in London and Manchester and 15% of all channels in Birmingham show an occupancy greater than 70% on the base transmit channel - with no account being taken of the traffic on the mobile transmit channel. Monitoring information is currently being collected for other areas and bands under an extensive monitoring programme being conducted by the Agency.

- Determine a threshold mobile count per channel that can be accommodated in the coverage/sterilised area and compare it with the actual mobile record in the RA database. Given a 65 mobile threshold standard in the average 30 km radius coverage area (or equivalently, 115 mobiles in the average 40 km radius sterilised area) for single-channel wide area shared PBR, London and Manchester respectively have 184 and 85 mobiles in a 30 km radius circle and Birmingham has 68 mobiles in a 30 km radius circle.

  Determine the number of base stations operating within a 100 km grid square.

- A subjective measure of congestion can be gauged on the level of difficulty experienced by the Agency in making new assignments given the licensing information available, the propagation tools available and local knowledge.

In all cases, the assessment of congestion needs be forward looking, taking into account not just the current position but the future needs as well.

Table 1 uses the above criteria to provide an initial assessment of the congestion for spectrum used for non-national mobile services in the different bands. The overall balance takes into account the numbers of channels that are used by the different services.

Table 1: Congestion by band and service.

BAND	PBR Wide Area	PBR On - site	CBS	PAMR regional	Over all balance
Band 1	No	-	No	-	No
Low	No	-	Yes	-	No
Mid	No	-	Yes	-	Yes
High	Yes	No	Yes	-	Yes
Band III	No	-	-	No	No
UHF1	Yes	Yes	Yes	-	Yes
UHF2	Yes	Yes	-	-	Yes

The valuation of mobile communications spectrum

In the light of comments received, a uniform charge for mobile communications spectrum has been devised which is referred to as the Spectrum Tariff Unit (STU) being the value of an element of spectrum over an element of geographical area such that 1 STU = 1 MHz per square kilometre (km^2).

Within the spectrum set aside for mobile services different congestion scenarios are encountered for the different services in the various bands, as shown in Table 1. However, there is a degree of commonality among the various congestion scenarios: London is heavily congested, Manchester and Birmingham are congested and elsewhere non-congested. This common scenario enables the determination of common tariffs for all mobile services across all bands both for national and regional exclusive channels and for shared channels.

For example, a figure of ECU 3,624 per 25 kHz has been assessed as the value of spectrum in a 40 km radius heavily congested area such as London (revised figure based on NERA/Smith System Engineering work) averaged across all mobile services. Based on this figure, one can determine an ECU 1,812 value in congested areas and an ECU 453 value in non-congested areas. Whilst, in theory, it would be possible, in respect of a standard 40km radius system, to reuse a channel over 40 times throughout the United Kingdom, in practice the need to provide a degree of separation between systems to reduce interference and the fact that some areas of the country would sustain few, if any, PBR systems, mean that a more modest reuse factor of 20 is justified and this has been use in the calculations in this document. Accordingly a charge for a national channel of 2 X 12.5khz is made up as follows:

(1 X ECU 3,624) + (2 X ECU 1,812 (17 X ECU 453) = ECU 14,949

The above assumes that of the available 20 systems, 1 is located in London, 2 in Manchester and Birmingham and the remainder in the rest of the country. The ECU 14,949 value of a national channel is equivalent to an STU of ECU 2.49 referred to earlier.

Establishing individual licence fees

Having established a value for mobile communications spectrum, the second step is to determine the final fee to be paid by users. The fee depends on the amount of frequency used (bandwidth), on the amount of area sterilised (sterilised area), on the amount of use (exclusivity) and on whether or not the occupied band (frequency band) and area (location) are congested.

Bandwidth

This is taken as the standard channel size - which can vary from 6.25khz to 200khz. This factor is determined on a strictly linear basis and takes account of whether the channel is duplex (where actually 2 channels are used for communications) or simplex (a single channel is used for communications in both directions - or where there is one way communication only, e.g. paging).

Sterilised area

The Agency has considered whether coverage area (the area within which an acceptable and usable signal is received) or sterilised area (the area within which another service using the same channel cannot be assigned without harmful interference) should be the relevant factor. Using the sterilised area of a service as the basis of the fee more faithfully reflects the actual spectrum usage and would encourage users to make maximum use of their coverage area within the sterilised area. This is the proposed approach.

