

The Digital Economy of the Region: a Distributed Infrastructure of the Industry Ecosystem

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Abstract. The paper analyzes the main processes occurring in the digital economy worldwide and shows the place and role of the Russian Federation in the implementation of these processes. The task of the study was to develop proposals for the formation of the sectoral ecosystem of the region's digital economy. It is shown that in the rating of countries introducing technologies for digitalization of economic relations, Russia is in the group of "novice leaders" (the level of digitalization is higher than the level of economic development) but so far lags behind the leading countries, such as South Korea, the Netherlands and China. The article substantiates the conclusion that it is advisable to build a virtual environment on the basis of university data centers constructed on the basis of new principles of the innovative engineering solution that allows it to scale and connect new participants, if required, without additional investments. The digital products and services platform is an essential element of the ecosystem of the digital regional economy and allows linking resources and consumers of products and services. The set of the most important tasks that should be solved while creating the organizational and technological platform of the regional sectoral ecosystem include creating a cloud for individual sectors of the regional economy, launching cloud-based industry services and individual projects, digitalizing the life cycle in the cloud, developing an environment of business tools and creating an integrated data center systems. The proposed structure of the sectoral ecosystem of the region's digital economy is universal and can be applied to most industries in different regions of the country.

I. INTRODUCTION

Nowadays, as well a hundred years ago, the world economy is on the verge of tremendous technological changes that, without doubt, will change not only the life and economy but also society itself. An important feature of these technologies will be the impossibility (or very high complexity) of copying them. In particular, this will lead to the unprecedented scale of the struggle for the authors of these technologies, since the most effective method of obtaining someone else's technology is to invite its key developers.

The development of infrastructure, reducing the cost of processing, storing and transferring data are taking technology to a new, qualitatively higher level. Mankind has already entered the fourth industrial revolution. The era of cyber-physical systems is coming.

In 2017, the digital revolution entered a crucial phase: every second inhabitant of the Earth is connected to the Internet. According to the McKinsey Global Institute (MGI), in the next 20 years up to 50% of production in the world can be

automated, and scale-wise this process will be comparable to the industrial revolution of the XVIII-XIX centuries. Today, Russia has a unique chance to realize its potential during the digital revolution and take its rightful place among its leaders.

Fig. 1 shows graphs reflecting the change in the level of per capita GDP in the leading countries of the world over the past 500 years [1]. It is evident that Russia has never been leading in this indicator, however, intelligent implementing of basic principles and objectives of the digital economy will give a unique chance to become the world's leader on the indicator.

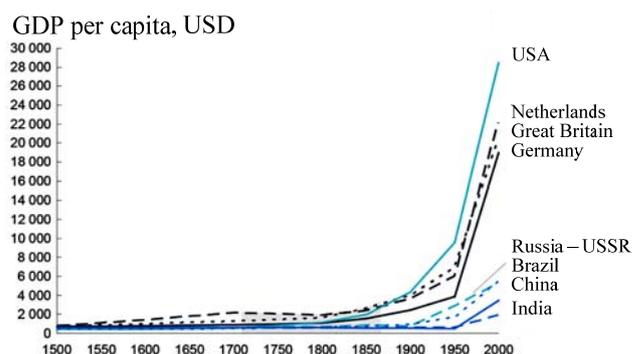


Fig. 1. Dynamics of GDP per capita

It should be noted that the essence of the new technological order is determined by a set of technologies that can be combined into the following groups:

- artificial intelligence and its application;
- robotics. Robots will be able to replace all employees whose actions can be formalized;
- micro- and nanotechnologies, biotechnologies.

Huge opportunities arise in healthcare: nanorobots will be able to eliminate tumors and put vessels in order. Methods of treatment at the cellular and molecular level will be also found, as well the technology of adjusting the human genome will develop.

Plasma control technology. The electric power received at thermonuclear power stations will be cheap enough to be exported and transmitted over long distances.

The onset of the new era will inevitably lead to fundamental geopolitical and social changes. Some countries for some time will pretend that the old economic order is still working out or can be revived. However, in addition to the scientific and technological base, active development of technology also

requires resources and markets. However, even the world's leading manufacturers lack markets. Since there are no more new markets, the great powers will eliminate their competitors from those markets that they control politically and militarily.

