Committee On Peaceful uses of Outer Space

Space debris

Research Report

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"Out of this world"

Forum:	Committee On Peaceful Uses of Outer Space (COPUOS)
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Introduction

With every launch into space, some amount of space debris is created. This space debris can consist of old, no longer functional satellites, old fairings jettisoned after a launch, or even specks of paint or metal. No matter the size, these parts pose a significant threat to any future launches and existing structures in space. Reaching up to 15 km/s, these parts are 10 times faster than a bullet and have the power to completely destroy anything in their path.[1] If humanity continues to tolerate increasing numbers of space debris, space exploration might be rendered impossible for generations. Therefore, there is a strong need for a working limitation and potentially also active reduction of the amount of space debris in orbit around earth.

You will engage in discussions with international partners in the COPUOS (Committee on the Peaceful Uses of Outer Space) committee, the only UN body dedicated to the civil use of Earth's orbit and outer space.

In the following pages, we will provide you with a brief overview on the issue at hand, as well as present you with some solutions you might pursue as a delegate.

We wish you the best of luck with your research!

Definition of Key Terms

Space Debris:

Also called "Space Junk", is a term used to describe used parts of artificial satellites which no longer serve a function. These include specks of paint but can also go up to entire satellites. Based on size, space debris can be divided into three categories: Small / Micro-Debris (< 1 cm), Medium Debris (1 – 10 cm), and Large Debris (> 10 cm). Due to their high velocity, very small parts also pose a significant threat to missions in orbit.

Kessler Syndrome:

The term Kessler Syndrome refers to a hypothetical scenario introduced by scientist Donald J. Kessler in 1978. In such a scenario, the amount of space debris in orbit around earth reaches a point where collisions between objects lead to a cascade, each collision generating more space debris and thus leading to even more collisions. Such a scenario would destroy all man made structures in the respective area of earth's orbit and would virtually render spaceflight impossible for centuries as it would be very difficult to launch spacecraft without them being destroyed immediately.[2]

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[1] NASA Orbital Debris Programme: FAQ. https://orbitaldebris.jsc.nasa.gov/faq/#:~:text=However%2C%20the%20average%20impact%20speed,the%20speed%20of%20a%20bullet (17.07.2024).
[2] esa.int. https://www.esa.int/Enabling_Support/Space_Engineering_Technology/The_Kessler_Effect_and_how_to_stop_it (17.07.2024).

Low Earth Orbit (LEO):

Orbits around earth can be divided according to their height. Low Earth Orbit (short: LEO) is an area around earth between the altitudes of 160 km and 2,000 km. This is the area with the most space debris.[3]

Collision Avoidance Manoeuvre:

A collision avoidance manoeuvre is a manoeuvre of a satellite or manned spacecraft to avoid collision with another spacecraft or a piece of space debris. For such a manoeuvre, a spacecraft can change its speed, altitude, or course.

End of Life- / Post-Mission-Disposal:

When a spacecraft is moved out of orbit through a deorbit-burn or by being moved to a parking orbit to avoid collisions, it is called an End of Life- / Post-Mission-Disposal.

Active Debris Removal (ADR):

Along with limiting the creation of new space debris, Active Debris Removal (ADR) is an integral part in the plan to mitigate the risks of space debris. As of now, there is no functional technology for removing space debris, but ideas include satellites collecting space debris or moving space debris out of its orbit with Earth-based lasers.

General Overview

We will now dive deeper into the matter and explore the main sources of space debris, as well as potential solutions for them.

Main Sources of Space Debris

Most space debris is a byproduct of missions. After the end of a mission, upper stages of rockets are often left in space. There are also other useless parts of rockets that end up in space after a mission, especially payload fairings (payload covers during launch). Space debris is of course also created if a satellite stops functioning properly and there is no possibility to solve the issue remotely. It is usually not possible to manually fix broken satellites in orbit. Such defective satellites then end up as space debris as it is not possible to remove them without being able to control them.

Even though the largest pieces of space debris are created in one of these ways, the by far largest amount of space debris, especially smaller than 10 cm is created by collisions between larger pieces of space debris. Such collisions between different pieces of space junk cannot be prevented currently.

