



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



**THE ROLE OF SPECTRUM PRICING AS A MEANS
OF SUPPORTING SPECTRUM MANAGEMENT**

Marbella, September 1999

EXECUTIVE SUMMARY

In May 1998 the ERC approved Report 53 on the introduction of economic criteria in spectrum management and the principles of fees and charging in the CEPT. After publication of ERC Report 53 it was decided to work further in this area and produce also an ERC Report on the practical implications of spectrum pricing. The aim of this Report is to compare the theoretical models presented in ERC Report 53 with the concrete plans and practical experiences of CEPT and other administrations.

This Report describes the practical applications and experiences with cost based pricing, administrative incentive pricing, auctions and spectrum trading and gives some initial thoughts on spectrum reforming.

Options for pricing and possible impact.

When cost based pricing is used, price setting may be basically addressed to:

- Set simple licence fees, e.g. for light regime licensing.
- Set differential fees to reflect spectrum use, but within a regime that still aims to recover the overall costs of the spectrum administration.

There are advantages in having very simple fee regimes for simple licences. They provide a form of registration of users so it is possible to monitor usage (in contrast to licence exemption).

Most administrations have however adopted some degree of differential pricing. This allows higher fees for more use of channels or more services.

Differential pricing is also suitable for other services, but its limitations start to arise for big blocks of spectrum, for which the cost based fee may be relatively low. This is when incentive pricing or auctions may be a better means of exercising spectrum management.

Administrative Incentive Pricing

The introduction of incentive pricing provides a means by which licences can be priced to reflect the value of the spectrum used. Where spectrum is in heavy demand, prices may be set higher. Where spectrum is under utilised, prices may be lowered to encourage more use. Prices may also be lowered to encourage new innovative uses of spectrum or to encourage more competition of services. Conversely the use of higher prices may also stimulate innovation itself.

Administrative incentive pricing (AIP) should be closely related to supporting spectrum management objectives.

In most administrations, new legislation may be necessary to enable AIP to be used.

The approach taken in most administrations around the world who have considered it, is to work out a number of models for treating spectrum as a raw material. Another key factor is the need to work closely with key customers to determine tariff units. Experiences from countries that are adopting AIP include, Australia, New Zealand, Canada and United Kingdom.

Auctions

Auctions have been used for a long time as an instrument to allocate goods. However the actual application of the auction instrument as a means to allocate spectrum has started quite recently. The first auctions were held in New Zealand and Australia. The auction design contained a number of flaws, which made them not very successful. Therefore the US chose a novel design which is now generally known as the '*simultaneous multiple round auction (SMR)*'.

Not only in New Zealand, Australia and the US but also in Europe auctions have been conducted over the (recent) years and more are planned. The designs and experiences of these auctions are discussed and advice is given, based on experiences of countries that have introduced auctions.

Spectrum Trading

Spectrum trading has been introduced for other intangible assets than spectrum and positive results were reached.

Australia and New Zealand have introduced some form of spectrum trading, but it is difficult to draw conclusions from this for the European market. United Kingdom has held a consultation on the introduction of spectrum trading. There was broad agreement that a spectrum market could:

- improve the economic efficiency of spectrum management;
- help to ensure that spectrum was assigned to those who could produce greatest benefit from it;
- provide valuable additional flexibility for spectrum assignments to be adjusted through the market in response to changes in demand.

There was also agreement in UK that spectrum trading should be introduced selectively in a way that took account of the market and technical characteristics of the different licence classes.

The ERC Report concludes that variations may need to be applied selectively and pragmatically and preferred spectrum trading solutions are likely to vary from country to country.

Reforming

It should be emphasised that reforming as such is a long standing and frequently used frequency management tool, used for strategic planning of spectrum aiming at efficient use and international harmonisation.

The new element that is brought into the discussion on reforming is whether and how this will be funded. Particularly important in the context of this Report is the role that administrative incentive pricing and secondary trading can have in these processes.

It should be emphasised that reforming is not a "first choice" activity. The possibilities of sharing of frequencies and the use of innovative technologies, which enable sharing should be used to the utmost in order to avoid reforming.

When time and transparency can not solve the issues, because reforming has to take place at short notice the issue of financial compensation of the existing users arises as does the question of who will pay for this compensation. There are a number of options for this, each with advantages and disadvantages.

Only the main issues surrounding the topic of reforming were touched upon, since it is not the prime subject of this Report. It is made clear though that administrative incentive pricing and secondary trading have a role to play in assisting reforming, as outlined above. The other issues are getting beyond the scope of this Report and should be studied further within the ERC.

Conclusions and recommendations

This Report is intended to be of an informative and advisory nature and does not propose ways of harmonisation in the area of spectrum pricing. Experiences and plans in this area, with the emphasis on CEPT countries are brought together for reference for the benefit of administrations, which are studying these issues.

It is recommended that each administration considers how pricing might best be used as a tool for assisting spectrum management. Circumstances will differ in every case, but administrations should be aware that the pressures on spectrum demand are likely to generally increase.

This Report sets out some of the experiences of how spectrum pricing can help. It is not an instrument, which can be introduced without a lot of preparation. However the benefits of using these new techniques can be significant in improving spectrum efficiency. It is therefore recommend that serious attention be given to the potential use of pricing. Those countries having experience with it are very willing to share that experience.

INDEX TABLE

1	INTRODUCTION	1
1.1	TERMINOLOGY	1
1.2	DEVELOPMENTS	2
1.3	POSSIBLE ADVANTAGES OF ECONOMIC SPECTRUM MANAGEMENT TOOLS	2
1.4	SCARCITY/CONGESTION.....	2
1.5	MISSION STATEMENT ERC	3
1.6	ROLE OF THE REGULATOR.....	3
2	OPTIONS FOR PRICING AND THE POSSIBLE IMPACT	3
2.1	COST BASED PRICING.....	3
2.2	ADMINISTRATIVE INCENTIVE PRICING.....	4
2.3	AUCTIONS	6
2.3.1	<i>Auctions: some chronological background information</i>	<i>8</i>
2.3.2	<i>Auctions in Europe</i>	<i>12</i>
2.3.3	<i>Future auctions.....</i>	<i>12</i>
2.3.4	<i>Auction mechanism developments: combinatorial auctioning</i>	<i>13</i>
2.3.5	<i>The relation between auctions and a secondary market.....</i>	<i>14</i>
3	SPECTRUM TRADING.....	14
3.1	BACKGROUND: EXPERIENCES WITH TRADABILITY OF INTANGIBLE ASSETS	15
3.2	BACKGROUND: THE AUSTRALIAN AND NEW ZEALAND SPECTRUM TRADING EXPERIENCES	15
3.3	EU GREEN PAPER ON RADIO SPECTRUM POLICY	16
3.4	MANAGING SPECTRUM BY THE MARKET IN THE UNITED KINGDOM.....	16
3.5	A POSSIBLE WAY FORWARD FOR EUROPE	17
3.6	POSSIBLE DRAWBACKS FROM TRADABILITY OF SPECTRUM USAGE RIGHTS.....	17
3.7	SUMMARY	17
4	SPECTRUM REFARMING.....	18
4.1	BEFORE REFARMING.....	18
4.2	FINANCIAL COMPENSATION	19
4.3	PRODUCING CEPT/ERC GUIDELINES?	20
4.4	CONCLUSION ON REFARMING ISSUES	21
5	CONCLUSIONS AND RECOMMENDATIONS.....	21
ANNEX 1:	DEVELOPMENTS WITH REGARD TO SPECTRUM PRICING IN INDIVIDUAL ADMINISTRATIONS	24

THE ROLE OF SPECTRUM PRICING AS A MEANS OF SUPPORTING SPECTRUM MANAGEMENT

1 INTRODUCTION

In May 1998 the ERC approved Report 53 on the introduction of economic criteria in spectrum management and the principles of fees and charging in the CEPT. That Report discussed among other things possible approaches to the introduction of economic criteria and gave an overview of the plans of CEPT administrations in this respect. After publication of ERC Report 53 it was decided to work further in this area and produce also a Report on the practical implications of spectrum pricing. The aim of this Report is to compare the theoretical models presented in ERC Report 53 with the concrete plans and practical experiences of CEPT and other administrations. Several administrations have introduced the instrument of auctions and/or administrative pricing and others are on the verge of doing so. Others are developing a policy on the issues and this group in particular could benefit from receiving information on the experience of other administrations. Insight in specific steps in the procedures, which - looking backwards with the benefit of hindsight - are very advisable to take or should on the other hand be advised against is very valuable knowledge when developing proposals in this area.

The Report is intended to be of an informative nature and does not propose ways of harmonisation in the area of spectrum pricing.

1.1 Terminology

In this Report some terms specific to spectrum pricing, administrative pricing and related issues are used and it may be helpful to define these terms at the beginning of this Report.

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.

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:

- incentive pricing, where an attempt is made to set prices to promote particular aspects of efficient spectrum use;
- regulatory pricing (cost based pricing), where fees are set unrelated to market considerations, for example, to recover spectrum management costs.

Beauty contest: A comparative selection mechanism that gives weight to criteria other than 'financial bids' in order to decide which offer(s) is (are) best. Financial transfers nevertheless can play a role in this decision making process, but only and solely as (*ex ante determined*) fixed criteria that have to be met.

Tender: A selection mechanism that gives weight to both financial and non-financial criteria in order to decide which offer(s) is (are) the best'. A tender looks like a 'mixture' of a beauty contest and an auction.

Auction: A selection mechanism that gives weight to financial criteria in order to decide which applicant(s) is (are) the best. Non-financial criteria nevertheless can play a role in this decision making process, but only and solely as (*ex ante determined*) fixed criteria that have to be met.

1.2 Developments

As described in ERC Report 53 the experience of many CEPT administrations is that existing licensing and charging policies and mechanisms need to be changed in order to cater for the developments in the radio communications global environment. In particular the increased demand for spectrum and its scarcity have generated a requirement for a more dynamic spectrum management process and its associated procedures. Administrations have become aware of ways in which their spectrum management policies and procedures can be improved by introducing transparency in the procedures, for example, by publishing frequency tables, licence conditions etc. and by introducing computerised spectrum assignment systems.

These changes have also led to the development of new approaches to spectrum management. These approaches have included, among other things, the use of economic criteria as part of spectrum management policy 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.

The speed with which these changes are being introduced varies between administrations. At the moment the situation is that some administrations have introduced auctions and/or full administrative incentive pricing or are planning to do so.

Even within a cost recovery regime many administrations differentiate prices to reflect the spectrum use or to encourage changes.

1.3 Possible advantages of economic spectrum management tools

Compared to regulation, economic spectrum management tools can offer advantages of speed, transparency, economic efficiency and flexibility. They are not expected to replace regulation, which will continue to play an important role in spectrum management. However, applied selectively, economic spectrum management tools could usefully complement regulation. It should be for national administrations to select whether and how to apply these complementary methods. In doing so, they will wish to take into account a number of considerations, including current and expected developments in the market for radio-based services and the balance between spectrum demand and availability in the various frequency bands. These considerations can be expected to vary from state to state and the optimal combination of regulation and economic tools will differ accordingly.

Spectrum pricing, whether by administrative pricing or auctions, can help ensure that the spectrum resource is allocated in a way that optimises economic benefits. In accordance with economic theory, charging licence fees that reflect the scarcity value of the spectrum will help ensure that the resource is distributed in a way that maximises economic welfare. However, in a period of rapid and unpredictable change, such as arise from the effects of convergence, it is necessary to go further and provide dynamic, rather than merely static, allocation efficiency.

Markets and technologies are changing at a rapid rate and it is increasingly desirable for spectrum assignments to be capable of being adjusted over time. It is doubtful whether regulation will be sufficiently quick in all cases. The creation of, for instance, a secondary market through the introduction of spectrum trading would provide a powerful mechanism to redistribute spectrum dynamically in response to changing conditions. It could also provide market information feedback to guide administrative pricing and help ensure licence fees are set at the economically optimal level.

1.4 Scarcity/congestion

It can be argued that instruments such as administrative incentive pricing and auctioning are only useful to introduce when spectrum is scarce. There is no necessity to use incentives when all requests for licences can be met. This is the position in some European countries, which do not have scarcity and congestion problems. It can also be stated that auctions are to be applied only when the number of bidders for spectrum is likely to be higher than the spectrum available.

It is envisaged that in a number of areas in Europe and particularly in certain frequency bands the growth in demand for spectrum may lead to more and more congestion.

1.5 Mission statement ERC

New ways of frequency management are also being considered by the ERC. In its mission statement, strategy and action plan, published in 1999, the ERC indicated that it should study new mechanisms to regulate the use of the frequency spectrum, including the introduction of economic criteria, where appropriate. The activities within the ITU Study group 1 and the experiences and research of administrations should be taken into account.

1.6 Role of the regulator

Regulators within the CEPT countries are tasked with managing the radio spectrum as efficiently and effectively as possible. They are also trying to facilitate and promote new services whilst also protecting essential services. Pricing is a tool, which can complement regulation to assist these processes.

2 OPTIONS FOR PRICING AND THE POSSIBLE IMPACT

The aim of spectrum management policy is to achieve the optimal social and overall economic benefit of the use of the radio spectrum, which is a finite natural resource or, in other words, to optimise its use as a public benefit. Spectrum is an essential raw material for the Information Age and demand, fuelled by innovation and growth, is rising rapidly in certain frequency bands.

Historically, spectrum management has been based exclusively on regulation. However, as changes in markets and technology become faster and less predictable and spectrum pressures increase, it will become increasingly difficult to make sufficient spectrum available by regulation alone. The resulting spectrum shortages could impose substantial economic and social costs. Administrations are therefore starting to consider, and, in some cases apply, economic spectrum management tools, such as spectrum pricing.

This chapter describes the practical applications and experiences with cost based pricing, administrative incentive pricing and auctions.

2.1 Cost based pricing

ERC Report 53 covers the basic elements of cost based pricing in some detail.

