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TÍTULO: El impacto de las tecnologías innovadoras en el desarrollo del mercado internacional de servicios espaciales.

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RESUMEN: El propósito del artículo es abordar los enfoques científicos para determinar la naturaleza de los servicios espaciales y sus principales participantes, identificando las características del mercado ruso en estos servicios, destacando y describiendo sus principales segmentos en la federación rusa. El artículo declara el aparato conceptual, resume los resultados del análisis de la formación y desarrollo del mercado internacional de servicios espaciales, describe el papel de las tecnologías innovadoras en la provisión de ventajas competitivas del espacio que lanza el líder del mercado moderno: la compañía SpaceX, así como hace una sistematización de los principales problemas en el desarrollo del mercado ruso de servicios espaciales para el período 2000-2018. El

artículo puede utilizarse por autoridades gubernamentales y corporaciones involucrados en servicios espaciales.

PALABRAS CLAVES: tiras cómicas, Roscosmos, SpaceX, tecnologías innovadoras.

TITLE: The impact of innovative technologies on the International Space Services Market Development.

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ABSTRACT: The purpose of the article is to address the attention towards scientific approaches to determine the nature of space services and their main participants, identifying the characteristics of the Russian market in these services, highlighting and describing their main segments in the Russian Federation. The article declares the conceptual apparatus, summarizes the results of the analysis of the formation and development of the international space services market, describes the role of innovative technologies in the provision of competitive advantages of the space launched by the modern market leader: the company SpaceX, as well as a systematization of the main problems in the development of the Russian market of space services for the period 2000-2018. The article can be used by government authorities and corporations involved in space services.

KEY WORDS: comic services, Roscosmos, SpaceX, innovative technologies.

INTRODUCTION.

Currently, we are all witnessing major changes in the space services market. It is clear that the large-scale space battle will unfold internationally in the next few years.

In the Russian Federation, the main and almost the only player in the market space is a corporation "Roscosmos". It exists solely through public funding. Events of recent years show that private foreign players, primarily the company by Elon Musk “SpaceX”, which in the year 2018 carried out the first a successful first cycle of reusable launch vehicles, that included start, acceleration and landing rocket. It has a negative impact on “Roscosmos” and weaken its position in this market. Some experts even conclude that Russia has almost lost one of the most demanded sectors of the international space services market - the withdrawal of the payload to orbit.

In order to assess the potential of the international space services market, as well as determine the development of innovative technologies, it is necessary to study the scientific and theoretical foundations of the space services market (Davoudi et al., 2018; Fartash et al., 2018; Tastan et al, 2018). Studies of the characteristics and structure of this market have been carried out for a long time. However, they have become most relevant in the last 10-15 years when the development of the rocket and space industry of the world leading countries reached a level. At that time, the main service topic related to the mass output of the payload to orbit moved from discussion to specific proposals for not only government agencies and large corporations but also private clients.

In Russia, the intensification of scientific research in this area occurred in the period since the second half of the first decade of the 21st century (Kiselev, Medvedev & Menshikov, 2002; Denchik & Denchik, 2006; Kvon et al., 2017). Therefore, the work of P.V. Primakov (2008) examines the issues of assessing and enhancing the provision of Russia's competitive advantages in this market. A.A. Dranaeva (2013) analyzes the issues of competitiveness of these services in her study. I.V.

Ratushnaya (2009) has devoted her research to the study of the influence of high technologies on the development of service industries, including space.

M.A. Volovnik (2007) in his study paid particular attention to evaluations of innovative components in the cost of space services that are ultimately determined by their competitiveness.

This study also focuses on the development of innovative technologies for both the entire international space services market and its Russian segment.

DEVELOPMENT.

Materials and methods.

The scientific basis of this study was the research of Russian and foreign scientists in the development of the international market for space services. To implement this study, the authors of the article used the methods of the comparative analysis of regulatory legal documents, analytical, survey and other materials, the interpretation of the results, the method of consolidation and synthesis of information, method of statistical, retrospective and factor analysis. Based on the results of the study, a summary of the results was introduced in the form of recommendations.

Results and discussion.

