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**PROMISING DIRECTIONS OF SPACE-ROCKET ENTERPRISES  
ACTIVITIES IN INTERNATIONAL HIGH TECHNOLOGY  
MARKETS**

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**Abstract**

Nowadays, the global economic development is based on using scientific knowledge and technology. Countries such as the USA, Japan and some EU countries are the leaders of high-tech production. Russia has a huge technological lag from the leading countries due to the strong dependence on the extractive industry. However, the volume of high-tech markets are superior to raw materials ones. The world market of space products and services is one of the most important high-tech segments. The basis of the Russian Space is a space-rocket industry. Space-rocket enterprises have a great innovative potential created in the framework of the state defense order. The increasing development in the world high-tech market and, as a consequence, increasing demand for space activity results justified the need to commercialize the innovative potential of space-rocket enterprises. It will provide the technological modernization and innovative development of the industry and economy in Russia. In the article, the main cost-effective and attractive scientific directions of space-rocket enterprises are considered. Based on the analysis, it was concluded that among the most important directions, there are such important sectors of the economy as Communication & Telecommunications, energy, aviation and mining industry, and medicine.

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## 1. Introduction

The role of high-tech industries has been increasing steadily in the economic development of countries and regions. At present, a significant scientific, technical and technological potential belongs to such



countries as the USA, Japan, Germany, Britain and France.

Beginning from the second half of the 20-th century, the production of output was based on advanced science and technology. The main distinctive features are:

- a high investment attractiveness;
- a high level of investment risk;
- using advanced scientific knowledge and technology;
- a high growth potential and expected high returns.

Russian has a huge technological lag from the leading countries due to the strong dependence the Russian economy on the extractive industries.

Export of fuel and energy resources represents the sale of ir retrievable supply which is necessary for future generations. The share of the three major Russian export commodities (crude oil, petroleum products, natural gas) has increased from 61.7% in 2007 to 70.5% in 2014 (Russian Statistical Yearbook, 2015). This fact plunges the Russian economy into the state of dependence on fluctuations of the world price on energy resources; and the necessity of development of domestic high-tech goods not conceding to the world level is conceived to be obvious.

The Strategy of 2020 (Russian Federation, 2012) highlights: "The country cannot live almost exclusively by exports of raw materials, not only due to the fact that their price volatility determines the instability of development, but also because, in this case, it is fated to more and more technological and institutional lag".

At present, an intensive development of high technology markets is observed in such spheres as: electronics, computer and telecommunications equipment, where the leading positions belong to China, Singapore, South Korea; the field of mechanical engineering, and chemical weapons – to the USA, Germany and China; pharmaceuticals and biotechnology – to Germany, Switzerland, Belgium.

Russian's export of high-tech makes up only 1.2% of China's exports, 3.7% — of the USA's and 4.3% — of Japan's exports (Dolgova, 2014). The major share of Russian exports accounts for the extractive industry. In 2014, the share of the high-tech products export made up only 3.83% of the total exports of Russia, in which the major part was represented by the products of aerospace industry (in 2014 - 1.19%). The data can be seen in Table 1.

Considering the trends and directions of development of world markets of high-tech products, the innovations created in industrial environments discover new businesses opportunities for enterprises. The world market of aerospace products and services represents one of the most significant segments of the high-tech market with all peculiarities typical for it. The development of the high-tech market is directly connected with scientific-and-technological advance.

Initially, the main target of the Russian space industry was ensuring the Defense and National Security. However, currently, there is a rapid spreading of the innovations, based on the results of the space industry. The unique advantages of the space industry are:

- the availability of a powerful production and technical base;
- the qualified scientific staff;
- the accumulated knowledge and experience in the production of advanced technologies.

Highlighted opportunities must be commercialized in Applied Science business.

**Table 1.** Export of Russian products according to the main types of products

Indicators	2010	2011	2012	2013	2014
Export – total:	100	100	100	100	100
Mineral products	68.5	69.3	71.3	71.5	70.5
High-tech products – total:	3.47	3.32	3.05	3.52	3.83
aerospace product	1.53	1.4	1.14	1.43	1.19
computer and office supplies	0.03	0.05	0.05	0.07	0.36
electronics and telecommunications equipment	0.22	0.23	0.2	0.23	0.32
pharmaceuticals	0.03	0.03	0.04	0.04	0.05
other goods	1.66	1.6	1.6	1.75	1.9

## 2. Methods

Analyzing the Russian and foreign literature, we have revealed basic contemporary processes of development of space activities:

- expanding the number of countries carrying out space research and development;
- putting into practice the principle of "dual-use" in order to create civilian products;
- increasing the complexity level of space products and services, involving the increase of requirements for space-based technologies;
- developing large-scale space enterprises for a purpose of financial stability and efficiency of investment, creating the branch establishments mastering and promoting high-tech civilian products.

