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The spectrum fees calculation methods with application of Economic incentives of increase spectrum use efficiency

Kinds of license fees

License fees - a way of perfecting economic and technical efficiency of spectrum use in comparison with the free issue of licenses, provided that they are determined not higher than that sum, which could be received when selling a spectrum on the auction.

If they are determined lower than that sum, which could be received from the auction, the cost-performance will increase, even though there will be increased necessity in the spectrum, but profits of authorities from spectrum use management will be lower than gained from the auction.

Unprofitable consequences of determination of too low price for the spectrum are concluded in that spectrum potentially can be used not efficiently and its overloading can increase.

Kinds:

- fees on the base of spectrum use management value;
- fees on the base of users profits;
- a formula of stimulating fees;
- a formula of fees on the basis of possibility values.

Fees on the base of spectrum use management value

Advantage of this approach for raising the profits of bodies, controlling spectrum use, in that it ensures sureness, that owners of licenses will, at least, pay certain nominal sum for spectrum use, simultaneously excluding that holders of licenses, who earn from using spectrum, insufficient even for payment of this nominal sum.

Main shortage – is absence of relationships between the administrative payment and degree level of a spectrum use. Because of absence of relationship between the payment and spectrum use, such payment is not sufficiently useful for efficient spectrum use.

Fees on the base of costs on spectrum management possibly to present in the total functional form:

$$F = D_i \quad (12)$$

$$F = f(D_i, L_i) \quad (13)$$

where:

- F – fee, imposed on the license owner;
- D_i – direct administrative costs on processing license applications;
- L_i – share of license owner in additional administrative costs;
- I – total additional costs.

Fees on the base of user profits

Determination of fees on the base of a certain profit, connected with using of a spectrum, has an advantage in that it allows to bodies, controlling using of a spectrum, to get significant profits in certain services. Also this kind of fees gives more profits to bodies, controlling using of a spectrum, when increasing the profits of license owners, which can be considered as efficient and equitable decision.

Such kind of fees has two main problems:

Method is used to users, who get profits directly connected with using of a spectrum.

Such payment not obligatorily ensures efficient spectrum use or equitable attitude to license holders, since their profits indirectly connected with the spectrum price.

Fees on the base of user profits can be presented in general functional form

$$F = f(?, R) \quad (15)$$

where:

- F – fees, imposed on license owner
- ? – proportional fees determined by regulating body;
- R – license owner's profits.

Formula of fees on the base of possibility value

Formula of fees on the base of possibility value in that it is directly focused on the desired aim, imitating prices, which could be received on auction.

Problem: excessively difficult to imitate auction, such modeling depends on evaluations of deciding the separate buyers and on integration of this information into the used model. Financial studies or extrapolations, based on a priori distribution of a secondary market of deals, can be useful to some extend, but modeling of a market will always remain very imperfect. For example, several auctions of SPS in the USA have given results, extremely distinguishing from that, which have been forecasted nearly by all analysts.

Formula of stimulating fees

Formula of stimulating fees has an advantage in that it reflects, at least, limitedness of spectral resource. Taking into account the factors as population, region and bandwidth used, formula in some cases can be approximated to the prices which could be gained on the auction.

Shortage – it doesn't take into account changes constantly occurring on the market, and these payments can turn out to be below or above that price, which might have been gained on the auction.

For some services technical factors do not enable a shortening of bandwidth and consequently, stimulating payments on the base of bandwidth can be unacceptable, for example, in radiolocation service.

Formula of stimulating payments can be shown in general functional form

$$F = f (B, G, L, E, T) \quad (16)$$

where:

F – payment, imposed on the license owner;

? – bandwidth;

G – served geographical area;

L – location;

? – exclusiveness of usage;

? – desirable profit (Appendix – this parameter is determined by administration arbitrarily)

Note: see. Report ITU-R SM.2012. "Economic aspects of spectrum use management".
Section 2.3.6.6

In formula (16) parameters ?, G, L, E affect on the size of spectral resource used and can be evaluated by this or other manner, for example, as we had seen before in three-dimensional frequency-spatial-time spectral resource presentation they enter either into time or territorial, or into frequency component of spectral resource.

