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A SHARE OF EUROPE IN THE GLOBAL SPACE MARKET IN THE FIRST QUARTER OF XXI CENTURY

Dr. Andrey K. Soubbotin
President of Foundation for Academic Studies and Global Development, leading research fellow of the Institute for Scientific Information on Social Sciences, Russian Academy of Science

Introduction

Intentions of the leading space powers to start development of Moon resources and manned flights to Mars as well as to transfer to the next phase of the Earth orbits infrastructure functioning including space tourism presented by leaders of the states and representatives of national space industries were to some extent devaluated by the global financial crisis. So the rise of activities in space market coincide in time with great changes in the world order. But theses changes will happen to be not only some obstacles on this way but also will create new opportunities in financial mechanisms and will provide more definite prospects of each space program to be realized. The goal of this study is to ground inevitability of new stage of the space development in the first quarter of this century, to focus on sections and segments of the space market, to evaluate the scale and distribution of sales at this market and to forecast dynamics of expenditures and competition efforts of the leading space powers.

1. A new stage of space development imperative.

The claim that it is too early to develop space because a lot of social problems has not been solved on the Earth successfully transferred from the XX to XXI century. The first stage in space development was initiated in the 60-s of the previous century, the next, second stage will be launched in the 20-s of this one. And those who hold the above mentioned opinion do not want to recognize that the world development gave birth to a set of problems which did not exit half a century before and that major part of old social problem were also not solved. Nobody could imagine fifty years ago, that states will get down to lead a policy of decreasing number of people with university diplomas, that the number of least developed countries could be twice more than half a century before. So this thesis can not be used as an argument against initiating a new stage in space development.

There are also a few serious arguments which make the start of this stage inevitable. First, financial capabilities of space powers. Big money in the sixties were calculated in billions of dollars, now they are calculated in trillions of dollars. In this decade in spite of the crisis the space budgets of the leading space countries were evidently artificially cut though a space market consume much more money. For fifty years considerable shifts took place in relationship of private and state capital volumes opening the way for commercialization of space development.

Second, technologies which can be used for development and exploitation of space launchers and vehicles made so great step ahead in comparison with those available in the 60-s and 70-s that now many problems seeming inaccessible at that time may be solved for less period of time and much cheaper. Even 20 years time gap provides different quality of space technologies used. To ground this idea it is enough to compare heavy launchers Saturn 5 and Energia, which were close by the level of payload in low orbits.

Third, a demand in personal space services emerged now which was practically absent in the past century. Under terms of such demands the projects of a large space ship with fifty tourists on board[1] and of a space hotel including a few rooms for tourists[2] are on schedule for

development now. Some countries from space club like China already accepted national space strategy and will follow it independently on terms of their competitors' strategy. Some other space powers like the United States being burdened by the crisis are still before the choice of national long term space strategy. But in any case all of them are coming into a new stage of space development.

2. The problem of space passengers and commercial cargo transportation.

The core difference of the first (1950 – 1990) and the second period (2010 – 2050) of space exploration is that economy becomes a dominating factor in strategic planning and decision making. Political ambitions, creating military instruments, curiosity of fundamental researches gives up the scene of activities to those who may ground not short time but long term economic expediency of a chosen strategy. It concerns means of space transportation in full scale. "Souz" launch system happened to be the most reliable for half a century to deliver manned space vehicles from the Earth to low orbit. But its payload is a little more than 10 tons. Now the problem number one is to create a very reliable launcher to deliver a payload about 200 tons into low orbits.[3]

The opponent of this viewpoint may say that new technologies in the field of aerospace materials will surely come to another version of space transportation development – 30 mt vehicle will be delivers to low orbits from board of heavy planes taking off from ordinary airports and theses space vehicles will be landing there in the same way. But it means that large sections of space loads will be assembled in space orbit, then delivered to orbits of the Moon or Mars and then disassembled again for construction on surface of these space bodies dependently on the tasks to be solved. Practically these two procedures will be developing in a parallel way, but it is impossible to keep positions in space among really aggressive competitors without heavy launchers. By the middle of XXI century each member of leading space countries group – US, China, Russia, Europe, Japan, India and perhaps Brazil will have its own heavy launcher. It means that such a country will be able to lead its independent space policy. Another scenario presumes that three first space powers will have its own launchers, the others will combine their renting.