Involving the results of space industry in the civil sector is considered by the Government of the Russian Federation as one of the basic directions recovering the Russian economy, ensuring the realization of national interests. In the ‘Innovative Development Strategy of the Russian Federation for the period till 2020’ (Russian Federation, 2011), an important role is assigned to dissemination of the scientific research results of advanced space technologies. Within this Strategy, the state development institutions, which can be involved into the co-financing of innovative projects - "ROSNANO", the Foundation for Development of the Centre and the commercialization of new technologies - "Skolkovo" have been established, as well as the number of other institutions, on the basis of which the commercial innovative potential of the industry is supposed to be created. In addition, nowadays there is an acute issue of import substitution. Developed and approved industry programs for the automobile industry, the industry of civil aviation, transport engineering and shipbuilding industries, for which the rocket-space enterprises are able to produce equipment not conceding to world analogues.

The aim of the present study was to review the innovations developing at enterprises of space-rocket industry, in the framework of national Defense, and to identify the possible directions of their using in the civilian high-tech sector.

## 3. Results

Enterprises of aerospace industry are the basis of the Russian space industry and characterized by a high degree of innovation opportunities and their using in the commercial sector. More than 60 enterprises of the space-rocket industry have been investigated in the framework of target. As a result,

cost-effective and attractive investment scientific directions were identified to commercialization in the civilian sector.

Namely, enterprises of rocket-space industries such as Scientific-Research Institute of Electromechanics, (2016), NPO Kvant, (2015), Scientific-Production Complex “Alternativnaya energetika”,(2012), JSC Scientific Research Battery Institute "NIAI "Istochnik", and other rocket-space enterprises have extensive experience in creating energy-saving and energy-efficient technologies, as well as the basic energy technologies aimed at improving the efficiency of generation, energy storage and transmission.

In particular, in the framework of improving the technologies of advanced propulsion systems at the enterprises of rocket-space industry NPO Saturn, (2015), NPO Iskra, (2006), the new structural and technological solutions of new generation were created for aircraft engines and gas turbine power plants. On the basis of these results, it will be possible to produce a new generation of a competitive gas turbine power plant.

Within the framework of projects in the field of Communication & Telecommunications at the enterprises: Khronichev State Research and Production Space Center (News Releases, 2016), S.P. Korolev Rocket and Space Corporation Energia (2016), (Research Institute of Precision Instruments, 2005) and other rocket-space enterprises, the following technologies were created:

- the technology providing the global speed and quality standards of communication;
- the digital broadcasting and mobile communication development in the country;
- the data transmission in the Ka-band frequency which provides high-speed Internet access for residents and businesses in sparsely populated and remote areas;
- GLONASS system development at the enterprises (Research Institute of Space Instrument, 2009), (Aerospace Mall, 2009), Progress Rocket Space Center, (2004) in the range of services which are important for consumers, etc.

Currently, in the field of communication and telecommunications of a rocket-space enterprises (RSE) render no more than 10% of all services, rendered by enterprises of Russian RSE. But on the basis of the global space market trends, it is this high-tech industrial sector, having innovation orientation, that has significant growth prospects. Development trends of basic space market segments until 2025 can be seen in Figure 1.

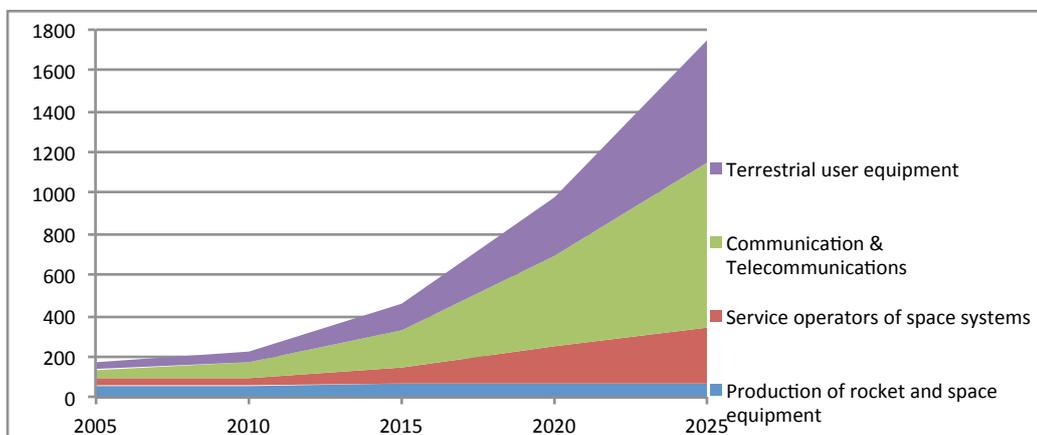


Fig. 1. Development trends of basic space market segments until 2025, billion \$

Owing to availability of the specialized production-experimental base and a large technological potential, the rocket-space industry “JSC Academician M.F. Reshetnev Information Satellite Systems” (Iss, 2016) can create a large transformable antenna by applying a cloth, woven from the finest wire with a diameter of 15 microns. These antennas are currently working in space mounted on three relay satellites of series Luch-5. Quality characteristics of the antenna products are continuously improved and can be widely used in the civilian sector.