Basically price setting may be addressed to:

- Set simple licence fees, e.g. for light regime licensing.
- Set differential fees to reflect spectrum use, but within a regime that still aims to recover the overall costs of the spectrum administration.

There are advantages in having very simple fee regimes for simple licences. Sometimes these are referred to as light licensing regimes. They provide a form registration of users so it is possible to monitor usage (in contrast to licence exemption). Key features of having simple fees to reflect simple licences are:

- Simple fees are suitable for licences which share spectrum, such as amateur licences, ships or aircraft licences. Also suitable for light regime are licences for Short Range Devices or VSAT.
- Simple fees should be low cost. Some administrations may require services to balance costs and fees exactly, but most do not. If not, then it is appropriate to set a minimum fee that is worth collecting for the simpler services.
- Low fees help encourage compliance for simple licences. Such simple licences are useful for frequencies where refarming may later be needed, or where use needs controlling (e.g. amateurs).

In some circumstances, licence exemption may be more suitable. Most administrations have found licence exemption to be suitable for subscriber terminals, for Short Range Devices or for PMR 446. Licensing is only necessary if this helps to control good spectrum use. In many cases, licensing may no longer be necessary and each case for light licensing should be reviewed on the spectrum management merits.

More complex licences

In a “pure” cost-recovery regime, it is necessary to exactly balance costs with fees for every type of licence. In a pure regime, fees would all have to be simple, but this leads to unfairness for those who have to pay the same amount for a licence to use little spectrum to those who use a lot. However most administrations are not bound by this, and some degree of cross-balance between services is often possible.

Most administrations have therefore adopted some degree of differential pricing. This allows higher fees for more use of channels or more services. This is usually regarded by users to be fairer for more sophisticated types of licence.

PMR and fixed links are both good examples where differential pricing can be used within an overall cost based framework. Some PMR users have exclusive spectrum covering large areas. Others share spectrum for small areas. Differential pricing may allow fees to be calculated by:

- number of channels
- coverage area
- exclusive or shared use
- extra facilities

In some countries, congestion is also being considered as a factor.

Similarly fixed links fees could reflect:

- number of links
- amount of bandwidth
- type of spectrum used

Differential pricing is also suitable for other services, but its limitations start to arise for big blocks of spectrum, for which the cost based fee may be relatively low. This is when incentive pricing or auctions may be a better means of exercising spectrum management.

2.2 Administrative Incentive Pricing

Reasons for introducing Administrative Incentive Pricing

In a dynamic communications market, the availability of suitable radio spectrum is a critical factor, which may determine the rate at which change may occur and new services be introduced. One of the principle drawbacks of cost-based pricing is that the cost of administering mature systems may be much lower than the cost of administering the development of a new or novel technology, so that there is less incentive to promote change.

As demand for spectrum use increases, so congestion starts to occur. “Congestion” is generally considered to be the condition where it starts to become difficult to use the spectrum because of capacity limitations. Traditionally administrations have relied on regulation to control congestion (e.g. by imposing tight operating conditions and by limiting the number of transmitting stations). However, hoarding and the use of older inefficient equipment are symptomatic of congested spectrum and stagnating markets, and if spectrum allocations become restricted, it is not then unknown for a black market in assignments to result.

The introduction of incentive pricing provides a means by which licences can be priced to reflect the value of the spectrum used. Where spectrum is in heavy demand, prices may be set higher. This will deter hoarding and encourage efficient usage. Where spectrum is under utilised, prices may be lowered to encourage more use. Prices may also be lowered to aid the introduction of more competition of services. Conversely the use of higher pricing may itself also stimulate innovation .

The application of AIP

Administrative incentive pricing (AIP) should be closely related to supporting spectrum management objectives. Where a new service is to be introduced, administrations will need to consider the type of licensing regime to be used. In turn this may affect the administration’s choice of charging method for the setting of fees for the new service. . Work done by Smith and NERA for the UK looked at models based on least cost alternatives and the UK Consultation Documents on

Implementing Spectrum Pricing, the first, second and third stage, have described in detail the mechanisms used in the UK. This work may provide a model which other countries may wish to follow.

Other factors which may need to be considered are:

- Licences for national exclusive bands of spectrum or channels are a considerable asset. These may be awarded by competition (auction or beauty contest). If the award is by auction, the market will determine the price subject to a reserve having been set by the NRA. (see 2.3 below) If awarded by beauty contest, the price will have to be determined administratively, but should take account of its exclusivity and premium value.
- Licences for regional exclusive bands or channels may be awarded on a similar basis to national channels, but reflecting the degree of coverage proportionately.
- Licences for bands or channels, which are not exclusive will have less value, but the degree of exclusivity and the degree to which the spectrum is free from external interference (e.g. from bands used for different purposes in neighbouring countries) should determine the value.
- Licences for fixed stations or fixed coverage areas will have a value (per kHz per extent of transmission) according to whether the station has exclusive channels at that point, whether the channels are in congested bands or areas.
- Licences for stations which are not assigned to a specific location and may thus share spectrum with many others will be of a light regime (or considered for exemption). The value of spectrum will often be minimal, so it may be appropriate to continue charging a minimum administrative fee or no fee.

Opportunity for introducing AIP

In most administrations, new legislation may be necessary to enable AIP to be used. In a growing market, demand for spectrum is often greater than supply, so inherently spectrum value will increase to a value which often may considerably exceed administrative cost. Currently many administrations are prevented from charging more than total administrative cost, so new national legislation may be needed to permit this condition.

Member States of the European Union need to comply with the Telecommunications Licensing Directive (97/13/EC) affecting most types of radio spectrum use. The Directive permits AIP provided it supports spectrum management objectives.

There are a number of factors which may help influence administrations to persuade their legislatures to bring in laws to permit AIP:

- Introducing a regime for liberalising telecommunications and broadcasting markets. A liberalised regime will be often likely to create increased spectrum demand.
- The introduction of new generations of systems. The demand for greater data capacity on many new systems may increase pressure on spectrum despite more efficient methods.
- Spectrum refarming is becoming increasingly necessary to help meet European and world-wide demands for harmonisation, liberalisation and competition. AIP may a useful tool both in coping with the extra spectrum demand during transition, and as an incentive to support the migration of services from one band to another (e.g. by increasing charges for the spectrum to be vacated and reducing it for the new bands).

How to apply AIP

Chapter 5.1 of ERC Report 53 sets out some of the factors for determining prices by AIP. One of the key points is that there needs to be an inherent fairness demonstrated and considerable transparency in calculating prices, which may be quite complex.

The approach taken in most administrations around the world who have considered it, is to work out a number of models for treating spectrum as a raw material. This may involve some economic appraisal in order to define a marginal value of spectrum as a starting point towards formulating some sort of spectrum building block (e.g. a spectrum tariff unit). The building block then needs to be applied to each relevant spectrum product.

Another key factor is the need to work closely with key customers to determine these tariff units. If customers have a hand in designing the building blocks, it is much more likely they will be ready to support the final calculation of prices being fair, even if it means a significant increase to them. Customers will also often be more aware than the NRA of likely future developments in technology and new services. If changes in price tend to be significant, it is advisable to give several years notice and to introduce the changes in incremental steps.

Experience from countries, which are adopting AIP

New legislation pioneered in **Australia and New Zealand** allowed for AIP, but because neither country are experiencing significant spectrum scarcity or congestion, it has only been applied to a limited extent within an overall cost recovery framework. Canada and the United Kingdom have now both introduced legislation to allow fees to be set above cost recovery levels.

In **Canada**, sophisticated new pricing tools have been developed to charge differential fees for services in urban areas based on congestion factors for each cell of coverage. The licence fees are calculated based on the amount of spectrum used and the relative scarcity of spectrum in the area. A geographically based spectrum grid is developed to provide a consistent way of measuring coverage areas around the country.

Each cell is designated to be very congested, congested or non congested and priced accordingly. The coverage area for each licensed service is then overlaid across the cells and charged according to the number and mix of cells covered. Thus a wide area service in a city centre would attract a very much higher fee than a small coverage system in a rural area.

In the **United Kingdom**, new legislation has facilitated differential pricing to be introduced where it is justified. It is already being applied to some existing and new fixed link and mobile services. **Annex I** on Developments within administrations, provides more detail under the United Kingdom entry.

2.3 Auctions

Until a few years ago frequency management did not use instruments like auctions to allocate parts of the radio spectrum to its users. However rapid and fundamental changes influenced the way spectrum allocation is being dealt with by the national spectrum managers.

The *first* change considered relevant is an overall and fundamental shift in political thinking. This change resulted, for instance, in the liberalisation of many key markets, with a strong emphasis on competition and entrepreneurship, and the de-monopolisation of many (state-owned) firms. This change also resulted in an altered view with regard to the status and definition of spectrum usage rights.

Secondly, there have been tremendous changes in the available technology, making it possible to produce all kind of sophisticated apparatus at relatively low cost. The available technology is still rapidly changing, especially in the field of telecommunication. The low cost aspect and the broad availability of the new technologies triggers many new services and many new users.

Both changes outlined above have had, and still have, an important impact on the further development of frequency management.

This is in the *first* place due to the liberalisation of the telecommunications market. The frequency managers of national administrations are being confronted with the entrepreneurial needs of their (new) customers and the competitive and societal aspects related to the availability of radio spectrum. One important societal aspect to mention here is related to the awareness of the public in relation to the availability of spectrum needed for new radio-applications. *Spectrum is no longer associated with abstract technology but is more and more regarded as a valuable resource in our information society.*

Secondly, due to the development of new technologies and the costs of these technologies (the price-performance of chip based technology roughly doubles every eighteen months) the demand for spectrum has risen sharply and will most probably continue to rise in the nearby future.

These developments suggest that spectrum has become a vital and scarce, and therefore valuable, resource in our modern economies.

These developments also suggest that frequency management has become a more complex discipline with a growing economic impact and a growing societal importance.

Auctions and other incentive oriented allocation instruments can be seen as the spectrum manager's answer to the changes in the complex environment. These *incentive oriented* instruments should be seen as an addition, not a replacement, to the more traditional *command and control* instruments of frequency management.

This does not mean, however, that the perceived usefulness of the 'traditional' instruments has not changed. For instance, the auction mechanism is sometimes regarded as a useful alternative to a beauty contest. In some cases an auction is regarded as a more transparent and faster allocation mechanism. Another argument why auctions are sometimes regarded as a useful alternative to a beauty contest is the argument of economic efficiency: auctions are a means to select the applicant that can generate most value from the spectrum resource. At the same time, they allow the price of the licence(s) to be determined directly by the market.

“Intermezzo”: beauty contest, tender or auction?

After reading several reports and articles on administrative pricing and spectrum pricing it was concluded that the typology used for the available selection methods used within the administrations seems to differ. In order to use these terms more unambiguously in this Report it is proposed to use the words 'beauty contest', 'tender' and 'auction' in the context outlined below.

	Financial offer	Other criteria
Beauty contest	fixed (<i>ex ante</i>)	Decisive
Tender	Decisive	Decisive
Auction	Decisive	Fixed (<i>ex ante</i>)

Figure 1 typologies: beauty contest, tender and auction

In this Report with **'beauty contest'** is meant 'a selection mechanism that gives weight to criteria other than 'financial bids' in order to decide which offer(s) is (are) best'. Financial transfers nevertheless can play a role in this decision making process, but only and solely as (*ex ante determined*) fixed criteria that have to be met.

For instance in a selection process that judges (/weights) an applicant on criteria like (promised) roll-out and even a range of (promised) consumer end prices as a means to determine which applicant is "the best" is, according to this typology, a *beauty contest*. The eventual presence of an (*ex ante decided and fixed*) 'entrance fee' for the applicant (for instance as an entrance criterion to be able to participate in the selection process) does not influence the 'beauty contest character' of the selection process.

In this Report with **'tender'** is meant 'a selection mechanism that gives weight to both financial and non-financial criteria in order to decide which offer(s) is (are) the best'. A tender looks like a 'mixture' of a beauty contest and an auction. The question that arises is 'does this mixture combines the best or the worst of two worlds'. This can only be judged case by case.

For instance in a selection process that judges an applicant on for instance roll-out planning and intentions regarding service levels and also on a financial offer is, according to this typology, a *tender*.

In this Report with **'auction'** is meant 'a selection mechanism that gives weight to financial criteria in order to decide which applicant(s) is (are) the best'. Non-financial criteria nevertheless can play a role in this decision making process, but only and solely as (*ex ante determined*) fixed criteria that have to be met.

For instance in a selection process that judges the applicants on the height of their financial bids is, according to this typology, an *auction*. The eventual presence of *ex ante* determined 'entrance criteria', like (fixed) minimal roll out criteria, does not influence the 'auction character' of the selection process

It is worth to mention *that regardless of the selection mechanism* transaction costs will exist. These transaction costs will differ case by case and can be considerable. These costs accrue from the very fact that the *preparation* of the selection procedure, the *actual selection* of the 'best' applicants and the '*after services*' (like monitoring the agreed levels, legal matters) consume resources like capacity, time and money.

2.3.1 Auctions: some chronological background information

Auctions have been used for a long time as an instrument to allocate goods. The mechanism is used to trade many commodities, varying from 'ordinary' goods like flowers to more abstract goods like the right to broadcast sports games. However the actual application of the auction instrument as a means to allocate spectrum has started quite recently, about one decade ago.

The beginning: auction developments in New Zealand and Australia

Although the idea to use auctions as a spectrum allocation instrument is not novel (the idea was promoted by Leo Herzl and Ronald Coase in the early fifties) the real implementation of a spectrum auction was started nearly forty years later in New Zealand¹. This illustrates the novelty of spectrum-auctions as a spectrum management tool, not the novelty of the idea to auction parts of the spectrum.

New Zealand

The New Zealand government decided to allocate usage rights in both the forms of *licence* rights (the right to use the spectrum only for a specific service, such as the right to use the spectrum for broadcast television signals). It was also decided to auction spectrum *management* rights (rights with no *ex ante* specified use) to the highest bidders².