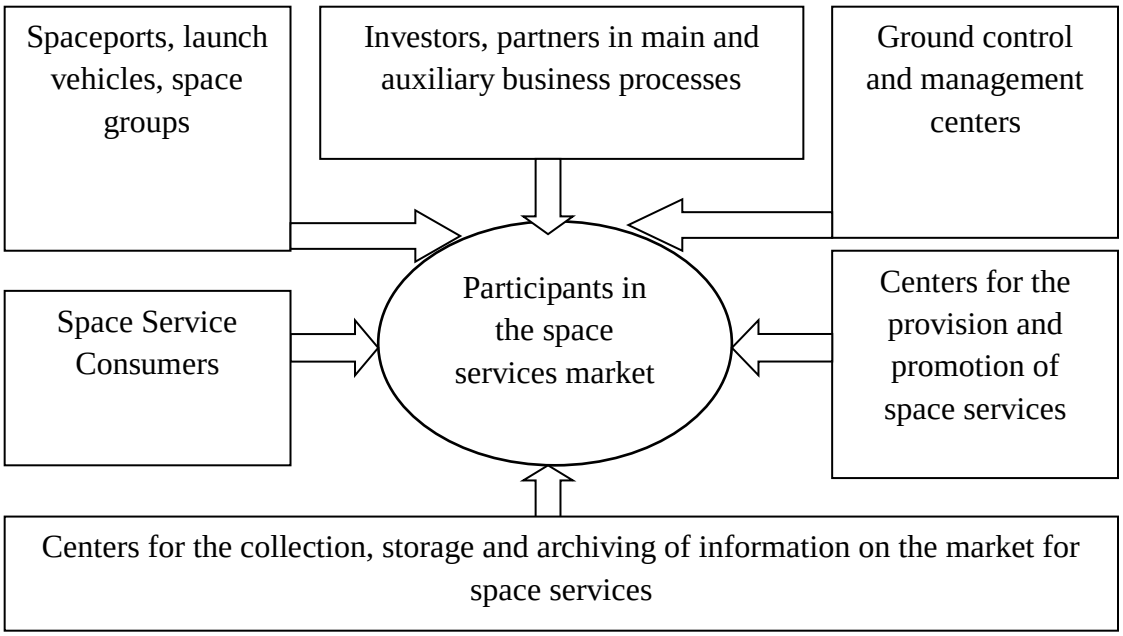
Structure and main characteristics of contemporary market of space services.

In Russia, the development of the space industry and the provision of satellite services is governed by complex regulatory legal acts. The most important of them are the "Principles of state policy in the field of space activities results use for the Russian economy modernization and the development of its regions for the period up to 2030". In this document, for the first time in modern Russia, at the state level, the essence of the notion “space service” is defined - a service in the provision of which the results of space activities provide a primary contribution to its consumer value.

This document also defines the term “space product”, which refers to a material object, software and hardware complex, an information product or system, in the process of creation, operation with the results of space activities provide a primary contribution to their consumer value.

Referring to the study of various scholars (Azarenko & Vokin, 2011; Azarenko, 2011; Nuriev & Galimova, 2016; Kenan, 2018), space services market structure can be collectively represented in the following diagram (Figure 1).

Figure 1. Structure of the space services market



Features of the Russian Space Services Market.

Different authors differently understand the essence of the space services market and its structure in the Russian Federation and in the world as A.S. Loktionov (2016) and A.N. Zhiganov, V.A. Zaichko and A.V. Maksimov (2014) offering allocate sub-markets or certain groups of these services. It seems more correct to speak not about the submarkets, but about the segments of the space services market with their own and certain characteristics (Table 1).

Table 1. The main segments of the space services market in the Russian Federation.

Segment name	Segment feature
The segment associated with the provision of communication services and data relay, including data from the Internet, television and radio broadcasting.	Modern communication and relay systems provide global backbone, internal and local communications, emergency communications, television and radio broadcasting, and a full range of telecommunications and relay services, especially for remote and hard-to-reach areas of the country.
Segment related to the provision of hydrometeorological information.	Such information may include meteorological, hydrological, heliogeophysical and other types of space information, which is used in various sectors of the national economy.
Segment associated with the provision of remote sensing data based on satellite imagery and derivative products.	This information can be used in almost all types of economic and social activities - from agriculture to a system for monitoring objects of nature.
Segment related to the provision of navigation information.	In Russia, such a navigation system is the Global Navigation Satellite System, the development of which began during the Soviet period. The possibilities of using this system go far beyond the limits of the space services market, in particular, the system is widely used in the transport industries (automotive, aviation)
Segment associated with the provision of cartographic space information.	Consumers of such information are primarily organizations engaged in the preparation and updating of topographic maps.