Initially, it is proposed that sterilised areas will be determined by reference to standard coverage areas translated, for fee calculation purposes, into a standard re-use factor. At some later stage, the Agency will consider whether it is appropriate to seek to determine sterilised areas more precisely for individual systems although the practicalities of doing this (there are 30,000 PBR licences) needs to be recognised. For example, a 40 km radius sterilised area has been adopted as the standard for wide-area PBR giving a 20 re-use factor and for CBS and regional PAMR, a 60 km sterilised area standard giving a 10 re-use factor. The sterilised area of CBS and regional PAMR (11,300 km^2) is approximately twice the area of PBR (5,100 km^2). On site PBR has a very much smaller coverage area (48km^2).

Assigned channels covering the whole (or most) of the United Kingdom, will be charged on the basis of national coverage. For channels assigned on a regional basis an appropriate adjustment will be made to reflect the actual area covered.

Exclusivity

Where, within the sterilised area, a channel is completely set aside for a user, this would be viewed as exclusive use (CBS, PAMR, Cellular and PCN systems are all planned on this basis). Otherwise the user has access to the channel on a shared basis.

Current fees for PBR shared users are charged under an arrangement where the greater the number of mobiles the greater the fee based on the concept that the number of mobiles provides a measure as to the amount of usage, or degree of exclusivity, a user will require from the channel. This can distort the anticipated loading because differing types of users make varying use of the channel. The current charging regime also allows multiple system users to gross up the total number of mobiles which is then not representative of the spectrum occupied. It is proposed to move progressively to new arrangements whereby the number of mobiles for each service and other information such as expected usage will be used to estimate the degree of sharing. Accordingly, the number of mobiles will be only one factor in determining the assignment of a shared channel (monitoring and other information will also be used).

It is also proposed to move away from the “per mobile” count as a basis for charging fees. An alternative approach would be to determine the degree of sharing on a percentage basis (10%, 20% etc) but the Agency is attracted to a simpler approach of three levels: (a) light use; (b) average use; (c) heavy use.

Band

As indicated above, there are some mobile bands, which do not currently appear congested. Consequently, it is proposed that premium prices will not apply to any users of these bands irrespective of the location of the users system. If, as a result of increased prices in other bands, demand in the less popular bands increases, this may need to be reviewed. Accordingly, increased spectrum prices will not be introduced in Band I, Low Band or Band III.

Location

As proposed above it is anticipated that systems within London, Birmingham and Manchester will be charged premium prices but with lower levels in the latter two areas.

Minimum fee

In all of these areas heavily congested, congested and non-congested it is anticipated that minimum fees will apply. Initial proposals for these are respectively ECU 302, ECU 151 and ECU 113.25. These are likely to affect only PBR on-site users and small wide-area PBR users in non-congested areas.

ANNEX VI

DEVELOPMENTS WITH REGARD TO SPECTRUM PRICING IN INDIVIDUAL ADMINISTRATIONS

Denmark

In Denmark, according to the Act on Radiocommunications and Assignment of Radio Frequencies spectrum fees shall reflect license holders' use of spectrum. Therefore fees shall be charged that reflect exclusive or shared use, the bandwidth used and geographical coverage. The basis of the calculation of fees is the cost of administration and of other services provided by the National Telecom Agency to the telecommunications sector in the field of radiocommunications, and is divided on the licence holders according to spectrum use.

The Act contains a provision for increased administrative pricing. But according to the legislators' comments to this provision, the method has several inadequacies and is to be used restrictively - only in a situation with general frequency scarcity, where the traditional frequency administrative methods have proved to be insufficient. According to the legislators' comments, this instrument would raise the price of the telecommunications service provided on the basis of the frequencies in question, as it must be expected that the network and service providers would pass the increased costs due to the instrument on the end-users. The Act contains no provisions for money auctions.

One of the aims of the Act is that users be given access to a wide, varied and inexpensive range of telecommunication services. Spectrum management principles that may increase the price of service to end-users are therefore generally inconsistent with Danish policy.

In areas where demand exceeds supply, and where the first-come-first-served principle cannot therefore be applied, the Act provides for the following frequency administrative methods: public tendering, administrative redistribution, requirements for changeover to more frequency effective methods of utilisation or technologies, requirements for reduced usage, and administrative withdrawal.

It is believed that these methods respect the requirements for transparency and non-discriminatory access to frequencies where the licence holders are selected on the basis of clear, objective and non-discriminatory rules, resulting in end-users getting the best possible services at the lowest price.

