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DEVELOPMENT OF LEGAL AND TECHNICAL REGULATION IN THE SPHERE OF QUANTUM COMMUNICATIONS**

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Subject. The article examines the latest changes in Russian legislation, reflecting the active processes of production and implementation of quantum communications industry products in the information security market, caused, among other things, by the adoption of the Concept of regulation of the quantum communications industry in the Russian Federation until 2030. The article presents an analysis of the state and direction of Russian legal regulation in the field of communications, as well as measures to support and stimulate the development of the quantum communications industry. The main problems and prospects for the development of technical regulation in the field of quantum communications, as well as the directions of its interaction with the legal regulation of this area, are identified.

The purpose of the article is to identify the main directions and patterns of development of legal and technical regulation in the field of quantum communications in Russia.

Methodology. The following methods were used: a combination of the dialectical method with the methods of formal logic, formal legal and comparative legal analysis. A legal and technical method was also used, which allows identifying the main promising areas of interaction between legal and technical regulation of relations in the field of quantum communications.

Main results. It has been established that the legal regulation of quantum communications by the legislation of the Russian Federation in the field of communications should be carried out through the creation of a legal mechanism for testing, trial operation and implementation of technologies without excessive administrative procedures while ensuring the necessary level of security and controllability by government agencies. Experimental legal regimes in the field of digital innovations can become a legal means for creating such a mechanism. Measures to support the quantum communications industry and their promising areas of development have been identified and analyzed.

It has been established that regulatory and technical regulation actually determines the main vectors of development of the quantum communications industry in Russia and in the world. The main measures necessary for the development of regulatory and technical regulation of quantum communications in Russia have been analyzed.

Conclusions. To integrate quantum communications into the unified telecommunication network of the Russian Federation, the need has been substantiated and the adoption of a number of regulatory legal acts has been proposed. The development of quantum communications technologies requires special state support for the implementation and application of experimental legal regimes in the field of digital and technological innovations, including special programs, the development of public-private partnerships, regional and special sites. The experience of foreign and international standardization in the field of quantum communications shows that the quantum Internet of Things is a promising technology, the development of which in Russia is only being discussed. In the Russian Federation, there are already quantum communication lines, but there are no permanent standards, which is a significant constraint in the development of the corresponding regulatory framework. To ensure the reliability, authenticity, security and interoperability of solutions in the field of quantum communications, it is necessary to bring the regulatory and technical regulation in this area to uniformity, taking into account existing international standards, the experience of foreign countries and the level of development of domestic technologies.

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1. Introduction

The United Nations has declared 2025 the International Year of Quantum Science and Technology. The development of these technologies is currently associated with the quantum revolution taking place worldwide and the introduction of these technologies of the future into all spheres of public life. However, quantum technologies are already considered high-risk today. Modern research shows, for example, that the creation of the same quantum computer can contribute to the "destruction" of a significant part of modern information security systems [1], since its algorithms are capable of deciphering modern cryptography methods and are already being implemented in practice[1]. Another threat in terms of the development of quantum technologies is global technological competition. Economically developed countries of the world set one of the key tasks to ensure technological leadership and sovereignty. Quantum technologies in this part are considered one of the key ones within the framework of these goals. In Russia, the development of quantum technologies is one of the most breakthrough areas, which allows us to confidently be among the world leaders. These and other threats determine the need for closer attention of the Russian state to this problem, including in terms of legal support for the prevention of such risks and threats [2-5].

Research methodology. The following methods were used in the study: a combination of the dialectical method with the methods of formal logic, formal-legal and comparative-legal analysis. A legal-technical method was also used, which allows identifying the main promising areas of interaction between legal and technical regulation of relations in the field of quantum communications.

2. Main areas of development of normative legal regulation in the field of quantum communications

An analysis of the tasks set in the Concept for regulating the quantum communications industry in the Russian Federation until 2030 indicates the need to develop a number of areas.

2.1. Development of regulation of relations in the field of quantum communications in the field of communications.

Today, there is an active discussion of the extension of telecommunication regulations to the field of quantum communications or the creation of a special type of communication - quantum and the development of special regulation. In particular, the conceptual apparatus is not fixed, it is necessary to develop legal mechanisms for the effective integration of existing and new quantum communications channels into existing communication networks, as well as to determine the rules for the provision of quantum communications.

