THE NEED FOR EVOLVING LEGAL FRAMEWORK FOR REGULATION OF SPACE DEBRIS CAUSED BY SATELLITE CONSTELLATIONS

by

Nikita Bhakare

IV B.A. LL.B. student, ILS Law College, Pune (India)

Email- nikitabhakare@gmail.com

ABSTRACT

The avidly discussed Starlink Network of SpaceX or that of other companies such as OneWeb or Amazon is paving way for a setting a new trend of mega-constellation culture in the commercial satellite world, simultaneously raising tremendous concern regarding the adverse impact it may have on its immediate environment in outer space as well as Low Earth Orbits (LEOs). Kessler Syndrome would certainly become more visible and apparent with an increase in such activities, especially when trails of unresponsive debris left-over from launches cease to manoeuvre in orbit while remaining unregulated.

Furthermore, accumulation of these can also cause a crisis in the wake for not just mere creation of additional undesirable traffic in outer space but can also pose a threat to life on the ISS or other functioning satellites. In some cases, measures such as the ASAT tests are initiated to mitigate the amount of dead objects hovering in space. However, all this is relatively recent technology and a legal framework for the same needs some revamping. This paper aims to evaluate the current policies and recommend novel additions to the existing regulatory regime, with an emphasis on the private industry. Whether the compliance of these companies is in harmony with national legislation along-with guidelines from international bodies like UNCOPUOS and IADC would be another important insight with respect to the issue highlighted in this paper.

Key words*: Satellite constellation, Space Debris, LEOs, Astronomy, Legal, Regulations, collisions, risk, damage*

ABBREVIATIONS (in order of appearance)

LEO: Low Earth Orbit

SATCON1: Satellite Constellation Working Group 1

SATCON2: Satellite Constellation Working Group 2

IDA: International Dark Skies Association

IAU: International Astronomical Union

NASA: National

OPP: Office of Planetary Protection

NID: National Interim Directive

NEPA: National Environmental Policy Act

SSN: Space Surveillance Network

ITU: International Telecommunications Union

FCC: Federal Communications Commission

NGC: New General Catalogue

ASAT: Anti- Satellite

UNCOPUOS: United Nations Committee on the Peaceful Uses of Outer Space

UNOOSA: United Nations Office for Outer Space Affairs

OST: The Outer Space Treaty

AAS: American Astronomical Society

TRAI: Telecom Regulatory Authority of India

WTO: World Trade Organisation

IADC: Inter-Agency Space Debris Mitigation Coordination Committee

ESA: European Space Agency

JAXA: Japan Aerospace Exploration Agency

UNGA: United Nations General Assembly

ISO: International Organization for Standardization

SSR: Space Sustainability Ratings

STM: Space-Traffic Management

ADR: Active Debris Removal

SDA: Space Data Association

1. INTRODUCTION

Ever since the first collection of Iridium and Globalstar satellites were launched into space, they have been the precursors to and pioneered a new wave of phenomena of satellite constellations. In today's world, the corporate ventures have taken over the satellite and communications industry and along with it, bring their fair share of practical challenges and legal concerns including that of space debris. The various instruments that play an important role in the regulation and monitoring of adverse impacts caused by the result of creation of space debris due to satellite constellations will be elaborated in this paper.

2. IMPACT OF SATELLITE CONSTELLATIONS

Swarms of small satellites tracking information together in a holistic manner as an alternative to one large satellite being used for the very same purpose, gives rise to the concept known as 'satellite constellations'. Their practical utility in the form of global communications coverage, connectivity and data extraction via remote sensing and Earth observation techniques has been revolutionising the sectors of education, economy, healthcare, services and also contributing to the overall development of sciences. [1] Needless to say, the impact of it all touches upon various domains such as Astronomy, orbital space and general usage of outer space, dark skies, economic enterprise and the environment amongst many. [2]

Furthermore, this influence can be significantly observed in the spatial mapping of the LEOs, and it is predicted that Earth's orbits are "together likely to represent a $1 trillion economy in the next 20 years, by housing the highest number of satellites in history". [3]