As to parameter ?, it depends on aims and tasks of a state when using a spectrum, in particular it is possible to use formula (1) from preceding my presentations, when state at the expense of total payments from all spectrum users covers their own expenses on spectrum use management and has certain additional rent, which can direct, for example, to the improvement of radiomonitoring system or to the output from certain frequency range of growing old equipment and other purposes.

Then the formula of stimulating payments it is possible to use at the development of a radio license fees calculation method Model.

1) If by the help of formulas (1), (2), (3), (4) annual amount is determined, which the state wants to get from users for the spectrum use.

2) If by the help of formulas (5), (6), (8), (9) spectral resource, used by any i-th frequency assignment from n frequency assignments, keeping in the national database is determined,

so it is possible to make the following steps

It is necessary to determine the general spectral resource Z, which will be used within the nation in the fiscal year according to the formula:

$$Z = L \sum_{i=1}^n Z_i \text{ (MHz} \cdot \text{km}^2 \cdot \text{1 year)} \quad (17)$$

where:

Z – general spectral resource, used in the country;

Z_i – spectral resource, used in i-th frequency assignment;

n – number of frequency assignments, registered in the National database

L – forecasted coefficient of change of used spectral resource. Introduction of this coefficient is stipulated that spectrum fees are defined beforehand, on the following fiscal year.

Price for the Qualified (averaged) Unit of the Used Spectral Resource

On the basis of the formula (1), taking into account formulas (2), (3), (4) the total amount of annual payment C_{an} can be determined which should be received from all users of the spectral resource.

On the basis of the formula (17), taking into account the formulas (5), (6), (8), (9) the whole value of the annually used spectral resource in the country can be determined.

Then it is possible to determine the price of DC_{an} for a qualified (averaged) unit of the spectral resource:

$$DC_{an} = L (C_{an} / W) \text{ (units of a national currency / MHz} \cdot \text{km}^2 \cdot \text{1 year)} \quad (18)$$

Note: either in this formula, or in the formula (1) factor of regulation, which takes into consideration possible changes to prices in the following fiscal year (coefficient of inflations and other factors) can be entered.

Annual Fees for Particular Frequency Assignment

According to formula (18) the price DC_{an} for the qualified (averaged) unit of the spectral resource is determined.

Formula (5) gives the value of the spectral resource Z_i used for a particular i -th frequency assignment.

Based on this, the amount of the annual payment C_j from the specific user of the spectrum for this frequency assignment will be determined as:

$$C_j = DC_{an} \times Z_j \quad (19)$$

If the particular radio communication operator has several frequency assignments, the payment for each assignment is determined as above and then they are summated in relation to all operator's frequency assignments.

Conclusion:

The Model focused on the certain spectrum cost calculation method and presents itself a concretization of generalised formula of stimulating payments, provided in the Report ITU-R SM. 2012.

Model is designed from the conceptual base that there is necessity in the spectrum pricing and that spectral resource pricing must reflect more administrative comforts.

Importance of the model is to provide to administrations a functional instrument, which can be used for the spectrum pricing calculation on the base palpable criterion.

Practically, model falls under the category of administrative methods of pricing, as dominating administrative approaches, it considers not only different criterion, used as contributions to the pricing, but as well as supports a weighting one or another criterion for reflecting importance of certain variants of spectrum use.

This also can be used for variation of pricing between different using of spectrum, where can be a lack of spectrum.

Purpose this model is to increase efficiency of the spectrum use. It is designed:

- to introduce non-discriminatory access to the spectrum for various categories of users;
- stimulate the use of less congested (particularly – higher) frequency bands;
- stimulate harmonised development of radio communication services throughout the country;
- cover the cost of spectrum management. It includes the consideration of the phased development and/or maintenance of spectrum management and monitoring facilities and reimbursement of expenditures of a national telecommunication Administration including its international activities within ITU.

