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RUSSIAN SPACE DEBRIS MITIGATION PLANS

A REFERENCE IN CONFIDENCE TO

CST MEMBERS, ASSOCIATES

AND CUSTOMERS

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ACRONYMS AND ABBREVIATIONS

ASPOS OKP	-	Automated System for Warning on Dangerous Situations in Near-Earth Space
BLITS	-	Ball Lens In The Space
FKP	-	Federal Space Programme
FSU	-	Former Soviet Union
GEO	-	Geostationary Earth Orbit
GTO	-	Geostationary Transfer Orbit
IAC	-	International Astronautical Congress
IS	-	Istrebitel Sputnikov (Interceptor Satellite)
ISS	-	International Space Station
LEO	-	Low Earth Orbit
MoD	-	Ministry of Defence
NES	-	Near Earth Space
RAN	-	Russian Academy of Science
RUR	-	Russian Roubles
SDI	-	Strategic Defense Initiative
SKKP	-	System of Space Surveillance
SOAR	-	Sub Orbital Aircraft Rocket
TsNII Cometa	-	Central R&D Institute of Radio and Electronics
TsNIIMash	-	Central R&D Institute of Machine building
TsUP	-	Central Flight Control Center

INTRODUCTION

Before manned spaceflight began, and even before unmanned space flight began, numerous authors of science fiction stories, writing about humanity's future space activities, thought that the main danger in space would be the possibility of spacecraft collision with meteorites; small hard objects of natural origin. They described artistically, how brave astronauts would manoeuvre in order to avoid these collisions, and, if unsuccessful, how they would battle against air leaks through pierced holes, and against other damage.

Soon after the start of spaceflight, it was found that the meteorite danger had been greatly exaggerated: the density of these 'foreign objects' in space, was near to negligible, and the probability of colliding with them was near to zero. However, humanity (or, at least, the portion of humanity that was engaged in space activity), was able to create a full-scale substitution for the imaginary meteorite danger.

Human space activity leaves a trail of material in space, starting in Low Earth Orbit, and the majority of this material is not only of no use and inert, but harmful. When spacecraft are launched into Low Earth Orbits (LEO), both intentionally, as well as parking orbits for further transit to elliptic and interplanetary trajectories, the top and upper stages of launch vehicles remain in LEO, as well as other separable parts; those upper stages, which reach higher orbits, including geostationary orbit (GEO), remain there; finally, satellites in all these orbits, which either have ended their lifetimes, or failed, also remain in orbit. Additionally, failures of some spacecraft have been accompanied by explosions of propellant residuals, or have been initiated by other causes, resulting in further debris, which is significantly smaller and more numerous than stages and spacecraft themselves, adding a greater share to the total number of objects generally littering near-Earth space.

Some measures to reduce inert objects in areas of near-Earth space, used most often for Earth related spacecraft missions i.e. LEO and GEO, began to be undertaken in the last few decades. These measures include preplanned deorbiting of top/upper stages of launch vehicles, and de-orbit of LEO satellites, after completion of their missions, with their ensuing burning up in the denser layers of the Earth's atmosphere; similar objects in GEO are transferred to a higher 'burial' or 'graveyard' orbit, where they would not disturb operation of active geostationary satellites.

However, these measures only began to be undertaken relatively recently, whilst the amount of space debris, which had accumulated before this initiative was applied, was significant, and the influence of these new measures is not yet that visible. Added to this, the number of artificial objects in near-Earth orbits continues to fragment, or remains without deorbiting, either due to malfunctions of corresponding on-board systems, or due to an absence of onboard systems. As a result, the amount of space debris continues to grow. This is seen in the graph in **Figure 1**. This graph shows the situation until 2011, when, as it seems, the total number of objects became permanent, whilst the number of fragmentation debris even decreased somewhat. However, unfortunately, recent statistics have not confirmed this favourable trend: thus, the number of fragmentation debris has reached 11299 objects by August 31, 2015 /1/.

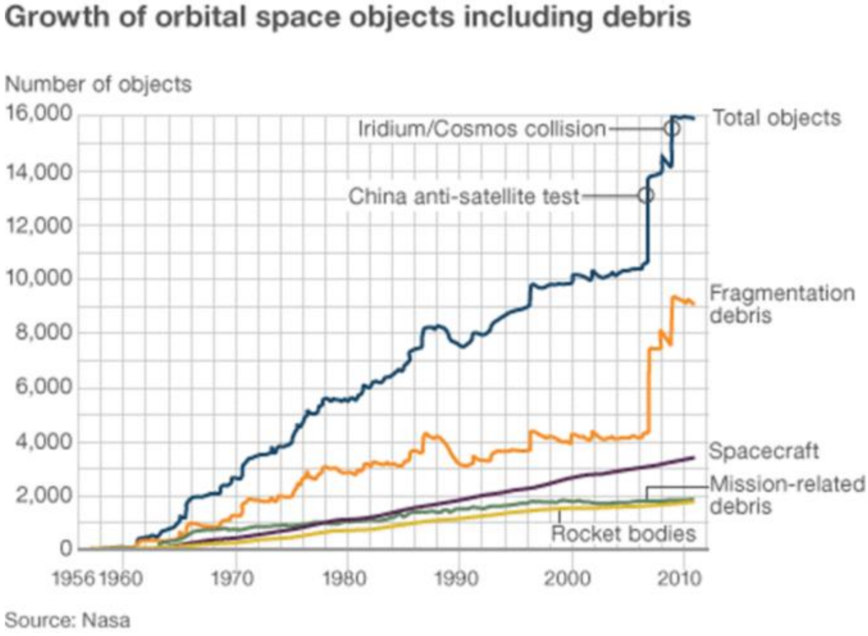

Fig. 1. Graph showing growth of number of artificial space objects including debris after the start of the space age.

Courtesy: NASA

Understandably, this growth of space debris in orbits which are actively used by spacecraft from a wide variety of countries, creates a threat for their operation, and this threat is also growing on a more permanent basis. Cases of operational satellites being damaged by collisions with this space debris are becoming more frequent. It is understood that the global astronautical community is aware of, and attending to this threat, trying to find methods to reduce its severity.

The situation in terms of studying the field of space debris, the problems caused, and attempts to find solutions, is assessed by taking as an example, one of the countries that is a world leader in terms of volume of orbital launches. The current leader in terms of the number of annual launches, is Russia, and Russia is also responsible for the largest number of space debris objects formed, as a result of its space activity. For this reason, the current situation regarding the space debris problem in Russia, is chosen as an example for the assessment.

Section 1 is dedicated to a presentation of Russian experts' opinions on the problem, and on possible solutions. These opinions were expressed in various sources, including scientific articles in specialised magazines, papers from scientific/technological forums and during personal meetings. The opinions are commented and analysed, followed by a general assessment of the problem.

A description of real cases of Russian spacecraft damaged by space debris, contained in **Section 2**, allows the seriousness of the threat to be understood, and explains why certain initiatives for legislating for practical work to be arranged to combat space debris, have been raised in Russia, in order to begin real development of corresponding programmes and projects.

Some anti-debris concepts, proposed in Russia and adopted from abroad, are described briefly in **Section 3,** showing the difficulty to realise them, and problematic results; this description explains why the idea arose to develop an anti-debris systems initially in GEO, within the framework of the 'Liquidator' project, that has been included into Russia's new Federal Space Programme for 2016-2025 (FKP-2025); a concept of this project is described as well. Discussion of planned continuation of the work is also presented, with an assessment of prospects for solving the space debris problem, albeit partially, within the framework of international cooperation.

The **Conclusions** contain a brief summary of the information presented in the report.

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