It is equally important to note that this trend and gradual movement from launching bulky, expensive and complex spacecrafts, towards a gaining preference for smaller and simpler, cost-effective versions has opened up barriers for business opportunities for private entities apart from government agencies and individual organisations. [4]

These constellations constituting bright satellites also play a factor in posing a fundamental threat to optical and infrared astronomy, according to a report in 2020 by SATCON1. It heralded that the process could severely affect astronomical research due to interference with the radio spectrum. Apart from the abovementioned, as stated by Vera. C. Rubin Observatory, the Starlink satellites, for example obstructed the ground-based telescope view used for the search and study of celestial objects such as comets or asteroids. [5] For example, the incident of Neowise, a rare comet's predicted sighting close to the sun in about 6800 years was ruined due to the same group of satellites. [6] Similarly, the debris and trail of the OneWeb fleet visible at peak night hours combined with an altitude factor can have negative effects on worldwide observations. [7] Regardless to mention, the light pollution will be alarmingly detrimental to night skies with respect to amateur astronomers, astrophotography and nature enthusiasts alike. [8] SATCON2 in early to mid-2021, aims to work upon the international regulatory framework in regard to the adverse impact of LEO-constellations on the night skies. A similar concern was observed to be upheld by the International Dark-Sky Association (IDA), and the International Astronomical Union (IAU).

Satellites and the debris associated with it may have the potential to impact planetary protection as another category. It is said that the incentive of launching constellations extends towards exploration and activity on the Moon, Mars and celestial bodies. Whether it is any damage associated with the debris or the general purpose of them being installed in orbits, contamination concerns- those assigned to the NASA's Office of Planetary Protection (OPP), a National interim directive (NID)

titled ‘Planetary Protection Categorization for Robotic and Crewed Missions to the Earth’s Moon’, and the National Environmental Policy Act (NEPA) were some speculative measures that were consequently allocated importance in light of the same. [9]

Lastly, “cultural practices with the night sky are in real time and cannot utilize filters or software to remove low-Earth orbit satellite constellation trails and interference with observations.” [10] The night skies hold sacred, cultural, and historic significance to several indigenous communities across the world, and the practices often tend to have an intertwined scientific connotation not unlike celestial navigation or wayfinding. [11]

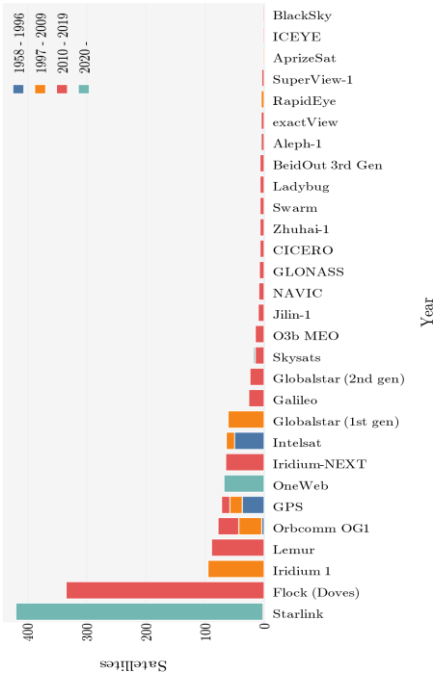
3. KESSLER SYNDROME AND SPACE DEBRIS

The Kessler Syndrome thesis ‘Collision Frequency of Artificial Satellites: The Creation of a Debris Belt’ in 1978 highlighted and mentioned the concept of ‘collisional cascading’ in which both Kessler and Cour-Palais argued that “the more debris there is in orbit, the more collisions will occur, and create more debris” thus setting off a dangerous chain reaction. [12] Kessler’s team in 2010 further predicted a “slow yet continuous growth in collision fragments that will not stop until the intact population is reduced in number”. [13]

