Preserving Space Autonomy: Addressing the Fragility of Low Earth Orbit

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This paper draws on insights from consultations with representatives from NATO, the Directorate-General for Defence Industry and Space (DG DEFIS) of the European Commission and the European External Action Service (EEAS), as well as researchers from the Brussels School of Governance and the European Space Policy Institute (ESPI).

Executive summary

- The Russian war in Ukraine has highlighted the importance of dual-use space capabilities. But it has also revealed the risks posed by new dependencies and the **inherent fragility of disputed orbits.** If not properly addressed, those risks could seriously compromise the **security of operations and access in this environment for defence and national security agencies**.

- **Low Earth orbit (LEO) fragility** is defined by the increasing risks to the integrity of space systems and more broadly, to the safe conduct of space operations in congested and limited orbits.

- Orbital congestion is the result of strong legal and commercial incentives for **the deployment of large numbers of satellites, informally known as mega-constellations,** in a portion of space closest to Earth.

- **Prevailing international law falls short of ensuring a secure and sustainable LEO environment** by favoring non-binding guidelines that were designed for a different era and fail to consider the full impact of large-scale, commercial space operations in LEO.

- Moving forward, European decision-makers should:
  1. **Adopt and address the concept of fragility as a part of threats to integrity of space assets and operations.**
  2. **Impose binding requirements** on space operators, based on **pre-emptive, holistic, and science-based risk assessment to safeguard its use of orbital assets,** in the upcoming European Union Space Law and national frameworks.
  3. **Lead international efforts to coalesce a coalition of the willing around a more adapted space rulebook.**

Introduction

Russia's illegal war in Ukraine has turned space into a priority for governments across the world. Events there and in other conflicts, between Israel and Hamas for example, have underlined the **growing importance of this domain** to modern warfare, notably in terms of space-generated imagery and connectivity to support forces in the field. A growing portion of space-based services are provided by private space companies that operate so-called dual-use capabilities, mostly in low Earth orbit.

Spacefaring nations have taken notice and have sought to expand existing space-related programs and resources. Newer actors have accelerated efforts to develop their own capabilities. This is particularly true for the lower portion of **low Earth orbit (LEO), generally accepted to be located between approximately 200 to 700 km above the surface of Earth**. There are to this day more than **fifty constellation projects** put forward by sovereign and private actors ranging from a few hundred satellites to many tens of thousands, from nanosatellites to large ones.

Even if some of those projects will not materialise and those emerging serve different commercial and sovereign purposes, the sum of all **considerably affects the safety of space operations and the long-term sustainability of this environment.** The proliferation of space objects, both in terms of operational satellites and space debris, but also threats stemming from counterspace capabilities (cyber, kinetic, or energy attacks) have **increased the fragility of the orbital environment. Against the New Space paradigm which puts a premium on quantity, are current regulatory frameworks, designed during the Cold War, still fit for purpose?**

AN INCREASINGLY COMPETITIVE AND CONGESTED GLOBAL COMMONS

LEO offers considerable benefits for communication, Earth and space imagery, defence, and scientific research, among others. Driven by inadequate regulation, low launch cost to orbit, given its relative proximity to Earth's surface, and short deployment times, LEO has become **an increasingly coveted place**.

Over the past few years, the **number of LEO systems has rapidly expanded** driven by the New Space industry that encourages the deployment of large numbers of satellites united in a common task, informally known as **mega-constellations**. In the last twenty-five years, the number of active satellites orbiting the Earth has increased from about 500 to 8,000[1], with 35% of those launched over the last three years.[2] Trends for the satellite industry indicate that **at least an additional 58,00 satellites will be launched in orbit by 2030**.[3]

[1] Opinion | A convention to clean up space debris threatening Earth's orbits - Washington Post
[2] Niklas Hedman, Space Watch Global, December 2022
[3] GAO-22-105166 report, the United States Government Accountability Office, September 2022, https://www.gao.gov/assets/gao-22-105166.pdf

This exponential growth in the number of satellites in LEO is partly the **result of strong economic incentives to engage in *'orbit grabbing'* strategies**. These commercial practices consist of occupying more orbital real estate than warranted, leading to the **monopolization of available resources** (orbital slots, frequency bands) by a few actors.

In fact, those New Space companies often **replicate the playbook of Big Tech**, which seek to build a dominant position to own an entire eco-system of services. Compounding this phenomenon is the fact that spacefaring nations are inclined to support monopolistic-like positions for their national champion. Not only is this problematic given that the orbits around Earth are **a global commons**, which contrary to conventional wisdom is finite, but it also runs the risk of creating a critical dependency, including for defence-related services, on private actors driven primarily by commercial interests.

