Dimensions of International Legal Regime of Changing Space Security

Ms. Jinia Kundu[1]
Prof. (Dr.) Bhavani Prasad Panda[2]

Abstract

The modern debate on space debris emphasizes on state liabilities from the prism of technological commercialization along with state liability questions emanating from the existing international conventions, treaties and agreements. With increased technological dependence, their pitfalls are causing obstacles. For instance, there is reliance on cyber infrastructure and proportionate vulnerability through cyber-attacks like Distributed Denial of Service (DDOS). While the 'new space movement' has augmented manifold private participation, there is consistent divergence between outdated treaties enforcement and the techno-legal narratives leading to interpretative challenges. This has implications for orbital debris. For instance, if a satellite relies on artificially intelligent algorithm to determine whether a potential breach could cause orbital debris, questions of state liability are inevitable. Further, technology induced interpretative issues having a bearing on space debris liability within Conventions such as the Outer Space Treaty, 1967 have emerged on account of lack of coherent provisions. Therefore, lack of harmony between outdated legal provisions and technology has distorted the debate on orbital debris state liability enforcement. The present paper is an attempt to analyze the aforesaid changed paradigms of techno-legal framework of orbital debris and provide suitable suggestions within the space security ambit.

Keywords: *Space debris, state liability, space security, techno-legal narratives, new space movement, technological commercialization, artificially intelligent algorithm.*

[1] Assistant Professor-II, KIIT School of Law, Bhubaneswar, Odisha, India
[2] Director, KIIT School of Law, Bhubaneswar, Odisha, India.

I. INTRODUCTION

'The use of space and space-based assets and services' are now prevalent to an extent that the international fraternity has become accustomed and extensively reliant on them[3]. This is an inevitable reality for numerous sectors such as telecommunication industry, environmental assessment and resource governance which are critical in managing different aspects of space security. The space industry is a complicated integration of evolving dynamics and ideas[4]. Space security is a multi-dimensional concept having widespread ramifications for the state sovereignty, the corresponding geo-political environment and the commercial industry applications. Corporations are focused on venturing into innovative technologies experimenting them with different space infrastructure. This has technological and legal implications for an evolving space security paradigm on account of greater investments in research and development which produces new imperatives and applications into the debate on space security, because the incumbent legal framework will have to adapt to technological consequences.

II. SPACE SECURITY: THE CONCEPT

Conventionally, space security as a concept has remained confined to the military security of the States which comprises of the genesis of space security. In addition to this, the military security is also reflective of State behavior, and in this context, space security has been expanded to apply to human space activities. Outer space has become a domain where a prominent quantum of States are dependent upon jurisdictional space assets[5] keeping in mind military and civilian functions. Moreover, space security has embraced the concept of autonomy of access and use of space by different jurisdictions who express interest to use outer space for military, socio-economic and commercial purposes.

Commercial and military activities were augmented by United States and erstwhile USSR. However, in the modern-day space age, many jurisdictions

[3] Kai Uwe Schrogl, INTRODUCTION IN HANDBOOK ON SPACE SECURITY 9 (Peter L. Hays et al. eds., 2nd ed., Springer 2014).
[4] M. Manulis et al., *Cyber security in New Space: Analysis of Threats, Key Enabling Technologies and Challenges* 20 (3) INT'L J. INFO. SEC. 288, 287-311 (2020).
[5] Lutfiie Ametova, *International interest in space assets under the Cape Town Convention* 92(2) ACTA ASTRONAUTICA 213, 213-225 (2013).

participate in space activities either directly or indirectly[6]. An important traditional component of space-security is the risk of impairment of outer-space environment and its consequent extent of state liability attached with it. On account of use of space by multiple states through space assets like satellites, and space weapons like the Anti-Satellite weapons (ASAT)[7], the outer space has been engulfed with enormous quantum of space debris generated through years of unrestricted access and experimentation with the outer-space environment. The quantum of orbital debris in the space-environment is proportional to the extent of damage not only from collision but also other factors like outer space activities that includes debris generated from stages of satellite launch, natural space debris (meteoroids, asteroids), etc.[8]

It may be noted that outer space debris causes damage not only to the space environment but also impacting the earth's atmosphere when making contact with the same. For instance, orbital debris generated out of satellite collision can cause the remnants to damage the marine or aquatic life and impact the eco-system on earth[9]. The orbital debris crisis also poses a risk to Earth when orbital debris enters the Earth's atmosphere and collides upon the surface of the land or water below[10]. In contrast with the earth's environment, outer-space environment differs in relation to of inability to measure and take remedial steps to reduce the negative environmental impact by the debris generated.