In this situation, the state focus on a particular aspect of the new technological order is impossible. All states will have to make a choice - own a full set of basic technologies (form their technological zone and become its core) or enter the technological zone formed by another state to become a market.

A coming decade will be the decade of struggle for the possibility of forming technological zones (between potential technological zones) and struggle for control over these zones (both between oligarchic groups and between individual countries).

The problems of the digital economy, the analysis of individual technologies, the effect of the introduction of such technologies are pretty much devoted to work of both domestic and foreign researchers and practitioners.

It should be noted that the concepts of "digital economy" and "Industry 4.0" adopted in Western countries are not identical, since in our country we bear in mind the economic order, new economic relations that are based on the digital ecosystem, digital infrastructure, i.e. it is more systematic, complex concept related to the understanding of Western researchers.

Papers [2], [3], [4], [5], [6], [7], [8] note that Industry 4.0 is characterized by advanced digitalization and integration of industrial production and logistics processes, as well as the use of the Internet and "smart" objects (machines and products) and merging of physical and virtual worlds through the introduction of information and communication technologies (ICT), which contributes to the creation of new human and industrial organizational systems and new organizational business models that affect the overall value chain, society and environment. Digital transformation will require strong leadership, enhanced employees' skills and overcoming a number of barriers to its successful implementation. Among negative effects we should mention that there would be a jobs cut for employees with low qualifications. However, this will lead to a significant amount of new jobs for highly skilled employees. For the first time in the history of industrial production, people act as partners, not resources, while the emphasis is made on innovation and development, with machines performing routine work.

A significant number of papers [9], [10], [11], [12], [13], [14] are devoted to various aspects of information security of new intellectual production systems. Special attention is paid to the application of new technologies, mobile devices, wireless communication of the 5G generation in digital control systems of various levels. It is noted that the existing technologies do not meet the requirements for ensuring the sustainability of business processes of production in the emerging digital economy. There is a strong need in new approaches, focused on integrated solutions that take into account both economic and technical requirements based on the methods of systems theory and system analysis.

A number of works [15], [16], [17] are also devoted to various aspects of the Internet of Things, as well as to the prospects for their use in industries and development prospects in various countries. For example, paper [17] marks that companies should take Industry 4.0 seriously, since they are developing their future initiatives, and traditional business process models do not correspond to Industry 4.0 technologies. Some of the following issues should be addressed with caution: information technology (IT) security, reliability and stability required for critical communication between machines; necessity to maintain the integrity of production processes, avoid networking and protect industrial know-how; lack of adequate skills, a general reluctance to change by stakeholders, and a major loss of jobs due to automated and IT-controlled processes.

Analysis of publications, works of scientists from leading countries of the world shows that the largest number of publications belongs to authors from the USA, China and the UK. At the same time, in recent years, the number of publications revealing various aspects of Industry 4.0 has increased dramatically.

It should be noted that in recent years, researchers also started using the concepts of "digital economy" and "ecosystem" [18], [19], [20] but now they interpret them significantly less comprehensively than domestic researchers are used to. At the same time, most researchers and practitioners agree that the digital economy is a complex concept based on the convergence of technologies but such works are practically absent in both domestic and international databases.

The purpose of the study is to analyze the main processes occurring in the digital economy world-wide, to clarify the place of Russia in this area, as well as to develop proposals for the formation of the sectorial ecosystem of the region's digital economy.

II. METHODS

In today's digital economy, the main advantages go to those who own and manage virtual digital space and provide access to the digital products and services platform. Fig. 2 shows a pattern of the interaction between existing resources and consumers in the virtual world based on the corresponding digital platform.

However, in order to ensure the functioning of the circuit presented in Fig. 2, it is necessary to carry out a digital transformation of all spheres of production (Fig. 3).

One of the main tasks of business in a digital economy is the ability to restructure corporate culture and organization. This also requires more resources for storing and processing large amounts of data. A consistent restructuring of business within the digital transformation will eventually bring the company to a new level of efficiency. In this case, the main trends that determine the essence of the processes of the digital economy are presented in Fig. 4.

At the same time, cloud technologies allow sharing infrastructure and thus using resources more efficiently. Big Data and advanced analytics allow making more accurate and faster decisions from primitive production processes to preventing the fraud transactions.