Economic incentives such as those described in the ERC Draft Report may fulfil a need for new approaches to spectrum management. However, it is the opinion of the National Telecom Agency that economic incentives cannot be used in isolation. Rather, it is believed that administrative methods based on clear, objective and non-discriminatory rules such as public tenders, spectrum withdrawal, and spectrum redistribution, are the most likely to secure end-users access to a wide, varied and inexpensive range of telecommunications services.

Finland

Finland has implemented a frequency fee for major frequency users like public mobile operators. The amount of the frequency fee depends on factors which take into account parameters like frequency band, coverage area and age of the system. The fees are higher in the most congested bands and lower in the less congested bands. Auctions are not planned.

For the other individually licenced radio equipment a traditional licence fee is collected.

Pricing is considered to be the method by which the administration finances its costs. The spectrum management is best being done through spectrum management.

<u>New methods of spectrum management</u>

A fully computerised spectrum management system is being prepared. The system includes already now a computerised frequency database, digital terrain map and interference calculation software. Digital frequency allocation tables to complete the system are being developed.

The aim of the automatic system is to:

* improve the spectrum management
* make maximum use of the frequency spectrum;
* speed up the processing of frequency assignments
* facilitate the work so that the increasing number of frequency assignments can be managed without remarkable staff increase.

France

In general, France uses administrative pricing and has no present intention to adopt more market driven pricing regimes. A new Telecommunications Law has been adopted fairly recently. This law regulates the issuing of licences to provide services. Licences are necessary to provide public telephone services and services that require the use of radio frequencies. The licences can only be refused on the basis of a limited number of grounds listed in the law. Provision of all other telecommunications services is free of licence.

Further an independent regulatory authority (ART) is established in order to separate the functions of the regulatory authority and the operator better. That authority is in charge of the attribution of frequencies to civil users except the broadcasting service.
Separately a frequency agency (ANFR) is established, in charge of spectrum co-ordination between national administrations – ART, CSA (Broadcasting regulator), Ministry of Defence etc. – and of European and international frequency matters.

Germany

New legislation for issuing licences and frequency assignments has been published in 1996 and 1997.
The new law has changed the system of charging individual licensees completely.

The new structure is:

1. Operators licences for services, which will be issued and paid for once (no yearly fee). The fee covers the attributable costs for issuing and administrating the licence. No surplus allowed.
2. Single fee for frequency assignment. As frequencies are regarded as scarce resources, the fee can take into account the attributable administrational costs as well as the economic value of the frequency. Therefore making a surplus is possible and allowed.
3. Annual contribution for the usage of frequencies. It covers the cost of frequency management that can not be attributed individually. The annual tax has to be re-calculated every year on a cost-recovery basis related to each user group.
4. Annual EMC contribution. It covers the cost of EMC-related work the government has to do. The annual tax has to be re-calculated every year on a cost-recovery basis related to each user group.

The general aim of the new regulation is to facilitate access to radiocommunications and keep it as cheap as possible.

Hungary

The Hungarian legislation defines several types of pricing in connection of frequencies.

1. Each frequency user, who obtained a radio licence pays an administrative incentive frequency fee:

- one-time fee for frequency reservation
- monthly fee for frequency usage

  The frequency usage fee depends on the service, the frequency band, the occupied bandwidth, the coverage area and whether shared or exclusive frequencies are assigned.

2. Some public telecommunications services (mobile networks, national paging, and broadcasting) may acquire a concession via tendering. The winning service provider obtains "Flexible Spectrum Rights" for the necessary spectrum. The frequency assignment for GSM and ERMES has been carried out in this way.

3. For other public services (e.g. national data transmission or local paging, broadcasting), the competence may be obtained via auction or lottery. The assignment given for the frequency contains strict conditions for radiation.

The surplus from licence revenues and concession fees is transferred to a fund from which refarming of frequency spectrum is financed.

The revenues of administrative fees cover the work and development of frequency management.

The Netherlands

In 1995 the Ministry of Transport and Public Works issued a Memorandum of Frequency Policy. This Memorandum which was discussed and approved in Parliament gives an outline of the future policy with regard to spectrum management. Its main elements are that a two yearly National Frequency Plan will be published, indicating how internationally agreed frequency allocations are to be divided among categories of use in The Netherlands. This document will be politically approved and is more policy oriented than the plan that is issued nowadays. Furthermore frequency assignment will be valid for a limited period and the introduction of a market mechanism is proposed. It was mentioned in the Memorandum that further study was necessary on how, in which cases and under what conditions this market mechanism can be used. These studies have been done and the conclusion, based on the study, is that auctioning and public tendering will both be used in future. Also the instrument of a scarcity levy, but determining the height of this levy is considered a difficult item. The first auctions of licences have taken place in 1998.