As opposed to the Earth's habitat which can be cleared-up and reinstated to earlier condition, outer-space is subject to celestial mechanics[11] which creates uncertainty regarding the methodology to mitigate space debris in an attempt to

---

[6] Hong-Je Cho, *Militarization of Space and Arms Control* 33 (2) J. AEROSPACE POL'Y & L. SOC'Y 444, 443-469 (2018).
[7] Sandeepa Bhat & Kiran Mohan V*, Anti-Satellite Missile Testing: A Challenge To Article Iv Of The Outer Space Treaty* 2 NUJS L. REV.205,205-212 (2009).
[8] Meghan R. Plantz, *Orbital Debris: Out of Space*, 40 GA. J. INT'L & COMP. L., 594, 585-618 (2012).
[9] Michael Clormann & Nina Klimburg-Witjes, *Troubled Orbits and Earthly Concerns: Space Debris as a Boundary Infrastructure* 47(5) SCI. TECH. & HUM. VALUES 970, 960-985 (2022).
[10] *Id*. at Meghan R. Plantz, *Orbital Debris: Out of Space*, 40 GA. J. INT'L & COMP. L., 594, 585-618 (2012).
[11] Rada Popova & Volker Schaus, *The Legal Framework for Space Debris Remediation as a Tool for Sustainability in Outer Space* 5(55) AEROSPACE 3, 1-17 (2018).

restore the stability through natural orbital decay of outer space environment. Another major environmental concern is in relation to radioactive components[12] which can be a consequence of emanating chemical release into earth's atmosphere resulting in re-entry and leading to ozone layer depletion and the resultant debris becomes an impediment for future space exploration activities.

III. SPACE SECURITY AND EVOLVING PARADIGM

Positive correlation may be inferred between increased quantum of satellites with space commercialization. This is further evidence of proliferated usage of space infrastructure by corporations representing different jurisdictions. However, it may be observed that owing to the aforesaid correlation, there is a discernible pattern, wherein satellites, remains of space rockets, etc. are contributing to quantifiable space debris and raising questions of remediation from the perspective of incumbent state liability. Having said that, increased commercialization has induced technological dependence in terms of existing and emerging technologies. Therefore, this has introduced debates on standardization, regulation of new technologies and data protection which has influenced the methodologies for determining space debris remediation and state liability. Consequently, space law is witnessing heightened friction between regulations and technological progress.

Law and technology are two seemingly inherent contractions which must always be in synchronization with each other, the opposite consequence of which is the technology-law conundrum. The phenomena refer to the legal framework's inability to be at par with the technological developments impacting enforcement of the incumbent legislative setup. From this perspective, technology epitomizes a tool of liberation and collaboration[13] wherein the regulatory framework must find its rightful place. From an orbital debris and space security perspective, technical challenges are prevalent. An important illustration in this regard is the widely documented inherent defects in the design of satellites such as them being

[12] Gershon Hasin, *Confronting Space Debris Through the Regime Evolution Approach* 97 INT'L L. STUD. 1079, 1073-1159 (2021).

[13] Sara M. Smyth, *The Facebook Conundrum: Is it Time to Usher in a New Era of Regulation for Big Tech?* 13 (2) INT'L J. CYBER CRIMINOLOGY 581, 578-595 (2019).

large and conspicuous[14] and having room for minimal manoeuvrability. In such scenario, scope for collision is likely to increase leading to space debris.

A. Space Security and Cyber Security: An Emerging Paradigm

A dominant contentious issue in international space regulatory regime is whether a uniform definition of 'peaceful purposes' and 'weapon' can be agreed upon. The terms are vaguely agreed upon and in terms of space security perspective, they assume special significance considering that cyber infrastructure constitutes a critical component of space industry[15] in areas like launch vehicles, satellites, secondary equipment to primary infrastructure, and the like. Strictly speaking from a space security perspective, the potential of usage of new kinds of technology, including emerging technologies, the rise of data economy and the proliferation of cyber-attacks on critical infrastructure, raise fundamental questions about space security from a new dimension.

Presently, developing security obstacles in the outer-space context have caused an unparalleled negative impact upon the foundation of the international space framework[16]. For instance, if SpaceX has developed a launch vehicle and a satellite system, both heavily reliant on complicated security protocols functioning on the basis of complex algorithms, however they go a step further and start appropriating resources from the moon, asteroids, etc. among others, the real question which arises for consideration is whether such kind of property rights are permissible within the existing legal regime. The quagmire is pertinent and undetermined. Certain response would epitomize the future of billion-dollar sector which presently stands on an unpredictable regulatory foundation[17].

