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The Effective Distribution Of A Radio Frequency Resource Based On An Auction As The Main Economic Tool For Its Management

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Abstract: The article deals with the issues of distribution of the radio frequency spectrum, a state natural resource, between telecom operators, carried out on the basis of auctions. Taking into account the basics of managing the use of a radio frequency resource and the procedure for conducting auctions in accordance with the regulatory legal acts of the Russian Federation, a scheme for allocating a radio frequency resource has been developed, and the main principles of its implementation have been defined. Individual stages of auctions are analysed and shortcomings of the procedures carried out in accordance with the current procedure are identified. The directions of improving the mechanism of spectrum management are identified and the need to develop scientifically based methodological approaches and algorithms for its distribution are determined.

1 INTRODUCTION

Unlike other types of economic activity, the specifics of the production process of infocommunication services are the use of unique resources in addition to the classical resources of economic theory (labor, fixed and current assets, etc.): information, numbering resource, and radio frequency resource/radio frequency spectrum. Interestingly, the use of information resources leads to an increase in their volume, and the use/distribution of the numbering resource and radio frequency resource leads to their scarcity (Volodina, 2018).

The development of the wireless services market requires an increase in the number of technologies using spectrum, which is a unique natural resource with a number of specific features, and an indispensable production resource for enterprises providing wireless communication services. The possibilities of using spectrum are limited, depending on frequency, space and time. At the same time, there is a tendency to decrease revenues from operators' activities in unit value (per 1 MHz) with an increase in the volume of radio frequency spectrum allocated to them. All of the above causes that the efficiency of distribution of the radio frequency spectrum among its potential users is becoming an increasingly urgent task (Devyatkin, Volodina, Sukhodolskiy, Sukhodolskaya, 2020; Volodina, Sukhodolskaya, 2024; Kukharenko, Korkunov, Gorodnichev, Salutina, 2019; Volodina, Kukharenko, Sukhodolskaya, 2024; Volodina, 2019)

As a natural resource, the radio frequency spectrum was discovered with the invention of radio (Marconi, Tesla, Hertz, Popov) and has been widely used since the 20s of the XX century. Radio communication services are provided on the basis of artificially created electromagnetic waves using radio-electronic equipment and devices. In the late 50s of the same century, the first scientific studies in the field of the economics of using spectrum appeared. Along with the term "radio frequency spectrum", some regulatory and economic sources include the term "radio frequency resource".

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Currently, there is a contradiction between the high demand for the radio frequency spectrum as a production resource and the low efficiency of its operational distribution for various fields of activity.

The purpose of the work is to analyse the current mechanism of managing emergency situations on the basis of bidding and to set scientific and methodological tasks for its improvement.

2 THE MAIN THEORETICAL, REGULATORY AND PRACTICAL FOUNDATIONS OF SPECTRUM MANAGEMENT AND DISTRIBUTION

The study of domestic and foreign experience has shown that such a control tool as radio frequency distribution is implemented on the basis of several methods (Butenko, Veerpalu, Volodina, etc., 2009). Since 2010, auctions have become widespread. The auction was first held in Russia in 2015. To date, as a result, four auctions have been held, and the last two of them, unfortunately, did not lead to the distribution of the frequency resource. This indicates the shortcomings of the current spectrum management mechanism, primarily due to the bias and lack of a systematic approach to the organization of bidding. Namely, insufficient consideration of the interests of all market participants in the process of providing wireless communication services, not only state institutions, but also spectrum users represented by legal entities and individuals.

Speaking about the interests of the parties participating in the organization and conduction of the auction, it should be noted that the main tasks for the State/ the Regulator in the distribution of spectrum at auction are to ensure:

- The demand for wireless communication services;
- The free competition,
- The production of radio communication equipment in Russia;
- National security;
- Communication systems work without interference.

For operators, the key tasks in the field of distribution of frequencies, including when planning participation in an auction, are to ensure the functioning of technological processes of production and the economic efficiency of the enterprise as a whole.

Taking into account the main regulatory legal acts in the field of bidding (Gerasimov, 2016; Novikov, 2011; Sukhodolskaya, 2021), the authors developed a scheme for spectrum distribution, revealing the interaction of State executive bodies and auction participants (Fig.1).

The organizer of the auction is the Regulator (State), which determines in which bands, which radio frequency bands and under what conditions they will be distributed at the auction. The second subject of the bidding process-the participant (operator) - is given the opportunity to either agree to the proposed terms or refuse to participate in the auction.