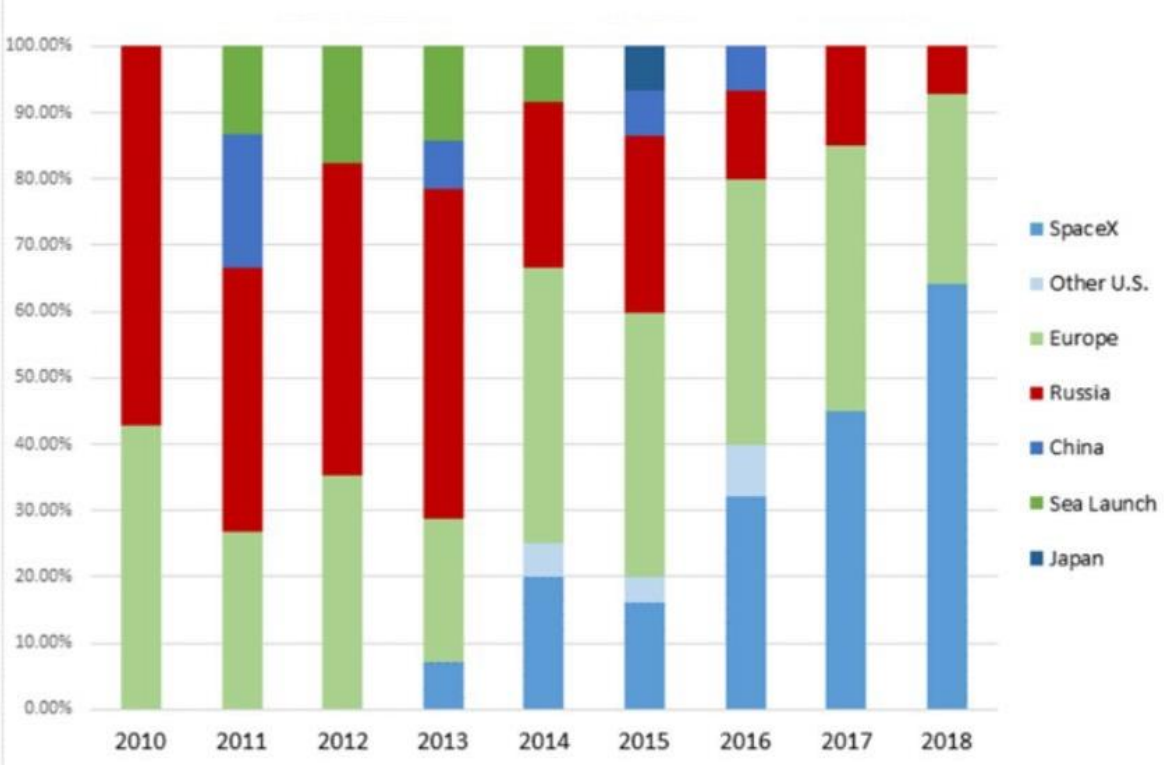
In addition to the sectors indicated in this table, we single out a segment of the space services market based on the integrated space activities results use through the integrated processing of various (two or more) types of space information. Consumers of such information are from various government bodies, as well as transport organizations, agriculture, forestry, road, water industry, oil and gas complex, tourist and recreation complex and other areas of activity.

The Role of Innovative Technologies in the International Space Services Market Formation and Development.

The main player in the international market of space launches, as can be seen from the data of Figure 2, is now the company of Elon Musk SpaceX. The company Space Exploration Technologies

Corporation (Space X) is an American company, a manufacturer of space technology headquartered in the city of Hawthorne (California, USA). It was founded in 2002 by former PayPal shareholder and Tesla Motors CEO Elon Musk to reduce the cost of space flight and open the way to the exploration of the Moon and Mars.

Figure 2. The structure of commercial launches in the international market of space launches from 2010 to 2018.



