Forum	United Nations Office on Outer Space Affairs
Issue	Governing commercial mega-constellations
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Introduction

Commercial mega-constellations, extremely large systems of satellites, have appeared and are radically changing the world of communication and navigation. There are thousands of these satellites which organizations release to provide adequate provision of the internet, better control of weather conditions, and navigation. Despite the enormous potential advantages, these approaches are accompanied by equally complex issues. Problems like space debris, light pollution and the emerging problems of space scarcity on orbits require immediate consideration.

But among all of them, one of the most urgent issues is space debris. The problem with so many satellites in space is that there is an even greater probability of collision. Every collision then generates thousands of fragments that pose a danger to other satellites and spacecraft. If left unchecked, this upshot propagates a chain reaction whose consequence is termed Kessler Syndrome that renders certain orbits unusable. This occurs when when the density of objects in low Earth orbit reaches a critical threshold, leading to a self-sustaining cascade of collisions. Similarly, light pollution caused by the sheer number of light-emitting satellites affects ground-based astronomy. Astronomers struggle to observe faint celestial objects, as satellite trails disrupt images and data collection. This not only hinders scientific research but also impacts our ability to monitor space for potential hazards such as asteroids.

In order to overcome the aforementioned challenges the following measures have been proposed. Satellite operators are using better tracking techniques to prevent collisions while satellites being fabricated are being designed to go back to Earth at the end of their useful life cycle. Innovative technologies, such as robotic debris removal systems, are being developed to clean up existing space junk. On the regulatory aspect, the United Nations as

well as other organizations are in the process of codifying standards for deployable and operational satellite programs.

However, these efforts require stronger global cooperation and enforceable legal frameworks. Countries and companies must work together to ensure space remains a shared and sustainable resource. Additionally, investing in research and development can lead to new technologies that address future challenges. By balancing innovation with responsibility, it is fully within reach to harness the benefits of commercial mega-constellations while protecting the night sky and maintaining the safety of the Earth's orbital environment. This report will delve into the essential information needed to fully understand the situation of commercial mega-constellations.

Definition of Key Terms

Mega-constellations

An assembly of satellites that are chained together in coordinated orbits to provide global coverage for communication, navigation, or other services. [1]

Kessler syndrome

A hypothetical scenario where a chain reaction of collisions between space debris creates more debris, making Earth's orbit unusable.

Light pollution

When artificial lights such as light emitting satellites interfere with view of celestial objects and make astronomical observation impossible

Orbital space

The finite regions around Earth where satellites can operate without external interference such as atmospheric drag and electromagnetic interference. Risks of collisions rise when this region is overcrowded with satellites or debris.

Space debris

[1] "Communication, navigation, and related services" including direct broadcasting and digital utilities such as television, radio, global positioning, data transmission, space operations, radio astronomy, and Earth observation. - WMO definition

Space debris includes but is not limited to non-functional satellites, fragments of machinery from collisions, and other manmade remnants orbiting Earth. These fragments pose risks for operational spacecraft.

History

It was only at the end of the twentieth century that mega-constellations were proposed following innovation in satellite systems and the expanding need for communication and Internet services. Initiators of satellites, GPS satellites, and meteorological satellites created a stage for further innovations. Work on lower-cost satellites began to emerge in the mid-2000s and further intensified in the 2010s with SpaceX and OneWeb launching massive networks of satellites aimed at providing worldwide broadband services[2], making a significant shift towards the business of space.

Technological innovation

Miniaturization[3] of machinery, reusable rocket boosters and relatively low launch costs make mega-constellations possible. These developments have allowed the competitive participation of private companies with regards to any space endeavors and uses. An example is SpaceX: seeing SpaceX recently launched their starlink project, reusable rockets lower costs substantially, significantly improving the rate at which satellites can be deployed.

Economic incentives

The need to have internet for economic and social activity has led to skyrocketing amounts of investments in satellite systems. Larger developing countries are looking at mega-constellations as a means to close the digital divide [4]and offer internet connectivity to disconnected places. From an investor point of view, these projects bring in massive revenue since the world continues to integrate itself in a manner that favors modern communication infrastructure. However, opponents claim that such stimuli are still more focused on revenue generation than sustainability and can deepen existing injustice.

Regulatory challenges

The amount of legal loopholes and other unprecedented activities have accelerated such that current laws and regulations appear inadequate, putting pressure on stakeholders. In response, lesser developed countries have raised concerns of the overwhelming dominance of bigger countries in space and the monopolization of orbital slots. At the same time, astronomers and environmentalists raised concerns about negative externalities for

[2] High-speed internet connection that allows users to access the internet and related services
[3] The process of making products and devices smaller
[4] The gap between people who have access to technology and those who do not

science and the environment, where artificial light trails disrupt stargazing and present yet another problem of space pollution.

Diverse perspectives on development

The amount of legal loopholes and other unprecedented activities have accelerated such that current laws and regulations appear inadequate, putting pressure on stakeholders. In response, lesser developed countries have raised concerns of the overwhelming dominance of bigger countries in space and the monopolization of orbital slots. At the same time, astronomers and environmentalists raised concerns about negative externalities for science and the environment, where artificial light trails disrupt stargazing and present yet another problem of space pollution.

