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PROBLEMS OF ANTHROPOGENIC POLLUTION OF SPACE

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Abstract
Since the inception of the Space Age emerged an unprecedented technological, economic, military and social development for the humanity, although brought inevitable negative consequences due to the early exploration of space. A side effect of this development is pollution in space that is increasing over the years. In general, the term pollution is used to indicate a despoiling of the natural environment. This term applies equally when it comes to space from the moment the first artificial satellite was launched into Earth's orbit, and is known as Space Debris. This article contains the concept of «space debris» and statistical data techno-genic pollution of outer space, and describes the possible methods of dealing with space debris and justifies the need for international cooperation to solve outer space pollution problem.

***Keywords**: (Space debris, Pollutions of outer space, Space low)*

1. INTRODUCTION

The Space Debris encompasses both natural micrometeoroid and artificial particles (man-made orbital debris). Meteoroids are in orbit around the sun, while most artificial debris is in orbit around the Earth. Besides the location there is a significant difference between natural and artificial debris that is the length of time that they remain in Near-Earth space, which will depend on orbital velocity and the altitude. For natural debris, such meteoroids it arrives unanticipated from the deepness of space and quickly pass through Near-Earth space and most of them will burn up in lower atmosphere or, in unusual cases fragments reach the surface of Earth. On the other side, artificial debris once the Man-made Orbital Debris (MOD) are launched from Earth into orbit, and the length of time that they remain can be thousands or even millions of years which represents danger for active spacecraft and satellite vehicles.
An investigation shows the statistic of the total number of MODs that remain in space and have listed by the automatic warning system for dangerous situations in near- Earth space until August 31,2015 and was a total of 17,250. Of this amount 1,362 space objects are active spacecraft and satellites. [1] On the other hand, 15,888 are man-made space debris (MSD), which represents a 92% of the total number of MODs in Near-Earth space. These man-made space debris are classified including: 2682 non-active spacecraft, 1907 upper-stage rockets and final stage vehicles, and 11,299 fragments of spacecraft, upper-stage rockets, final stage vehicles and other elements. [2] Other data provided by the National Aeronautics and Space Administration (NASA) shows that there are more than 20,000 pieces of debris larger than a softball orbiting the Earth. They travel at speeds up to 17,500 mph, fast enough for a relatively small piece of orbital debris to damage a satellite or a spacecraft, and there are 500,000 pieces of debris which size of a marble or larger, also there are many millions of pieces of debris that are so small they can’t be tracked. [3]

2. SPACE SECURITY AND SPACE DEBRIS TERMS

The primacy in the space sphere as dawn of the space age, and now means for state domination not only in the space, but throughout the world. Therefore successful participation in the

exploration of outer space has a strategic importance for modern states. The result of the realization of this fact was the resumption of in the XXI century struggle for control over the pace that led to the beginning of the "second space race".

Along with the opportunities that give practical space exploration, appeared a new problem in the sphere of global security and increasing its dependence on reliable work of space infrastructure. The cessation of the functioning of space information systems can lead to the escalation of the conflicts. One of the main problems is the clogging outer space that creates threats not only for the existence and effective operation of space vehicles, but it also affects development and security various spheres of life of the states and society, including the provision of space and, in turn, national and global security.

Today under space security understand not only the ability of one state to have military superiority in space before another, but also above all "the ability of state to control part of the cosmic space and carry out a certain activity without being subject to external pressure, threats or attack from the parties of opponents " [4]. Very important to notice that today the threat of space security no longer solely from hostile subjects and natural disturbances, but an increasing threat from pollution of outer space.

In international law there is no definition the concept of "space debris". In the legal literature there is the following definition: "This kind of pollution includes any artificial objects in orbit around Earth, which are non-functional and in respect of which one cannot expect a start or the renewal of their intended functioning, which is authorized in the future, including fragments and parts thereof. Space debris Includes inactive spacecraft, used parts of missiles, material of formations as a result of planned space operations, fragments formed satellites and upper levels as a result of explosion or collision, as well as containing on board dangerous (nuclear, toxic, etc.) materials "[3, c. 119].