Generally, it is increasingly becoming a prerogative to design space infrastructure with prominent reference to the cyber-related aspects associated with the

[14] David A. Koplow, *The Fault Is Not in Our Stars: Avoiding an Arms Race in Outer Space* 59 (2) HARV. INT'L L.J. 345, 331-388 (2018).
[15] James Pavur & Ivan Martinovic, *Building a launchpad for satellite cyber-security research: lessons from 60 years of spaceflight* 8(1) J. Cybersecurity 1, 1-17 (2022).
[16] Fabio Van Loon, *Codifying Jus in Bello Spatialis-The Space Law of Tomorrow,* STRATEGIC STUD. Q. 2, 1-18 (2021).
[17] Melissa J. Durkee, *Interstitial Space Law* 97 (2) WASH. U. L. REV. 450, 423-481 (2019),

functional and operational elements of that infrastructure[18]. In light of the fact that satellites in space have been hacked before and resulting in outer space debris, it would be safe to presume that a space weapon does not necessarily have to be a physical weapon but instead demolishes the target's command, control, and space surveillance equipment[19] making all of them *sine qua non* for smooth operation of spacecraft and satellites. Hence, the real question for consideration is the extent up to which the OST along with other related instruments can be considered useful for bringing into the fold such categories of weapons within their ambit. This would further lead to a more contentious issue of the nature of the liability that is to be borne by the private entities and the nation states to which such entities must be registered.

Private participation in this technologically advanced industry resulted in an influx of a diverse space infrastructure such as radio frequency spectrum, slots in geostationary orbits (GSO)[20] making such space infrastructure vulnerable to cyber-attacks. However, the multitude of standards and regulations do not provide for a uniform mechanism to deal with eventualities when such attacks happen. In fact, it has been documented that there are considerable differences among States' approaches to remote sensing regulations, depending on their perceived needs for security, access to information and other factors[21].

IV. SPACE WEAPONIZATION AND SPACE DEBRIS: AN INTERPRETATIVE DILEMMA

Space weaponization is intricately connected with the quantum of space debris generation because the different modes of weaponry are directly proportional to the typology of space debris that can be prevalent. Two of the most prominent

18 Steven Freeland, *The Limits of Law: Challenges to the Global Governance of Space Activities* 150 (1) J.& PROC. ROYAL SOC'Y NEW SOUTH WALES 72, 70-82 (2020).

19 Sa'id Mosteshar, Space Law and Weapons in Space, Planetary Science (May 15, 2022, 8:02 PM), https://oxfordre.com/planetaryscience/view/10.1093/acrefore/9780190647926.001.0001/acrefore-9780190647926-e-74?print=pdf.

20 K.R. Sridhara Murthi & V. Gopalakrishnan, *Trends In Outer Space Activities—Legal And Policy Challenges,* in RECENT DEVELOPMENTS IN SPACE LAW: OPPORTUNITIES AND CHALLENGES 37 (R. Venkata Rao et al. eds., Springer Nature, Singapore 2017).

21 Sa'id Mosteshar, *Regulation of Remote Sensing by Satellites* in ROUTLEDGE HANDBOOK OF SPACE LAW 158 (Ram S. Jakhu et al. eds., Routledge UK 2017).

examples of this phenomenon are the deliberate destruction of the Chinese *Fengyun-IC*[22] in 2007 by ASAT and collision of COSMOS 2251 with IRIDIUM 33[23] in 2009, causing complete disintegration of both the satellites[24] and generating substantial orbital debris. With the passage of time as more countries have entered the space race, the scope for such orbital debris has increased in myriad proportions, thereby distorting the legal certainty created through the existing instruments of international space law. For instance, commentators have opined that on account of the international legal framework remaining unchanged, the scope for international responsibility and liability[25] has also remained unpredictable.

Therefore, questions on state liability can arise due to the inability of the existing international legal instruments to incorporate technological consequences. For instance, a space satellite equipped with complex data analysis algorithm and telecommunication infrastructure if malfunctions and becomes an object of space debris can raise questions of state liability. Therefore, the necessity of examining space security from this contemporary stand point cannot be undermined. This is further exacerbated by the fact that several countries are headed towards an overt weaponization of space[26], from which orbital debris is an inevitable reality.

V. REGULATORY FRAMEWORK: EXISTING DIVERGENCE

The incumbent international legal instruments are a reflection of the efficacy of international collaboration within the realm of outer-space exploration in its peaceful use. This is essential to propagate uniformity and cohesiveness among nation states with regards to a holistic outer-space access and the consequent

---

[22] Arjun Tan and Mark Dokhanian, *Velocity Perturbations Analysis of the Fengyun-1C Satellite Fragmentation Event* 3 (1) ADVANCES IN AEROSPACE SCI. & APPLICATIONS 35, 35-46 (2013).