Additionally, Moore's Law derived from the domain of electronics, has helped in an exponential development of small satellites, a causal-effect relationship contributed to the incessant usage of smartphones in the modern era. [14]

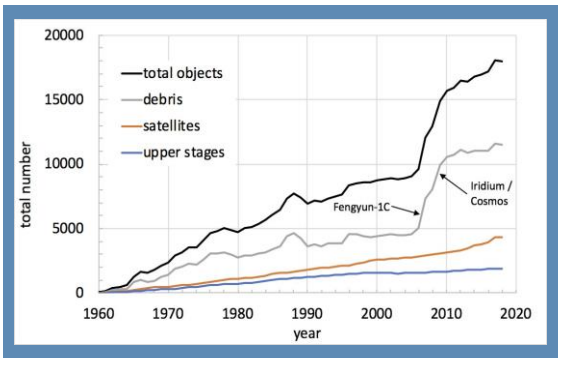
According to a 2020 thesis report depicted, the number of satellites launched in constellations has been rising at an alarming rate and with it the brings the risks and challenges, in general as well as those caused to the operators due to in-orbit collisions, debris generation, and interference with human activities.[15] The companies responsible for the launches are also demonstrated.

Figure 1: Satellites launched per constellation and coloured by year of launch



In another report by Center for Space Policy and Strategy, the graph cited below sheds light on the number of objects registered in the Space Surveillance Network (SSN) increasing over the past decades. [16] This without a doubt calls for an urgent need to evaluate the current situation of possibility to the creation of space debris in not just the LEOs but also the harm associated with it in all arenas.

Figure 2: Number of objects in SSN catalogue.



4. PRIVATE MEGACONSTELLATIONS

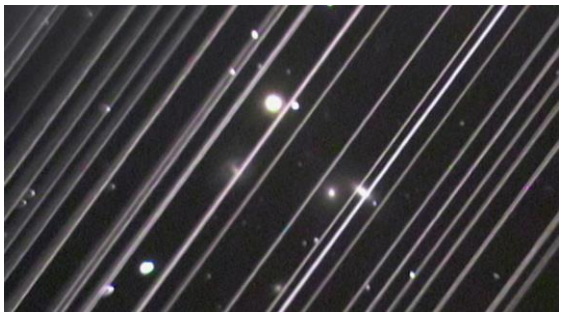
Webs of networked satellites, generally ranging from hundreds to even thousands, launched in the LEOs with the incentive of providing network coverage and services all over the Earth are said to give rise to a phenomenon popularly termed as megaconstellations. The grand LEO megastructures as of now plan to operate via the Ka or Ku band as

"these frequencies enable higher data rates, smaller antennas, narrower beams, and greater security" which objectively provides for increasing individual satellite capacity.[17] Following are some major sets of structures owned by Private corporations that may affect the space debris situation in the near future.

4.1 STARLINK

One of SpaceX's most ambitious projects in the LEO region, it consists of around 30,000 satellites launched in batches of 60 at an altitude of 300 miles above the earth's surface for the purpose of ensuring internet connectivity amongst others over long distance and for individual users. They are said to have a magnitude between 4 and 6 in the average night sky. The proposal for the non-geo Ku-band by the company was filed with the International Telecommunications Union (ITU), along-with an FCC filing, raising apprehension from a good chunk of the global astronomy community. If successful in launch endeavours, it may pave way for a high series of collisions as three percent of the total number of satellites are already estimated to be out of working order.

Figure 3: A publicly released IAU image Galaxy of the group NGC 5353/4 at Lowell Observatory shows the launched Starlink satellite trails obstructing telescope observations, a warning indicator.