SpaceX's share in the international market for space launches in 2017 was 45 percent, the share of Russia - 15 percent (four times less than in 2013). In 2018, Elon Musk plans to seize more than 60 percent of the market, with the result that the Russian share will be reduced to 10 percent or even less (Elon Musk destroyed the Russian space program, 2018). However, this is primarily due to the lighter rocket Falcon 9 (Falcon Heavy consists of these three).

The new extra heavy carrier may be useful for not-so-frequent launches of heavy vehicles; for example, spy satellites, but this rocket was created for more distant journeys. SpaceX is developing a program of tourist flights to the Moon (however, it has not yet been decided whether the Falcon

Heavy or the new- generation BFR rocket will be used for this), but its main purpose is research and, eventually, exploration of Mars.

Before the advent of Falcon 9, launching satellites independently was not very profitable for them economically. Elon Musk and his private company changed this paradigm. In fact, he provided the United States with a complete import substitution, proposing to NASA and the military its fundamentally new concept of launches, based on reusable launch vehicles. SpaceX calls the new Falcon the most powerful rocket in the world. Its maximum carrying capacity is almost 64 tons, a rocket will be able to deliver about 17 tons of cargo to Mars (Elon Musk coped with the "heavy" weight, 2018).

It was the perseverance and ingenuity of both the manager and specialists of SpaceX, its success in reducing costs through the repeated use of rockets that made it the leader of the international space services market. As a result, the Roscosmos corporation finally recognized the threat from SpaceX, and is now working on a 20 percent reduction in launch costs and on the reuse of rocket components (Space Crown: Can Russian rockets push the Elon Musk projects, 2018).

The main problems in the development of the Russian market of Space Services.

After the collapse of the Soviet Union, the Russian space program developed by inertia, pragmatically using the time-tested Soviet technology. All this allowed Russia, at the end of the 20th century, to seize the leadership in the market of commercial launches.

Based on a review of the available analytical and reporting data (Davydov, 2012; Azarenko, 2012; What did Rogozin achieve by supervising Roscosmos for six years, 2017; Russia's space failures since 2000, 2018; Black Hole of the budget, 2018), we can consider what events the Russian Federation has given up so strongly in this market (Table 2).

Table 2. Failed launches of spacecraft in Russia in the period from 2000 to 2018.

Year.	Problem content.	Financial losses due to accidents / insurance size.
2000	The launch of the Cosmos-3M launch vehicle (PH) with the American QuickBird-1 satellite, insured for $ 265 million, and the launch of the Cyclone-3 rocket launcher with six space vehicles, ended in accidents. Partly successful was the launch of the "Union-U" with the satellite layout.	
2002	The launch of the Soyuz-U launch vehicle with the Foton-M apparatus ended in failure. The amount of damage was not reported. The launch of the Proton-K, which failed to launch the European satellite Astra 1K, was also an emergency launch.	The spacecraft was insured for $ 217 million.
2004	The launch of the Cyclone-3 launch vehicle with the Ukrainian Sich-1M satellite and the KS5 MF-2 microsatellite was emergency.	The amount of damage was not reported.
2005	The launches of the Molniya-M launch vehicle with the Molniya-3K military communications satellite, the Volna launch vehicle with the Kosmos-1 satellite, and the Rokot launch vehicle with the European CryoSat satellite failed.	Financial losses due to accidents and subsequent forced breaks in launches exceeded $ 200 million.
2006	The Proton-M launch vehicle failed to deliver the ArabSat-4A Arab communication satellite to the specified orbit. Due to the accident of the Dnepr launch vehicle, 18 satellites were lost.	No damages were reported.
2007	Due to the failure of the second-tier steering engines, the Proton-M with the Japanese JCSat-11 communications satellite fell. In the event of an accident, highly toxic fuel fell into the ground,	Kazakh authorities estimated the damage at more than $ 8 million.
2008	The Proton-M RN did not launch the American communications satellite AMC-14 into orbit.	The amount of damage was not reported.
2009	The Soyuz-2.1a launch vehicle put the Meridian-2 satellite into an off-design orbit; the launch was recognized as partially successful. In the same year, a loss of the Persona satellite was announced at the Roskosmos collegium, with which the military could for the first time since 2001 receive operational images of the Earth. The device went into orbit on July 26, 2008, but did not work.	The amount of damage was not reported.
2010	The launch of the Proton-M launch vehicle ended in failure, with the result that three GLONASS-M vehicles fell into the Pacific Ocean.	The damage was estimated at 2.5 billion rubles.
2011	Became a record for the number of unsuccessful launches: 5 out of 32 were recognized as emergency or partially successful. The military satellite “Geo-IK-2”, satellites “Express-AM4”, “Meridian”, the space truck “Progress M-12M” and the apparatus were lost. "Phobos-Grunt".	Damage from accidents exceeded 18 billion rubles.
2012	The Proton-M RN could not launch the Express-MD2 and Telkom-3 communication satellites into the calculated orbit. Damage amounted to 6	The damage was estimated at € 73 million.