Norway

The Norwegian Post and Telecommunications Authority (NPT) is financed by cost recovery. That means that the fees shall cover the total costs (direct and indirect costs). As a consequence the income and expenses shall in principle be equal each year. Even if the income and expenses are balanced in the budget, surplus or deficit can occur. In order to cope with these fluctuations in the license fee structure a regulation fund is established. The differences between income and expenses are added or subtracted from the regulation fund by respectively surplus of fee income and deficit of the fee incomes. This provides for stable fees from one year to another.
In order to establish the fee levels all relevant direct activity for a user group are recorded to that particular service. The fees are calculated in relation to the use of resources each of the user groups bring upon NPT through direct activity and indirect activity.

The Telecommunication Act of 23 June 1995 gives the possibility to charge major frequency users for the use of the frequency spectrum with fees, which goes to the governmental budget. An example of a radio license fee which goes beyond the cost recovery for the administration is the fee for the frequency usage of the DCS 1800 system. Such spectrum pricing is also under consideration for other radio systems.

The current Telecommunication Act requires a radio licence to posses and use radio equipment of any category. The intention is to change this and see whether license exemption of some categories of equipment is possible.

Poland

Resolutions of the Parliament (21 April 1995) on the development of telecommunications services market in Poland laid down the obligations for the government to prepare:

- a strategy for telecommunication sector development

and

- a new telecommunication law before the end of 1997.

The document *Telecommunication Development Policy*, prepared by the Ministry of Post and Telecommunications, has

been approved by government May 28, 1996.

The draft of a new *Telecommunications Act* is now in the final stage of preparation. By the end of 1997 it should be presented to the Parliament. The new *Act* will replace the actual law, existing from November 1990 with some amendments from June 1995, and will be prepared in parallel with the new *Postal Act.*

According to the present *Act* entrance to the market is controlled by concessions, licences and simple registration. The Minister of Post and Telecommunication may give out concessions for telecommunication service providers. Licences are in competence of the National Radiocommunication Agency. Concessions for broadcasting operators are in the competence of the National Council of Radio and Television. This Council is nominated by the Parliament (3 persons), the Senate (2 persons) and the President (2 persons).

Auctions are going to be used in the area of public telecommunications networks.

Fees and charges

1. The fee for the concession depends on the success of the auction. It is an income to the state budget.
2. Charges for radio licences go to the state budget (one off fee every 5 years = the licence duration).
3. Yearly charges for the usage of radio equipment go to the state budget. These charges depend on the kind of equipment and other parameters.
4. Yearly fees for frequencies constitute the income of the National Radiocommunication Agency. From this income all costs of the Agency are covered.
5. Charges for broadcast concessions go to the state budget.

Sweden

The National Telecommunications Agency is governed by Law and is therefore not under the influence of a Ministry. In the past auctioning of broadcasting licences has taken place within the administration, but under the existing law governing the Agency auctioning or administrative pricing, like differentiation on the basis of frequency band, is not possible. The licence fees that are charged are covering the costs of the Agency.

In the previous years many applications have been made licence exempt. The system in Sweden is that in principle all applications are licence exempt unless there are reasons for licensing individually, like international obligations or the necessary frequency planning. It is the intention to go further on this road see whether licence exemption of even more equipment might be possible. Thoughts go in the direction of maritime and aeronautical equipment and maybe radio amateurs, although it is realised this has international constraints.

The UK

There is little available spectrum below 3 GHz and the region between 3 and 30 GHz is becoming increasingly congested. There is concern that constraints on the availability of spectrum could inhibit growth in some areas.

Provision of fair access to spectrum has been important in stimulating the competitive development of communication services in the UK. However, some spectrum assignments are thought to be used ineffectively or not at all by some licensees and tighter management could lessen congestion.

There has been an increasing awareness that that a more responsive and reactive system is required to allocate spectrum effectively and in particular to stimulate the introduction of new services and technologies and to recover under-used spectrum.