Moreover, certain LEO operators are developing **constellation designs relying on low-cost satellites**, based on **disposability and replaceability parameters** (LEO satellites often have short mission lives and are becoming increasingly affordable to mass produce and launch). But, by favouring cost versus safety trade-offs, this approach leads to heightened collision risks in increasingly congested orbits.

The dramatically rising population of active satellites in LEO not only increases the **number of conjunctions** (understood as a close encounter between a satellite and another object in orbit) but also is affected by the increasing **amount of trackable and un-trackable space debris** resulting from collisions, derelicy satellites, derelict rocket body breakups, etc. Today, according to ESA's Space Debris Office, it is estimated that "lethal non-trackable debris" (LNT) comprises about 1 million fragments of space debris between 1cm to 10cm, and more than 130 million particles smaller than 1 cm are currently orbiting out of control, each with the ability to do serious damage.[4] Despite the promises of Space Surveillance and Tracking and Space Traffic Management technologies in helping to track debris and prevent collision risks, **all conjunctions cannot be foreseen and all collisions cannot be avoided.[5]**

Defence operations are directly impacted by this densification of LEO. Military authorities have started recognizing that the growth of orbital objects increasingly challenge defence postures and assets.[6]

GROWING CONTESTATION IN THE LEO ENVIRONMENT

In a domain that is increasingly congested, some of this space junk is **the result of deliberate incidents**. This is notably the case of **explosions resulting from direct ascent anti-satellite missiles (DA-ASATs).** As these weapons can simply be launched with **short-range missiles to strike their targets**, assets closer to Earth are comparatively more vulnerable than satellites in other orbits.

[4] https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers
[5] Wheeler, Joanne, 'Regulation—a restraint of liberty or an enabler? Implementing sustainability guidelines for commercial space activities—normalising the regulatory 'race to the top' in an ESG world', in Charles S. Cockell (ed.), The Institutions of Extraterrestrial Liberty (Oxford, 2022; online edn, Oxford Academic, 19 Jan. 2023), *https://doi.org/10.1093/oso/9780192897985.003.0030*
[6] https://www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Challenges_Security_Space_2022.pdf

For instance, a Chinese DA-ASAT missile test in January 2007 created more than 2,000 trackable items the size of a golf ball or larger and an estimated 150,000 LNT.[7] More recently, in November 2021, a similar Russian DA-ASAT test struck one of its own Cosmos 1408 satellites, generating a field of at least 1,500 trackable pieces of debris and at least 77,000 pieces of LNT that poses a threat to satellites in the same or overlapping orbits. As demonstrated in recent research, "the **consequences of satellite collisions and successful ASAT tests are indistinguishable**, posing a threat to LEO satellites, the ISS, and other space systems for decades, or even centuries."[8]

Other **counterspace capabilities** – such as cyberattacks, electronic jamming or spoofing, and EMP - can affect all types of space assets. Operators that fall victim to these attacks may lose control over targeted satellites and be unable to manoeuvre to avoid collisions, if not cause one.

However there too, systems in LEO, an already heavily exploited environment, **are susceptible to generate more in-orbit damage when targeted**. Constellations in LEO may have resilience when it comes to a failure of a single satellite, but they have a **vulnerability because an attack or collision involving one satellite can generate a cascading series of collisions with all or many other spacecraft in a common orbital shell and even shells in nearby orbital altitudes. A higher debris population combined with a heightened risks of kinetic attacks create LEO fragility.**

AN INADEQUATE LEGAL AND POLICY FRAMEWORK

In this fast-changing environment, existing legal frameworks have long been **outpaced by technology and marketplace advances**. The prevailing corpus of international law for space regulation stems from a United Nations (UN) system adopted in the early days of space exploration. Established guidelines mostly focused on preventing the militarization of space, then only accessible by a handful of spacefaring nations.

But the current era marks an **unprecedented shift in the global space sector characterized by two intertwined dynamics**. First, the landscape is shaped by an **escalating competition between the United States and China**, accompanied by a surge in second-tier contenders capitalizing on lower barriers to entry. Second, this new space age is defined by the **exponential growth of private sector involvement in space activities and the emergence of versatile dual-use technologies**. And while this has ushered in significant opportunities and cost-effectiveness, over-reliance on commercial capabilities also generates its own risks, as seen with the case of Starlink in Ukraine.[9]

Existing rules **are insufficient and inadequate in managing this global common, notably the growing congestion problem in LEO.** Despite the multiplication of recent initiatives encouraging more sustainable