The first spectrum auction took place in 1990, the used auction mechanism is known as a '*second price sealed one round auction*'³. This name refers to the primary auction design rules: in a 'second price sealed one round' auction interested parties could bring out a sealed bid in a one round process. The bidder with the highest bid has to pay the *second* highest price.

In New Zealand more than one licence was to be auctioned and a 'second price sealed one round auction' was conducted sequentially for each licence.

The first spectrum auction led -as could be foreseen by auction experts- to some disappointing results:

1. For bidders it was difficult to decide on their optimal strategy with regards to the (multiple) lot(s) to bid on. The *sequential* nature of the auction design was an important factor (at least on theoretical grounds) to predict that this auction could not be expected to assign licences to those who value them most. Sequentiality can lead to allocation problems since it impedes aggregation by eliminating back up strategies. Sequentiality means that the different lots are being auctioned at different auctions, and not in one auction at the same time. 'Building' packages of several lots is more difficult using a set of sequential auctions than with using one simultaneous auction. "A bidding firm may rethink its evaluation of one of the early licences; but in a sequential auction the bidder cannot go back"⁴. An information asymmetry (only (price)information related to already auctioned lots is available, no information about lots to be auctioned is already available) will occur, making it difficult for bidders to decide on their optimal bidding strategy.
2. The second price auction was designed in such a way that the (in the New Zealand case) large differences between the *first* price (in this case the first prices could be expected to display the bidder's 'willingness to pay') and the second price (i.e. the prices that actually had to be paid) were disclosed to the public. This is normal in a second price auction but can be seen as (and is experienced as) a political defect of the auction. The second price auction triggered a large political embarrassment since everyone knew the firm(s) valued the licence(s) at more than they actually paid. "***This scope for criticism would exist even if it was unjustified, in that the auction had generated the best possible price***".⁵ The best possible price in a second price auction will be the same price as in an English auction, however the mechanism by which the price is derived differs. Most people think -erroneously- that the mechanism *in itself*

¹ See: Herzl, L., 'Public' interest and the Market in Color Television, *University of Chicago Law Review* (18), 1951, pp. 802- 16 and Coase, R., The Federal Communications Commission, *Journal of Law and Economics* (2), 1959, pp. 1- 40.

² As far as we know the only other country who has ever auctioned *management* rights is Australia, most countries that use spectrum auctions decide to auction licence rights. At the moment that this contribution was written Canada's spectrum manager *Industry Canada* is contemplating a similar (*management* rights) approach in their (planned) auction for the 24 and 38 Ghz spectrum.

³ As explored by the economist W. Vickrey

⁴ McMillan, J., Selling spectrum rights, *Journal of Economic Perspectives*, summer 1994, p. 153

⁵ See Mueller, M. Reform of spectrum management, the lessons from New Zealand, *Policy insight*, no. 135, 1991 and McMillan, p. 148

determines the price, and tend to accept or reject the price according (as happened with the second price in New Zealand).

Later, having learned from the early experiences with regard to second price auctions, the New Zealand government decided to use a ‘first price’ sealed bid auction as a spectrum allocation instrument. This meant in terms of the above-mentioned ‘willingness to pay’ that the *actual* ‘willingness to pay’ was no longer displayed.

But the *major* drawbacks of ‘sequential sealed bid auction’ still were not solved. Actually, in a ‘first price sealed bid’ auction it is more difficult for bidders to decide on their optimal strategy. This can lead to a worse outcome with regard to the distribution of the licences, especially with multiple goods.

Australia

Australia decided to have their first spectrum auction in 1993, two licences for satellite-television services were offered. As in New Zealand, the Australian administration used a first-price sealed bid auction to allocate the licences.

The auction design missed a deposit and a penalty for non-payment. The Australians also introduced a rule that meant that licences had to be re-rewarded at the next highest bids to the next highest bidders.

These flaws were outsmarted by two ‘parvenu’ bidders. They offered very high bids to secure to win the auction. *However, they had no intention, nor a credible incentive, to actually pay these bids.* At the same time the very same bidders also put in a large series of lower bids.

The winners proceeded by not paying their highest bids. The flaws in the auction design made it possible not to pay the highest bids *without losing deposits or being penalised.* The re-rewarding rule ensured that the licences were rewarded once again *to the same* bidders, only at lower prices (the next highest bid!). By successively not paying bids the winning bidders cascaded the prices further down. Due to all this, the real introduction of the service the licence was intended for was delayed by almost a year.⁶

The policy decision to use an auction at all was a political breakthrough, but getting the <u>right</u> auction design is of great and critical importance for the policy’s <i>success</i> .	
The use of an auction design is not enough. The detailed rules of auction design, including a sound theoretical and experimental background, are crucial if the spectrum manager has the objective of putting usage rights into the hands of those who value them most. Mistakes in the design can lead to harmful repercussions.	
Do	Don’t
<ul style="list-style-type: none"> • use existing theoretical and practical knowledge on auctions to design an auction. • assess the impact of the auction design on the (potential) strategic behaviour of bidders • include deposits • and default penalties 	<ul style="list-style-type: none"> • Use an auction design that has not been designed and tested properly, • use ‘one shot’ sealed bid auctions with multiple goods

Learning from the early experiences: PCS auctions in the US

In the United States the traditional ‘comparative hearings’ used to evaluate competing (licence) requests led to large delays in the licence assignment and legal challenges. The large delays were considered a threat to the development of US wireless communications⁷.

⁶ Milgom, P., pp. 148-50

⁷ At that time new technologies, like PCS cellular telephones, created a large demand for PCS-spectrum licences. See also Milgrom, P., *Auction theory for privatisation*, 1995 (labelled ‘forthcoming’), Cambridge University Press, pp. 12-.

As an alternative the FCC (*Federal Communications Commission*) used lotteries. Originally the advisors of former president Reagan proposed auctions as an instrument in the licence assignment process, however Congress authorised lotteries instead.

Later, when the first lotteries had taken place, the Congress recognised the drawbacks of lotteries and decided that this process led to an '*unjust enrichment*' of the random lottery winners. In 1993 Congress authorised the FCC to use auctions as the instrument for the assignment of PCS licences, with the primary objective to ensure the '*efficient and intensive use*' of the spectrum⁸.

However, given the perceived drawbacks of the spectrum auctions in New Zealand and Australia, see the text above, the FCC concluded that more 'traditional' auction designs were seriously inadequate for the primary objective. The FCC then decided to develop a new and more suitable auction using the opportunity to learn from the early experiences in New Zealand and Australia.

The main difficulties with the development of a novel auction model were *firstly* due to the perceived interdependencies of lots (when more than one licence is auctioned), *secondly* because of the awareness that even small details in the (complex) auction design can have large consequences (and repercussions) and *thirdly* due to the fact that in some 'traditional' auction designs information problems exist, making it difficult for bidders to decide on their optimal bidding strategy.

The deliberation process led to a novel design that was mainly developed by and tested by economists. The auction type that resulted is now generally known as the '*simultaneous multiple round auction (SMR)*'⁹.

The *SMR* model is designed to 'cope' with typical problems like lot-interdependencies and information problems. A modern *SMR* is much more complex to design than a more 'traditional' auction. However this higher *design complexity* contributes to an auction process in which it is *easier (!) for the bidders* to make up their minds about their optimal bidding strategy and to place their bids. The *SMR* auction design makes it easier for bidders to take into account the interdependencies between lots (a lot is a usage right that is to be allocated by an auction). This feature is due to the fact that the auction consists of more than one round. In each round bidders can bring out a bid on the lots simultaneously, after each round information (like the prices bid) is displayed to all bidders. The multiple round character allows bidders to 'learn' from the valuations of other bidders and gives them the opportunity to respond accordingly in a next round.

⁸ Ibid.

⁹ To be more precise: the idea to auction several commodities is not novel: the nineteenth century French economist Leon Walras already described a process with similar characteristics known as the *tatonnement* process. The economist Evan Kwerel raised the possibility of a simultaneous auction already in the eighties. Ibid.

A simultaneous multiple round auction consists of the following ‘blocks’ of rules:

- **Application rules:** rules that can be used to define whether or not applicants can enter/join the actual bidding process:
 - These rules can be used to meet certain policy objectives. For instance: the rule that only parties who guarantee a certain coverage or roll out can enter the actual auction process.
- **‘Activity rules’:** these rules describe the cases in which the participants are allowed to or are obliged to place a bid in the next bidding round
 - These activity rules are considered necessary in a multiple round auction due to the fact that a multiple round auction needs ‘active bidders’. For instance as a means to speed up the auction and to provide the bidders with price information.
- **Pricing rules,** these rules can be used to set start prices at the beginning of the auction and minimum prices during the auction.
- **Stopping rules:** these rules define when the auction process has been fully ‘played’, and therefore who the definite highest bidders (the winners) are.
 - Normally, a (simultaneous) multiple round auction ends when the bidding process has stopped. This explains also the need for an activity rule in a SMR.
- **Information rules:** needed to inform the participants (for instance on the bids of the previous round)
 - previous round’s data (most relevant is price information) is important because the participants need this information to decide on the bids in the next bidding round
 - Not all data are relevant, the disclosure of some data can even harm the allocation process because it can be used by applicants to work together.
- **Other rules:**
 - These rules can facilitate the bidders and the bidding process. For instance in the United States’ SMR’s there is a ‘*bid withdrawal*’ rule. Also ‘waivers’ can be used to facilitate the participants in the bidding process. A waiver is a right *not* to bid in an auction and is a part of the set of activity rules..

Experiences in the US

The first auctions (auctions for the licence rights for narrow-band and wide-band PCS) were considered a remarkable (but anticipated) success. According to one of the auction designers ‘*The theoretical virtues of the design became practical realities....*’¹⁰.

Later auctions, with slightly changed rules, were in some cases less successful.

- The so-called ‘D, E and F block’-auctions a single lot contained an amount of spectrum that was perceived insufficient for the technical applications it was intended for. Only the purchasing of several adjacent lots (in the auction or after the auction had taken place on the secondary market) would guarantee sufficient bandwidth for the application the spectrum were intended for. It seems that many bidders were not able to acquire multiple adjacent parts of the spectrum, leaving them with a technical useless set of lots,
- In other auctions (in the so-called C block auctions) the FCC had created special payment rules for bidders. This led to a situation in which bidders *first* tried to acquire lots in the auction process and afterwards tried to find a financier. In many cases the outcome was not ideal; some of the ‘winning’ bidders went broke due to the fact that they were not able to find the necessary funds. Without a ‘special’ payment scheme these parties might not have participated in the auctions at all. At least (financial) experts would have assessed their (business) plans more carefully *ex ante*; this would have added a kind of capital market test before entering the auction.

Do	Don’t
<p>Be careful with ‘special’ payment schemes (capital markets are the most efficient institutions for payment schemes).</p>	<p>Auction spectrum in too small packages (in relation to the application)</p>

¹⁰ See Crampton, P., *The PCS Spectrum Auctions: An Early assessment*, university of Maryland, 1995, p. 35

2.3.2 Auctions in Europe

Not only in New Zealand, Australia and the US but also in Europe auctions have been conducted over the (recent) years.

Germany

In Germany ERMES was auctioned in September 1996. The German *BAPT (Bundesamt für Post und Telecommunication)* used an FCC-style simultaneous multiple round auction to allocate three national ERMES licences and 10 regional licences.

In this first German spectrum auction there were only three bidders (T-Mobil, Miniruf, Mobile Info-Dienste) interested in both the national and regional licences and, due to this low demand for the ERMES licences, the auction ended with the reward of the licences at minimum prices to the bidders.

In Germany GSM 1800 is next to be auctioned. UMTS will follow later. According to the German Law auctioning of UMTS is possible due to the fact that UMTS can be considered as a new system.

The Netherlands

In the Netherlands both licences for extended GSM and DCS 1800 were auctioned. In the allocation process a simultaneous multiple round auction was used. Bidders could bring out their (written) bids at a location.

The auction, by which 18 lots (a total of 75 MHz GSM/DCS spectrum) were allocated, had a total revenue of 18 billion Dutch Guilders (about 9 billion EURO). The eighteen lots went mostly in packages to the winners. The auction process lasted for 137 rounds.

Two of the lots were so called 'national licences' and carried the obligation to roll out a nation-wide service in three years. For the other lots there were no obligations of such kind. These lots could be used for a wide range of purposes, like for instance the Wireless Local Loop or (regional) mobile telephony.

According to the government of The Netherlands the auction system is transparent and provides more scope for business to determine the final use of the frequencies.

Sweden

The Swedish government experimented with auctions in 1993. As far as known the Swedish regulator used an 'oral outcry' English auction (this is an auction that is also used to sell art and antique) to distribute eighty licence rights for local radio broadcasting.

There were several restrictions in the auction mechanism, for instance the restriction that a bidder could not obtain more than one licence. This goal was achieved, but shortly after the auction the (new) local radio-stations began to organise themselves into several single format networks. The regulator did not intend this outcome, nor did the government regard it as a positive development of the broadcasting sector.

The Swedish government did not organise other auctions and the current law prohibits this.

2.3.3 Future auctions

Spectrum auctions have evolved to a mature and well-tested allocation mechanism. According to information received from administrations more and more countries are intending to use auctions as a spectrum-management tool or are at least discussing it internally.

Germany

The auction of GSM 1800 will take place in October 1999. Ten frequency blocks are to be allocated, 9 of 2x1 MHz and 1 of 2x1.4 MHz. Only the current GSM operators: D1, D2, E1 and E2 have the right to take part in the auction. The minimum offers are for each 2x1 MHz block 511.291,88 EURO and for the 1.4 MHz block 715.808,63 EURO.

The President's Chamber announced on the procedure for the award of licences for UMTS¹¹.