[23] A. Tan, T.X. Zhang et.al., *Analysis of the Iridium 33 and Cosmos 2251 Collision using Velocity Perturbations of the Fragments* 3 (1) ADVANCES IN AEROSPACE SCI. AND APPLICATIONS 13, 13-25 (2013).

[24] Habimana Sylvestrea & V. R. Ramakrishna Paramab, *Space Debris: Reasons, Types, Impacts and Management,* 46 INDIAN J. OF RADIO & SPACE PHYSICS 21, 20-26 (2017).

[25] Lawrence Li, *Space Debris Mitigation as an International Law Obligation* 17 (3) INT'L COMMUNITY L. REV. 297, 297-335, (2015).

[26] Joan Johnson-Freese and David Burbach, *The Outer Space Treaty and the Weaponization of Space*, 75 (4) BULL. OF THE ATOM. SCIENTISTS 137, 137-141 (2019).

implications from a technical and legal perspective. From a regulatory standpoint, legal perspective encompasses questions on state liability, rights and obligations of multiple stakeholders.

Much of the international space law regime was drafted keeping in mind state liability as the focal area. As a result, though, the 'new space movement' has brought in a paradigm shift in the space industry with private participation as different stakeholders, the legal interpretation on certain issues pertaining to their roles and liabilities still remains a question mark[27]. This is of special relevance from the space security perspective as for instance, if a Low Earth Orbit[28] satellite in outer space[29] funded by private investors malfunctions on account of harmful interference leading to severe data breaches[30], there is a incoherence between the determination of liability and interpretation of existence legal instruments.

Problems may arise when outer space explorations are executed through the non-state entities as the development of commercial space activities is given effect to by private enterprises which are registered in a launching state. From this perspective, the debate on the extent of state liability assumes significance in the context of the international instruments discussed hereinafter:

A. United Nations[31] and Existing International Legal Instruments: Framework and Predicaments

The Outer Space Treaty, 1967

The importance of outer space sustainability has gained a new international dimension from a technical and policy standpoint. Given a background about orbital debris challenges, apt consideration for legal framework emphasizing upon mitigation and remediation of orbital debris constitutes a viable mechanism

[27] MELISSA DE ZWART, INTELLECTUAL PROPERTY, INNOVATION AND NEW SPACE TECHNOLOGY 144 (G. Austin et al eds., ACROSS INTELLECTUAL PROPERTY: ESSAYS IN HONOUR OF SAM RICKETSON Cambridge Univ. 2021).

[28] Hereinafter mentioned as LEO.

[29] Majority of the space satellites are operational in the LEO which proportionately increases the scope for greater orbital debris.

[30] Paul Larsen, *Small Satellite Legal Issues* 82 (2) J. AIR L.& COMM. 277, 275-309, (2017).

[31] Hereinafter mentioned as UN.

contributing to space sustainability. It is pertinent to mention that the term 'debris' has not been defined under the Outer Space Treaty, 1967[32] even though they are classified as space objects[33]. This is amplified by the fact that the idea of launching state under the OST does not entertain the notion of 'non state entity'. However, Article VI of the same treaty defines 'launching state' by referring to the space exploration executed by a non-state entity on the authorization of the state, based on its outer space activities.

Aforementioned problem is further exacerbated in the scenario of the Cold War, the socialist and capitalist ideas were put in contrast of each other. These prominent political and socio-economic contradictions impacted the execution of the property rights proposition in the OST[34]. Thus, though the OST envisioned private participation through the idea of 'non state entity', the nature and extent of liability of private actors was not within the realm of the same[35]. Since, in the modern space age, states engage in competitiveness through private entities, the lack of holistic inclusion of such non state actors within the OST will create hurdles for enforcing state liability. This is further compounded on account of increased influence of cyber technologies.

Strictly speaking from a space security perspective, the potential of usage of new kinds of technology, including emerging technologies, the rise of data economy and the proliferation of cyber-attacks on critical infrastructure, raise fundamental questions about space security from a new dimension. Presently, developing security quagmire in the outer-space context have created an unparalleled impact upon the robustness of the international space regime.[36] A case in point is the extension of the idea of the property rights jurisprudence from states to non-state

[32] Hereinafter mentioned as OST.
[33] Scott Michael Steele, *Space Debris: A Basis for Actively Removing Objects Under an International Legal Order* 8 (2) AM. J. AEROSPACE ENG'G 45, 45-60 (2022).
[34] Evarist Jonckheere, The Privatization of Outer Space and the Consequences for Space Law, (May 2018) (unpublished LL.M Dissertation) (Faculty of Law and Criminology, Department of European, Public and International Law, Ghent University) (on file with the Ghent University).
[35] A Ferreira Snyman*, Challenges to the Prohibition on Sovereignty in Outer Space - A New Frontier for Space Governance*, 24 POTCHEFSTROOM ELECTRONIC L. J. 3, 1-50 (2021).
[36] Fabio Van Loon, *Codifying Jus in Bello Spatialis— The Space Law of Tomorrow,* 15 STRATEGIC STUD. Q. 2, 1-18 (2021).