[7] 2022_PSD_PUB_Space.indd (friendsofeurope.org)
[8] Viasat white paper, Satellite Collisions Have the Same Consequences as ASAT Tests, November 2021
[9] Ukraine's Starlink problems show the dangers of digital dependency (ft.com)

behaviours in space, both at the UN-level or from other bodies, these are rarely successfully implemented or widely embraced due to their **non-binding nature.**[10]

Regional organisations have taken it upon themselves to develop their own approaches to space. In recent years, the EU has seized on the space issue as a new area for regulation with its upcoming European Union Space Law (EUSL) and its Strategy for Security and Defense in Space.[11]

Recommendations

ADOPTING AND DEVELOPPING THE OVERARCHING CONCEPT OF LEO FRAGILITY

The upcoming proposal for an EUSL is a unique opportunity to embrace a more holistic approach to risk management by addressing the **notion of fragility that encompasses both safety and security aspects.** Indeed, most legislative initiatives to date consider safety and security risks distinctly. For instance, a DA-ASAT attack would be considered a "security" risk whilst the resulting untrackable debris would fall under the "safety" category.

This siloed approach creates a potential gap into a **comprehensive overview of risks inherent** to LEO. LEO fragility however encourages us to **look at these concepts as two sides of the same coin**, with both directly adding to the **general deterioration of the orbital environment** and therefore threatening the integrity of space assets and operations.

DEVELOPING BINDING REQUIREMENTS FOR LICENSING

To understand the current space environment, its expected evolution, and the expected consequences of proposed uses of LEO, a science-based approach, using a holistic model is essential. European organizations (industry, academia, and universities) are **among the best placed to assess the impact of existing and planned LEO systems** and help us understand the implications of multiple large constellations occupying neighbouring, intersecting, or overlapping orbits.

The current patchwork of national regulations mean that Europe has little capacity to create a level playing field between non-EU players and European ones and mitigate the risks of 'out-of-scale' constellations. Through **the EUSL** however**,** the EU has **an ideal vehicle to impose binding measures** that adequately reflect concerns for LEO fragility.

[10] Rules of international law only apply to the sovereign States members of the intergovernmental organisations that set them. Lies on these States the responsibility to enforce them to national private and public entities. In the event of non-compliance with these rules, other member states are responsible for sanctioning the state in breach of its obligations. The interplay of geopolitical forces makes it difficult to enforce certain rules on the most powerful states.

[11] Joint communication to the European Parliament and the Council – European Union Space strategy for Security and Defence – March 2023

The EU **should leverage its vast internal market to export ambitious rules for sustainable behaviour in space**. Although licensing is a national competency under EU law, there are some hybrid models – like 5G - where the EU can play a greater coordinating role in updating and aligning national regulations. This could notably see all operators - both EU and third country - comply with a **pre-emptive, holistic, and sciences-based impact assessment before a constellation is allowed to serve European markets**.

SPEARHEADING EFFORTS TO BUILD A GLOBAL COALITION OF WILLING SPACE POWERS

As leading institutions recognize, **adopting suitable rules at international bodies such as the UN would take far too long**[12]. Yet, across the world, various initiatives and legislation concerning the sustainability and safety of outer space is gaining traction. At the forefront of addressing environmental concerns on Earth, **the EU is best positioned to coalesce and lead the efforts** – including those of organizations such as the Organisation for Economic Cooperation and Development (OECD) - **to prevent a long-anticipated disaster** and ensure the sustainable exploitation of the near-Earth portion of space, for the benefit of all.

[12] R. Buchs, Policy Options to Address Collision Risk From Space Debris, Lausanne: EPFL International Risk Governance Center (2021), at ii

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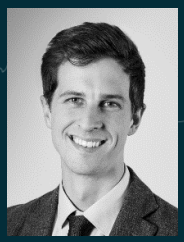

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About Rasmussen Global

Founded by Anders Fogh Rasmussen after his term as NATO Secretary General in 2014, and with a presence in Berlin, Brussels, Copenhagen, and Kyiv, Rasmussen Global is a firm with a purpose: we advise and support democratic governments and multinational companies in navigating geopolitical trends and major public policy developments.

We have worked closely with, in, and on Ukraine for the past seven years and have been working pro-bono with the Ukrainian President's Office since July 2022 on Ukraine's long-term security. This work resulted in the Kyiv Security Compact, co-authored by Anders Fogh Rasmussen and Andriy Yermak.

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2. Reach governments, institutions, and key opinion-makers, shaping policies on behalf of our clients.
3. Employ a commanding media outreach, to shape ideas and mobilize public opinion.

Rasmussen Global has been working alongside global telecommunication company Viasat Inc. for four years, on a campaign to promote space sustainability. This paper was produced with the support of Viasat Inc.

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