Over the next 5 years the demand for spectrum will grow and a better way of allocating this resource must be found to provide for:

- the introduction of narrow bandwidth private mobile services;
- assignment of spectrum currently allocated to PCN services;
- additional spectrum for GSM;
- clearing of 1-2 GHz for new mobile services including mobile satellite services;
- opening up of new bands for fixed services, particularly in the local loop;
- clearing the way for terrestrial digital TV.

The present UK practice is to assign administratively within the ITU framework to a fee schedule reflecting the Radiocommunications Agency costs.

Accordingly in March 1995, the UK Radiocommunications Agency issued a consultative document spelling out the options and inviting replies. Some 400 responses have been received. There was, however, a large measure of agreement that differential pricing should play a role in frequency allocation.

In June 1996, the Government published a White Paper entitled "Spectrum Management into the 21st Century". The White Paper spelt out a new approach to spectrum pricing. It indicated a move away from cost-based pricing.

The White Paper presents detailed proposals for a regime of spectrum pricing encompassing both auctions and administrative pricing. The Government adopts a preferential stance towards auction pricing. However, it upholds the role of administrative pricing which will be used to complement regulatory spectrum management. Administrative pricing should continue to be used where there is insufficient spectrum to meet demand.

The Governments intends to maintain a strategic presence, through the Radiocommunications Agency, in planning, allocating and assigning spectrum.

The Government had invited comments on the White Paper and has, having considered views of operators and users on the pricing of spectrum, brought forward legislative proposals in 1997.

Accordingly in May 1997, the UK Radiocommunications Agency issued a consultation document on Implementing Spectrum Pricing inviting replies by September 1997.

Comments were received from just over sixty organisations from a wide cross-section of leading players and users in the radio industry. An overview of the comments is given below.

Need for new fee regime

There was agreement from respondents that the Agency needed to break away from constraints imposed through cost recovery in order to introduce fairer prices that reflect the scarcity and value of the spectrum being used. The existing fee regime, it was widely recognised, does not provide the Agency with the tools it requires to manage radio spectrum and to meet the demand of a dynamic and growing industry, present in the UK.

The proposals in the consultation document were recognised by many respondents as a logical progression towards a more effective market based form of spectrum management. There was concern that the proposals should not be viewed in isolation; and that the Agency should make clear its long-term spectrum management objectives and link these to its spectrum pricing objectives.

There was broad-based support from both the public and private sectors for the introduction for administrative pricing. However, the proposals to concentrate initially on just three sectors (fixed point-to-point services, private business radio and public mobile communications), were believed by some to be too limited.

There existed a clear understanding of the need to use market-based mechanisms as a means of promoting good spectrum management practice; and recognition that, in some areas, the Agency faces difficulties in addressing anomalies caused though historical allocations.

It was considered important to ensure equitable treatment for all services. The development of spectrum pricing could provide

increasing transparency in the valuation of radio spectrum for different users. The proposals for spectrum pricing were regarded as a starting point for the evolution of a robust system of pricing radio spectrum in the future. This should be carried out in full consultation with the industry.

The three year transitional period, from the existing fee regime to one in which the full increase in fees would commence was considered by some to be too short; particularly where a major increase in fees was envisaged. Some respondents considered that the three year transitional period would penalise organisations who have made large scale investments under the existing scheme.

Pricing

Movement by the Agency towards greater transparency in its licensing procedures and processes was welcomed by the radio industry and users alike. This development would, it was thought, be assisted through further development of spectrum pricing values expressed in terms of the Spectrum Tariff Unit (STU)[22] to express licence fees. This would enable pricing comparisons across different parts of the spectrum.

Views were mixed on the concept of a uniform charge per STU. Some believed that this would allow the existence of a level playing field. Others argued that there was a need to take into account other factors such as competition, choice, spectral efficiency, and quality of service and self-management of spectrum.

There was concern, that under the proposals the main burden of spectrum price increases would fall on the mobile telephone companies and larger users of fixed links. There was perceived to be a need, within this group, for the Agency to justify proposed increases on the grounds of the promotion of spectrum management objectives. Mobile telephony operators claimed that existing commercial drivers oblige them to make optimal use of current spectrum allocations; and that the emergence of spectrum pricing would not provide any further incentive to maximise the use of current assignments.

Concern was expressed on the illustrative licence fee increases for mobile communications contained in the consultation document. Many operators believed that, in heavily congested areas, the proposals would lead to fee increases which they would be unable to pass on to customers. Some Common Base Station operators pointed to tight operating margins in their businesses, which would be unable to sustain the increases suggested in the consultation document.