actors like private corporations, especially SpaceX, Moon Express, Blue Origin, among others joining the global space race and looking for newer ways to exercise property rights in space[37]. For instance, if SpaceX has developed a launch vehicle and a satellite system, both heavily reliant on complex security protocols functioning on the basis of complex algorithms, however they go a step further and start appropriating resources from the moon, celestial bodies, asteroids, among others, the real question which arises for consideration is whether such kind of property rights are permissible within the existing legal regime. The question is both pertinent and unanswered. A settled response would determine the future of a burgeoning, billion-dollar industry that currently exists on an unstable legal foundation.[38]

Such kind of uncertainty can also get entangled in municipal laws and their sketchy implementation leading to regulatory issues and shying away of private players from certain areas of the industry. An illustration of this is the nature of the agreements with the DoS[39] and ISRO[40] which are often not in a standard format[41] adding to the roadblocks for effective contract negotiations with government entities, especially when India does not have a dedicated space legislation. This has the potential to stall any kind of technological progress made on the space security front by the private entities.

Private participation in the space-sector has induced in an influx of a broad spectrum of space infrastructure such as radio frequency spectrum, slots in geostationary orbits (GSO),[42] making such space infrastructure vulnerable to cyber-attacks. However, the multitude of standards and regulations as discussed in the previous chapter, do not provide for a uniform mechanism to deal with eventualities when such attacks happen. In fact, it has been documented that there

[37] Andrew J. Cannon, *The Great Space Rush: Regulating Space Mining*, 39(1) AUSTRALIAN RESOURCES AND ENERGY L. J. 3, 1-19 (2020).
[38] Melissa J. Durkee, *Interstitial Space Law* 97 WASH. U. L. REV. 450, 423-481 (2019).
[39] Department of Space, Government of India.
[40] Indian Space Research Organization.
[41] NITIN SARIN et al., INDIA, 69 (Joanne Wheeler MBE ed., Law Business Research Ltd 2020).
[42] K.R. Sridhara Murthi & V. Gopalakrishnan, *Trends in Outer Space Activities—Legal and Policy Challenges* in Recent Developments in SPACE LAW: OPPORTUNITIES AND CHALLENGES 37 (R. Venkata Rao et al. eds., Springer Nature Singapore 2017).

are considerable differences among States' approaches to remote sensing regulation, depending on their perceived needs for security, access to information and other factors.[43]

One of the most contentious debates in international space legal jurisprudence is whether a uniform definition of the phrases 'peaceful-purposes' and 'weapon' can be consented to. The terms are vaguely agreed upon and in context of space security perspective, they assume special significance considering that cyber infrastructure constitutes a critical component of space industry in areas like launch vehicles, satellites, secondary equipment to primary infrastructure, and the like. Moreover, it is imperative to construct space-infrastructure with regard to the cyber-related aspects relevant to the execution, operation and utilization of the infrastructure.[44]

In light of the fact that satellites in space have been hacked before and resulting in outer space debris, it would be safe to assume that a space weapon does not necessarily have to be a physical weapon but instead demolishes the target's command, control, and space surveillance equipment,[45] all of which are sine qua non for smooth operation of spacecraft and satellites. Hence, the real question for consideration is the extent up to which the OST along with other related instruments can be considered useful for bringing into the fold such categories of weapons within their ambit. This would further lead to a more contentious issue of the nature of responsibility which is to be incurred by the states and private corporations to which such entities must be registered.

Articles VI and VII articulates international liability for national activities irrespective of being conducted by state agencies or by non-state actors. It propagates international liability on each state party which engages in launching a space-object and consequently affecting the corresponding member-state to the

[43] Sa'Id Mosteshar, *Regulation of Remote Sensing by Satellites* in ROUTLEDGE HANDBOOK OF SPACE LAW 158 (Ram S. Jakhu et al. eds., Routledge UK 2017).
[44] Steven Freeland, *The Limits of Law: Challenges to the Global Governance of Space Activities* 150(1) J.& PROC. ROYAL SOC'Y NEW SOUTH WALES 72, 70-82 (2020).
[45] Sa'id Mosteshar, Space Law and Weapons in Space, Planetary Science (May 15, 2022 8:02 PM) https://oxfordre.com/planetaryscience/view/10.1093/acrefore/9780190647926.001.0001/acrefore-9780190647926-e-74?print=pdf.

OST. The liability is restricted to activities against the other state party and not to actions that leads to pollution in outer space.