Licences for UMTS will be awarded by auction. UMTS is recognised as a new product market and hence a different product market from cellular mobile radio (GSM networks). It is also regarded that the geographical market for UMTS is, in principle, the territory of the Federal Republic of Germany. However, regional licensing may also be considered.

In Germany 2 x 60 MHz paired and 30 MHz unpaired is available. Subject to the minimum requirements in terms of specialised skills and qualifications all candidates are eligible to bid. For national licences the coverage requirement is 50% of the population; a coverage requirement for any regional licences will need to be determined. UMTS licences will be valid for a period of 20 years.

¹¹ The announcement was made on May 10th. See the Ruling by the President's Chamber, reference no: BK-1b-98/005-. The text is based on this publication.

United Kingdom

In the United Kingdom an auction for Third Generation (3G includes the UMTS standard) licences is being prepared. It has been decided to offer five Third Generation licences with the largest reserved for a new entrant. This is to encourage market entry and competition. Subject to market and other developments and to final decisions in a nearer time, the auction is expected to take place in the second half of the financial year 1999-2000.

The proposed auction design is a multiple-round type auction. Each participant is eligible to obtain one licence at the maximum. Licensees will be expected to roll out a Third Generation mobile communications network across the United Kingdom.

The United Kingdom government is still contemplating the allocation method of usage rights for broadband wireless access (BWA) for interactive multimedia services in 2000. This issue has been covered in a consultative document.

The Netherlands

In the new Telecommunications Law of The Netherlands the auction is explicitly mentioned as an instrument that can be used to allocate spectrum. Auctions for UMTS licences, T-DAB and commercial broadcasting licences can therefore be expected. Also the auctioning of other applications, like WLL of the spectrum is considered.

For UMTS the policy intentions are to award four licences using an auction to allocate the spectrum. The licensing procedure will start in 1999, so that the auction can be held in the spring of 2000. No party will be excluded in advance from applying for a licence. The licences will be awarded for a period of 15 years commercial operation. The licensees will have to pay for their licences lump sum, immediately after the auction. A licence awarded by auction may not be extended, after the expiring of the licence the frequencies will revert to the government, which will assign them once again.

Switzerland

Switzerland has decided to auction 48 Wireless Local Loop licences in February 2000 and 4 UMTS licences later that year. The WLL licences will run for 10 years and a company will only be allowed to own one national licence and one regional licence. In the second quarter of 2000 it will be decided who can participate in the UMTS auctions and the auction will take place in the third quarter of that year.

Canada

Canada has prepared its first spectrum auction and published information on the auction conditions in May 1999. The auction used in Canada is a simultaneous multiple round auction for the allocation of licences in the 24 and 38 GHz bands. The auction starts in October 1999. Licensees will have the maximum possible flexibility in determining the services they will offer and the technologies they will employ.

There are 354 licences available: one 400 MHz licence in the 24 GHz band, one 400 MHz licence in the 38 GHz band and four 100 MHz licences in the 38 GHz band in each of 59 Tier 3 service areas. The 24 and 38 GHz bands are fully aligned with the same spectrum in the United States.

Licences have a term of ten years with a high expectation of renewal. Licences are transferable and divisible in the secondary market. No moratorium is imposed. In an area, any entity and its affiliates, other than an incumbent local exchange carrier whose local exchange area overlaps that area, will be eligible to hold spectrum licences covering frequency assignments aggregating up to a total of 600 MHz of spectrum. A spectrum aggregation limit of 200 MHz is applied to incumbent local exchange carriers and their affiliates in service areas that overlap their local exchange areas. An aggregation limit of 600 MHz is applied to incumbent local exchange carriers and their affiliates in service areas that do not overlap their local exchange areas.¹²

The governments of France, Slovakia, Hungary and the Russian Federation appear to be contemplating the introduction of auctions.

2.3.4 Auction mechanism developments: combinatorial auctioning

As outlined at this moment the most used auction type is the simultaneous multiple round auction. One of the current innovations in auction theory is the so-called 'combinatorial auction'. In this multiple round auction allocation can take place by bidding on (several) independent lots *but also* by placing **one** bid on a certain combination of lots. This can enhance the bidding process in the case that there are strong complementarities amongst the lots. One of the drawbacks of a combinatorial auction is its complexity. It is perceived to be difficult to develop open and transparent decision rules in order to be able to decide on a winning combinatorial bid. Great difficulties can arise when 'overlapping combinatorial bids' have to be compared.

¹² Industry Canada, *Policy and Licensing Procedures for the Auction of the 24 and 38 GHz Frequency Bands*, May 1999

"Intermezzo" Will auctions have an effect on consumer prices?

One of the most prominent questions in the debate on auctions is whether or not auctions will have an effect on consumer prices. The intuitive answer mostly heard is 'yes, because the award of a licence by an auction will generate extra costs for the entrepreneur. The entrepreneur will reflect these costs in the consumer prices'.

Why is the above-mentioned answer not valid?

First, the implicit assumption is made that the overall cost level *determines* consumer prices. This is not a valid assumption. *Fixed costs*, i.e. costs that have no correlation with the output of a company, *do not affect the cost level that is relevant for price setting calculations*. Normally auction payments are not correlated with (future) outputs, and therefore can be considered a fixed cost.

Secondly, it must be made explicit that an entrepreneur will maximise profits, not prices. The competitive environment will erode the position of entrepreneurs that do not succeed to maximise the profit of their organisation. Consumer prices will be calculated and set at a level that optimises the expected profits.

The *optimal* price is found by assessing what the effect of a (small) price change will be on the extra revenues of the company and the extra costs. Mind that the difference between the extra revenues of the company and the extra costs is the extra profit a company can make by changing its price.

The consumer prices are optimal when the last price change adds no profit. Therefore the optimal price is found by setting the price level such that the extra (so called marginal) costs are balanced with the extra (marginal) revenues. *Fixed costs play no role in this* (only the marginal costs) therefore auction prices will not affect the consumer prices. There will be an effect on the total profit of the organisation however, and thus an effect on the position of the owners/shareholders¹³.

2.3.5 The relation between auctions and a secondary market

This chapter dealt with the allocation of usage rights using the auction mechanism. It is good to emphasise that an auction mechanism, in the same way as tender, first come first served or a beauty contest, deals with the initial allocation of usage rights at a certain moment in time. The allocation is 'static' and does not change as the environment (like consumer demand, technology, applicable rulings) can change. In order to be able to alter the initial allocation, instruments like a secondary market can be used. The subject is elaborated upon in the next chapter.

3 SPECTRUM TRADING

The market is widely recognised as the best mechanism for distributing resources and goods so as to achieve maximum benefit and radio spectrum can be considered as having many of the characteristics of other economic assets. In other words, spectrum usage rights may be considered as an investment in an asset in the same way as investment in machinery or information technology. However, there are some differences. For example, spectrum is intangible and is not consumed when it is used and so does not depreciate in the same way as a conventional asset (although this may not strictly be true for a licence giving access to spectrum for a fixed period). Once a particular radio use ceases, the frequencies employed remain available for a new application. Moreover, the propensity of radio signals to interfere with each other creates externalities and part of the value of spectrum derives from regulation of the usage rights ("with everybody in the air nobody could be heard" as the US Supreme Court said).

¹³ Optimising profits is finding the optimum of the profitcurve. This profitcurve can be found by calculating the difference between the total revenue and the total costs at different price levels. The profit is therefore a function of the price level. The maximum profit can be found by calculating the first derivative of the profit function and set it to zero (and have a check on this with a second order derivative). Since the profit is determined by both the revenue and cost levels at a certain price level, the optimal profit can also be found by looking at the difference between *the first derivatives* of both the total revenue and the total costs are zero (this is the so-called MR-MC=0 rule).

The first derivative of a fixed item is, off course, zero. And therefore fixed costs (and fixed revenues) are irrelevant for the determination of the optimal price **and hence -a change in- fixed cost will not influence the consumer prices**. However the fixed costs will have an effect on the profits, since profit is the difference between the (total) revenue and (total) costs and the total costs change.

It is in the very character of an investment, that the investor may realise the value of the asset by using it for his own production as well as by selling, renting or leasing it to someone else.

Thus, the question must be asked if spectrum usage rights might be passed on to someone else on a contractual basis or not and what the implications of different solutions could be.

For reasons of simplification, the possible contractual transfer in the context of this Report will be called "tradability of spectrum usage rights". It is not at all the intention to indicate that it is necessary to see some sort of "property rights" in radio spectrum. There is a fundamental difference between a property right of the sort that subsists in most tangible assets, such as machinery or land, and a spectrum licence, which constitutes permission to use radio equipment at a given frequency at a given location over a specified area and time period. However, in principle, there seems no reason why a spectrum licence should not be made assignable and hence tradable in the same way as a spectrum property right. The focus of this Report is the economic model of allocating usage rights on radio spectrum, not the legal character or the legal instrument by which access to the spectrum is conferred, which may differ from country to country according to legal and constitutional conventions.

Tradability of spectrum usage rights may affect refarming issues. (see chapter 4)

3.1 Background: Experiences with tradability of intangible assets

A market approach has been adopted for other intangible assets. For example, very interesting experience has been gained in the field of environmental protection with regard to allocation mechanisms using tradable SO₂ emission allowances in the US. Of course the very nature of the allocated asset differs in many aspects from spectrum usage rights (e.g. SO₂ emission allowances may be moved geographically or may be "stocked" over time and the overall goal is to limit the SO₂ emissions to a decreasing ceiling). However, there are certain parallels that may be drawn and some fruitful insights into elements of the regulation model that could be adopted for radio spectrum.¹⁴

3.2 Background: The Australian and New Zealand spectrum trading experiences

There is extensive economic literature on the development of markets. However, relatively few countries have so far had practical experience of the operation of tradability of spectrum usage rights. However, two cases are known by almost everybody: Australia and New Zealand.

The experience in those countries is often used as an example that introduction of economic spectrum management tools would probably not solve any problems but certainly add a couple of new ones. Nevertheless, there are several good reasons why the Australian and New Zealand experience should not be used as a general benchmark in the field of secondary spectrum markets:

- There were only few special bands brought on the market where it was possible to give the usage rights away with very little or no usage conditions.
- There was only a very small portion of spectrum brought on the market. 90% of the spectrum is still regulated by the state agencies.
- The special geographical situation of Australia and New Zealand allows for a lean local radio regulation that would not be possible in Europe.
- No theoretical economic model was preceding the regulation.
- The regulator did not exactly define its future role with regard to the spectrum rights brought to the market. Therefore, the regulator finds it now very difficult to stay clear of conflicts and difficulties that arise amongst the holders of these usage rights.

Of more importance and interest could be the existing European experiences and especially the answers to the recent EU Green Paper on Radio Spectrum Policy.

¹⁴ More information on the SO₂ Allowance Trading can be found in:

- Robert N. Stavins: What can we learn from the Grand Policy Experiment? Lessons from SO₂ Allowance Trading, in: Journal of Economic Perspectives, Volume 12, Number 3, Summer 1998, pages 69-88
- Schmalensee, Joskow, Ellerman, Montero and Bailey: An interim Evaluation of Sulfur Dioxide Emissions Trading, in: Journal of Economic Perspectives, Volume 12, Number 3, Summer 1998, pages 53-68

3.3 EU Green Paper on Radio Spectrum Policy

The Green Paper on Radio Spectrum Policy of the European Commission, published in December 1998, posed the question whether a secondary market should be introduced and what safeguards are needed. The answers received from those that commented to the Green Paper revealed mixed opinions with regard to the issue of spectrum trading. The issue of simple licence transfer was in general looked at more positively than actual trading. Some reactions were positive and saw secondary trading as a contribution towards the efficient use of frequencies, at least when certain conditions were taken into account. Mentioned conditions were that spectrum could only be sold to operators employing the same or similar services, in order not to endanger European harmonisation and that the regulator should control the trading. The majority of the respondents however were afraid of fragmentation or misuse of the frequency spectrum, endangering European harmonisation, higher costs or a risk for monopolisation. The CEPT response to the Paper indicated that spectrum trading was considered a valid instrument but since it was a relatively new idea, it had to be studied further. It was stressed that safeguards for the users had to be in place before introduction could take place.

3.4 Managing Spectrum by the Market in The United Kingdom

The United Kingdom is now considering the advantages of spectrum trading. In October 1998, the Radiocommunications Agency published a consultative document, *Managing Spectrum through the Market*. This sought views on a selective approach to spectrum trading in which different forms of spectrum trading would apply in different frequency bands within a framework of effective market regulation. There was substantial and broadly based support for spectrum trading from over 90% of those responding, including from the independent Spectrum Management Advisory Group, which described trading as "an essential and inevitable progression".

There was broad agreement that a spectrum market could:

- improve the economic efficiency of spectrum management;
- help to ensure that spectrum was assigned to those who could produce greatest benefit from it;
- provide valuable additional flexibility for spectrum assignments to be adjusted through the market in response to changes in demand.

There was also agreement that spectrum trading should be introduced selectively in a way that took account of the market and technical characteristics of the different licence classes. In principle, responses favoured giving licensees a degree of additional flexibility as to technology and application within certain limitations.

It was recognised that a strong and competitive spectrum market would require a clear and effective framework of regulation, although differences of view as to how restrictive this needed to be. Various concerns were expressed, including by some supporting spectrum trading, about how spectrum trading might work in practice if not subjected to a suitable regulatory framework and that safeguards would be necessary to:

- prevent hoarding and interference;
- ensure spectrum continues to be managed strategically;
- protect access to spectrum by small and medium enterprises and essential services;
- maintain competition; and
- ensure compliance with international requirements on spectrum use.

Statistical highlights from the responses to the consultation:

- 90% in favour of spectrum trading in principle, including both simple transferability and selective application of more complex trading variants that would allow users to divide and amalgamate assignments.
- 80% of those expressing a view favoured allowing licensees a measure of flexibility as regards the technology used and application employed, subject to boundary conditions to ensure non-interference with other radio users and compliance with international obligations.
- About 80% of those expressing a view broadly supported a phased, selective approach to spectrum trading as proposed in the consultative document.
- About two-thirds of those expressing a view considered there should be no distinction in the application of spectrum trading between licences subject to administrative pricing and those that had been auctioned.
- Evenly divided views on the questions of the need for sector-specific competition rules to govern spectrum trading and the conversion of current apparatus licences to spectrum usage rights.