The incident in which space debris is created does not occur regularly but is all the more significant: military operations aimed at demonstrating a country's capability to destroy a satellite. Such so-called ASAT (Anti-Satellite-Activities) have been carried out several times in recent years by China (2007), the United States (2008), India (2019), and Russia (2021). Each time, the amount of space debris in orbit was increased significantly.[4] [5]

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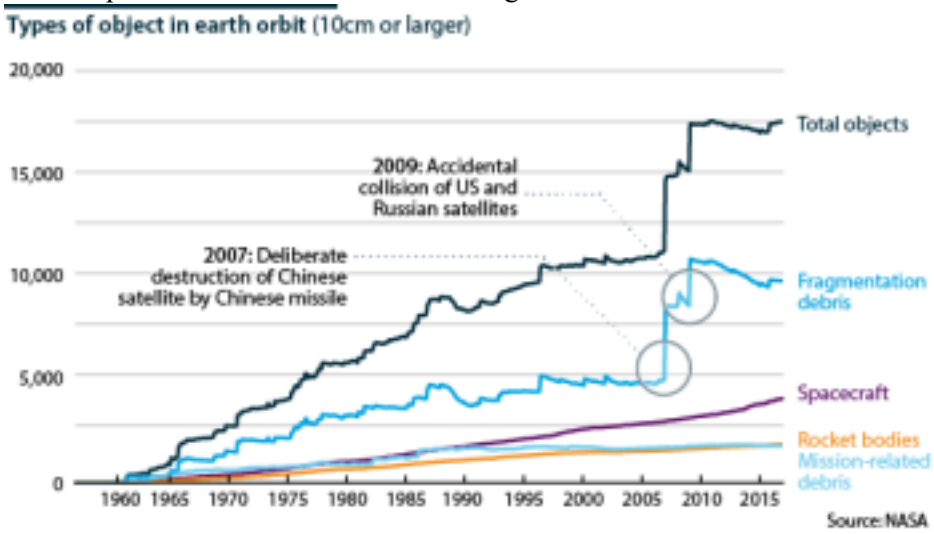
[3] NASA Orbital Debris Programme: FAQ. https://orbitaldebris.jsc.nasa.gov/faq/#:~:text=However%2C%20the%20average%20impact%20speed,the%20speed%20of%20a%20bullet (17.07.2024).
[4] Skinner, B., spacesecurityindex.org, April 2020. https://spacesecurityindex.org/2020/04/ground-based-weapons-kinetic-antisatellite-weapons/ (17.08.2024).
[5] sw.found.org, List of all ASAT Tests, 11 July 2023. https://swfound.org/news/all-news/2023/07/counterspace-fact-sheets-2023 (18.08.2024).

ASAT Tests can be divided into two different categories: Co-Orbital ASATs (CO-ASAT) and Direct Ascent ASATs (DA-ASAT). In a Co-Orbital ASAT, an object in orbit destroys another one. In a Direct Ascent ASAT, a rocket launched from Earth destroys a satellite.

The development of the number of space debris, as well as the significance of ASAT and collisions between space debris can be seen in this diagram:[6]



Active Legislation

There is already a wide variety of existing legislation touching on the issue of space debris. First and foremost, there are the "Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space". This document defines 7 key strategies to limit the risk posed by and the creation of space debris. You can read further details in the document in the annotations.[7]

UNOOSA also published "Guidelines for the Long-Term Sustainability of Outer Space Activities", which also touch on the area of space debris.[8] [9]

The Outer Space Treaty (1967) also briefly mentions space debris and pollution of space:

> *"States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.''*[10]

In the United Nations Convention on the Registration of Objects Launched into Outer Space (or short: Registration Convention, 1976) space debris is a topic as well, seeing the convention makes registration of launched objects obligatory, thus supporting the

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[6] dailybrief.oxan.com, October 2018. https://dailybrief.oxan.com/Analysis/DB238840/Space-debris-threatens-global-economy-and-security (17.08.2024).
[7] unoosa.org, Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space. https://www.unoosa.org/pdf/publications/st_space_49E.pdf (17.08.2024).
[8] unoosa.org, About Long-Term Sustainability of Outer Space Activities. https://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html (17.08.2024)
[9] unoosa.org, Guidelines for the Long-Term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space. https://www.unoosa.org/documents/pdf/PromotingSpaceSustainability/Publication_Final_English_June2021.pdf (17.08.2024).
[10] unoosa.org, Outer Space Treaty. https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html (17.08.2024).

tracking of potential sources of space junk.[11]

Despite this large amount of already existing legislation, the Inter-Agency Space Debris Coordination Committee (short: IADC) also promotes international cooperation to mitigate the risks of space debris.[12]

And to top all of this, a lot of countries with large space programmes also have domestic regulations on how to deal with the creation of space debris. Please look this up for your country. You might use this compendium by UNOOSA as a starting point for your research.[13]

Major Parties Involved

We will now take a closer look at some of the most important players with regards to this issue.