Greater uniformity in the price of spectrum between mobile and fixed services was advocated by some, who noted that the illustrative prices in the consultation document did not offer reasonable parity, between sectors, for the price of radio spectrum.

Congestion

It would be crucial to demonstrate congestion in order to justify increases in fees. The design and application of methodologies for both defining and measuring the existence of congestion (or otherwise) was regarded as critical to the success of spectrum pricing and confidence in its future application.

The Agency's initial scooping of congestion outlined in the consultation document was regarded as giving insufficient resolution to define areas in which there is congestion.

Spectrum management

Spectrum management should be designed to support clear and explicit spectrum management objectives, linked to the Agency's spectrum strategy.

There was concern that spectrum pricing should not be regarded as a substitute for the use of other spectrum management tools available to the Agency.

Some respondents were critical of some current spectrum management practices. It was felt that Agency resources should be transferred to the management of services suffering from particular problems.

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[22] The Spectrum Tariff Unit (STU) is a calculated figure based on the value of MHz of spectrum covering 1 $km^{2.}$

ANNEX VII

A GLOSSARY OF SPECTRUM PRICING

Terms defined in this glossary are printed in *italics*.

Administrative pricing A form of *spectrum pricing* in which *apparatus licence* fees or charges for *spectrum rights* are set by the spectrum manager. Administrative pricing may include such variants as:

- *shadow pricing* (see below)
- *incentive pricing*, where an attempt is made to set prices to promote efficient spectrum use;
- *regulatory pricing*, where fees are set unrelated to market considerations, for example, to recover spectrum management costs.

Apparatus licence A permission to possess, install or use radio equipment. This will specify the frequency or frequency band to be used and may also impose terms and conditions restricting matters such as the type of apparatus to be used, power, coverage area, geographical location or service to be provided. The extent and specificity of the restrictions will depend on circumstances and the characteristics of the service in question.

Auction A form of *spectrum pricing* - as well as a spectrum assignment mechanism - in which *apparatus licences* or *spectrum rights* are assigned to the winner(s) of a competitive process selected on the basis of price. (In some countries, other objective factors, such as quality of service, speed of roll-out and financial viability, may also be taken into account, either in the assessment of the bids or as pre-qualification criteria.*) Auctions* may take various forms, including:

- the *English auction*, where the auctioneer increases the price until a single bidder is left;
- the *first-price sealed bid auction*, where bidders submit sealed bids and the highest wins;
- the *second-price sealed bid auction*, where bidders submit sealed bids and the highest bidder wins but pays the second highest amount bid;
- the *Dutch auction*, where the auctioneer announces a high price and reduces it until a bidder shouts “mine”;
- the *simultaneous multiple round auction*, as pioneered by the Federal Communications Commission in the USA. This involves multiple rounds of bidding for a number of lots that are offered simultaneously. The highest bid on each lot is revealed to all bidders before the next round when bids are again accepted on all lots. The identity of the high bidder may or may not be revealed after each round, but is revealed at the auction's close. The process continues until a round occurs in which no new bids are submitted on any lots. This variant is more complex than single-round auctions but offers bidders greater flexibility to combine lots in different ways, and, because it is more open than a sealed bid process, limits the impact of the *winner’s curse,* allowing bidders to bid with more confidence.

Auctions are commonly considered to have advantages of economic efficiency, transparency and speed compared to alternative assignment methods and also capture the market value of spectrum rights for the administration holding the auction. They can give rise to anti-competitive outcomes if they result in large operators acquiring an undue concentration of the available spectrum but various safeguards against this can be introduced, for example restrictions on the amount of spectrum an individual bidder may win or ‘use it or lose it’ provisions to prevent hoarding.

Bidding credit A discount given to certain bidders. Bidding credits were given to smaller, entrepreneurial firms in some FCC auctions. For example, a 25% bidding credit would mean that if an entrepreneurial firm submitted a winning bid of $1,000,000, it would pay only $750,000. Originally, bidding credits were also proposed for women and racial minorities; however, the FCC dropped this proposal after the U.S. Supreme Court's *Adarand* decision, which declared that such preferences were discriminatory, and therefore illegal.

First-come, first-served An assignment procedure in which spectrum is assigned to applicants until it is exhausted, subject only to compliance with minimum technical or financial criteria. This procedure has tended to be used for small scale assignments, such as individual private business radio and fixed links licences. It works best where spectrum is not scarce.