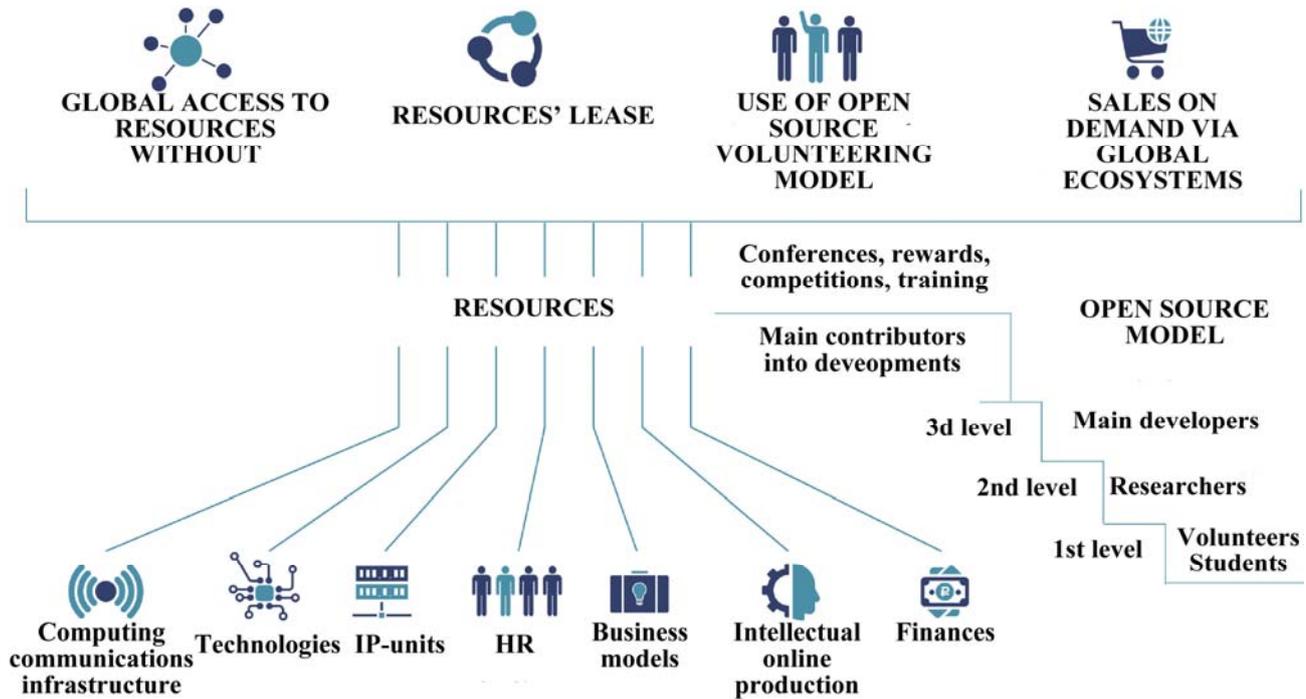


Fig. 2. Pattern of interaction between resources and their consumers

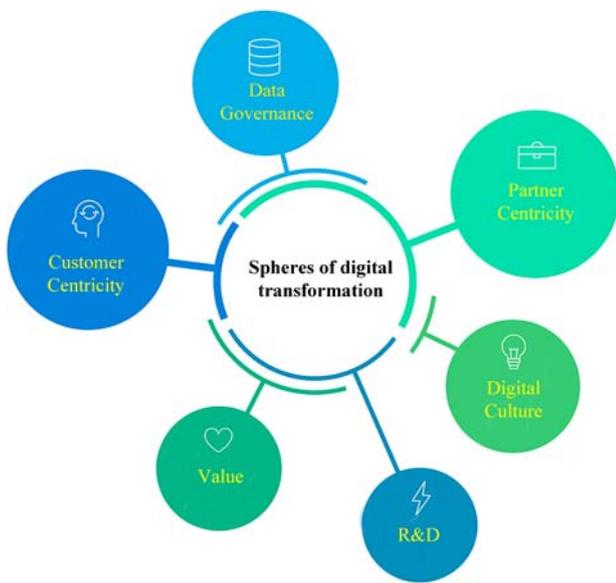


Fig. 3. Spheres of digital transformation

The size of the market and the economy of joint consumption, which implies a more efficient utilization of capacity, is already estimated at 150 billion dollars. This fundamentally changes the structure of the global economic system, expands the consumers' capabilities, as well as affects the structure of industries and the role of states in this system.