4.2 ONEWEB

The GBR Registered company's Mega-project revolves around a constellation made of 648 satellites at an altitude of 1200 km and beaming internet across the oceans and airspace.[18] OneWeb has placed their satellites in a relatively clean orbit, with almost no presence of junk or debris, however one cannot rule out the entire possibility of it remaining in the same state. The Ku-band global license has already been issued by the ITU and they will be teaming up with Airbus as well. Interestingly, it is one of the companies that will be taking an initiative to mitigate the grievance of space debris. [19]

4.3 KUIPER, LEOSAT ET AL

Amazon's novel venture, Kuiper is a collective set of 3200 satellites hovering at a range from 590 to 630 km and operating at Ka band frequencies, with already having gotten the FCC approval. [20] It has garnered scepticism for leaving trails amounting to light pollution besides leaving behind traces of malfunctioning hardware in space.

LeoSat strategy consists of around 140 Ka band satellites launched into space at 1400 km polar orbits. [21] There are multiple other companies such as Telesat, Honyan, SES Satellites, Facebook's Athena Project and the GX7 plan by Inmarsat in collaboration with Airbus that aim to launch their own large-scale satellite webs in the future. Commercial Cube-sat constellations would soon be the next concepts in line. It is reasonable to assume that the concept of satellite constellations is becoming staple as humans now exist in a time for re-evaluating traditional strategies.

5. ANTI-SATELLITE (ASAT) TECHNOLOGY AND SPACE DEBRIS

The ASAT test conducted by India, after China, as another example in the past couple of years raised critical apprehension from the states claiming that the debris caused by the destruction of their satellites can pose harm to the International Space Station. While India claimed that the ASAT was only used for freeing up space for their property by disposing their own satellite structures, the action called against them was that of unnecessary nature. The silent hostility can be traced back to two prominent incidences, namely a Chinese anti-satellite test in 2007 and when 2 satellites accidentally collided with each other in the year 2009. Whether the ASAT mission amounted as an act of crime under International Space Law is a mind perspiring debate even today.

6. EXISTING LEGAL FRAMEWORK

The tangible development of all these events is indicative of the presence of massive commercial mega-constellation movement that is not far from taking over the telecommunications and private space industry. It is therefore important to be careful of the fact that there does not exist solid concrete grounds for regulation and that no entity takes advantage of activities that may generate junk or

associate with any debris in the arena of orbital Space.

6.1 UNITED NATIONS

UNCOPUOS and **UNOOSA** are the Regulatory and Advisory bodies in case of occurrence of conflicts regarding satellites and space debris. While International Space Law has not yet defined the concept of Space Debris, the Outer Space Treaty of 1967, the Liability Convention of 1972 and the Registration Convention enacted in 1976 have been acting as key legislations in determining damage around this. Articles VIII, IX of the **OST**, Article I of the Liability Convention, etc are some examples that elaborate upon the application of space law principles to any satellite activity of unethical or abnormal manner.

The Nairobi International Convention on the Removal of Wrecks and The Bogota Declaration are a few more supporting authorities to refer to satellites and legal issues associated.

6.2 International Astronomical Union (IAU)

While IAU is not the strictly authoritative regulatory body when it comes to issues on debris, it has always played an instrumental role by advising and organising International discussion platforms and forums such as Workshops such as AAS's initiative for SATCON1, etc, Working Groups, and in collaboration with several global research institutions such as the International Dark Skies Association to support the cause of 'protecting our Dark and Radio-quiet Skies'.

6.3 International Telecommunications Union (ITU)

The International Telecommunications Union is perhaps one of the most important authorities on the mentioned matter at hand. ITU tries to "keep satellite communications free of interference and prevent congestion of orbital slots." [22]

Dual-sovereignty can be seen here as the ITU initially issues global spectrum licenses on first come, first-served basis, after which the national telecom regulators (US-FCC, India-TRAI/DeitY) step up and grant domestic territorial landing rights. [23] Conventionally, these landing rights are based on the principle of reciprocity in satellite markets between the host and home countries, made easier if both are WTO member states. [24] ITU thus acts as the premier step for license clearance for the launch of satellites.