The situation on the eve of the second decade shows that only two countries already have real results of the work done in anticipation. The United States have the experience of almost five years of exploitation and technologies of Saturn V launchers as well as almost two decades of Shuttle exploitation. A new launcher Ares V with five-segment solid propellant rocket boosters for the first stage, RS-68 liquid-fuel oxygen and liquid hydrogen engines below a larger version of the space shuttle external tank. The upper stage will use J-2X oxygen and liquid hydrogen engine. It will deliver into low orbit about 130 mt[4] – practically Saturn V capability.

Russia has technologies and experience of two successful flights of Energia launcher which was a sample of the most powerful and technologically perfect booster in the world at the end of 80-s. It could deliver in low orbit up to 175 mt[5] and modification could provide up to 240 mt. Under political reasons open sources of information don't discover the up-to-date state of Energia launcher. That's why it is impossible to claim it exists now or it followed the fate of Saturn V. Angara launchers series also include a heavy version Angara 7 with payload in low orbid up to 75 mt., but it does not have necessary financial support to be developed to the level of the first test flight.[6]

China has ambitious plans of space exploration, now it is developing CZ-5 launcher to deliver 25 mt in low orbit.[7] A launcher with payload 75 mt is also planned to be developed, but it is early to discuss it since China has to pass the way gone by its space competitors - USA and Russia. Modifications of Arian 5 and Japanese launcher H-II may provide 25 mt in low orbit like CZ-5 launcher, but no really heavy launcher is being developed in Japan or Europe. Chinese probable attempt to reach the Moon using a launcher with 75 mt payload in low orbit would be a political decision like in the Soviet Union with the launcher N-1 which did not manage to make a

successful flight. So the space power capable to build a reliable launcher with payload in low orbit more than a hundred, better two hundred mt will become a real competitor in the process of creation space hotels for tourists and Moon and Mars space settlements.

3. Structure of the forming space market.

The structure of the forming space market may seem rather simple and logic from the functional viewpoint, but it becomes much more complicated from the moment of deepening into details and attempts to estimate the role of separate components and time of their realization especially if to take into account interests of the main players. A general structure of the world space market can be represented by commercial activities at the following five fields: the Earth, including surface and orbits, the Moon, Mars and other planets with the same addition, transport means and devices connecting all of them, and activities for all the four previous fields. This approach affords to see from the beginning the scales of each market segments and degree of its current development.

In accordance with proposed scheme the Earth ground industry plays the basic role in functioning the space market (field 1). Beside production of goods and services, Science and Space Technology Development, also the sale of used hardware, items flown in space and even products with only a marketing tie-in space, takes place also in the field 1. The field 2 activities include Space Business Parks (commercial space stations) and activities connected with the Strategic Ozone Initiative (large solar powered lasers in orbit creating ozone). A wide set of space goods and services is produced in orbits of the Earth and surfaces of the Moon and other planets and space bodies (fields 2, 3 and 4): Communications, Government Intelligence, Positioning Satellite Service, Remote Sensing, Space Burial (Launching human remains), Space manufacturing, Entertainment (Theme parks, space athletic events, spacecraft telepresence, etc.), Movies of TV shows made in space, Advertising, Space Services and Transfer (Hubble-style repairs), Space Rescue (ability to launch quickly to save a mission), Space Debris Management, Space tourism, Space Settlements, Hazardous Waste Disposal, Development of Extraterrestrial Resources, Space Medical Facilities/Hospitals, Space Utilities (Using space-based assets to generate or transmit power for use on Earth), Earth Transport (Fast Package Delivery, i.e. Ultra High Speed Transport using suborbital trajectories. The field 5 includes all kinds of launchers and space vehicle for transportation of passengers and commercial loads from the surface of space bodies to orbits as well as for interplanetary delivery of payloads.[8]