Gross Domestic Product (GDP) The sum of the value of all final goods and services sold within the geographic borders of a country in a year.

Lottery A process for assigning *apparatus licences* or *spectrum rights* to applicants selected at random. *Lotteries* have the advantage of speed and simplicity but they are unlikely to lead to an economically optimum outcome and can give rise to speculative applications because of the prospect of windfall gains.

Mutual exclusivity A situation in which two or more applicants are competing for the same spectrum assignment.

Oligopoly A situation in which only a small number of firms are supplying a product or service. This situation may be contrasted with a monopoly situation, in which there is only one firm supplying a product or service.

Opportunity cost The benefits foregone by not putting a resource to its best alternative use. For example, the best alternative use of a frequency band currently used for a broadcast service might be for a mobile service. In an auction, the bidder with the highest willingness to pay will win, with a bid that is just above the valuation of the bidder with the second highest willingness to pay. This second highest valuation represents the opportunity cost.

Resource rents The term economists use to categorise the value of a resource. The rent accruing to a resource right, such as a spectrum right, can be quantified by the price that the right would fetch in an open market.

Secondary trading Buying and selling of *apparatus licences* or *spectrum rights* after initial assignment by the spectrum manager. Dealing may take place directly between the parties or through an intermediary.

Shadow pricing A form of administrative pricing in which the price is set according to a predetermined formula intended to mimic the effect of market forces by taking spectrum consumption, value and scarcity into account. Parameters commonly used include bandwidth, frequency location, geographical location and coverage area.

Spectrum efficiency scheme A scheme to facilitate or accelerate desirable changes in spectrum use, for example through the provision of financial assistance to users to offset the cost of re-equipping with more spectrum-efficient technology or migrating to alternative bands. The scheme may, but need not necessarily, be financed from *spectrum pricing* proceeds by a separate fund.

Spectrum pricing A generic term denoting the use of pricing as a spectrum management tool. It covers both *administrative incentive pricing* and *auctions* of either *apparatus licences* or *spectrum rights*. Under *spectrum pricing*, charges are not set by reference to the fully allocated costs of spectrum management attributable to particular user categories but are intended to balance supply of and demand for spectrum or to achieve other spectrum management policy objectives, such as facilitating the introduction of new services or promoting competition.

Spectrum right The right, analogous to a leased property right, to use a specified frequency or range of frequencies in a particular location or throughout a nation or region for a particular time period. Where such rights have been introduced, restrictions on the type of equipment to be used or service to be provided may be minimal apart from technical non-interference conditions in relation to adjacent *spectrum rights*. It may be possible to assemble *spectrum rights* to provide increased bandwidth or coverage area or both.

Threshold qualifications Qualifications that are a prerequisite to participate in some process, such as a lottery or auction. Threshold qualifications may include financial and technical viability, and a service plan that satisfies certain social goals.

Unjust enrichment An award, such as the award of a valuable frequency assignment, to a person or company that exceeds that person's or company's entitlement to the award.

Winner's curse A possible effect of an auction, most commonly a sealed-bid auction. Assuming that some bidders will over-estimate the value of the lot, the winner may be the most optimistic rather than the most skilful in assessing the value of the lot. In a sealed-bid auction, auction proceeds may be reduced as bidders attempt to minimise this effect. *Winner's curse* can be reduced or eliminated by careful design, particularly by using multiple round auctions (see *simultaneous multi-round auction*).

ANNEX VIII

SPECTRUM REFARMING ISSUES

This section is not a complete study of the spectrum refarming, as the problems with which it is associated will vary considerably with the type of spectrum management regime operating in a country, the number of items of equipment involved and the extent of spectrum congestion.

What is it

Spectrum refarming is a spectrum management function and is the physical process by which a spectrum management authority recovers spectrum from its existing users for the purpose of reassignment, either for new uses, or for the introduction of new spectrally efficient technology. Resolution of all spectrum refarming issues is necessary before the spectrum planning process, to which it is linked, can be successfully completed. Spectrum refarming commences once a frequency band has been identified for redevelopment and firm proposals exist to either remove the existing occupants, or restructure the band plan. It is completed when the existing users have agreed to the changes and any associated preconditions to that agreement (e.g. co-ordination in a replacement frequency band) have been successfully concluded.

Associated Problems

Spectrum refarming raises a number of issues for both the users and spectrum management authority. If the spectrum refarming process is to work quickly and avoid unnecessary delays, it is important both groups understand each others viewpoint.