6.4 Inter-Agency Space Debris Mitigation Coordination Committee (IADC)

The Inter-Agency Space Debris Mitigation Coordination Committee (IADC), composed of the ESA, NASA, JAXA, the Russian Federal Space Agency, Roscosmos, issued the Space Debris Mitigation Guidelines in 2002 which defined "space debris" as "all man-made space objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional" however it was still internationally and legally regarded as hazardous by its profile, as should be kept in consideration while launching large scale satellite structures in space. [25] Guidelines in 2002 were also endorsed by the UNGA in 2007.

The International Organization for Standardization (ISO) also provides detailed technical instructions for the implementation of the Space Debris Mitigation Guidelines, in spite of the non-binding nature of both, several states across the world have chosen to abide by the prescribed code of conduct while undertaking any such activity in space, especially in grave consideration of the actively occupied LEO region. [26]

6.5 National Environmental Policy Act (NEPA)

The National Environmental Policy Act enacted in 1970, "obligates all federal agencies to consider the environmental impacts of any projects they approve which may generally range from environmental disputes to overall climate change, Sec. 2 throws light on policies that promote "enjoyable harmony between man and his environment which will prevent or eliminate damage to the environment and biosphere." [27]

Amazon's Project is currently under FCC review, not to mention the FCC was deemed to be in non-compliance and in violation with NEPA procedure while procuring licences for SpaceX in the Case of Starlink. [28]

7. PROPOSED FOCUS AND INCLUSION

In view of all the grey areas of Law and Policies in order to regulate satellite constellations, it has been clear that since the law is not always binding, it tends to leave much scope for ruthless exploitation of the legislative frameworks. Hence, it could prove to be valuable by incorporating the following concepts while allowing large sat-structures up in the skies.

7.1 Space Sustainability Ratings (SSR) and Space-Traffic Management (STM)

Space Sustainability Ratings is a novel concept that implores companies to inculcate the Long-Term Sustainability Principles while tracking the satellite activity, in this case, in corporate and commercial ventures, an initiative by MIT and Bryce Space.

Space-Traffic Management is a highly essential technique that should be made non-negotiable and mandatory for every entity present in space. It may include methods such as Active Debris Removal (ADR). “Rules of the road, including right of way and similar behavioural norms, are in their infancy today for space in the way of practice, domestic policy or international guidelines” and the Space Data Association (SDA) is working on co-operation for international mutual benefit via formal rules of distributing information, coordinating manoeuvres, etc, also applied at high seas and international airspaces as well. [29]

7.2 Newspace & Public-Private Partnerships

In an era of Privatisation, it only makes sense to resort to Public-private partnerships in order to facilitate ease of legal access besides financial and business relationships. The concept of NewSpace must be inculcated in the traditional Space Code and Policies, in order to not restrict the growth of human endeavours. There are several ways where the outcome of Government and private companies interacting is advantageous. For eg, CleanSpace, engaging in ADR mentioned above.

8. CONCLUSION

The threat of satellite constellations is not only limited to life on Earth, but also life and property in Space such as the International Space Station. It is concluded that the legal concerns mainly deal with IPR, contracts, tortious liability connected to insurances, especially when it is difficult to determine liability in the first place, due to lacking definition. Whether the licensing agencies are in compliance to all regulatory procedures is another common obstacle while dealing with such large-scale projects. Calculation of losses under policies, recoverable or assessing the uninsured risks, negligence and compensation, degrees of causation, these are all areas that are still unclear with respect to this topic and must be probed into further. [30]

REFERENCES

[1] Chen, Chuan, and Yang, Wulin, (2017). The impact of large constellations on space debris environment and its Countermeasures. *8th European Conference for Aeronautics and Space Sciences (Eucass)*. DOI: 10.13009/EUCASS2019-885. Available online at www.eucass.eu/doi/EUCASS2019-0885.pdf

[2] Venkatesan, Aparna et al. (2020). The impact of satellite constellations on space as an ancestral global commons. *Nature Astronomy*. VOL 4. 1043–1048. https://doi.org/10.1038/s41550-020-01238-3 Available online at www.nature.com/articles/s41550-020-01238-3.pdf