3.5 A possible way forward for Europe

Spectrum trading encompasses a range of possibilities from straightforward change of ownership with no change of use made of spectrum to more advanced variations in which assignments might be sub-divided or amalgamated and licensees given freedom to change the use made of the spectrum within certain limits. These variations may need to be applied selectively and pragmatically. For example, forms of trading that are beneficial for exclusive national channels may well not be appropriate for shared localised assignments. Preferred spectrum trading solutions are likely to vary from country to country.

It should be emphasised that, generally speaking, markets work best within an effective framework of regulation. A spectrum market would be no exception. There would need to be safeguards, for example, to ensure compliance with international radio regulations and other requirements; to ensure spectrum transactions were not incompatible with overall spectrum strategy; to prevent interference; to maintain competition; and to ensure access to spectrum for small businesses and essential services. The precise form that these safeguards take will depend on national circumstances.

Some systems of national regulation within CEPT have already anticipated the possibility of a transfer of spectrum usage rights, such as in **Spain, The Netherlands and Germany**. In others, changes to legislation may be necessary to permit this. It is advisable to make spectrum trading legally possible, even when there are no immediate plans to introduce the possibility. It is also relevant to note that the EU Licensing Directive has unintentionally restricted the introduction of spectrum trading and would need to be amended to allow spectrum trading to be fully developed. So that also in the case of competitively awarded licences a secondary market could develop.

In all cases known at the moment, spectrum transfers require permission from the administration and these transfers are introduced not to promote economic efficiency but to simplify administration by facilitating changes of ownership in certain limited circumstances (e.g. bankruptcy of the licensee or take-over of a licensee by another enterprise in a merger or an acquisition).

3.6 Possible drawbacks from tradability of spectrum usage rights

As practical experience on a bigger scale is widely missing, there is a high risk of possible design mistakes and unwanted negative economic or social impacts in the starting period. The regulator might therefore wish to take care to implement changes cautiously and political consequences have to be thought through. When for instance a secondary market is introduced for services where the licences have been issued by way of beauty contest, profits made with the transfer of licences could lead to political embarrassment, when it becomes obvious how valuable the spectrum that is given away freely actually turns out to be.

However, there exist already examples of transferred spectrum usage rights in that sector in almost all countries of the world that work perfectly well: the GSM-roaming contracts are in fact transferred (traded) spectrum usage rights. An operator transfers the right to use his spectrum in a given location to the subscribers of another operator on contractual bases. Economic valuation of the spectrum is likely to rise with roaming contracts.

3.7 Summary

<p>DO:</p> <ul style="list-style-type: none"> • Approach the item step by step and case by case and develop the necessary safeguards • Start by easing the unchanged transfer of existing licences to other holders • Include the possibility in the legal framework even if it is not used immediately 	<p>DONT:</p> <ul style="list-style-type: none"> • Start discussing the issue as an important matter of policy • Compare the national situation with early experiences in Australia or New Zealand • Start with a general over all approach and iron principles
--	---

4 SPECTRUM REFARMING

ERC Report 53 described spectrum refarming as: "a spectrum management function and 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".

The last couple of years see a growing interest in the topic refarming due to a number of developments such as digitalisation and the introduction of third generation mobile services. The topic is also addressed in relation to the DSI III process. The reason being that the band that is in focus in this process, the 862 - 3400 GHz band is very heavily used. Two new services namely the Broadcasting Services with Digital Audio Broadcasting and the Mobile Services with UMTS/IMT 2000 will lead to modifications in the planning and the structure of the band. These services will impose changes to other services in particular the Fixed Service and a variety of military services and systems.

It should however be emphasised that refarming as such is of course a long standing and frequently used frequency management tool used for strategic planning of spectrum aiming at efficient use as well as in many cases international spectrum harmonisation.

The new element that is brought into the discussion is whether and how this will be funded, the role that administrative incentive pricing and secondary trading can have and whether there should be some European harmonisation in this area by way of the establishing of common guidelines or principles. Beyond these issues this Report does not look at the other aspects of refarming.

4.1 Before refarming

It should be emphasised that refarming is not a "first choice" activity. The possibilities of sharing of frequencies and the use of innovative technologies, which enable sharing should be used to the utmost in order to avoid refarming.

That sharing etc. should be tried first is obvious, since it enhances frequency efficiency and furthermore avoids costs for the existing frequency users (whether compensated in any form or not). Lastly refarming could be seen by the users as a breach of the confidence they have in the government and the instrument should therefore be used as sparsely as possible.

There are two other elements that have an influence on refarming and the reimbursement of costs and these are time and transparency.

When decisions taken at for instance a WRC have a sufficiently long implementation period, decisions on refarming can be taken by the administration without applying the element of financial compensation.

The issuing of licences for a fixed period of time, related to the investment costs of the network or the equipment, will support this. When the licence is renewed, clauses should be included covering also refarming issues.

Using notice periods and licences with a fixed duration is at the moment the method that is most frequently used.

Transparency in the area of frequency management is also an element that is important, since when users are aware of for instance decisions taken at WRCs or ERC Decisions that will influence the national frequency table, this might prevent them from doing investments, which would lead to refarming in future.¹⁵

Administrative incentive pricing could also be used to make refarming processes easier, by way of down pricing the frequencies where the refarmed services have to go to and pricing up the frequencies that have to be vacated.

¹⁵ That this is not a purely theoretical issue proves the experience of a CEPT country which could fight off a compensation claim by being able to prove that the frequency user was aware of certain decisions taken at a WRC.

A similar role could be played by the secondary market. When it is possible for licence holders to sell their usage rights to others, whose use is in conformity with the new frequency plan, this could make refarming more acceptable and easier to accomplish. Also the question who pays is then solved automatically.

4.2 Financial compensation

When time and transparency can not solve the issues, because refarming has to take place at short notice the issue of financial compensation of the existing users arises and the question of who will pay for this compensation. There are a number of options:

a. The existing users pay themselves

Advantages

There will be no discussions or disputes about calculations of costs of the refarming.

Disadvantages:

The decisions of the administration to move users from the band could be challenged in Court.

Experiences within administrations:

As far as known, administrations respect a certain notice period between 3 and 10 years depending on the nature of the services. When this notice period is respected no financial compensation is deemed necessary. This is practised for instance in **Switzerland** and the **United Kingdom**. It is possible to use the element of frequency pricing to support the migration. One of the CEPT administration for instance is envisaging to refarm a certain sub band in the UHF range and intends to give a 5 years notice period. During this period the licence fees for the band that the services have to move to will be lowered, in order to support the refarming process.

b. The new entrant pays for the migration

Advantages

Spectrum is freed when needed for the new service

Only the spectrum absolutely needed for the new entrant will be freed

Disadvantages

A new operator may have to pay higher costs of spectrum in one country or even in one region of a country than in another country or region. This could influence the competition between European operators.

When compensation of the existing users is a condition when auctioning the spectrum, bids will be lower and the refarming might therefore in practice be paid by the administration.

Disputes might arise between existing and new users, where the administration has to mediate, which will lead to costs for the administration.

Experiences within administrations

This system has been used in several countries for particular services where a quick migration was necessary. This has for instance been practised in **Italy** when introducing GSM 1800. In this case the new operators paid the Ministry of Defence, who made the band available. In Italy the total cost to be paid are composed of the costs of migration of the equipment to a different band. These costs, although complex to calculate, can be calculated on the basis of objective parameters. If applicable also the cost related to the loss of spectrum is paid. These costs are different to calculate, since it implies the development and agreement on parameters for the calculation of a theoretical spectrum value.

c. A national refarming fund is established

Such a fund could be contributed to in various ways: by new entrants, by all licence holders, by spectrum pricing/auction revenues, by the public treasury or combinations of the aforementioned.

Advantages

- Such a fund makes it possible to spread the costs over a large group of contributors.
- When spectrum pricing surpluses flow into such a fund these will contribute directly to frequency management.

Disadvantages

- The establishment of such a fund generally requires a change in the law and the political will to do so, which might be time consuming.
- The management of such a fund could be a burden for the administration.
- The existence of a fund could lead to more claims.

Experiences within administrations

A refarming fund has been introduced in **Hungary** and in **France**.

In **France** a Commission is installed to advise about the refarming costs. The Commission consists of different government bodies, the public mobile telecommunications network operators and industry trade associations with frequency related interests. The Commission reviews the validity of the files, decides upon the required level of funding and proposes the method of financing which it judges to be most appropriate, all the while ensuring that the funds are used to exert a positive influence on the implementation schedule for spectrum re-farming. Up till now, the only support for the funds that finance the spectrum re-farming projects has come from grants made by the Public Treasury. It is expected that those operators benefiting from the new allocations resulting from spectrum re-farming projects will contribute towards project finances.

In **Hungary** the surplus from licence revenues and concession fees is transferred to a fund from which refarming of frequency spectrum is financed.

d. The administration pays for refarming

The costs are paid either by the national treasury or by the frequency management organisation. In this case tax payers or licence holders pay for the costs.

Advantages

- There is a wide group of contributors, namely the tax payers or the licence holders.

Disadvantages

- It leads to higher costs for the administration.

Experiences within administrations

This is, as far as known, the most widely method used at the moment in order to solve these issues when no sufficient notice period can be given.

4.3 Producing CEPT/ERC guidelines?

In the CEPT response to the Green Paper on Radio Spectrum Policy from the European Commission it is stated that: refarming is a strategic issue, as it is a tool for long term strategic planning. It has international connotations, as it is the technique used to harmonise spectrum utilisation; but how to implement a decision to make available specific frequencies is a matter for each national administration to decide.

Most other respondents to the Green Paper were also of the opinion that refarming is a strategic management tool. For European services, harmonised decisions on frequency allocations should be taken, but the majority view was that because of national differences between the countries, refarming should be carried out on a national basis, although a European policy or guidelines might be established, according to some. Many respondents emphasised the importance of an open dialogue with the users of the spectrum before taking any refarming decisions and emphasised that refarming decisions should be market led. The importance of using the instrument of sharing and using the element of time to the utmost was mentioned by some respondents. A number of respondents were of the opinion that the EU could have a political role in the process or could contribute by making the necessary funds available. Some also indicated that recovering unused spectrum from government users was a task for the national spectrum authorities.

In the DSI III process it is suggested to develop ERC guidelines for refarming and a discussion document was produced. At the moment of finalising this ERC Report the discussions in the DSI III are still going on and may result in some guidelines to be published in the beginning of 2000.

4.4 Conclusion on refarming issues

In this Report only the main issues surrounding the topic of refarming were touched upon, since it is not the prime subject of this Report. It is made clear though that administrative incentive pricing and secondary trading have a role to play in assisting refarming, as outlined above. The other issues are getting beyond the scope of this Report and should be studied further within the ERC.

5 CONCLUSIONS AND RECOMMENDATIONS

This Report is intended to be of an informative nature and does not propose ways of harmonisation in the area of spectrum pricing. Experiences and plans in this area, with the emphasis of the CEPT countries are brought together in a Report for reference for administrations, which are studying the issues.

Throughout the Report some recommendations are made or proposals for further work are indicated. These recommendations and proposals are grouped here.

The introduction and application of spectrum pricing

1. Economic spectrum management tools are not expected to replace regulation, which will continue to play an important role in spectrum management but applied selectively, economic they could usefully complement regulation.
2. It should be for national administrations to select whether and how to apply these complementary methods. In doing so, they will wish to take into account a number of considerations, including current and expected developments in the market for radio-based services and the balance between spectrum demand and availability in the various frequency bands. These considerations can be expected to vary from state to state and the optimal combination of regulation and economic tools will differ accordingly.

Administrative Incentive Pricing

1. Administrative incentive pricing (AIP) should be closely related to supporting spectrum management objectives.
2. Where a new service is to be introduced, administrations will need to consider the type of licensing regime to be used. In turn this may affect the administration's choice of charging method for the setting of fees for the new service.
 - Licences for national exclusive bands of spectrum or channels are a considerable asset. These may be awarded by competition (auction or beauty contest). If the award is by auction, the market will determine the price subject to a reserve having been set by the NRA. (see 2.3 below) If awarded by beauty contest, the price will have to be determined administratively, but should take account of its exclusivity and premium value.
 - Licences for regional exclusive bands or channels may be awarded on a similar basis to national channels, but reflecting the degree of coverage proportionately.
 - Licences for bands or channels, which are not exclusive will have less value, but the degree of exclusivity and the degree to which the spectrum is free from external interference (e.g. from bands used for different purposes in neighbouring countries) should determine the value.
 - Licences for fixed stations or fixed coverage areas will have a value (per kHz per extent of transmission) according to whether the station has exclusive channels at that point, whether the channels are in congested bands or areas.
 - Licences for stations, which are not assigned to a specific location and may thus share spectrum with many others will be of a light regime (or considered for exemption). The value of spectrum will often be minimal, so it may be appropriate to continue charging a minimum administrative fee or no fee.

Introducing AIP

1. In most administrations, new legislation may be necessary to enable AIP to be used. There are a number of factors which may help influence administrations to persuade their legislatures to bring in laws to permit AIP:
 - Introducing a regime for liberalising telecommunications and broadcasting markets. A liberalised regime will be often likely to create increased spectrum demand.
 - The introduction of new generations of systems. The demand for greater data capacity on many new systems may increase pressure on spectrum despite more efficient methods.
 - Spectrum refarming is becoming increasingly necessary to help meet European and world-wide demands for harmonisation, liberalisation and competition. AIP may a useful tool both in coping with the extra spectrum demand during transition, and as an incentive to support the migration of services from one band to another.
1. One of the key points is that there needs to be an inherent fairness demonstrated and considerable transparency in calculating prices, which may be quite complex.
2. The approach taken in most administrations around the world who have considered it, is to work out a number of models for treating spectrum as a raw material.
3. Another key factor is the need to work closely with key customers to determine these tariff units.