We suggested the following definition: "*The artificial debris (or Space Pollution) is considerate any object send by the man which no longer serves a useful function; like inactive satellites, nonfunctional spacecraft, abandoned launch vehicle stages, mission-related debris and fragmentation debris.*"

In addition to the threats that space debris be directly implemented space activities, there is a danger of it uncontrolled descent from orbit, incomplete combustion during the passage of the atmosphere and the fall on the surface of the Earth.

The term "space debris" is used for all artificial objects and their small fragments in outer space, which will never function again and can serve no useful purpose, but which are a dangerous functioning spacecraft.

The problem of pollution of near-Earth space by "space debris" it theoretically appeared immediately after the launch of the first artificial earth satellites in the 50-ies of the XX century, but at the international level received official status only after the fact, as the Secretary-General of the United Nations, on 10 December 1993, gave a presentation on the theme "Space environmental activities ", in which he indicated the international and global he pattern of clogging of the outer space of the Earth with various wastes.

3. STATISTICS OF SPACE DEBRIS

In 2014, according to experts, near-Earth space was more than 200 thousand objects larger than 1 cm and over 330 million objects larger than 1 mm in size more than 5 000 tons. Only about 10% of them were detected, tracked and entered into catalogs with using ground-based radar and optical means. For example, for 2013, the US military command contained 16,600 objects (mostly larger than 10 cm) [3], and Russian catalog contained 15,800 objects of "space debris" in August 2014 [4]. All these objects was formed from launched to the orbit Space crafts. Total amount of launched spacecraft and launch failure showing on Figure1.

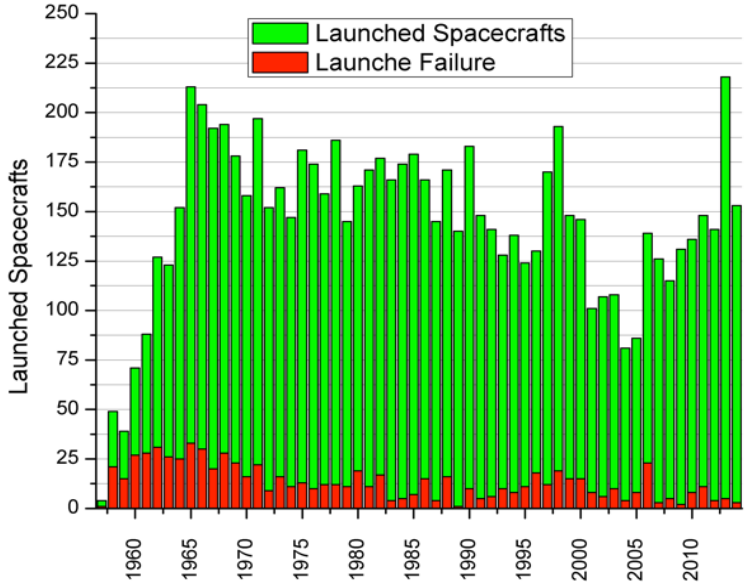

Figure 1 - Total Launched Space crafts and Launch Failure (1957 - 2015)

As we can notice, the process of launching spacecrafts to the orbit is going with high intensity. But from 1990-th to 2004-th intensity was decreasing mostly because of political situation in Soviet Union and Russian Federation. Russia still holding leading positions in space exploration: we can see it from plots on Figure 2, showing success-launched spacecraft total and by countries.