The world space industries already propose a few space shops: Space Structures Shop, Space Launchers Shop, Space Launchers Parts Shop, Space Ships shops, Space Ships Parts Shop, Space Satellites Shops, Space Satellites Parts shop, Space Buildings, Space Science Equipment and Scientific Instruments Shop, Space Services Shop, Space Projects Financing Shop. For instance, the Space Ships Pats shop offers: space ship corpus, life support system, engines, sensors, illumination, navigation systems, communication devices, power generation systems.[9] Space Structures Shop may offer single and multi-layer grids, braced domes, braced folded structures, connectors, stressed skin systems, cable suspended structures, tensile membrane structures.[10]

Research institutes and industries in the second decade of XXI century demonstrate capabilities which correspond to Dr. Igore Rubashov's* concept of the 70-s: "We can develop absolutely everything, you should only give money". Robert Bussard's** Inertial Electrostatic Confinement Fusion could provide thermonuclear space engine for flight within Solar System[11.]

*Dr. Igore Rubashov is well known Soviet space researcher and manager, inventor of special computer tomography for lungs.

**Dr. Robert Bussard is well known American space scientist and developer of fusion reactors schemes for space engines.

Space market happed to be so wide that some developing countries got down to joining it and the number of such countries goes up. For instance, the market of launchers development, production and services is being occupied by such countries as South Korea, North Korea, Iran, Indonesia[12] while three of four BRIC countries are on this market about three decades. Strategy planning of countries leading space policy presumes an accent on development of own space launchers which opens the way for independent space policy. For instance, total investment of India into national space program in the middle of the first decade in this century was about 7 bln. $, and 39 % was spent for launch vehicles, 36 % for satellite communication and meteorology14 % for earth observation, 6 % for space sciences and 5 % for other programs.[13]

Investment aspects and financial output from the space activities looks much more complicated and carry in itself a lot of uncertainties.

4. Global space market revenues and financial scale of its segments.

The global space market earned revenues were $ 257 billion. in 2008,[14] and in 2009 it was $ 261 billion.[15] British sources claim that in 2020 it will be close to one trillion dollars.[16] More than 80 % of the space market is controlled by the United States,[17] the state California accounts for 21 % of global space market.[18] Russia has only 0.5 % of the market, but when the Vostochny space center is built, the share of market belonging to Russia is expected to reach at least 10 %.[19] At the commercial satellite market, being only a part of the global space market, California, the state of the USA, has 34 % of the dominant global share of satellite manufacturing and 26 % of the $ 67 billion global satellite services,[20] while China is planning 20 % share in the world satellite business in 2015.[21]

The other important segment of the global space market is expected to be occupied by tourism. 70 % of men and 57 % of women in the United States would like to visit space at least one time during their life and ready to pay from three month to one year salary for such flight. The estimated development cost of the tourist space vehicle is not more than $ 16 billion.[22] .

Japan's space agency is planning to construct a solar power station and use it to beam energy down to Earth using lasers.[23] The projects seems to become real since a few countries continue researches in the field of wireless power transmission.[24] India cooperates with the United States in development of space-based solar power station.[25]

But the most promising segment of the global space market is development and production of launchers. The top of this activities is creating a heavy lift 200 mt launcher.[26] Finally each of three leading space powers – US, Russia and China will manage to have it but long and tortuous way leads to this goal. These future launchers – they will be to some extent different by design, - will provide a wide series of Moon and Mars missions including construction of permanent bases and even the first generation of settlements on the surface of them. The cost of the Mars project is estimated from twenty to more than a hundred billion dollars. But laws of market demand to divide such projects into stages and calculate expenditures and revenues of each stage. That's why Asian space racing with China, India and Japan as participants will be over before the beginning because competition demands prevailing economic and social factors over political and military ones.

5. Dynamics of financial, scientific and industrial potential of leading space powers.

Total space development expenditures of space powers reached $ 62 billion,[27] but a sum of national space agencies expenditures as it is shone in the Table 1 is about twice less. It means that beside national space agencies a lot of other governmental bodies are involved in the corresponding activities and at least halve of the space budget is being spent for defense systems in space or the their ground supply systems.