Auctions

1. It was concluded that the typology used for the available selection methods used within the administrations seems to differ. In order to use these terms more unambiguously in this Report it is proposed to define the words ‘beauty contest’, ‘tender’ and ‘auction’ in the following way:

Beauty contest: A selection mechanism that gives weight to criteria other than ‘financial bids’ in order to decide which offer(s) is (are) best. Financial transfers nevertheless can play a role in this decision making process, but only and solely as (*ex ante determined*) fixed criteria that have to be met.

Tender: A selection mechanism that gives weight to both financial and non-financial criteria in order to decide which offer(s) is (are) the best’. A tender looks like a ‘mixture’ of a beauty contest and an auction.

Auction: A selection mechanism that gives weight to financial criteria in order to decide which applicant(s) is (are) the best. Non-financial criteria nevertheless can play a role in this decision making process, but only and solely as (*ex ante determined*) fixed criteria that have to be met.

2. The use of an auction design is not enough. The detailed rules of auction design, including a sound theoretical and experimental background, are crucial if the spectrum manager has the objective of putting usage rights into the hands of those who value them most. Mistakes in the design can lead to harmful repercussions.

It is therefore recommended to:

- use existing theoretical and practical knowledge on auctions to design an auction
- assess the impact of the auction design on the (potential) strategic behaviour of bidders
- include deposits
- default penalties
- be careful with ‘special’ payment schemes (capital markets are the most efficient institutions for payment schemes).

and not to:

- use an auction design that has not been designed and tested properly
- use ‘one shot’ sealed bid auctions with multiple goods
- auction spectrum in too small packages (in relation to the application)

Spectrum Trading

Spectrum trading encompasses a range of possibilities from straightforward change of ownership with no change of use made of spectrum to more advanced variations in which assignments might be sub-divided or amalgamated and licensees given freedom to change the use made of the spectrum within certain limits.

1. These variations may need to be applied selectively and pragmatically.
2. There would need to be safeguards, for example, to ensure compliance with international radio regulations and other requirements; to ensure spectrum transactions were not incompatible with overall spectrum strategy; to prevent interference; to maintain competition; and to ensure access to spectrum for small businesses and essential services. The precise form that these safeguards take will depend on national circumstances.
3. It is therefore recommended to:
 - Approach the item step by step and case by case and develop the necessary safeguards
 - Start by easing the unchanged transfer of existing licences to other holders
 - Include the possibility in the legal framework even if it is not used immediately

And not to:

- Start discussing the issue as an important matter of policy
- Compare the national situation with early experiences in Australia or New Zealand
- Start with a general over all approach and iron principles

Refarming

Refarming is a long standing and frequently used frequency management tool. Before refarming the possibilities of sharing of frequencies and the use of innovative technologies, which enable sharing should be used to the utmost, as well as the elements of time and transparency.

1. Administrative incentive pricing could also be used to make refarming processes easier, by way of down pricing the frequencies where the refarmed services have to go to and pricing up the frequencies that have to be vacated.
2. A similar role could be played by the secondary market. When it is possible for licence holders to sell their usage rights to others, whose use is in conformity with the new frequency plan, this could make refarming more acceptable and easier to accomplish. Also the question who pays is then solved automatically.

When time and transparency can not solve the issues, because refarming has to take place at short notice the issue of financial compensation of the existing users arises and the question of who will pay for this compensation. There are a number of options:

- a. The existing users pay themselves
- b. The new entrant pays for the migration
- c. A national refarming fund is established
- d. The administration pays for refarming

In this Report only the main issues surrounding the topic of refarming were touched upon, since it is not the prime subject of this Report. It is made clear though that administrative incentive pricing and secondary trading have a role to play in assisting refarming, as outlined above.

1. The other issues are getting beyond the scope of this Report and should be studied further within the ERC.

ANNEX 1:

DEVELOPMENTS WITH REGARD TO SPECTRUM PRICING IN INDIVIDUAL ADMINISTRATIONS

Czech Republic

At present the Czech Administration - Czech Telecommunication Office (CTO) - uses administrative pricing in spectrum management. There are the following types of fees in connection with frequencies:

- * one off (single) licence fee for an operator's licence for a telecommunication service,
- * annual fees for permission to establish and operate radio equipment. Fees depend on such factors as bandwidth, power, covered area, exclusive or shared use, etc. No surplus is allowed.

Collected fees go to the state budget and all administrative activities of the CTO are financed from it.

Operator's licences for public telecommunication services requiring beforehand defined spectrum, i.e. mobile networks, country wide paging, are issued by public tender. Auctions were not organised. Operator's licences contains spectrum rights for the assigned part of spectrum but besides that the operator is issued also permission to establish and operate the base stations for which it is necessary to pay annual fees. The Czech Republic, in compliance with ERC Decisions on exemption of individual licences of certain radio and satellite terminals, issues a general licence for this kind of terminals.

The existing fee regime does not provide the Czech administration with efficient tools for spectrum management because the current level of fees was set many years ago and does not correspond to new economical conditions.

In connection with the new Telecommunications Law that should come into force in 2000, there is a new fee regime for improving spectrum management under preparation. The aim of the new regime is to take into account the economic value of frequencies.

Regarding refarming, the new entrants to the market are enabled to compensate the incumbent spectrum users and this is the way to introduce some new and more effective spectrum technologies and services to the market. There exists no financial mechanism to compensate incumbent spectrum users now, but the new Telecommunications Law counts on the establishment of a Radio communications fund for this purpose.

Three operators have licences for GSM services and networks in the Czech Republic.

Croatia

The new Law on Telecommunications was recently passed by the Croatian National Parliament. (June 1999). A State administrative organisation, the Croatian Institute of Telecommunications will be established as an independent regulatory authority. The secondary legislation pursuant to the new law shall be passed within one year of the entry into force of the law. According to the present regulations fees have to be paid for the issuing of various documents as for instance radio licences, radio equipment importing approval, type approval certificate, accreditation certificate and others. This has to be paid only once as monetary contribution to the state budget. Various fees such as frequency usage fee, accreditation fee (for example for accreditation of testing laboratories), fees for the concessions (for broadcasting networks, for various mobile networks: GSM, ERMES, Trunking etc.) have to be paid as yearly fees mostly intended for improving spectrum management.

Note: All ERC Decisions on exemption from individual licences of various types of radio terminals have been implemented in Croatia. This means that no licences fees or frequency usage fees for the equipment concerned are levied.

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 ERC Report 53 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.

A national study on the economic value of spectrum has recently been initiated which will be completed end of 1999.

Estonia

Radio transmitting equipment requiring an individual licence requires a registration fee, which depends on the radiocommunications service (land mobile, fixed, maritime mobile etc.) This kind of fee is paid for the registration of the transmitter.

Annual fees have to be paid for frequency usage, which depend on frequency band, radiocommunications service, bandwidth, coverage area, whether the channel is used exclusively or shared and whether the channel is local, regional or national.

Finland

Finland has implemented a frequency fee for frequency users like public mobile operators, WLL, public paging, TETS and emergency TETRA. 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 (VHF) and lower in the less congested bands (above 1 GHz).

Auctions are not planned.

For the other individually licensed radio equipment a traditional licence fee is collected at the moment, but we plan the implementation of frequency fee also for them at some point in time in the future.

The fees are considered to be the method by which the administration finances its costs. Spectrum pricing is not considered to be an appropriate method for spectrum management.

Extension of the computerised spectrum management system continues. The system in use includes a computerised frequency database, digital terrain map and interference calculation software as well as digital frequency allocation tables in database format.

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.

The experience with this method of spectrum management and in particular with not using frequency auctions is very good and has among other things the following consequences:

- very high penetration of all kinds of radio equipment and services
- low user prices for services
- relatively small amount of interference even in the most congested areas
- readiness of approving the use of new networks quickly
- ability of packing a relatively high amount of stations in a given spectrum / geographical area without risk of interference
- feasibility of re-farming and relocation exercises when required
- effective use of frequencies.

France

In general, France uses administrative pricing and has at present no firm intention to adopt more market driven pricing regimes, although the use of auctions for UMTS is under discussion. A new Telecommunications Law has been adopted in 1996. 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.

A Decree, issued in 1997, prescribes spectrum fees for the public sector users except for the broadcasting sector and the astronomy research department. In June 1999, an advisory commission was set up within the Agency to deal with spectrum valorisation aspects. This Commission is constituted like the Commission on spectrum re-farming.

Spectrum re-farming in France

1) In France, spectrum management responsibilities are shared between two independent authorities in charge of the telecommunication and broadcasting sectors respectively, and seven administrative bodies operating within government departments. Each has rights and obligations in respect of certain frequency bands, either on an exclusive or a shared basis.

The ANFR acts in the general interest to promote progress in the planning and allocation of the spectrum, to ensure that suitable procedures for achieving harmonious coexistence between users are in place, and to review frequency use especially with regard to compliance with regulatory procedures at the national, European and international levels.

2) A specific advisory commission was set up within the Agency in 1997 to deal with the financial aspects of spectrum re-farming. The Commission is responsible for making proposals to the Agency's Director General and submitting them, if need be, to the Agency's Board of Directors in respect of:

- assessing the costs associated with spectrum re-farming projects;
- drawing up an implementation schedule;
- applying the funds reserved for financing re-farming projects.

3) The Commission consists of representatives nominated by:

- the two authorities and the seven administrative bodies mentioned above,
- the Ministry of Economy, Finance and Industry and the Ministry of Foreign Affairs;
- the public mobile telecommunications network operators;
- the industry trade associations with frequency related interests.

- 4) Functioning of the Commission:
- the Commission usually meets every two months ;
 - the re-farming case files are first sent to the Agency by the administrative bodies and authorities with spectrum management responsibilities, and those cases found eligible to benefit from the spectrum re-farming funds are then presented to the Commission;
 - the Commission reviews the validity of the files deposited by the spectrum management bodies, decides upon the required level of funding and proposes the method of financing which it judges to be most appropriate, all the while ensuring that the funds are used to exert a positive influence on the implementation schedule for spectrum re-farming;
 - each file accepted becomes subject to an agreement, previously approved by the Agency's Board of Directors, between the parties concerned; the level of funding needed to carry out the re-farming, which represents the maximum amounts involved, is set out in the agreement.
- 5) Five files are currently under consideration, one of which relates to the release of the first of the UMTS frequency bands needed to open the service in January 2002.
- 6) Up till now, the only support for the funds that finance the spectrum re-farming projects has come from grants made by the Public Treasury. The total of government grants since 1997 has now reached FF 100 million.
- 7) It is expected that those operators benefiting from the new allocations resulting from spectrum re-farming projects will contribute towards project finances. As a general rule, it is accepted that, in respect of the displaced users, the beneficiary has to cover any additional costs, excluding amortisation, generated by the earlier than planned renewal of the equipment that has to vacate the newly allocated frequency bands.
This principle was already anticipated in the licence given in 1994 to the third GSM operator. At that time, before the Agency came into being, the operator negotiated directly with the Defence Ministry who, as the displaced user, was the other party affected by the spectrum re farming.
- 8) Methods of financing spectrum re-farming projects remain a topic of continuing debate in France.

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 administrative 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.

1. 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.
2. 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 revenues of administrative fees cover the work and development of frequency management.

The surplus from licence revenues and concession fees is transferred to a fund from which refarming of frequency spectrum is financed. It is the intention to have more income than expenses from such a fund. The military were, for instance, recently refunded out of this fund for freeing the 1800 MHz band out of the concession fee for the tender for a GSM 1800 licence. A surplus was retained to cover for future refarming procedures.

The above mentioned tender procedure for GSM 1800 was held in two rounds, technical as well as financial criteria played a role in the selection. The winner paid \$202 million for the concession. The licence duration is 15 years.

It is intended to hold auctions for Fixed Wireless Access licences in the 3.5 GHz band in the first quarter of 2000. Only companies who have a preliminary service licence or a service licence can participate in the auctions.

Malta

Spectrum pricing in Malta is regulated by the "Fees (Wireless Telegraphy) Regulations, 1995", which were last amended in 1997. Fees are generally charged per service or per station. Some links are priced by bandwidth or bit-rate. There is at the moment no fee for the reservation of frequencies.

It is intended to revise these Regulations in order to relate fees more closely to spectrum occupancy and to charge for reservations of frequencies.

Because the market in Malta is small, frequencies have, up to now, been assigned on a first come, first served basis. The possibility of frequency auctions may be considered in the future for more congested parts of the spectrum.

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 beauty contest will both be used in future. The first auction for GSM 1800 licences has been held in 1998 and further ones for broadcasting, Wireless Local Loop and UMTS are planned to be held in 2000.

In the area where the instrument of administrative incentive pricing could be introduced, it was concluded that in the near future there would be no scarcity beyond the areas where auctions are introduced. For this reason it was decided not to introduce administrative incentive pricing.

Norway

The Norwegian Post and Telecommunications Authority (PT) is financed by charges imposed on telecommunication operators, cable TV operators and radio spectrum users for cost recovery. A regulation fund serves as a buffer for eliminating discrepancies in the balance between charges and costs year by year in order to obtain stable charges over time. Charges are standardised and are in general imposed on the organisations/persons in question according to the related costs. Costs not directly related to organisations or persons are shared out according to certain criteria.

If necessary, the Telecommunication Act of 23rd of June 1995 allow charging of spectrum fees for major concessionaires. Fees are already applied for scarce number series in the numbering plan (i.e. 5-digit numbers) are priced with a fee. Public property aspects form the reasoning for frequency and number fees in excess of administrative costs. Number fees in excess

of costs are left to general governmental spending. Today DCS 1800 licences are subject to charges that exceed the administrative costs. NMT and GSM 900, however, are subject to fees that recover administration costs.