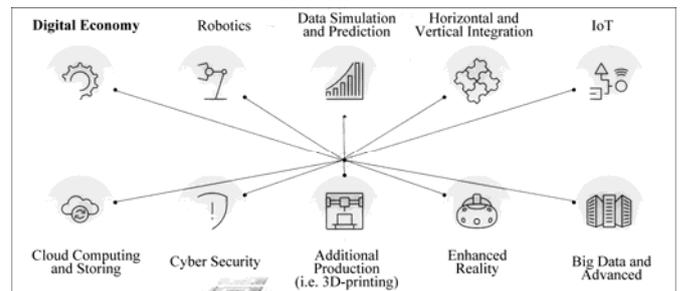


Fig. 4. Basic trends in digital revolution

Urban infrastructure is increasingly in need of smart management. Cities consume up to 2/3 of all world resources, and there is a real opportunity to increase the efficiency of this consumption. Elements of smart infrastructure are present in 2.5 thousand cities of the world. The control system of the in city is built on the basis of smart technologies.

E-government development programs in different countries of the world are undergoing rebranding. A transition to an intellectual government implies the emergence of simpler and more convenient services and, as a result, the switching of society to digital channels of obtaining services.

Development of infrastructure increasing incomes of potential consumers and the advent of a new generation of users also leads to the growth of online consumption. This in turn also stimulates an increase in the share of the digital economy (Fig. 5).

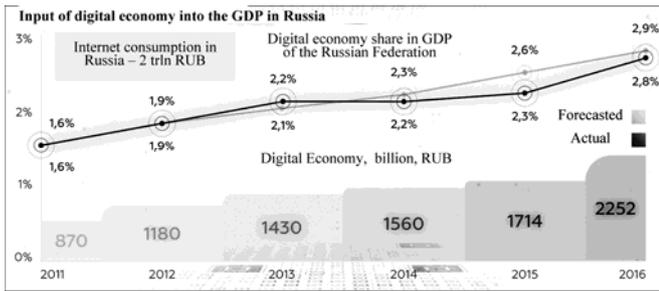


Fig. 5. Input of digital economy into the GDP in Russia

Level of digitalization of the world economy is constantly growing, quite unequally though. All countries can be divided into five groups according to the intensity of digitalization: leaders, main group, countries lagging behind, beginner leaders and catching up countries (Fig. 6).

Russia still remains on the periphery. However, over the past 5 years it has moved from the group of catching-up countries to the main one. Comparing the current level of digitalization of the Russian economy with the dynamics of the development of the rating leaders, we can conclude that at the moment Russia's lag is 5-8 years.

Some positive trends should also be mentioned. First of all, Russia is improving its position in the segment of broadband Internet access and increasing the share of smartphone sales. In addition, the speed of 3G connection in Russia is higher than the average speed in Central and Eastern Europe. The level of infrastructure development is presented in Fig. 7.

In terms of infrastructure development for digitalization, Russia is the leader among the BRICS countries, but it is not even up to the average for OECD member countries. The state encourages involvement in the digital economy, introduces digital technologies, e-procurement and e-government.

The level of involvement in the digital economy is presented in Fig. 8. According to the I-DESI index, published by the European Commission in 2016, Russia's development of the digital economy used to lag behind the EU, Australia and Canada but was ahead of China, Turkey, and Brazil. In terms of availability of fixed broadband, Russia was ahead of the EU and the rest of the countries. In terms of human capital, Russia had better positions than the average for the EU, Turkey, Mexico and Brazil but significantly lagged behind Japan, Korea, Sweden, Finland, the United Kingdom and the leading EU countries.