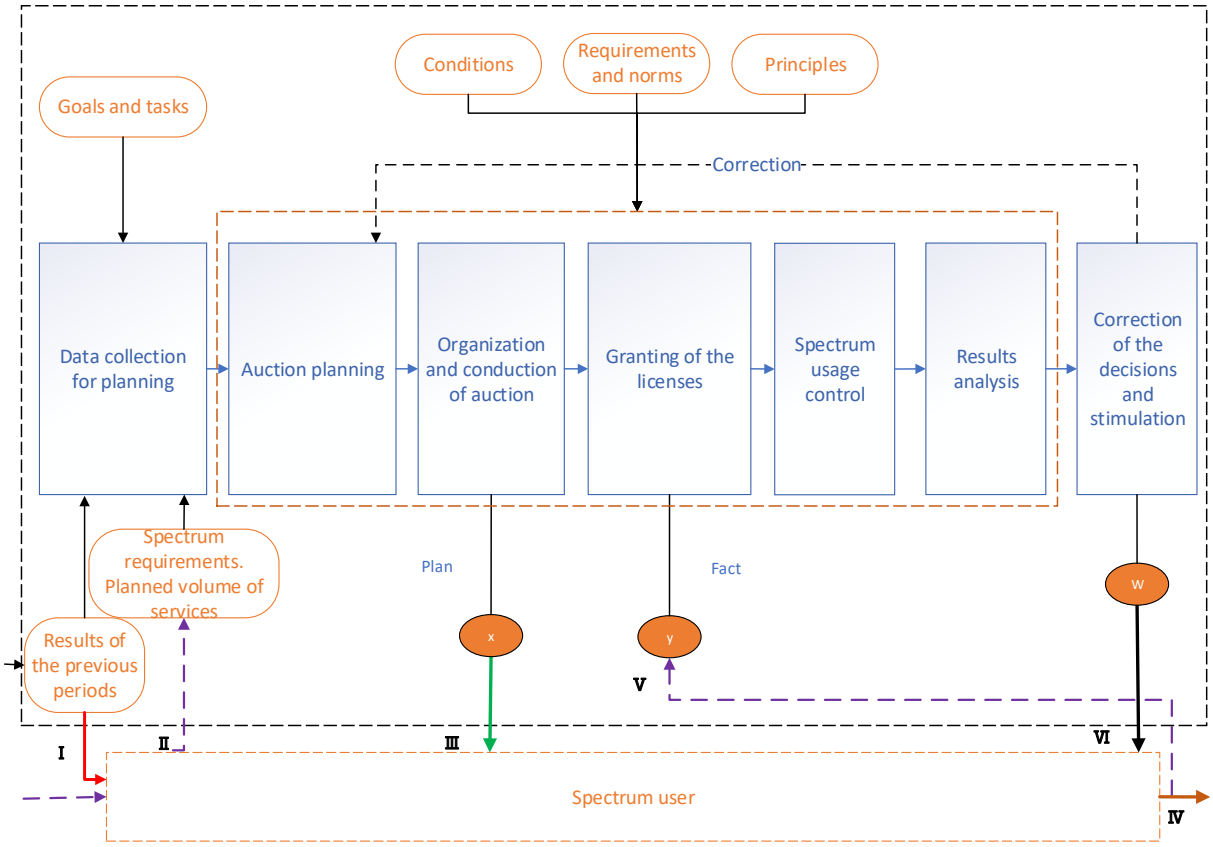

Figure 1: A scheme for spectrum distribution, revealing the interaction of State executive bodies and auction participants.

At the initial stage (Stage I in Figure 1) of spectrum distribution process, information necessary for planning an auction is collected, and an analysis of auctions already held both in Russia and abroad is carried out. At this stage, the draft tender documentation can be discussed with the operators.

At stage II, the user submits to the Regulator their comments on the draft tender documentation, and can also provide information about their needs for the resource that is supposed to be put up for auction.

Next (stage III) the regulator forms a decision on holding an auction. If it is positive, the final version of the tender documentation is published and the process of preparing and conducting the auction is initiated.

At stage IV, the user makes a decision to participate or refuse to participate in the auction and acts in accordance with the decision made.

At stage V, after the end of bidding, the Regulator analyses the results achieved in the distribution of frequencies put up for auction.

At the final stage (VI), adjustments are made to the decisions taken regarding the distribution of frequencies, including, the possible cancellation of permitting documents, or, on the contrary, the granting of preferences.

The goal defines the general requirements for the result of the activity. The main objectives of the State in the distribution of spectrum, including the organization of an auction, along with ensuring national security, are the effective use of frequencies.

For operators, the purpose of using spectrum is to maximize the profit of the enterprise, in particular, in the bidding process, it seeks to obtain the resource it needs at the lowest price and ensure maximum efficiency of its further operation (Volodina, Livshitz, 2022).