A working party was established in order to clarify general principles of frequency pricing. The working party delivered its concluding report in June 1999, which included technical and legal considerations as well as general economic principles. From a legal point of view it has become clear that frequency pricing in excess of administrative costs must be considered as taxation, which in principle has to be kept apart from the term charge or fee. Consequently the practical arrangements whether frequency pricing should be implemented by means of the present Telecommunications Act or also a separate tax resolution by the Parliament is not yet clarified.

The current Telecommunications Act requires a radio licence for possession and utilisation of radio equipment of any category. A regulation for free utilisation of certain categories of radio equipment has been prepared according to the EU R&TTE directive, and will be implemented in the year 2000.

Poland

Following the Parliament Resolution from 21 April 1995 the new Telecommunications Law is actually presented to the Polish parliament. The first reading took place in the beginning of summer 1999. It is expected that voting on the Telecommunications Law will take place in the first half of 2000 and the law will come into force in the beginning of 2001.

In accordance with the new law there will be two Regulatory Offices, the Regulation of Telecommunications Office and the National Radiocommunications Agency (NRA). All concessions for service providers and all aspects of wired telecommunications will be dealt with by the Regulation of Telecommunications Office. In the NRA all frequency management issues, the issuing of radio licences and enforcement activities will be dealt with.

According to the present *Act* entrance to the market is controlled by concessions, licences and simple registration. Licences or licences with permits for telecommunication activities are granted by the Minister of Posts and Telecommunications, while the National Radiocommunication Agency grant the permits for the deployment and operation of radiocommunications equipment.

Fees and charges

1. The fee for the concession depends on the success of the bidding. 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.

Bidding

According to the present telecommunication law all concessions for public telecommunication operators (wires as well as wireless) are granted by way of open bidding procedures based on definite conditions and rights (for example Polish participation not less than 51%).

In case of Radio and Television the concession system is based on beauty contests.

The bidding for choosing strategic partners for Telekomunikacja Polska S.A. (TP S.A.) to provide an analogue cellular telephony NMT-450 took place in 1991. After winning of tender, TP S.A. with American and French partners created the new entity "CENTERTEL", which received the licence from the Minister of Posts and Telecommunications to provide this services.

In 1995 Minister of Posts and Telecommunications announced the tender for two digital cellular telephony GSM 900 licences. Winners were POLKOMTEL Company „Plus GSM” Total fee for the concession 301 millions ECU (6 instalments) and Polish Digital Telephony Company „ERA GSM” (fee about 220 millions ECU in 6 instalments)

In 1997 Polska Telekomunikacja S.A. (TP S.A.) announced the tender for delivery of the telephony systems CDMA for tree regions and the Minister of Posts and Telecommunications announced tender for GSM 1800. The auction for GSM 1800 took place in two stags because there was only one applicant.

In 1998 Polska Telekomunikacja S.A. (TP S.A.) announced the tender for delivery of three new regional telephony systems CDMA and for a local telephony CDMA network in Warsaw.

In summer 1999 the Minister of PTT assigned a new, third, concession for GSM 900 to the current operator of GSM 1800 in an administrative way. The fee for the concession was 100 million ECU. Because no bidding procedure has taken place, the two current GSM 900 operators received concessions for GSM 1800 for 100million ECU each.

In 1999 it is planned to organise bidding for a domestic TETRA Civil licence and probably ERMES licences.

Russian Federation

With a view to ensuring more efficient use of the radio-frequency spectrum, which is a limited national resource, the Government of the Russian Federation adopted a decree in June 1998 on the "Introduction of charges for use of the radio-frequency spectrum". Under this decree, with effect from September 1998 commercial organisations, individual entrepreneurs and other persons using the radio-frequency spectrum in the Russian Federation for the provision of telecommunication services to commercial ends shall be charged for such use, pursuant to the "List of telecommunication services for whose provision use of the radio-frequency spectrum shall be on a paid basis" set forth in the decree.

Operators providing the following types of service are required to pay for use of the spectrum:

1. mobile telephony;
2. cellular telephony;
3. radiopaging;
4. radiopaging with VHF FM channel multiplexing;
5. global mobile personal communications by satellite;
6. distribution of television programmes using MMDS, LMDS and MVDS type systems.

For implementation of the charging scheme for use of the spectrum, regulations were also adopted on "Payment for use of the radio-frequency spectrum in the Russian Federation". The regulations set out the basic principles and general conditions for payment for the use of radio channels by all organisations - irrespective of their type of ownership - and individual entrepreneurs that use the radio-frequency spectrum on the territory of the Russian Federation for the provision of telecommunication services to commercial ends. Charges for use of the spectrum are set separately for each category of service, depending on the service area, number of channels used and the bandwidth used.

The amount of the charge levied for use of the spectrum is set annually. Annual charges for use of the spectrum are payable to Russia's national frequency management authority, in equal quarterly instalments, not later than the fifth day of the first month of each quarter.

The payment is distributed as follows:

- 50% to cover the expenses of the national spectrum management authorities;
- 50% as income to the federal budget.

Failure to respect the procedures for payment for use of the spectrum constitutes grounds for withdrawal of the licence for provision of the telecommunication services for which the spectrum is used.

With a view to improving still further the mechanism for charging for use of the spectrum, in February 1999 the Government of the Russian Federation adopted a decree stipulating that "after the entry into force of this decree, in respect of organisations applying for a licence or other authorisation to use the radio-frequency spectrum for the provision of cellular telephone services in bands above 1800 MHz and television programme distribution services using MMDS, LMDS and MVDS type systems, charges for use of the spectrum will be determined on the basis of the results of competitions for such licences or authorisations conducted under the procedure set by the Government of the Russian Federation".

Thus, the principle of competitive licensing is adopted for the following services from the above-mentioned list of telecommunication services provided through use of the spectrum on a paid basis:

- cellular telephony above 1800 MHz;
- distribution of television programmes using MMDS, LMDS and MVDS type systems.

In order to define the mechanism for competitive bidding, regulations were also adopted on the competitive award of licences for activities associated with the provision of these types of services. These regulations lay down the competitive procedure, conditions governing participation in the competition, financial arrangements and specifications for the issuing of licences on the basis of the results of the competition.

For the purpose of organising and conducting competitions, the State Committee for Telecommunications of the Russian Federation (Gostelekom):

- forms a commission, decides on its composition and, where necessary, attaches to it the necessary independent experts;
- sets the amount of the starting price, based on the average annual income and profitability of cellular communication networks. The starting price will constitute the initial annual charge for operations associated with the provision of cellular telephone services using radio frequencies;
- organises the preparation and publication of an information note on the holding of competitions;
- receives applications from persons intending to take part in the competitions (hereinafter referred to as "candidates"), entering them in the register of applications in the order of receipt, with a corresponding registration number and an indication of when the documents were tendered (date, month, time in hours and minutes);
- verifies that the documents submitted by candidates are in due and proper form;
- organises the receipt of starting bids from candidates.

The commission fulfils the following functions:

- examines the information transmitted by Gostelekom (or its representative) on applications received;
- examines the information transmitted by Gostelekom (or its representative) on the payments of starting prices received from candidates and other documents, and verifies their conformity with the requirements of Russian law;
- on expiry of the deadline for receipt of applications, on the basis of the information on applications received transmitted by Gostelekom (or its representative), draws up the official list of applications received;
- takes a decision on whether or not to allow candidates to take part in the competition and draws up the official list of participants in the competition;
- draws up the official record of the results of the competition.

Participation in the competition is open to legal persons and individual entrepreneurs who have submitted an application to participate in the competition in due time, have submitted in due and proper form the requisite documents listed in the information note published concerning the holding of the competition, and have deposited the requisite sum of money within the specified time-limit.

An application to participate in the competition from a candidate is deemed to constitute an expression of its intent to take part in the competition under the conditions set in the regulations and published in the information note on the holding of the competition. The form of application is endorsed by Gostelekom.

The starting price indicated in the information note on holding of the competition shall be transferred to one of the accounts indicated in the information note after submission of the application. The number of the application shall be indicated on the payment order.

Confirmation of receipt of payments of starting prices in the accounts opened with the corresponding banks for receipt of the sums in question is provided by extracts from account statements. Such extracts must be provided to the commission before candidates are recognised as participants in the competition. A candidate assumes the status of participant in the competition when the members of the commission sign the official list of participants in the competition.

In order to determine the winner of the competition, the chairperson of the commission opens the bid envelopes in the presence of the members of the commission and representatives of the candidates and announces the proposed amounts of the annual payment. The highest bidder wins. In the event of identical bids, the winner shall be the candidate that submitted its bid earlier.

The starting price payments of participants who do not win the competition are returned to them within 15 days after identification of the winner of the competition.

Upon receipt of the transfer of the annual payment from the winner in full to the account indicated in the information note, the State Committee for Telecommunications of the Russian Federation grants the licence under the established procedure.

The annual charge payable by the winner of the competition is distributed as follows:

- 80% as income to the federal budget, to be used in equal proportions to finance the Ministry of Defence of the Russian Federation (to cover expenses associated with releasing frequency bands) and the Russian Space Agency.
- 10% as income to the budget of the unit of the Russian Federation on whose territory the licence is valid (if the licence covers the territory of several units of the Russian Federation, the amount is divided among them proportionate to their populations).
- 10% to Gostelekorn to cover expenses incurred for licensing and the holding of competitions, for registration of radio frequencies and for monitoring services.

Slovakia

At present a draft new Telecommunication Act is being prepared, which is intended to come into force end 1999. The new legislation will solve inter alia the questions of frequency fees and the licensing process and bring it into line with European Directives.

The current practice is the following:

1./ The Frequency user pays:

- ⇒ A one off fee for issuing the licence
- ⇒ A monthly fees for frequency usage
- ⇒ A yearly fees for frequency reservation (GSM operators only)

2./ Public telecommunication services (mobile networks) can acquire a licence via a tender procedure (most often used e. g. GSM).

3./ Slovakia is of the opinion that the most transparent way of frequency assignment is by way of auctioning.

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.

Switzerland

The Swiss regime on fees and charges under the telecommunications act of 1997 provides for radio licence fees that are composed of two different categories of financial contributions:

- **the administrative charge** (*Verwaltungsgebühr, émolument*) is strictly cost based and covers the cost of regulatory tasks related to the frequency management, the delivery and maintenance of the licence or a group of licenses. The administrative charge is an income to the budget of the regulatory authority (OFCOM).

In addition to the administrative charge each license has to pay.

- **the licence fee or frequency usage fee** (*Konzessionsgebühr, redevance de concession*) which is a formal compensation for the transfer of a public resource and monopoly right (assignment of radio frequency usage) to a defined user. The frequency usage fee, therefore, is in principle not cost related in any way. According to the telecommunications act the fee must reflect the value and the amount of spectrum consumed and has to take into account the parameters of frequency range and class as well as bandwidth, territorial coverage and the duration of usage. However, in practice up to now the fee was in most cases defined as a percentage of the administrative charge for reasons of administrative simplification. Thus, the current fee structure offers little or no incentive for the user to change to more frequency efficient technologies and creates refarming problems for the frequency management. The frequency usage fee is an income to the general state budget.

Both categories are under a general review at the moment.

The **administrative charge** will be aligned with new figures of the cost allocation system (based on SAP R3) recently introduced in the regulatory authority (OFCOM).

The revision project of the **frequency usage fees** aims at introducing market generated (in case of auction) or market near administrative generated (in case of beauty contest or first come first served) frequency usage fees reflecting the economic value of the frequency usage. It is a strategic goal of the regulator to create stronger incentives for efficient use of radio frequencies to encourage changes to modern technology and to ease assignment and refarming operations. Also the fees for broadcast and telecommunications frequency usage should be harmonised in order to meet the requirements of a level playing field for convergent applications.

A first step has been taken by the revision of the frequency usage fee regulation for wireless local loop (WLL) applications in early 1999. An auction procedure is envisaged and the adequate design is currently under study. However, the auction has not been started yet and practical experience is still missing.

Turkey

In Turkey, according to the Act on Wireless and Assignment of Radio Frequencies, spectrum fees shall reflect licence holders' use of spectrum. Therefore fees shall be charged that reflect exclusive or shared use, the number of channels for each equipment, distance of HF systems and the kind of radio systems and broadcasting etc.

Furthermore, there might be different estimations on fee tariffs for radio systems for different kinds of systems, which are used in Turkey.

Licence fees are charged once, occasionally it is stable for each equipment. On the application of annual usage fees, for different kinds of radio systems there are different kinds of charge procedures for each of the equipment. Furthermore there are some fee procedures which depend on number of channels, which is to be used by relevant equipment, distance and power (in HF systems exp.).

So in this respect, unfortunately it is not possible to say the fee policy in Turkey depends on only spectrum usage.

On VHF, UHF, SHF radio systems for each channel whose frequency was allocated the fee is established according to the number of radio equipment used in the system. For mobile cellular phone systems, rural phone systems, radio paging systems subscriber equipment, satellite earth stations for each equipment etc. spectrum fees are charged.

As seen above, usage fees might be different for each equipment according to some parameters such as number of channels, coverage area, the kind of radio system or broadcasting etc.

Auctions are not planned in Turkey.

United Kingdom

Spectrum pricing in the UK

Spectrum pricing may be defined as charging fees for access to spectrum that reflect its value. The Wireless Telegraphy Act 1998, which entered into force in June 1998, substituted spectrum pricing for cost recovery as the basis for setting radio spectrum licence fees in the UK.

This approach is in line with standard economic theory that the distribution of a scarce resource, such as spectrum, will be optimised in terms of economic welfare if it is priced at its marginal value, thereby ensuring that it is assigned to those who can achieve most benefit from its use. If it is priced below this level, those who generate less benefit have little incentive to relinquish it in favour of those who can add more value; and businesses, consumers and jobs suffer. It is also likely that fees charged to recover costs will discriminate unfairly against small business users as the cost of administering a licence is unrelated to the amount or value of the spectrum occupied.