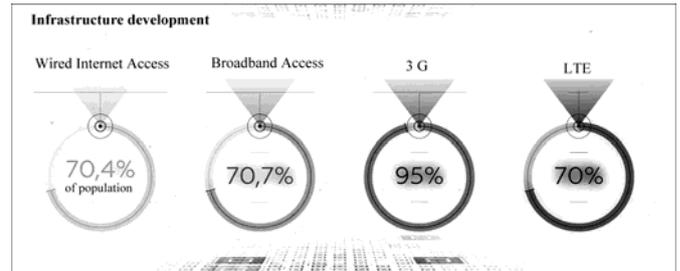


Fig. 7. Infrastructure development in Russia

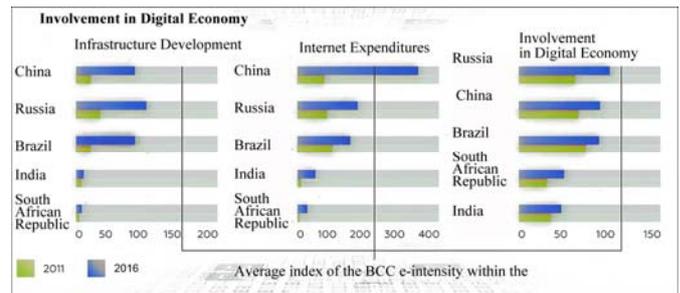


Fig. 8. Involvement in digital economy

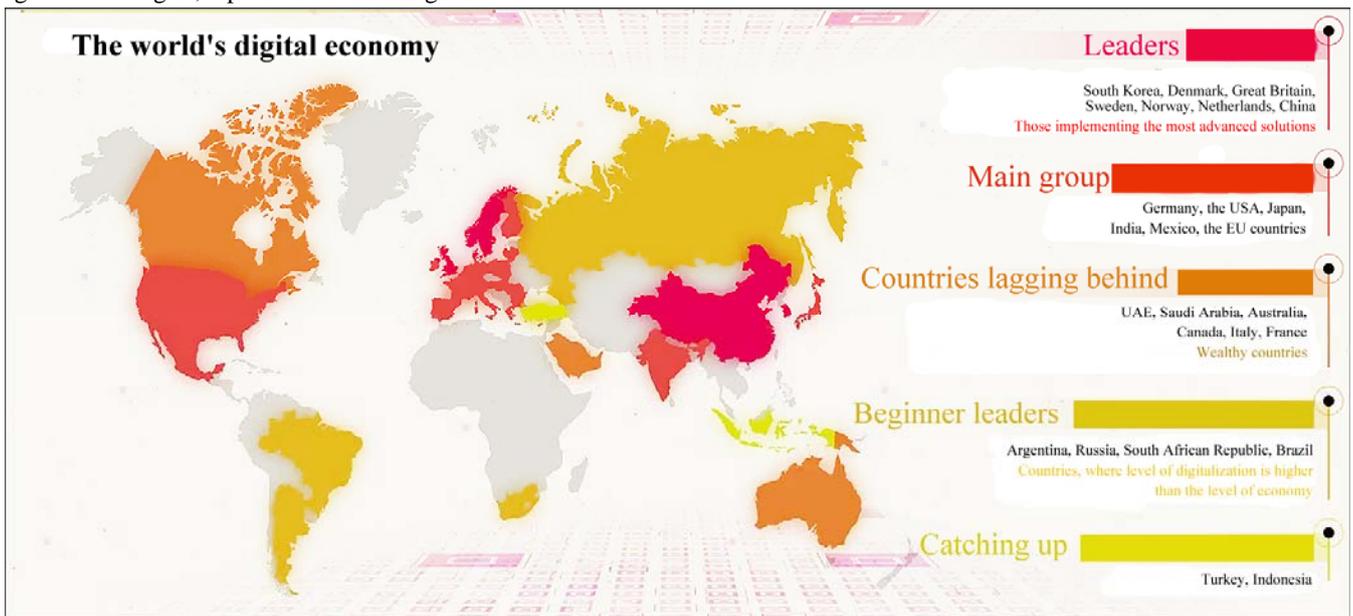


Fig. 6. Place of Russia in the world's digital economy

Regarding the frequency of using the Internet (on average daily and regularly), Russia showed not very high positions in comparison with the EU, the USA, New Zealand and Australia but was ahead of China, Brazil, and Mexico. In the field of digital technology adoption by enterprises, Russia lagged far behind the EU and other countries, and was only slightly ahead of Turkey, China and Mexico. Russia ranked 46th in the Global Innovation Index. In 2017, the Russian Federation was in 45th place.

Leadership in the list remains with Switzerland. The second position is occupied by the Netherlands, the third one – by Sweden. The first five included the United Kingdom and Singapore. The United States, Finland, Denmark, Germany and Ireland were in the top 10. China scored five lines at once and became the 17th. The rating was launched by the World Intellectual Property Organization (WIPO), Cornell University and the independent organizations of GII Knowledge Partners and INSTEAD. The Global Innovation Index has been published annually since 2007. It represents an international rating, within the framework of which its experts are trying to assess how different countries of the world are developing innovative sectors of the economy and trying to bring them to life. Evaluation uses 80 parameters that give a complete picture of innovative development, including an overview of the political situation, the state of education, and level of development of infrastructure and business. The global economy is formed under the influence of accelerating innovation waves (Fig. 9).