Every State Party to the OST that engages in launching or to procure to initiate to launch of a space-object and an individual State Party which provides a platform for commencing a launch, is internationally accountable for causing detriment to the other State Party or to its natural persons or artificial personalities[46]. The impact may be perpetrated by a space-object or its constituent fragments either on earth's surface or in air or outer-space.[47]

The Rescue Agreement, 1968

Relying upon Articles V and VIII of the OST, it enumerates that member-States shall ensure application of reasonable measures to assist in astronaut rescue and immediately restore those back to the launching State. Further on the request, if necessary, the States must ensure cooperation to launching-States in retrieving space-objects upon re-entry to Earth outside the State's territorial jurisdiction which launched the said objects. It is pertinent to mention that the Rescue Agreement, 1968 is one of the foundational treaties[48] in international space law. It can be said that considering the timeline in which the treaty was drafted and the needs of the contemporary space industry, a strong divergence is observable between the language of the treaty and enforcement.

For instance, the term 'space object',[49] a critical component of space security debates, has not been defined in the said Agreement, even though the generally accepted idea is that the nomenclature applies to the Liability Convention and the Registration Convention expressly. Despite the aforesaid anomaly, it is interesting to observe that the jurisdictional competencies for state parties with respect to 'space objects' has been given recognition in that the state facilitating

[46] Article VII of the Outer Space Treaty, 1967.
[47] *Id*.
[48] Ram Sarup Jakhu & Steven Freeland, *A Vital Artery or a Stent Needing Replacement?: A Global Space Governance System without the Outer Space Treaty?* 513, 505-519 (2019), cited in the Proceedings of the International Institute of Space Law, IISL (2019).
[49] Frans G. von der Dunk, *A Sleeping Beauty Awakens: The 1968 Rescue Agreement after Forty Years* 34 J. SPACE L. 422, 411-434 (2008).

a space object to launch shall maintain jurisdiction[50], regardless of the launch commissioned by the state directly or through private participation.

The Liability Convention, 1972

It primarily addresses the issue of state-liability, the importance to deliberate upon robust international rules and procedures in relation to the liability arising from injury due to space-objects. It must take into account the necessity for payment immediately to the extent of a full and equitable amount of pecuniary claim to aggrieved in case such loss occurs. However, space debris, being able to be generated due to factors such as technical satellite malfunction, portions of space rockets in space, among others, presents unique enforcement challenges for the said Convention. The present regime was developed in a time frame when states took precedence in outer space exploration. In the spirit of states taking predominance, the following discussion enumerates the nature and extent of the liability.

i. Absolute Liability and Fault Liability

State parties shall not be exempted from liability when it becomes absolute on account of loss to a space-object either on earth's surface, or to an aircraft in-flight mode[51]. However, fault liability standards, arguably are hinged upon the below mentioned thresholds. State liability must only follow if the damage is caused either by the virtue of one launching State's space-object which is subject to that jurisdiction, or to any persons, property on board such a space object wherein the injury caused is on account of a space object belonging to another state party to the launch[52].

ii. Joint and Severable Liability

Such liability as articulated in law of torts, takes precedence under the Convention if two or more states[53] are simultaneously parties to the launch[54]. If damage is

[50] Christina Isnardi, *Problems with Enforcing International Space Law on Private Actors* 58 (2) COLUM. J. TRANSNAT'L L. 504, 491-509 (2020).
[51] Article II of the Liability Convention, 1972.
[52] Article III of the Liability Convention, 1972.
[53] Marco Pedrazzi, *Outer Space, Liability for Damage* 4, 1-9, Max Planck Encyclopedias of International Law, Oxford University Press, 2015.
[54] Article 5 of the Liability Convention, 1972.

caused at a place other than on the surface of the Earth such as[55] to a space-object wherein one member-state can claim liability because of the launch, or to persons or property on board by virtue of a space-object belonging to another launching state-party, and of damage created to a third-party State or its natural or artificial personalities.

The Convention ensures that the first two States[56] must comply with being jointly and severally liable to the third State for the proportion that in case the loss has been incurred to another member-State not actively involved in the launch, however on the surface of the Earth or to aircraft in flight, such a state can expect the damage causing states to be absolutely liable. If the injury has been perpetrated upon a space object with ownership claims by another third- party state or to persons or property on board at a place other than on the surface of the Earth, there shall arise fault liability[57] to the third State based on direct fault attributed to the damage causing states or to any person for whom the state perpetrating the launch is directly responsible.