We believe that the legal regulation of quantum communications by the legislation of the Russian Federation in the field of communications should be carried out through the creation of a legal mechanism for testing, trial operation and implementation of technologies without excessive administrative procedures, ensuring the necessary level of security and controllability by government agencies. Experimental legal regimes in the field of digital innovations can become a legal means for creating such a mechanism [6, 7]. We believe that in order to integrate quantum communications into the unified telecommunications network of the Russian Federation, it is necessary to adopt regulatory legal acts that ensure:

- the creation, operation and connection of quantum communications networks belonging to different legal entities, as well as the interaction of quantum communications networks with other telecommunications networks included in the unified telecommunications network of the Russian Federation;
- the development of quantum communications and quantum cryptography technologies (quantum key distribution);
- ensuring access of individuals and legal entities to quantum communications networks. When providing access to quantum communications for a wide range of people, the problem of regulating the relations between the subject providing the service and the consumer arises. To regulate these legal relations, it is permissible to either conclude an agreement or establish special rules for the provision of services. In this regard, we have developed a draft of the "Rules for the Provision of Quantum Communications Services".

Also, within the framework of this area of legal regulation of quantum communications in the Russian Federation, the Preliminary National Standard of the

[1] Chinese researchers develop quantum computer-based method to crack RSA encryption. URL: https://gigazine.net/gsc_news/en/20241015-rsa-encryption-quantum-computer (accessed: 01.05.2025).

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Russian Federation - PNST 829-2023. Quantum communications. General provisions, which was put into effect by the Order of Rosstandart dated 11.07.2023 No. 22-pnst, was approved. This normative technical document sets out a typical quantum communication scheme. As follows from it, quantum communications require three communication channels: a quantum channel; a synchronization channel; a service channel. All of them together make up a quantum communications system that ensures data transmission between a quantum transmitter and a quantum receiver. At the same time, the service channel and the synchronization channel can be implemented using any telecommunication lines, and a quantum channel requires a special communication line, which, from a technical point of view, cannot be classified as a telecommunication line. In this regard, a legal paradox arises: although from a physical point of view, a quantum communication channel does not belong to a telecommunication line, its independent functioning within the framework of the current national standard is impossible. Therefore, the quantum communications network should be considered as a telecommunications network, which allows extending the general legal regime governing the creation and operation of elements of the Unified Telecommunications Network of the Russian Federation to quantum communications lines. Thus, there is an interaction and influence of the normative and technical regulation of quantum communications on the normative legal one. In this part, today the main direction will be the corresponding adaptation of the legislation on communications to the emerging quantum communications system.

Within the framework of the general legal regime, the formed quantum communications networks can be classified as: dedicated communications networks; technological communications networks. These communications networks do not have strict legal regulation, and their owners themselves determine the procedure for their functioning. In this regard, it is proposed to begin operating quantum communications networks within the framework of the existing legal regime, and after testing, initiate amendments to the current regulatory legal acts regulating the interaction of quantum communications networks with other telecommunications networks included in the Unified Telecommunications Network of the Russian Federation.

2.2. System of legal regulation of stimulation and support of the quantum communications industry

One of the basic directions of development of legislation on quantum communications is the system of stimulation and support of the quantum communications industry. Here we can highlight the following key areas of development.

2.2.1. Basic measures have been implemented in the form of forming product codes by types of economic activity in the current classifiers. Thus, a number of special codes have been added to the All-Russian Classifier of Products by Types of Economic Activity OK 034-2014 (KPES 2008).

This measure has greatly contributed to both the direct development of markets for relevant products and services, an increase in their quantity and quality, and has also allowed the development of other legislation based on their use. For example, legislation on procurement, including in terms of limits and prohibitions on the purchase of relevant products in the field of quantum communications by Russian government bodies and state enterprises and organizations from foreign manufacturers. This will also contribute to the promotion of relevant products within the framework of regional and international associations in which the Russian Federation participates, including the EAEU, CIS, SCO, BRICS, etc.

Securing products in the quantum sphere in classifiers allows us to create a mechanism for assessing quantum equipment for its production, component base specifically on the territory of Russia. This will support the domestic market of quantum communications and contribute to the development of Russia's technological sovereignty [8]. Also, the introduction of codes for products and services in the field of quantum communications has become the basis for modern developments in this part in relation to the field of quantum measurements and the use of a quantum computer. It is also rapidly developing in terms of not only experimental implementation, but also potential use in government bodies and commercial use by Russian enterprises in the near future.