The most important digital trends of the modern world can be divided into three groups.

For companies:

- Ownership of digital assets creates a competitive advantage;
- Fast growth: the winner gets everything;
- Digital platforms take place of classic intermediaries;
- Specialization is growing and new players are emerging;
- Digital players are entering new markets.

For consumers:

- Digital economy creates many benefits for consumers and society;
- Digital economy transforms the labor market.
- For the state:
- Provision of public services in a digital format by default;
- Ease of interaction with citizens;
- Transition of internal processes and interagency interactions in a fully digital format;
- Feedback from government and social services;
- Formation and analysis of large data arrays.

In the modern digital economy, the main advantages are those who:

- Owns and manages virtual digital space;
- Provides access to a platform of digital products and services.

It should be noted that the platform of digital products and services is an essential element of the ecosystem of a digital economy at various levels, including the regional one. Let's consider the main provisions aimed at the formation of such a platform at the regional level, as well as the structure of the ecosystem being created.

III. RESULTS AND DISCUSSION

The platform is a virtual territory where business connections are established between the participants, hosting their businesses here, and developments in this virtual space.

It is advisable to build a virtual environment on the basis of university data processing centers built on new principles. It should be borne in mind that federal universities are entrusted with the task of playing the role of scientific and technological "locomotives" of the regional economy, while leading higher education institutions and scientific organizations (for example, the Russian Academy of Sciences [21], Moscow State University [22] and a number of other organizations) solve similar problems at the state level.

An innovative engineering solution is applied to the development of the platform, which allows it to scale and connect new participants as needed, without additional investments required.

The organizational and technological platform of the region's digital economy includes, as a basis, a technological platform on which the main management tools can be implemented to ensure the operation of the digital management space, and ensures the interaction of needs and capabilities of suppliers and consumers of resources, products and services based on innovative technologies and principles of the digital economy. The basic elements and connections of such a platform are shown in Fig. 10.