USA

With the largest space programme in the world, the USA is obviously playing a very significant role with regards to creation but also reduction of space debris. The USA also carried out a Direct Ascent ASAT Test in 2008.[14]

China

Over the last decade, China developed its space programme to be one of the largest there is. China uses its space programme to project military power into space. Accordingly, China has carried out a number of ASAT Tests, one of them in 2007 being the origin of a large amount of space debris.

Russia

Historically, Russia has been a very important partner for western Space Agencies, especially in the ISS programme. It has also carried out a number of ASAT Tests, the most recent DA-Test took place in 2021.[15]

India

India carried out a DA-ASAT Test in 2019.[16]

ESA

ESA is the only large Space Agency that did not carry out an ASAT Test.

Commercial Companies (e.g. SpaceX)

Commercial Companies also contribute hugely to the amount of space debris in Orbit. One company especially noteworthy in this context is SpaceX. Even though they contributed to the reduction of space debris with their almost fully reusable Falcon Rockets, their Starlink-Project, aiming to provide reliable satellite internet everywhere

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[11] unoosa.org, About Registration Convention. https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/int-roregistration-convention.html (17.08.2024).
[12] iadc-home.de, Homepage of IADC. https://iadc-home.org/what_iadc (17.08.2024).
[13] unoosa.org, Compendium of space debris mitigation standards adopted by States and international organizations. https://www.unoosa.org/oosa/en/ourwork/topics/space-debris/compendium.html (17.08.2024).
[14] swfound.org, List of DA ASAT Tests by USA, July 2023. https://swfound.org/media/207610/fs23-07_us-da-asat-testing_0723.pdf (18.08.2024).
[15] swfound.org, List of DA ASAT Tests by Russia, July 2023. https://swfound.org/media/207607/fs23-04_russian-da-asat-testing_0723.pdf (19.08.2024).
[16] swfound.org, List of DA ASAT Tests by India, July 2023. https://swfound.org/media/207606/fs23-03_indian-da-asat-testing_0723.pdf (19.08.2024).

on the globe, poses a major risk to increase the number of space debris. There have been a number of incidents where satellites by Space Agencies had to change course to avert collision with Starlink satellites.[17]

Of course, there is also an array of companies working towards ADR and other techniques with the objective of reducing the number of space debris. The most promising in this field are AstroScale and ClearSpace. The Tokyo-based company AstroSpace has already carried out successful demonstration missions and is working on several space debris reduction strategies like End-of-Life (EOL), Active Debris Removal (ADR), and Life Extension (LEX).[18] Another prominent enterprise is the European ClearSpace, which is also backed by ESA.[19]

Timeline of Events

1957	USSR launches Sputnik 1, creating the first ever human-made piece of space debris[20]
1967	UN Outer Space Treaty
1965	Explosion of the OV2-1 Rocket Body, creating 473 pieces of debris
1972	UN Convention on Registration of Objects launched into Outer Space
1978	NASA Scientist Donald J. Kessler proposes his "Kessler Syndrome", predicting a cascade of collisions between pieces of space debris
1986	Explosion of the Spot Rocket Body, creating 506 pieces of debris
1996	Explosion of the Step 2 Rocket Body, creating 756 pieces of debris
2002	Inter-Agency Space Debris Coordination Committee (IADC) publishes Space debris Mitigation Guidelines
2007	China conducts an ASAT Test, destroying the Fengyun-1C satellite and creating 3549 pieces of debris
2008	The USA conduct an ASAT Test, destroying a satellite and creating 174 pieces of debris
2009	Collision between the Iridium 33 (USA) and Kosmos 2251 (Russia) satellites, creating 2,375 pieces of debris
2019	India conducts an ASAT Test, destroying a satellite and creating 129 pieces of debris

[17] Pultarova, T., space.com, 06 July 2023. https://www.space.com/starlink-satellite-conjunction-increase-threatens-space-sustainability (19.08.2024).
[18] astroscale.com. https://astroscale.com (19.08.2024).
[19] clearspace.today. https://clearspace.today (19.08.2024).
[20] areospace.org, 02 November 2022. https://aerospace.org/article/brief-history-space-debris (19.08.2024).

2021 Russia conducts an ASAT Test, creating 1,562 pieces of debris[21]

Possible Solutions

There are only two real solutions you might consider for your country in some combination. Cooperation with other countries should be easy, as every country acknowledges the risk posed by space debris.

Debris Reduction

One functioning solution is reducing the amount of debris created with every launch. Several space agencies are already committed to such a strategy, working on DFSM (Debris Free Space Missions).

Active Debris Removal (ADR)

The other strategy for this issue is Active Debris Removal (ADR). The name already explains what this is about: Technologies to remove debris from Earth's orbit. There are different approaches here, ranging from physically collecting the debris to shooting down debris with Earth-based lasers.

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