	billion rubles. In addition, due to problems with the Briz-M upper stage, it was not possible to bring the Yamal-402 satellite into the calculated orbit.	
2013	The launch of the Zenit-3SL launch vehicle with the American Intelstat-27 satellite ended in an accident. The launch of the Rokot rocket launcher with three Rodnik spacecraft was partially successful. Another major accident occurred during the launch of the Proton-M launch vehicle with three GLONASS-M spacecraft.	Damage exceeded 4 billion rubles.
May 2014	The communications satellite Express-AM4P and the Proton-M launch vehicle burned down in dense layers due to a failure of the third-stage steering engine. In addition, the European navigation satellites Galileo, launched in August from the Kourou cosmodrome with the help of the Soyuz-ST-B launch vehicle with the Fregat-MT upper stage, went into an off-design orbit.	The amount of damage was not reported. The satellites were insured for 7.8 billion rubles.
April 2015	The cargo transport ship Progress M-27M after launch from the Baikonur spaceport went 30 km above the calculated orbit and subsequently burned down in dense layers of the atmosphere. Damage estimated at 5 billion. rub. In May, the launch of the Proton-M launch vehicle with the Mexican satellite MexSat-1 ended in an accident. In addition, in July, the Soyuz TMA-17M spacecraft docked with the ISS with an unexplored solar battery, and in December, the newest Earth remote sensing satellite, Kanopus-ST, was lost.	The amount of damage was not reported.
Dec-2016	The Progress MS-04 cargo vehicle launched from Baikonur had problems with telemetry, which caused it to enter an unplanned orbit and had an accident.	The amount of damage was not reported.
Nov-28, 2017	The Soyuz-2.1b launch vehicle with the Fregat accelerating unit was supposed to launch the Meteor-M spacecraft and another 18 units of various vehicles into orbit. Because of failures in the upper stage, both the Fregat and all 19 spacecraft sank in the Atlantic Ocean.	The amount of damage was not reported.
Oct-11, 2018	During the launch of the Soyuz MS-10 rocket at the 119th second, a carrier crashed. On board were astronauts Alexei Ovchinin (Russia) and Nick Haig (USA). According to Roscosmos, both astronauts did not need serious medical care. Rescue teams arrived to the place of emergency landing.	The amount of damage was not reported.

CONCLUSIONS.

In 2018, there were changes in the management of the space-rocket activity in Russia – the former deputy defense minister, Yuri Borisov, who possesses high competence, authority and ability to solve complex tasks. He will be able to counter this activity. However, his powers for the most part concern

the military space, satisfying the needs of all Russian armed forces. This means that the strategy for the commercialization of space services will still not be implemented.

The structure of the state corporation Roscosmos presupposes the provision of primarily state interests in working with outer space. In this case, the corporation is practically not compete with small private companies that receive licenses for commercial launches, and in future will organize first cargo mission to the conclusion of the payload into space, and then, piloted.

The company is currently going through a complex procedure of internal audit. In this case, large-scale reductions are already known today – 150 billion rubles will reduce only in the Federal Space Program. The lack of efficiency, and as a result, financing, can affect both dozens of interplanetary projects aimed at studying the features of the nearest planets of the solar system, and the program to provide the country with a national platform for outputting payload - the second stage of the Vostochny spaceport.

Combining all the facts we may discover that the success and profitability of "Roscosmos" is still provided due to state support. However, the world is changing, and in order to find funds for the implementation of space programs, it is necessary to be more efficient than main competitors, to offer cheaper, practical and reliable solutions.

What place Roscosmos will take on the international space services market will become clear in the next two or three years. However, in order to have Russian companies appear with a competitive bid, the strategic decision to strengthen its presence in the international space services market must be taken right now.

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