Spectrum refarming from the users perspective

For the users, spectrum refarming raises concerns on the potential impact, in both the short and long term, on the profitability, and possibly viability of their business. The level of concern may also increase if refarming includes a change in frequency band, rather than a straight upgrading of the spectral efficiency of their existing equipment (e.g. a change in bandwidth from 12.5 kHz to 6.25 kHz). Specific points are:

1) The existing users radio equipment represents an investment which they will want to recover before moving to new equipment, or a new frequency band, otherwise they may face a financial loss. The cost of the users equipment should not be considered in isolation, it must be related to the size of the organisation, its turnover and profit margins. Although it is easy for spectrum planners to understand the impact of the cost of a new transmitter network on a national broadcaster, there is also a need to appreciate that the cost of new radio equipment to a small company may also be significant.

2) The use of radio may be integral to the profitability of an organisation and a change to a different frequency band, or another means of communications, may affect its profitability or damage its operations.

3) An existing user's requirement from radio may be based on the particular properties of a limited range of radio frequencies; this may restrict their ability to move to another part of the spectrum.

4) Evidence that change will improve spectral efficiency and spectrum usage may be based solely on a valued judgement by the administration.

5) New users of a frequency band may have specific time limits within which they need access to spectrum: too early and there may be insufficient demand for their services, preventing recovery of the cost of the equipment within an acceptable time period; too late and they may lose market share to a competitor, or be completely bypassed by developments in new technology.

6) Possible disruption to the business during the changeover and consequential loss of income.

Spectrum refarming from the administrations perspective

From the administrations viewpoint, spectrum refarming is a process that has to be completed, otherwise the planned improvement in spectral efficiency or the development of spectrum usage, cannot take place. There are two main obstacles: reaching agreement on any change and the timescales within which it will be implemented. If these involve a change to a new frequency band, it may take 15 to 20 years before the old frequency band is vacated, depending on the service, or the type of user. For example, a national broadcaster will have difficulty in withdrawing an existing service from the public without simulcasting in the old and new frequency bands for a period of time; if there is simulcasting, then there is only the novelty of the new service and any perceived benefits, as an incentive to replace existing receivers.

In practice, changes in spectral use can only be achieved if the spectrum management authority closes access to the band for new users and implements one of the following options:

a) ordering the existing users to vacate the band;

b) allowing the number of existing users to decrease with time;

c) persuading the existing users to vacate the band.

The success a spectrum management authority achieves with any specific option will depend on a number of factors:

i) whether the country has a single regulatory spectrum management authority;

ii) if there are any legal considerations e.g. long term licence, devolved spectrum rights;

iii) the type of existing user and service, e.g. broadcasting.

The factors involved in any refarming decision may limit the options available. Single regulatory authorities may have greater powers and may therefore be less likely to have problems with devolved spectrum rights, but may also have less flexibility in negotiations to persuade users to vacate a band. For some users and services (e.g. the military, broadcasting) the only option available is persuasion, as the number of users is unlikely to decrease with time and it may not be practicable to order them to vacate a frequency band. This may also be true for users, or services, where there are possible legal considerations. While in other cases, persuasion or financial compensation may be impractical due to diversity of opinion amongst users. Flexibility in approach is therefore necessary to enable the spectrum management authority to resolve the problems presented by the different services and user groups.

Summary

A spectrum management authority needs to take into consideration the requirements of both the existing and potential, users of a band. They must also consider their responsibilities to their country as managers of a limited national resource and its contribution to the national economy. Increasing spectrum congestion, and resistance to change will limit the access available to new users and services. This may lead to impairment in spectrum use and stagnation in radiocommunications development. Without resorting to a strict regulatory regime which could inhibit investment, the only possible solution to these problems involves improving communications between the spectrum management authority and users, and raising awareness of national requirements. There are a variety of methods that can help convey this information (e.g. national seminars, publications on developments in radio, reports on spectrum usage and planning) and although they are necessary to increase awareness of spectrum management issues, they are not necessarily sufficient in themselves to make spectrum users appreciate the spectrum’s value, or its scarcity.

The concerns raised by limited spectral availability and the timescales required for making a frequency band available to new users, have led some countries to consider ways they can further improve awareness of the value of the radio spectrum. The problems arising from spectrum congestion and refarming are among the main reasons for many countries considering the proposed introduction of spectrum pricing.