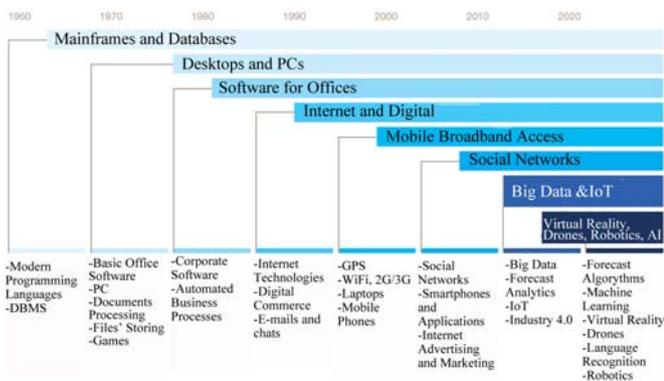


Fig. 9. Features of innovation waves

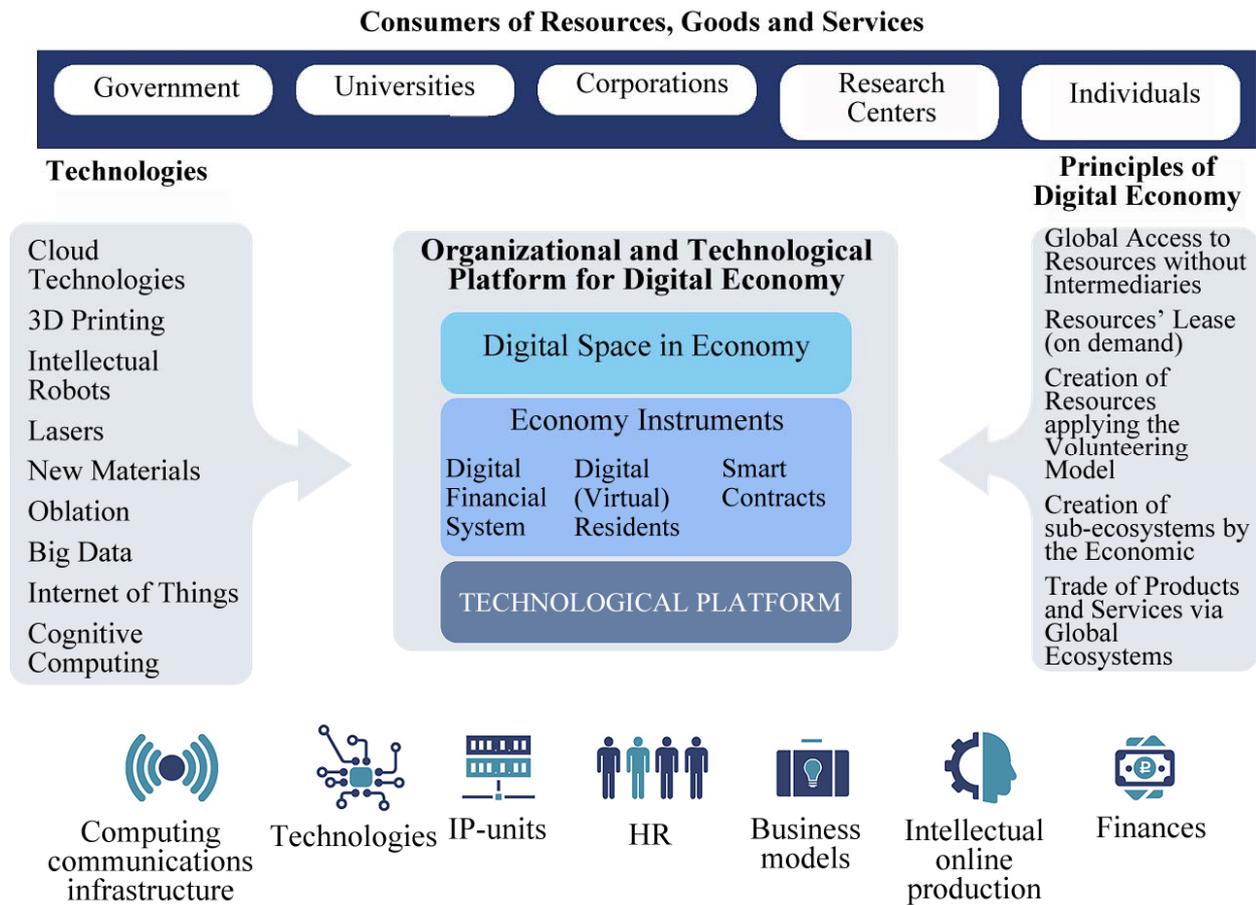


Fig. 10. Organizational and technological platform

The creation of the organizational and technological platform of the regional sectorial ecosystem foresees the solution of a number of important tasks:

- • Creation of clouds and sub-clouds for individual branches of the regional economy (education, medicine, agriculture, architecture and construction, engineering, electronics, government, energy, recreation and tourism);
- • Launch of cloud industry services (industry ecosystems) and individual projects;
- • Development of design, production and sales of products and services (digitalization of the life cycle in the cloud);
- • Development of business tools;
- • Creation of an integrated data center system (based on OpenStack, containers, SDS, SDN);
- • Creation of a service management system of the Ministry of Science and Higher Education; provision of scientific services for collective use centers of organizations subordinate to the Ministry of Science and Higher Education to scientific and educational institutions of the region;
- • Creation of digital school centers.

As an option for the possible structure of the digital industry systems in the region, one should consider a set of regional

ecosystems with the selected branch ecosystems “Agriculture” and “Electronics” shown in Fig. 11.

IV. CONCLUSIONS

The purpose of this article is to analyze the main processes occurring in the digital economy worldwide, to clarify Russia's place in this area, as well as to develop proposals for the formation of the sectorial ecosystem of the region's digital economy. As a result of the analysis, the following conclusions can be formulated:

1) Digital transformation of economic relations is actively taking place in the world, which is the essence of the 4th technological revolution (Industry 4.0), while such processes in Russia (digital economy) are deeper and more complex, based on the convergence of innovative technologies of the economy, information and communication technologies, as well as humanitarian, political, legal and educational technologies.

2) In the rating of countries introducing technologies for digitalization of economic relations, Russia is in the group of “novice leaders” (the level of digitalization is higher than the level of economic development), but so far lags behind the leading countries, such as South Korea, the Netherlands and China.