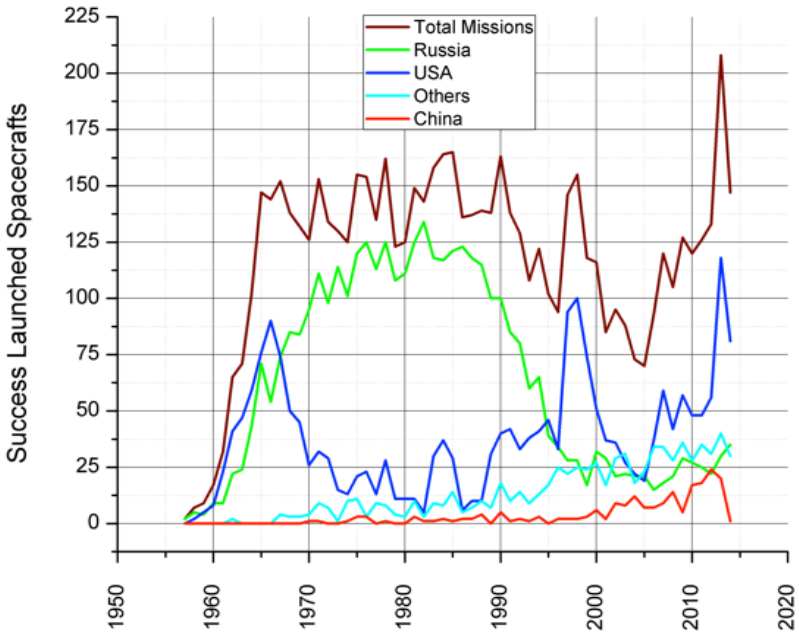

Figure 2 - Success launched spacecrafts by countries (Russia, USA, Others and China) and total (1957 - 2015)

The total number of spacecraft Launched in this period is 8,593. Number of Russian spacecraft is 3,743; number of USA spacecraft – 2,022; number of other governments (Europe, Japan, China, Canada, India and others) spacecraft is 1,162. Among them, the number of Civilian Spacecraft is

4,519, and Military spacecraft – 4,074. In Civilian Programs the number of Piloted Spaceships (+35 military) is 610; number of Planetary Probes is 248; number of Communication Satellites is 1,381; and number of Meteorology Satellites is 241. Some of mentioned statistical information presented on Figure 3.

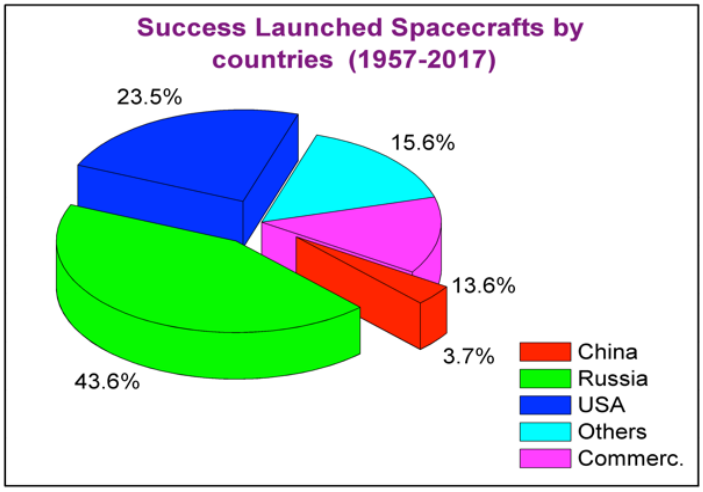

Figure 3 - Success launched spacecraft by countries (Russia, USA, Others and China)

According to some estimates, the contribution to the creation of "space debris" by country is following: China - 40%; the USA - 27,5%; Russia - 25.5%; other countries - 7% [5]. According to other estimates (for 2014): Russia -39.7%; The United States - 28.9%; China - 22.8% [6]. Our estimation of contribution Russia, USA, China, and other countries to the “forming” of space pollution presented on Figure 4.