If an international intergovernmental organization is responsible for loss by virtue of any provisions of the aforementioned Convention, then the said entity and members that are state-parties are jointly and severally liable[58]. Any pecuniary claim shall be at the earliest apprised to the entity. In case the entity has not paid, within a six months' time-period, any quantum of money consented upon or determined as damages, the claimant State may invoke the liability of the state parties to this Convention who are the members.

iii. Apportionment of Compensation

Every instance of joint and several liability follows the norm of proportionate distribution of compensation between the first two State parties contingent upon the extent to their fault[59]. In case, if the nature of the States fault liability is incapable to be proved, the burden of damages has to be divided equitably

[55] Article 4 of the Liability Convention, 1972.
[56] Trevor Kehrer, *Closing the Liability Loophole: The Liability Convention and the Future of Conflict in Space,* 20(1) CHI. J. INT'L. L. 207, 178-216 (2019).
[57] Guoyu Wang & Chao Li, *Applicability of the Liability Convention for Private Spaceflight*, 2021 SPACE: SCI. & TECH. 6, 1-11 (2021).
[58] Article 22 (3) of the Liability Convention, 1972.
[59] Article 4 (2) of the Liability Convention, 1972.

between the parties. Such division must commence without compromising third party's right, State to claim the wholesome quantum of pecuniary damages from any of the member states who are active to the launch.

The compensation which such states are responsible to pay for injury are benchmarked upon international law[60] and equitable principles[61]. It is imperative to mention that the goal of such claim of quantum of compensation is establishing restoration of the natural or artificial personality affected, or the state or the intergovernmental institution which has been impacted. A launching State, which has compensated for the injury, has the right of indemnification[62] from other member states in regards to the collaborative launch[63]. A state which provides territory or facility provides a platform for launching space object is considered as a participant in a joint-launching[64].

iv. Process for Claiming Compensation

A claim for damages for injury can be presented to a state actively involved in the launch within one year since the date of happening of the event leading to injury or the identification of the launching State that is liable[65].

v. Limitation of Claim

In the event that a state expresses inability regarding information about the happening of the injury or has shown inability to make known the launching State which is accountable, there is autonomy to make a claim within one year since the date, the state was made aware about the aforementioned facts. Under no circumstances, this time-frame should transcend a year since the date on which the State could conduct due diligence.

[60] Piotr Manikowski, *Examples of space damages in the light of international space law*, 6(1) POZNAŃ UNIV. OF ECON. REV. 60, 54-68 (2006).
[61] Article 12 of the Liability Convention, 1972.
[62] Caley Albert, *Liability in International Law and the Ramifications on Commercial Space Launches and Space Tourism* 36(2) LOY. L.A. INT'L & COMP. L. REV. 250, 233-261 (2014).
[63] Article 5 (2) of the Liability Convention, 1972.
[64] Article 5 (3) of the Liability Convention, 1972.
[65] Article 10 (1) of the Liability Convention, 1972.

Despite the aforesaid systematic methodology regarding nature of liability and claims regarding compensation, the Liability Convention, 1972 is also witness to contemporary challenges of the space industry wherein private companies have transcended the state parties in terms of participation directly in outer space activities. This has caused friction between the technologically intensive space industry and the provisions of the incumbent provisions of the Liability Convention, 1972. Hence, it is reasonable to understand that there is an urgent necessity to alter the provisions on account of their irrelevance[66] in the present circumstances. A number of instances can be cited with regards to this.

Firstly, the Convention does not define the nomenclatures such as fault, negligence and causation[67], which are critical to determine state liability. Thereby the provisions of the Convention are rendered meaningless if a private company registered to a certain state engages in an activity which causes orbital debris wherein the key determination shall be based on the parameters for state liability. The Convention emphasizes upon absolute state responsibility for injury caused in outer space, earth's surface and atmosphere. Even though the Convention identifies liability based on fault, a pertinent issue is there are no rules constituting the ambit of the term 'fault'. This is especially significant considering that many space debris are extremely difficult to trace, which makes the task of holding states liable[68] within the aforesaid binding instrument. The lack of discussion and coherence regarding attribution of liability to fault, on the grounds of negligence and causation in the Convention raises a complimentary problem. For instance, the Convention does not make a reference of duty of care[69] standard which forms the bedrock for liability under law of torts. Thus, for instance, while the potential for tortuous liability is prominent, the foundation of such liability can be complicated in the absence of a coherent framework for the same.

---

[66] Wian Erlank, *Property Rights in Space: Moving the Goal Posts so the Players don't Notice* 19(1) POTCHEFSTROOM ELECTRONIC L. J. 7, 1-31 (2016).

[67] Fawaz Haroun & Shalom Ajibade et al. *Toward the Sustainability of Outer Space: Addressing the Issue of Space Debris* 9(1) NEW SPACE THE J. SPACE ENTREPRENEURSHIP & INNOVATION, 65,63-71 (2021).