The Model determines the value of annual payments to be made for the spectrum use using a pricing formula based on the following basic elements:

- Three-dimensional radio frequency-spatial-time resource, referred to as the **spectral resource**, used in the country and representing the common spectral value applicable to all frequency assignments, stored in the national Spectrum Management database and which is calculated on an annual basis.
- For each frequency assignment the spectral value is determined by the frequency band occupied by the emission, multiplied by an area, occupied by the emission (which is determined by the power of transmitter, height and direction of the antenna etc.).
- The annual administration cost of spectrum use management
- The average price for the spectral resource unit determined from the above values.
- The annual payment by a specific user determined from the actual value of used spectral resource.

A number of incentive weighting factors are entered in the formula.

Thus the spectrum price will depend not only on the relevant occupied bandwidth and coverage area values, but also on:

- time-sharing conditions, geographical location of the station,
- economic development level or population density in the coverage area,
- social factors,
- exclusivity, type of radio service, spectrum employment,

as well as some operational factors such as complexity of radio monitoring and imposing sanctions etc.

The proposed model allows the user at any moment to determine the value of his annual payment for the spectrum and also renders it to be transparent and accessible to all users. Thus, if the user employs greater bandwidth and service area, operates in more populated geographical area or the area is more economically developed and operates full time in more congested frequency bands, the larger will be the payment.

The approach thus encourages more efficient spectrum use and is an incentive for the user to implement more modern equipment and operate in new higher frequency bands. It should also encourage the use if possible of time-sharing regimes with other users, avoid

using redundant margins for the power of a transmitter and height of antenna etc. and support expansion of its coverage to rural and remote areas.

General Principles for the Model Development

It is necessary to underline that the number and values of all particular coefficients below are given only as illustrative examples. They are based on available data and the experts estimations.

Each National Telecommunication Administration can chose other values and add other coefficients reflecting its particular needs and experiences.

The Model is intended to cover those cases (and they are the great majority of frequency assignments) for which simplified calculation methods of some important parameters (mainly – service or occupied areas) can be used.

This approach has been chosen also from the understanding that for purposes of fees calculation it is much more important to provide universal procedures to guarantee equal conditions for all users belonging to one group (by radio service or its particular application) rather than to obtain a high accuracy of technical parameter calculations.

Based on a general principal that not only a transmitter but also a receiver occupies a particular spectral resource by denying operation of other transmitters (other than a communicating one) in a particular frequency band within the limits of a particular territory (Recommendation ITU-R SM.1046-1), the model can be used for calculating fees for receivers as well in a case when a user requires protection of a receiver from interference and it is registered in a National Frequency Assignment Database.

For some new radio systems for which the service area or occupied frequency band calculations are very complicated and when they have not been definitively fixed, calculations can be postponed and fixed license fee regimes could continued to be used.

Naturally, at the determination of value of total payment φ_{an} according to the formula (1), these payments must enter into the formula (1) with the sign “-“. Just the same for all frequency assignments of these radio systems factor of regulation χ in the formula (10) must be zero.

That is to say, if the initial data for application of the model are values of total payment φ_{an} and total value used spectral resource Z , all that does not enter to the system of using the model, must be excluded.

Using of the model is oriented on automatic spectrum use management systems.

For payments can be used:

- ◆ electronic database on frequency assignments;
- ◆ electronic territory map, divided on to elementary areas with fixed area and assigned weight coefficient in accordance with category of areas, to which divided the whole territory;
- ◆ for the determination of service areas or coverage areas it is better to use digital maps and programs of calculation of service areas, if applied.

Must be designed programs, as for the whole calculation of payment from users according to the model, so and series of subprograms for calculation of separate cycles of the method.