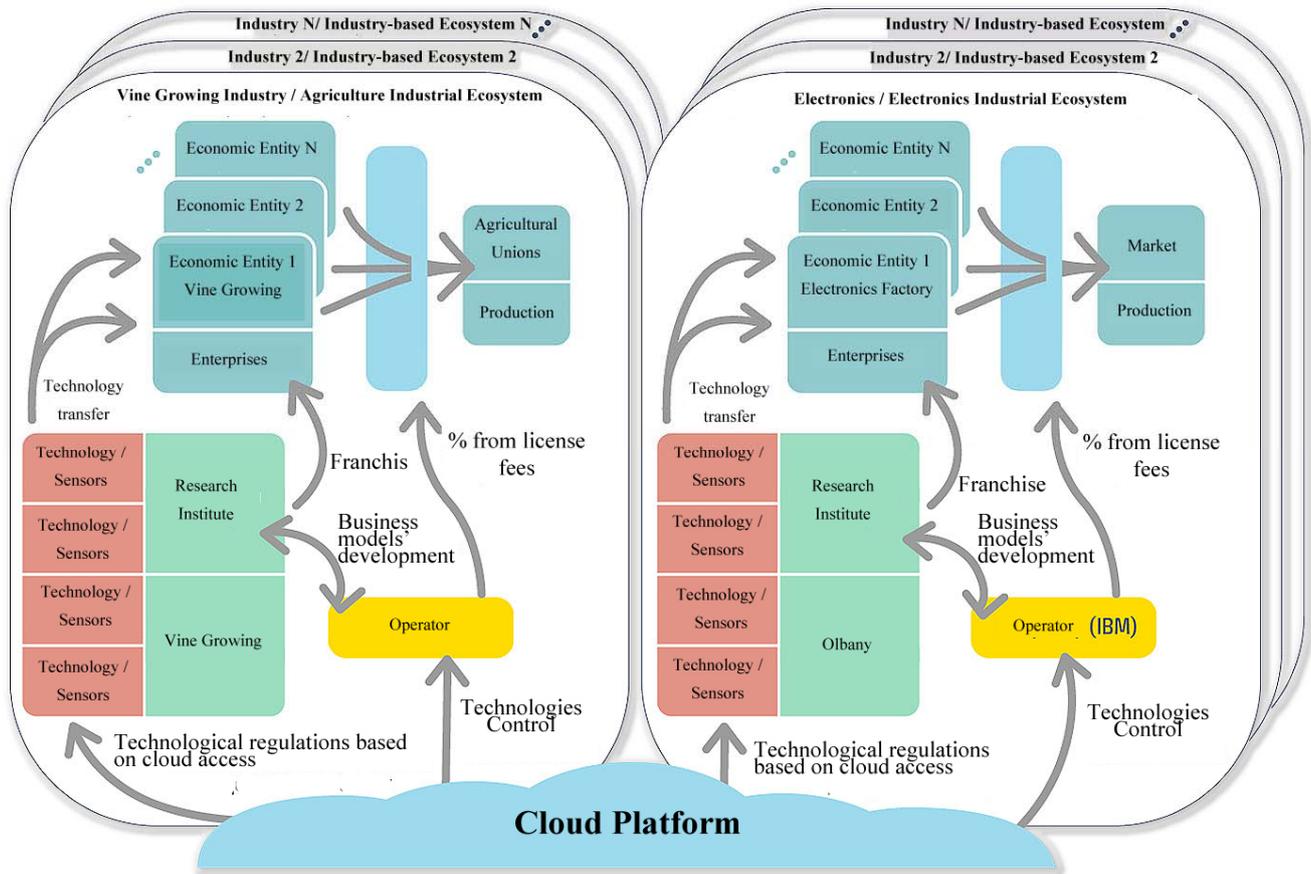


Fig. 11. Structure of the digital industry ecosystem of the region's digital economy

3) It is advisable to create a virtual environment on the basis of university data processing centers built on new principles, characterized by innovative engineering solution, which allows scaling up and connecting new participants as needed, without requiring additional investments.

4) The digital products and services platform is an essential element of the ecosystem of the digital regional economy;

5) The proposed structure of the sectorial ecosystem of the regional digital economy is universal and can be applied to most industries in different regions of the country.

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