Political and social concerns

The dominance of mega-constellations in space by a few nations or private organizations has led to debates regarding sovereignty in space. Less developed countries claimed that these seemingly unfair systems worsen the dispute between spacefaring and non-spacefaring nations. Additionally, the excessive reliance on commercial organizations who approach space technologies with profit-based goals for crucial services has raised questions about the accountability and reliability of mega-constellations. One example is the concern that the Starlink and OneWeb dominance leads to access inequality. Developing nations with limited space programs struggle to participate on equal footing.

Humanitarian and environmental impacts

From a humanitarian perspective, the potential of these groups of satellites is extremely beneficial to the public. Benefits include support for agriculture, weather monitoring, and more advanced disaster response technologies. However, the environmental tolls that follow are equally unavoidable. The carbon footprint caused by the frequent launch of satellites accompanied by the broader problems of space debris highlights the critical need for a more sustainable alternative to offering services through space innovations.

Long term implications

The question of how humanity should govern the use of shared global resources like orbital space remains a crucial topic for debate among countries. Historical conflicts over natural resources such as oil reserves have displayed to the world that without comprehensive and socially equitable agreements, competition will exacerbate, further deepening the challenges of sustainability in space. International cooperation and communication will be vital in building an ideal future where the benefits of mega-constellations are harnessed while refraining from compromising the safety of Earth's orbital environments

Major Parties Involved

SpaceX

SpaceX, a world-dominant space launch provider and manufacturer has been a notable player in the development of mega-constellations. Its recent Starlink program aims to provide global internet coverage by utilizing mega-constellations. Although it has pushed efforts to promote reusable rocket technology mainly to reduce costs and accelerate satellite launches, it has still faced numerous criticisms regarding its vast contribution to overcrowding in Earth's orbital regions. In order to overcome these problems, SpaceX has implemented solutions into practice such as painting satellites black to lessen brightness and upgrading tracking systems to lessen collision threats. However, questions concerning the sustainability and accountability of SpaceX's activities are still consistently being brought to attention.

OneWeb

Another major contender in the mega-constellation industry, OneWeb's goal is to provide global broadband connectivity in order to bridge divides internationally. Unlike SpaceX, OneWeb has focused their work on collaborating with governments and other international organizations to offer more accessible internet systems in regions without the necessary financial capacity or technological innovation. Although OneWeb's scale is much smaller than SpaceX's Starlink, it has put comparably more effort into creating sustainable alternatives for satellites through ways such as creating de-orbiting satellites. However, it has recently faced many financial challenges.

National Aeronautics and Space Administration (NASA)

NASA is one of the major governmental organizations[5] involved in space exploration and scientific research. Although NASA has been somewhat passive on its stance regarding the management of commercial mega-constellations, it has expressed its concerns for the problems of space debris and the necessity for global cooperation when approaching this issue. NASA gives backing to space debris removability innovative technologies and calls for stricter regulations on harnessing the benefits of space.

United Nations Office on Outer Space Affairs (UNOOSA)

A department within the UN secretariat, The United Nations Office for Outer Space Affairs (UNOOSA) promotes international cooperation in space exploration and the peaceful

[5] Within the USA

use of outer space. It helps develop space law, supports capacity-building in space technology, and assists countries in using space for sustainable development.

Previous Attempts to Solve the Issue

Many initiatives were advocated for to mitigate the environmental impact of mega-constellations. Many private companies such as SpaceX and OneWeb have developed new satellites equipped with the necessary propulsion systems, allowing them to de-orbit after their useful cycle. Other new alternatives were also implemented including advanced tracking systems to avoid collisions and dark covers on satellites to minimize light pollution. While these measures have reduced the potential risks, they are not implemented on an international basis, limiting their influence on this issue.

In the regulatory aspect, many organizations such as UNOOSA have collaborated with the international community in setting new equitable guidelines regarding the mitigation of space debris and overall the utilization of space as a shared resource. Despite these efforts, regulation reinforcements at this stage can only go so far with its influence and its rate of compliance essentially depends on the dominant entities' goodwill. Additionally, there have been concerns about the dual use of technology in space, where these machines could be repurposed for military operations, ultimately slowing down international cooperation.

Actions have also been taken to remove the already existing space debris from space through innovative solutions. Machinery such as robotic arms and nets have been develop to clean up Earth's orbital region. Numerous organizations such as the European Space Agency have launched projects to test these solutions, with some proving themselves to be successful. However, the financial burden and technological challenges remain as obstacles to completely clearing out Earth's orbital space of debris.

Possible Solutions

- As seen in the previous attempts, innovation is a major faction of the solutions that can be implemented. By developing new technologies that either help to stop the production of space debris for the future or collect already existing debris, worse situations can be avoided.
- Another previously mentioned solution is the promotion of international cooperation. All nations and relevant parties must have a say in the decisions that are made as space is a shared resource.
- Governments could take measures to incentivize sustainable practices in the mega-constellation market.

- Public education could be utilized to raise awareness of the importance of governing space as a shared resource
- The issue of monopolization in space could also be addressed by offering equitable access to space.
- Strengthening legal frameworks is essential to establishing order in space.

Appendix

Below are some helpful resources that delegates may use for research 😊

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"Mega-Constellations Are Set to Flood Earth's Orbit." *Keep Track*, keeptrack.space/deep-dive/mega-constellations/#:~:text=As%20of%202023%2C%20there%20are,by%20aerospace%20companies%20and%20researchers. Accessed 12 Feb. 2025.