In accordance with article 11.2 of the EU Licensing Directive¹⁶, it is a cardinal principle in the UK that spectrum pricing should be used to achieve spectrum management objectives, not to maximise licence revenue. Since other EU member states are also subject to article 11.2, the transposition of this provision into UK law and its mode of application may be of wider interest.

The Act introduced two forms of spectrum pricing:

- auctions, in which fees are set directly by the market; and
- ‘administrative pricing’, in which fees are set by regulation on the basis of spectrum management criteria.

The legislation was preceded by widespread public consultation, including a consultative document¹⁷, White Paper¹⁸ and a study of the application of spectrum pricing¹⁹. This consultation demonstrated widespread support for spectrum pricing in principle and helped construct consensus for reform. There has since been further extensive consultation on detailed implementation²⁰.

Auctions

Compared to the alternative of comparative selection, auctions offer important advantages of:

- *economic efficiency*. A well-designed auction ensures that licences are awarded to operators that value them most and can generate greatest economic benefit;
- *fairness*. Selection by administrative criteria is more subjective and less transparent;
- *being less unfavourable to new market entrants*. Comparative selection tends to favour incumbents with established track records.

However, auctions are not suitable in all circumstances. For example, they would be impracticable for high volume-low value licences for private business radio used by taxis or individual fixed links. The Government has made clear that auctions will be used selectively in the UK for new national or regional services where there are more applicants than can be accommodated in the spectrum available. Existing operators will not be required to enter a spectrum auction for the right to continue their existing services within existing allocations. Nor will broadcasters who have won their broadcasting franchises in an auction under the broadcasting legislation be required to enter a spectrum auction.

¹⁶ Directive 97/13/EC. Article 11.2 states, “Member States may, where scarce resources are to be used, allow their national regulatory authorities to impose charges which reflect the need to ensure the optimal use of these resources. Those charges shall be non-discriminatory and take into particular account the need to foster the development of innovative services and competition.”

¹⁷ “The Future Management of the Radio Spectrum”, Radiocommunications Agency, March 1994.

¹⁸ “Spectrum Management: into the 21st Century”, HMSO, June 1996 (Cm 3252).

¹⁹ “Study into the Use of Spectrum Pricing”, by National Economic Research Associates and Smith System Engineering Ltd, published by the Radiocommunications Agency, June 1996.

²⁰ See “Implementing Spectrum Pricing”, May 1997, and “Spectrum Pricing: Implementing the Second Stage”, September 1998, both published by the Radiocommunications Agency.

The new Third Generation mobile telecommunications services appear to meet the general criteria set out by Ministers and preparations to auction spectrum licences in the UK are well advanced. On 6 May 1999, UK Telecoms Minister, Michael Wills MP, confirmed the Government's intention to auction spectrum licences for the new Third Generation of mobile telecommunications. He announced that, following extensive consultation with the industry, it had been decided to offer five licences for different amounts of spectrum - three for 2x10 MHz plus 5 MHz unpaired, one for 2x15 MHz and one for 2x15 MHz plus 5 MHz unpaired. The largest will be reserved for a new market entrant.

The Government expects that, subject to market and other developments and to final decisions nearer the time, the auction will take place in the second half of the 1999-2000 financial year.

Provided there is sufficient demand for the licences, an auction offers two main advantages over administrative pricing. First, it will enable the licence fee to be set directly by the market instead of having to be estimated. Second, it will select the operators who can make the most valuable use of the spectrum. Administrative pricing could still require some form of comparative selection procedure, with the associated disadvantages.

Experience shows that auction design is critical to a successful outcome. The design of the Third Generation auction has been subject to careful consideration with the help of experts in Game Theory and extensive consultation and has been tested experimentally. The basic design is a simultaneous multi-round auction with a ratcheted reserve price to ensure that the price paid for the licence reserved for a new entrant is not disproportionate to that paid for the other licences. The simultaneous multi-round design is well-adapted to achieving an economically efficient outcome because bidders gain information during the bidding about others' valuations and can adjust their strategy accordingly. Full details are available on the Agency's website.

Effect on the market

As mentioned above, an auction should achieve greater economic efficiency by selecting operators that can make best use of the spectrum and greater speed and certainty in the selection process. The particular design chosen in the UK will promote innovation and competition by providing for at least one new market entrant.

It has been suggested that an auction may increase operators' costs, slow down development of Third Generation services and lead to higher prices for consumers. Economic theory and experience in countries that have auctioned licences do not support these concerns.

An auction is not a 'licence to print money' for the Government. Bids will be determined directly by bidders' own valuations of the worth of the spectrum. In a well-designed auction, the winners will be those that can derive most benefit from the licences. This, plus competition, will encourage them to roll out networks more quickly to recoup their outlay. Bidders will take into account the costs they face, of which the spectrum fee is by no means the largest element, and should not bid more than they can afford.

As far as prices to consumers are concerned, these will tend to be determined by the demand curve for Third Generation services, not by the costs of inputs, such as spectrum. If operators attempt to increase charges above a certain level, demand and revenue will both fall. Bidders can be presumed to have incorporated in their business plans forecasts of demand at the tariffs they propose to charge; and can be expected not to make bids that would require them to overprice their services in order to earn a commercial return on their investment. In a competitive market, such as will exist for Third Generation, competition will effectively discourage both overbidding and overcharging.

Administrative pricing

Administrative pricing involves the spectrum manager in setting the level of licence fees as a surrogate for market forces. Most licence fees are set by administrative pricing rather than auctions.

The 1998 Act requires the Secretary of State, in setting spectrum licence fees, to have regard in particular to various spectrum management factors. These are:

- the balance between spectrum availability and current and expected future demand; and
- the desirability of promoting:
 - efficient spectrum use and management;
 - economic benefits;
 - development of innovative services; and
 - competition.

The legislation therefore ensures that spectrum pricing cannot be used as a form of taxation. Indeed, the Act ended the statutory requirement for licence fee regulations to be approved by the Treasury. Under proposals for administrative pricing in the UK, although some users with exclusive national channels or assignments in parts of the country affected by congestion will pay higher fees, tens of thousands of smaller business users will pay no more than previously or will benefit from fee reductions. Even where fees are increased, they will be no higher than necessary for spectrum management purposes.

It also follows that spectrum pricing is being applied in a focused way. Spectrum pricing is not an appropriate tool in some circumstances. For example, the use of spectrum pricing is not normally indicated where spectrum is not congested or technical standards, such as bandwidth and frequency, are mandated by international regulation and users cannot respond to price signals by adopting alternative technology.

Setting licence fees in practice

A brief account of the UK's methodology for setting licence fees may be of interest. A fuller description may be found in the documents referenced above. To the best of the author's knowledge, this methodology is unique to the UK in the way that it seeks objectively to quantify the marginal value of the radio spectrum. Although it is necessarily an approximation to the true value of the spectrum, which cannot be calculated with absolute precision, it is a considerable advance on other methods based on allocating spectrum management costs or an arbitrary revenue target.

Ideally, administrative pricing would result in fees equal to *market clearing rates* that balance supply and demand for spectrum. In practice, it is extremely difficult to estimate this rate. In a competitive market, such a fee would equate marginal costs to marginal benefits. Since profit-maximising firms would use spectrum only if their marginal benefits exceed their marginal costs, ie the administrative pricing fee, the task of the Agency is to set a licence fee that reflects the cost to the economy of their spectrum occupancy.

Where there is congestion, this cost is principally the unrealised cost savings of those who are excluded from using the spectrum. This opportunity cost is the difference between the cost of using the frequency in question and the cost of the least expensive practicable alternative to the existing assignment. That alternative may be another service, frequency band, technology or medium, such as cable.

A number of possible methodologies are discussed in the literature, including the user's revenue or profitability. But these do not necessarily optimise the allocation of spectrum. The amount a user can afford to pay is not necessarily an indicator of the value of the activity to the economy, especially if radio contributes a relatively minor part of its activities. There may also be practical difficulties in gathering data on profits. Nevertheless, comparisons with revenues and profits are helpful in putting into perspective the effect of revised fees on users and have been used to demonstrate that the UK's spectrum pricing proposals should not result in significant price increases for consumers.

The UK methodology may be summarised as follows.

- i. *Define alternatives to the current assignment.* For example, in the case of private business radio used by taxi firms, couriers etc. the use of narrow band technology, trunked systems, more efficient sharing and re-use and moving to a different frequency band.
- ii. *Cost the alternatives over the lifetime of the equipment.* The additional cost of the cheapest alternative compared to current radio costs (in the example quoted above this was a move to trunked systems) provides a measure of the marginal value of the spectrum for the application in question. In the case of mobile radio, the marginal values differed between services and an average 'Spectrum Tariff Unit' is being applied to all mobile radio in the interests of fair competition. This amounts to about £1.65/MHz/km².

- iii. *Derive licence fees from the marginal value of spectrum* on the basis of pre-selected parameters. In the example of private business radio, those proposed are bandwidth, coverage area and the degree of sharing as indicated by the number of mobiles as a proxy for traffic generated. Location is also taken into account with higher fees in congested areas. Congestion is quantified on the basis of a formula for each cell in a grid of 10 km x 10 km squares covering the whole country, leading to the definition of three charging regions: central London, which is heavily congested, Birmingham, Manchester and Liverpool, which are congested and the rest of the country, which is not congested. Fees for exclusive regional and national channels can also be derived.
- iv. *Apply 'modifiers'*, i.e. numerical factors to take account of various spectrum management factors, such as competition, choice and diversity, quality of service and spectrum usage constraints. For example, spectrum above 1 GHz is considered less valuable than spectrum below that frequency because of its propagation characteristics.

Phased implementation of administrative pricing

The new regime is being implemented in three waves, each phased in over 4 years so that users have an opportunity to adjust, as follows.

- The first wave of administrative pricing, which began in July 1998, tackled the worst distortions of the previous cost-based regime by increasing fees for mobile telecommunications networks and reducing them for thousands of users of on-site private business radio.
- The second wave, planned to start in July 1999, will extend spectrum pricing principles to other mobile radio and point-to-point fixed links. Fees for national telecommunications networks will continue to increase but smaller private business radio users will continue to benefit from fee reductions outside congested areas.
- The third wave, due to commence in July 2000, will cover other licence classes, including broadcasting, which raises special issues as some broadcasting franchises, as opposed to spectrum licences, are already auctioned.

This will also enable the effects to be monitored and licence fees to be modified if necessary to achieve the desired spectrum management objectives.

Affordability

The Agency has published detailed Regulatory Impact Assessments for the first and second waves of administrative pricing. These documents analyse the business sectors affected and the costs and benefits of the new policy with particular reference to small businesses. For the second wave, the Agency estimates that:

- over 60% of the current 57,000 private business radio licensees will pay no more than at present or enjoy fee reductions of up to 65%;
- the fee increases for a small private business radio user, such as a taxi company, that will pay more would be no more than 8p per taxi per week;
- the increase for a mobile telecommunications network would amount to just 5p per subscriber per week and even this modest amount may not be passed on to subscribers in view of fierce market competition;
- the potential economic benefits from the greater spectrum efficiency spectrum pricing should promote would far exceed the costs to business of the additional licence revenue.

As can be seen, planned fee increases are modest. The figures convincingly demonstrate that spectrum pricing in the UK will not make radio too expensive for businesses to afford.

Spectrum pricing for the public sector too

It has been a consistent feature of UK policy that the public sector, including the armed forces and emergency services, should be charged for spectrum on a comparable basis to the private sector. The public sector is a major user of spectrum. For example, the armed forces occupy more than 30% of the spectrum between 9 kHz and 30 GHz. It is seen as important that the public sector should also have incentives to use spectrum more efficiently and this has been a key factor in securing general acceptance of spectrum pricing.

Comparability is being achieved through the application of administrative pricing principles to public sector users, including the armed forces. The details of how public sector spectrum will be valued are under negotiation with the other Departments concerned but the principle is established as an essential component of the new regime.

Allocation policy

Spectrum pricing is envisaged as operating within the framework of existing allocations. However, marginal spectrum values may be used as an indicator of adjustments to allocations that could realise economic benefits. For example, if the marginal value of spectrum for one application is much higher than that for another use, this could indicate that it would be

advantageous to allocate more spectrum to the former. Economic methodology could therefore play a role at the allocation level. It is not suggested that it should be the sole determinant but, equally, it would not be prudent to ignore it completely.

Beyond spectrum pricing: spectrum trading

The creation of a spectrum market to enable users to trade spectrum between themselves instead of having to be directly licensed by the Government would be a logical development of spectrum pricing. It would provide an increased incentive to relinquish surplus spectrum and an additional mechanism to help new services gain access to spectrum more quickly. This would be a considerable advantage at a time of rapid and unpredictable change. Spectrum trading has already been successfully introduced in Australia, New Zealand and the USA and is expected to be introduced in Canada.

Spectrum trading covers a range of possibilities, from straightforward change of ownership of an assignment with no change of use to more advanced variants in which assignments may be divided or amalgamated and use changed. Not all of these are equally suitable for all services and some may be better suited to exclusive national channels than to shared local assignments.

There would need to be an effective regulatory framework to provide certain safeguards, for example to ensure compliance with international requirements, to prevent interference, to maintain competition and to protect access to spectrum by small firms and essential services. For example, transactions could have to be notified to the spectrum authority, which would have a power of veto.

Fuller details of the thinking underlying spectrum trading may be found in a consultative document²¹ issued at the end of 1998. The responses showed strong support in principle for the introduction of spectrum trading. The Agency is developing detailed proposals in consultation with industry but their introduction would require amendments to be made to the Licensing Directive. In its current form, the Directive has the apparently unintended effect of severely limiting spectrum trading. It is hoped that the Directive will be amended to allow member states that wish to do so to introduce spectrum trading.

²¹ "Managing Spectrum through the Market", October 1998, published by the Radiocommunications Agency.