Table 1. Budget expenditures of leading space powers for development of space

under terms of non-crisis development *,**

№№	Country	2000	2005	2010	2015	2020	2025	2030
1	USA (NASA)	13,4	15.6	16.7	20.0	25.0	30.0	35.0
2	China (CNSA)	0.3	0.5	1,5	5.0	10.0	15.0	20.0
3	Russia (RFSA)	0.3	0.6	2.4	4.0	7.0	10.0	15.0
4	Europe (ESA)	3.0	4.0	5.0	7.0	9.0	12.0	15.0
5	Japan (JAXA)	1.6	2.4	3.1	5.0	8.0	12.0	15.0
6	India (ISRO)	0.4	0.5	1,2	3.0	6.0	9.0	12.0
7	Brazil (BSA)	0.01	0.03	0.4	1.5	3.0	5.0	8.0
8	Others	0.1	0.3	0.5	1.0	2.0	3.0	4.0
9	Total	15.11	23.93	30.8	46.5	70.0	97.0	124.0

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* 2000 – 2010 – calculated or estimated on the basis of separate data, 2015 – 2030 – author's forecast

******NASA – National Aeronautical and Space Administration
CNSA – China National Space Administration
RFSA – Russian Federal Space Agency
ESA – European Space Agency
JAXA – Japan Aerospace Exploration Agency
ISRO – Indian Space Research Organization
BSA – Brazilian Space Agency

In the beginning of the second decade of the XXI century three countries, USA, Russia and China may have a claim on development of space technology necessary to deploy infrastructure in the Earth orbit including permanent stations and tourist hotels, construction of the Moon and Mars bases. Space strategy of one of these three countries – Russia, - gives rise to doubts under two reasons: absence of general national strategy including strategic planning as well as the view of the world financial elite on Russia as on the country of raw materials and energy natural resources economy profile. For twenty years such a global strategy towards Russia was quite efficient and so long-term space national strategy may simply be brought to

ruin. That's why intention of Khrunichev enterprise to manufacture 120 boosters per year and to support 20 missions annually looks promising and quite optimistic.[28]

Three main program – orbital hotel, manned flights to the Moon and Mars demand heavy launchers. If only three space powers have the capability to develop, produce and exploit them, the question arises – where will be the others? Any answer to this question now would be premature. Only first preliminary steps to find partners in space games were made. All of them may be reduced to the following steps which can not be interpreted as definite directions of the future cooperation strategies. China doesn't look for any partners for these programs and is going to carry them out alone. But it does not mean that it won't cooperate in other fields. For instance, it is developing satellites for Pakistan and Nigeria,[29] a number of potential Chinese clients is not limited. NASA softly rejected autonomous attempts of Roskosmos and ESA to join American Moon and Mars programs, so first steps of Roskosmos and ESA were made to form a joint program. NASA prefers only United Kingdom to be its partner in these programs.[30] United Kingdom offered its aid in space development to India, the United States removed India from the blacklist of countries who can not import space technologies.[31] India applied to Russia for space technologies and provision in launching Indian piloted space vehicle.[32]

Analysis of space countries efforts to be on the level of required technological capability together with the state expenditures for theses purposes afford to make a forecast of space market shares in 2030. i.e. in twenty years. The results of this forecast are presented in Table 2.

Table 2. Distribution of space market shares between the space powers in 2030 (objective and desirable trends), %

№№	Country	Objective trends	Desirable trends
1	**United States**	**30**	**25**
2	**China**	**25**	**20**
3	**Russia**	**15**	**18**
4	**Europe**	**12**	**15**
5	**Japan**	**11**	**12**
6	**India**	**4**	**5**
7	**Brazil**	**2**	**3**
8	**Other countries**	**1**	**2**

References: author's vision of countries activities in space

Conclusions

A new stage of the space development will be started in the first and cover the second quarter of the XXI century. It is stipulated by developing a set of new space technologies, forming demands in several sections of space markets and emerging "a new wealth" – increasing financial potential of some space powers. There are at least two classifications of space market: location of space objects and functional one. The first classification presumes creation of Earth orbit infrastructure, development of the Moon, manned flights to Mars and investigation of other planets. Functional classification is presented by space market segments. Total sales at the space market is expected to be close to one trillion dollars in 2030. The United States, China and Russia are expected to be the leading space countries and keep the main part of the global space market. Europe, Japan, India, Brazil as well as space market newcomers will also be participants of different market segments with less shares. Large scale space projects will be realized on the basis of close cooperation of all the space countries.

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