Thus, these measures are aimed at providing support to domestic manufacturers in the quantum communications industry, as well as ensuring the development of the quantum communications industry

in the face of unfriendly actions against the Russian Federation, Russian companies and citizens.

2.2.2. The development of support measures is largely implemented through experimental legal regulation. According to the Decree of the Government of the Russian Federation of October 28, 2020 No. 1750 "On approval of the list of technologies used within the framework of experimental legal regimes in the field of digital innovations", quantum technologies, including quantum communications, are included in the list of technologies that are used in experimental legal regimes. To date, the Register of Experimental Legal Regimes does not contain either proposals or actual introduced regimes providing for the use of quantum technologies in general. Thus, there is not a single experimental legal regime yet, but there is a corresponding request from participants in the quantum communications industry. During conferences, roundtables and strategic sessions, industry representatives and public authorities have spoken positively about this method of regulating quantum technologies. However, to date, no legal entity has agreed to initiate an experimental legal regime in the field of digital innovation.

Today, a number of key areas have been identified in which it is possible to introduce such a regime in the future. This is the use of quantum communications technologies in the information security system within individual government agencies or state corporations, in the banking sector, and in the electoral process. In addition, we have found that it is advisable to introduce experimental regimes to regulate quantum communications in certain areas, including unmanned transport and logistics, the Internet of Things, portable electronics, modern and prospective mobile networks, as well as other areas where there is a need to increase the level of information security. In addition, today there is clearly an opportunity to remove quantum communications lines from the system of norms that form the general legal regulation in the field of communications, information protection, cryptography, and foreign economic activity. But this clearly requires the creation of special conditions on the part of stakeholders in the quantum communications industry and the state to create organizational and legal conditions for the development and implementation of experimental legal regimes in this area. The introduction of experimental legal regimes is also possible in the context of using these technologies in technology parks, special economic zones and centers. Thus, by the Decree of the Government of the Russian Federation of November 30, 2021 No. 2133, the innovative scientific and technological center "Quantum Valley" was created and is operating. Within the framework of these zones, entities in the quantum communications industry are already receiving various support measures, including tax ones. Objectively, this can be implemented in these zones and within the framework of experimental legal regimes, which made it possible to more effectively use the capabilities of this legal instrument.

With the extension of legislation on experimental legal regimes to public-private partnerships, it is also possible in the future to implement such projects in connection with the introduction and use of quantum communications technologies and other technologies.

In addition, experimental regimes in the field of quantum communications can in the future be implemented within individual constituent entities of the Russian Federation, aimed at making this state a national US leader in the field of quantum technologies, promoting the development of quantum computing, quantum communications and sensor technologies.

2.2.3. Support for the quantum communications sector within the research and educational track. Here we see a number of initiatives that are reflected in the legislation. Thus, the List of instructions from 03.09.2023 No. Pr-1734, approved by the President of the Russian Federation, the Government of the Russian Federation must ensure the development of tools for comprehensive support of the development of quantum communications, including:

- uninterrupted activities of research teams and laboratories in the field of data security and using quantum encryption technology in these areas;
- active involvement of domestic and foreign specialists to conduct research in this area;
- simplification of the procedure for using state support for scientific research on the topic of quantum communications;
- creation of a special university in the field of quantum technologies;
- expansion of scientific cooperation with the

BRICS countries;

- intensification of the exchange of scientific information, including through the creation of international scientific journals and holding conferences; and others.

In order to accelerate the development of secure quantum data transmission systems, by Decree of the President of the Russian Federation dated 18.06.2024 No. 529 "On approval of priority areas of scientific and technological development and the list of the most important science-intensive technologies" they were included in the list of the most important science-intensive technologies. They also act as the best available technologies [9]. Accordingly, they relate to the areas of grant budget support.

In order to develop educational programs aimed at training personnel in the field of quantum communications, a number of professional standards for specialists in the field of quantum communications were approved.

3. Development of normative and technical regulation of the quantum communications industry

The most important direction of regulation of the quantum communications sphere is normative and technical regulation. It is important today to ensure a system of effective interaction between legal and technical regulation of this sphere. Normative and technical regulation actually determines the main vectors of development of the quantum communications industry [10, p. 237]. Normative legal regulation largely depends on it both in terms of the conceptual apparatus and the formation of the limits of legal regulation of the emerging relations. An analysis of the experience of legal regulation of quantum communications abroad shows that almost all leading economically developed countries of the world, setting goals for technological world leadership, focus on the priority development of technical regulation and on determining the directions of normative legal regulation on its basis [11].