The goal is determined by your needs. In this case, needs are the amount of emergency response that is necessary for society, business, and security agencies. (Kukharenko, Alyushina, Yankevskiy, 2021, Kukharenko, Yankevskiy, 2022; Salutina, Klesareva, Platunina, 2021; Salutina, Platunina, Vasileva, 2021; Volodina, Kukharenko, 2024) The assessment of needs for frequencies is carried out by both spectrum users and the State.

Based on the analysis of the use features and specific properties of the radio frequency spectrum, the principles of spectrum control were formulated (Table 1).

Table 1: The principles of spectrum control.

Properties and features of the frequency resource	Principles
Has no boundaries	The principle of centralization and control The principle of management
Limited in use	The principle of efficiency The principle of planning The principle of proportionality in management
Expands production opportunities	The principle of economy
Has economic value Can be the subject of purchase and sale	The principle of unity of politics and economics
Connections and interrelations of the characteristics and properties of spectrum in various aspects of its use	The principle of consistency

The absence of borders determines the need for supranational regulation of the distribution of frequencies and national control over its use. In other words, when distributing the radio frequency spectrum, the principles of centralization, control and management must be observed.

Due to the limited radio frequency resource, the principles of efficiency of its use, planning and proportionality in managing the distribution of spectrum resources follow.

The introduction and use of more modern and promising communication technologies allows to transmit more information using a unit of spectrum, increase the speed of data transmission, provide new communication services, and increase production efficiency. In other words, to expand the production capabilities of operators and enterprises through the use of frequencies, which, in turn, determines the need to reduce the time for preparing and implementing solutions in the field of its distribution.

Since radio frequency spectrum has an economic value and can be subject to bidding, the spectrum distribution management system should take into account the principle of unity of politics and economics.

The principle of consistency in the management process is determined by the interrelationships of the properties and characteristics of spectrum in physical, industrial, economic and managerial terms.

3 ASSESSMENT AND SUGGESTIONS FOR IMPROVEMENT OF THE CURRENT SPECTRUM DISTRIBUTION SYSTEM

The decomposition and justification of the principles of implementing the procedure for allocating radio frequency resources in the form of auctions allow to more objectively analyse the process of organizing and conducting individual bidding procedures, identify shortcomings, and formulate actual tasks for solving them and improving the mechanism as a whole.

Analysis of the results of auctions conducted in terms of prices for lots to be displayed, calculated in accordance with the current methodology, was many times higher than the similar prices calculated by the authors on the basis of alternative methodological approaches widely used abroad (Volodina, Devyatkin, Sukhodolskaya, 2016).

It should be noted that the initial prices for lots are the main factor influencing the results of auction, namely, the successful distribution of the radio frequency resource allocated by the Regulator and its further involvement in the production process of providing cellular mobile communication services (Volodina, Devyatkin, Sukhodolskaya, 2014).

An equally important factor in the successful implementation of auctions is the justification of the quantitative parameters of the subject of bidding, namely, the number and size of lots that reflect the regional needs of operators in the radio frequency resource. Obtaining the amount of radio frequency resource that the company needs to develop new technologies and communication networks in a particular region based on the auction results is an important incentive factor for the company when making a decision to participate in the auction. If there are not enough radio frequencies available in regional lots for new technologies to work, then their development is impossible, and this will slow down the growth of innovative activity of operators. It is these conditions and the needs of operators that should guide the Regulator when preparing trades, in particular when determining the number of lots and the frequency bandwidth associated with each lot.

Thus, considerable attention should be paid to the selection of the optimal combination of parameters and conditions of the auction, taking into account the mutual interests of the state and telecom operators, when forming lots to be put up for auction. Unfortunately, an administrative approach is used to conduct auction which is a market-based method of distribution of frequencies.

Analysis of the problems and shortcomings of the existing system of distribution of spectrum allowed to set several tasks for the development of scientific and methodological approaches to:

- Evaluation of the number and size of lots to be auctioned, allowing for consideration of regional radio frequency needs;
- Determination of the initial bid price that encourages the development of innovative radio technologies in the regions of the Russian Federation;
- Choose the optimal combination of parameters and conditions for holding an auction, taking into account the mutual interests of the state and telecom operators.

4 CONCLUSIONS

The analysis of theoretical, methodological and applied issues of conducting auctions revealed the following:

1. Increasing demand for radio frequency resources as part of the digitalization of society, aimed at applying new wireless communication technologies

2. The lack of radio frequency spectrum as a resource, including ready-to-use radio frequency bands for the development and implementation of innovative technologies, which indicates the need for an effective mechanism for distributing licenses for activities using radio frequencies, which contributes to the innovative activity of telecom operators.

3. Imperfection of the use of bidding as a method of distribution of frequencies, due to the shortcomings of the regulatory and methodological framework for conducting auctions for the distribution of radio frequencies in terms of determining quantitative and price indicators, due to which it is possible to stimulate the introduction and development of new radiotechnologies.

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