In addition, developing new materials is also one of the main directions at the enterprises of space-rocket industry. From 20 to 40 new varieties of materials: metals, alloys, polymers, coatings, adhesives and other materials are annually developed and implemented. The main target is lightening the construction with maintaining or even improving product quality. Polymer composites are the main materials being used in the space industry. Load-bearing units of the body, adapters, plating honeycombs, rods, solar frames, antennas are made of polymer. At the moment, research and manufacturing experience allows us to solve non-standard problems on the use of polymers in various units and mechanisms. Polymer materials and plastic products are already widely used in manufacturing and in the national economy. Currently, the production of polymers is a promising and rapidly growing sector in the industry, such as Heavy Machinery Construct Agency, Ural Research Institute of composite materials, Krasnoyarsk Machine Building Plant and other rocket-space enterprises.

Modern spacecrafts are capable of performing high-frequency measurements of the Earth's surface parameters, the sea surface height and the movement of tides, as well as clarification of geophysical data needed to solve a wide range of scientific-research and applied problems, including enhancement of the quality of meteorological forecasts and long-term forecasting of natural disasters.

In addition, the Russian medicine equipment depends by 80% on import. In order to correct the situation, it was decided to produce medical equipment in the Russian military-industrial factories, and in the particular, at the enterprises of space-rocket industry. As the Deputy Prime Minister of Defence, Dmitry Rogozin, claimed, the enterprises of the space-rocket industry are capable of producing a complete medical apparatus with the required tolerances and desired quality of the metal.

Among the key areas, we can identify such important sectors of the economy as communications and telecommunications, energy, aviation and mining industry, and medicine.

In view of the reviewed directions of innovative potential commercialization at the space-rocket enterprises with the purpose of using in civilian high-tech sector, it is important to identify factors influencing the commercialization, and conditions facilitating commercialization.

The factors influencing the innovative potential of commercialization of space-rocket enterprises have been revealed and systematized. The investigated factors were classified into external and internal and systematized according to the spheres of influence: scientific and technical, labor, industrial-engineering and the marketing sphere.

The main factors include:

- the share and the level of advanced research and development, advanced engineering and technology of production corresponding to the world standards, the experience and competence of the labor staff in the creation of rocket and space technology;
- the lack of market experience, knowledge and appropriate competences in the field of technology commercialization;

- the discrepancy between the Russian certification of the technical regulations and the international standards;
- the consumer ignorance of the civil sector of the high-tech opportunities of space-rocket enterprises, and as a consequence, lack of demand for high-tech products made by them.

Based on the identified factors, the necessary conditions have been formulated for the commercialization of the innovative potential:

- availability of the mechanism of determining the additional ways of spreading the available advanced developments (patents), high-tech military equipment in the civil sphere;
- forming the commercial internal structure at the space-rocket enterprises for the purpose of R & D marketing support from the moment of detection of the commercial use prospects and ending with the realization of the business project;
- creating a well-functioning process of innovative potential commercialization at the space-rocket enterprises, including effective mechanisms, forms and methods of commercialization;
- forming a selection system of commercially promising business projects.

The issue of innovative potential commercialization at the space-rocket enterprises had not previously been so relevant because of the defense specifics of the industry's enterprises, focused on the implementation of the government defense order, secrecy of established technologies and products.

But the "market" approach, in contrast to the current "technical" one at the enterprises, involves using the functions and marketing methods with the possibility of the commercial use of the innovative potential of space-rocket enterprises.

#### **4. Conclusions**

Thus, among the main tasks, on which the enterprises of space-rocket industry are anticipated to concentrate their efforts in the near-term outlook, it is necessary to highlight:

- the product diversification and the development of highly technical release of competitive civilian products for the benefit of the most important sectors of the national economy;
- the implementation of measures to enhance the commercialization of new technologies, determination of access procedure of business structures to the results of scientific and technical activity of the space-rocket industry;
- active implementation of marketing structures at the enterprises of space-rocket industry in order to find commercially viable ways of commercialization the scientific, technical and technological capabilities of industry;
- active interaction with innovative and educational clusters, technoparks and engineering centers.

The transition of companies of space industry to the production of high-tech civilian products can stimulate a new round of the use of available resources and create an additional financial source of innovative activity of the enterprises.

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