From the perspective of the prospects for the development of normative and technical regulation, the highest priority is given to national standards that establish requirements for quantum communications networks; software; equipment; the use of quantum communications technologies in existing communication lines; testing of quantum communications networks, equipment and software. This list largely corresponds to international standards in this area. All these standards are first-generation technical documents, so they are designed for a short-term period of validity only. In the future, they are planned to be preserved or changed. This approach is generally accepted, but it clearly carries risks for entities in the quantum communications industry, which today bear significant costs for the formation of a national quantum communications ecosystem. These include Russian Railways, which have already built and are using a backbone network of quantum communications, as well as the Consortium of Russian Universities, which created an inter-university quantum communications network [12]. When changing preliminary national standards, there is a risk that it will become very difficult or impossible to operate the created quantum communications networks. In this regard, today there is an objective need for regulatory and technical acts in the field of quantum communications of permanent effect. The lack of permanent standards is a significant factor limiting the development of regulatory legal regulation of the quantum communications industry today. This is primarily due to the impossibility of defining specific priority areas of technological development in the field of quantum communications that would be supported by the state. Permanent standards would greatly contribute to the stabilization of the quantum equipment market and the corresponding specific measures of its state support.

The issue of priority areas for standardization in the quantum communications sphere is also very relevant. From the point of view of the prospects of technologies, one of the most important is the technology of transmitting quantum keys using a satellite [13]. However, in Russia, the satellite part of quantum communications networks is still absent, so it is hardly rational to consider it as a priority for the standardization of quantum technologies.

One of the priority areas for the development of normative and technical regulation in the quantum communications sphere is synchronization with international standardization organizations \

Standardization is the most important element in the development of the quantum communications industry. In the absence of national standards, equipment manufacturers will use technologies that

may not meet the declared characteristics, and, therefore, will not perform the function of protecting confidential information. Domestic experts rightly note that very often in practical quantum key distribution schemes, various real imperfections of devices are usually neglected [14]. No post-quantum algorithm can currently be considered completely safe until the actual testing of high-power quantum computing technologies. This is a very important area of standardization, because, as has been repeatedly noted, there is a list of really feasible attacks on quantum communication channels [15]. All this determines the importance of this area of development of quantum communications regulation, which has a significant impact on the law of quantum communications.

Analysis of domestic standards in the field of quantum communications shows that we are at the first stage of standardization, characterized by the development of technical terminology for a new industry. At the same time, resources for standardization are spent irrationally. The development of technical documents requires time and financial costs. In 2023, they were spent on the creation of four standards for the quantum Internet of Things and only two standards for quantum communication. At the same time, industry analysis shows that today there is a primary need for standardization: quantum communication channels; quantum communication equipment (quantum receivers and transmitters).

Experience of foreign and international standardization in the field of quantum communications shows that the quantum Internet of Things is a promising technology, the development of which in Russia is only being discussed. In the Russian Federation, quantum communication lines already exist, but there are no permanent standards, which is a significant constraint in the development of the relevant regulatory framework.

Active standardization of quantum communication technologies is taking place abroad, which is being transformed into the adoption of the first international standards. The Russian Federation does not participate in this process actively enough. Only in 2024, for the first time, a delegation of our experts took part in a meeting of the joint international technical committee for the standardization of quantum technologies, formed by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). An analysis of international standardization entities allows us to say that this is the most optimal platform for our country. However, there are risks that its role may be reduced by a number of states that oppose Russia's inclusion in these processes as part of global technological competition. In this regard, today, at the state level, it is very important to apply the maximum number of measures to stimulate and support inclusion in these processes.

4. Conclusions.

To integrate quantum communications into the unified telecommunications network of the Russian Federation, the need is substantiated and the adoption of a number of regulatory legal acts is proposed. The development of quantum communications technologies requires special state support for the implementation and application of experimental legal regimes in the field of digital and technological innovations, including special programs, the development of public-private partnerships, regional and special platforms for such development.

Based on the above, it is advisable to consider the possibility of adopting bilateral agreements in the field of standardization with the SCO, BRICS, and EAEU countries. This will help domestic manufacturers avoid the influence of foreign standards without prejudice to their entry into export markets.

To ensure the reliability, reliability, security and interoperability of solutions in the field of quantum communications, it is necessary to harmonize the regulatory and technical regulation in this area, taking into account existing international standards, the experience of foreign countries and the level of development of domestic technologies.

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