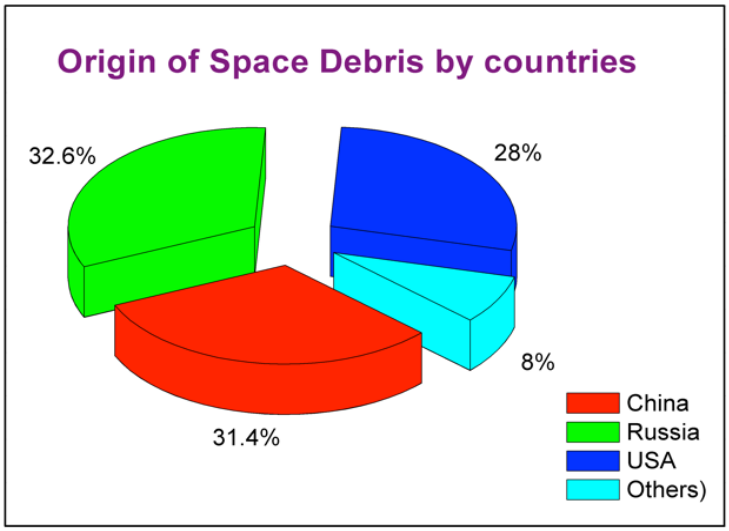

Figure 4 - Origin of Space Debris by countries (Russia, USA, Others and China)

Here important to notice that when we speak about the amount of Space Debris we are dealing with approximate number, but the top three leaders are Russia, USA and China, and the growth of space junk is the most serious in the last few years.

4. PROBLEMS OF ANTHROPOGENIC POLLUTION OF SPACE

Existing intensity of investigation the space and an increase in the number of participants in space activities contribute to a significant increase quantity of Space Pollution. Explosions of waste space vehicles and an increase in the number of particles from accidental collisions of large Space objects can lead to the effect of cascading from collisions.

While increasing the rate of pollution, the use of some altitudes will be complicated or will be completely impossible. So, because of the space pollution, in future will not be possible to use geostationary orbit where located space vehicles for various purposes - from communication satellites to systems of early warning of a missile attack. Also is polluting the area of low Earth circular orbits with a altitude of up to 2 thousand km, on which orbital grouping of space vehicles of various purpose and programs are being implemented for manned space flight and in the long term it is planned to organize works on the assembly of interplanetary space complexes.

In addition, increasing the probability of termination functioning of existing spacecraft and the threat to safety launching new ones. It should be noted that the damage can made by debris particles up to 1 cm large, and avoid this type of collision practically is impossible due to lack of technology tracking particles of a given size.

Thus, in 1991, the US shuttle in order to avoid a collision with remnants of the Soviet satellite Kosmos-955 had to make a series of maneuvers. In 1996 a fragment of the third stage of the French rocket "Ariane-4" disabled French satellite "Cerise". International Space Station has repeatedly adjusted the orbit to avoid collision with Space Debris. And in 2009, the US commercial satellite collided with a non-functioning Russian military communications satellite "Cosmos-2251" [9].

Serious consequences can have cases fall of large space objects on Earth, in areas of large concentrations of people and on the territory of hazardous industrial facilities.

According to experts, in 40-50 years humanity will face the so-called "Debris rain" – unauthorized space debris, some of which because of its size cannot completely burn out when passing through dense layers of the atmosphere, from orbits to the Earth.

All this affects not only the provision of interests of national security of the states, but also to ensure global security generally, and it leads humanity to understand the need to solve this problem. However, this is possible only with joint efforts of the entire world community. The realities are such that in view of many factors (scientific, technical, legal and financial) no one countries cannot solve this problem by oneself. At the international level, work on this problem is mainly going in the two structures - Scientific and Technical Subcommittee of the Committee The United Nations Space Agency and the Inter-Agency Committee on Space Debris.

In addition, countries such as Russia, the United States, Japan, and the European Union have its near-Earth monitoring systems space for observation, cataloging and analysis of environmental conditions and prevention collisions in space. Each system uses various methods of monitoring and exchanges data with others, which allows more quickly and efficiently collision avoidance measures operating spacecraft with space debris.

Since the problem of "space debris" affects the interests of all countries involved in space exploration, its solution needs an international legal basis and close cooperation. For the adoption of agreements in this area, it is important to recognize importance of the problem by all global community.

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