[3] Qureshi, Afiyah, (2020). The Startup Building the First Constellation of Satellites to Track Space Debris. *The Wire*. Available online at science.thewire.in/spaceflight/interview-northstar-orbital-debris-space-situational-awareness-project-skylark/

[4] Lag, Steinar, (2020). Mega-constellation satellites on the horizon. *DNV GL Technology Outlook 2030*. Available online at www.dnv.com/to2030/technology/mega-constellation-satellites-on-the-horizon.html

[5] AAS Press Release, (2020). Astronomers’ issue report on the effect of ‘satellite constellations’ on astronomy. *EarthSky News*. Available online at earthsky.org/space/astronomers-report-effect-of-satellite-constellations-astronomy

[6] Singh, Srijesh. (2020). Starlink Project: Why The Law Needs To Catch Up. *Law School Policy Review & Kautilya Society*. Available online at lawschoolpolicyreview.com/2020/07/29/starlink-project-why-the-law-needs-to-catch-up/

[7] Supra note 5.

[8] Ibid.

[9] Supra note 2.

[10] Supra.

[11] Ibid.

[12] Obolewicz, Jerzy et al. (2020). Safety Engineering of Anthropogenic Objects: A Map of Knowledge and its Importance in The Life Cycle of a Construction Object. *ResearchGate*. Available online at www.researchgate.net/publication/342570991_SAFETY_ENGINEERING_OF_ANTHROPOGENIC_OBJECTS_A_MAP_OF_KNOWLEDGE_AND_I

TS_IMPORTANCE_IN_THE_LIFE_CYCLE_OF_A_CONSTRUCTIOM_OBJECT

[13] Supra.

[14] Velivela, Vignan. (2015). Small Satellite Constellations: The Promise of 'Internet for All'. *ORF ISSUE BRIEF No. 107*. Available online at orfonline.org/wp-content/uploads/2015/12/IBrief1071.pdf

[15] Supra.

[16] Peterson, Glenn et al. (2018). Space Traffic Management in the Age of New Space. *Center for Space Policy and Strategy.* Available online at aerospace.org/sites/default/files/2018-05/SpaceTrafficMgmt_0.pdf

[17] Daehnick, Chris et al. (2020). Large LEO satellite constellations: Will it be different this time? *McKinsey and Company, Aerospace and Defense*. Available online at www.mckinsey.com/industries/aerospace-and-defense/our-insights/large-leo-satellite-constellations-will-it-be-different-this-time#

[18] Supra note 14.

[19] OneWeb Access for Everyone Proprietary. (2017) OneWeb's Approach to Space Debris Mitigation. *UN/UAE High Level Forum*. Available online at www.unoosa.org/documents/pdf/hlf/HLF2017/presentations/Day3/Special_Session/Presentation2.pdf

[20] Hebden, Kerry, (2020). Amazon's Kuiper mega constellation gets FCC approval. *Room Space Journal of Asgardia*. Available online at room.eu.com/news/amazons-kuiper-mega-constellation-gets-fcc-approval

[21] Supra note 18.

[22] Supra supra.

[23] Ibid.

[24] Ibid.

[25] IADC, 2002, Revision 1, 2007, 3.1. Space Debris.

[26] Kaiser, Martha Mejía, (2020). Space Law and Hazardous Space Debris. *International Institute of Space Law.* Available online at doi.org/10.1093/acrefore/9780190647926.013.70

[27] O'Callaghan, Jonathan, (2020). Starlink Mega Constellation May Have Been Unlawful. *Scientific American*. Available at www.scientificamerican.com/article/the-fccs-approval-of-spacexs-starlink-mega-constellation-may-have-been-unlawful/

[28] Supra.

[29] Lewis, Hugh. (2018). New space, new dimensions, new challenges: How satellite constellations impact space risk. *Swiss Re*. Available online at swissre.com/Library/how-satellite-constellations-impact-space-risk.html

[30] Supra.