[68] Paul B. Larsen, *Solving the Space Debris Crisis* 83 (3) J. AIR L. & COM. 487, 475-519 (2018).

[69] Joel A. Dennerley, *State Liability for Space Object Collisions: The Proper Interpretation of 'Fault' for the Purposes of International Space Law* 29(1) EUR.J.INT'L L. 282, 281-301 (2018).

It is pertinent to mention that the Liability Convention constitutes an attempt to make state parties liable for their actions or omissions based on fault for damage caused, however, challenges emanate at two levels.

Firstly, there are no explicit provisions regarding tracking space debris considering that such considerations were irrelevant at the time when the Convention came into force. Secondly, even if the space debris can be identified, the issue of determining the extent of negligence by the state party[70] is difficult to identify. For instance, in case of an orbital collision between two satellites of different states, if one of the satellites' parts also collides with a defective satellite component belonging to the other state, questions of state liability from a contributory negligence perspective will arise.

It is also significant to mention that greater quantum of space debris has a direct bearing upon space traffic management and space sustainability. Outer space being in a peculiar position to be regulated, the appropriate lack of regulations[71] on space traffic management, complicate the question of state liabilities from an orbital debris perspective. This is so because at present none of the international instruments as discussed aforesaid clearly articulate the extent, typology and nature of liability which can be attributed to state liability while removing space debris. As companies and nations look to disintegrate space architecture such as orbital satellites and debris, the question of proprietary rights looms large. Since outer space is considered as the domain for use relating to benefit of mankind, questions regarding liability from this viewpoint are also imminent.

The Registration Convention, 1975

The said Convention is based on interest put forward by States in the OST, the Rescue Agreement, 1968 and the Liability Convention, 1972 to provide a robust system where jurisdictions can lend a helping hand to identify space-objects. It addressed issues relating to the extent of accountability which the member states must undertake in relation to their space objects. Information

[70] Joshua Talis, *Remediating Space Debris Legal and Technical Barriers* 2 STRATEGIC STUD. Q. 90, 86-99 (2015).
[71] Giacomo Curzi et al., *Large Constellations of Small Satellites: A Survey of Near Future Challenges and Missions* 7 (133) AEROSPACE 7, 1-20 (2020).

transparency and symmetry[72] among stakeholders is one of the cornerstones of the convention.

At the moment, non-functional space objects[73] like orbital debris is witness to lack of consensus on whether they should be within the ambit of a space object, as per the definition of "space object" of Art. I of both the Liability Convention and the Registration Convention. The pertinent dilemma of attribution through registration shares a close nexus with the jurisdiction exercised over space objects. While outer space and celestial bodies are exempt from territorial sovereignty claims, according to Art. VIII of the OST states shall exercise jurisdiction and control over the space objects on their registry. The term "jurisdiction" implies that countries have autonomy to legally enforce sanctioning mechanisms over their space objects, but in the absence of a coherent definition for space debris, enforcement through this Convention becomes dicey. This problem can get compounded through procedural bottlenecks involved in making claims under the convention.

It has been widely documented that the Convention does not accurately specify the appropriate methodology for multiple[74] state party claimants especially when one of such states also happens to be one of the launching states. For instance, five state parties collaborating on an international space project might have contributed differently to space debris through their jurisdiction registered companies in outer space thereby injuring another third party. However, in the absence of a clear legislative sanction, affixing liability and the foundation for it will be difficult to determine.

Thus, a few conclusions about the challenges can be drawn. Firstly, the substantive law under the Convention relating to fault, negligence, causation, definition of launching state needs to be demarcated in alignment with evolving international space law standards. Secondly, the procedural framework needs to

---

[72] Ram S. Jakhu & Bhupendra Jasani et al *Critical issues related to registration of space objects and transparency of space activities* 143 ACTA ASTRONAUTICA 407,406-420 (2018).

[73] Rada Popova & Volker Schaus, *The Legal Framework for Space Debris Remediation as a Tool for Sustainability in Outer Space* 5(55) AEROSPACE 2, 1-17 (2018).

[74] Alexander P. Reinert, *Updating the Liability Regime in Outer Space: Why Spacefaring Companies Should Be Internationally Liable For Their Space Objects* 62(1) Wm. & Mary L. Rev. 344, 325-355 (2020).

have robust backing to support the substantive framework considering that the Convention is one of the most frequently used instruments regarding state liability. Further, the role of private companies in space security and their evolving dynamics must be explored through the provisions as the trend is increasingly shifting towards commercialization and in this context state liability ought to be seen.

The Moon Agreement, 1979

Article 14 envisages that nation states which are parties to the said Agreement must oblige with international accountability for municipal activities on the Moon, regardless of being implemented by government entities or otherwise, and for ensuring that municipal manifestations of activity are conducted in compliance with the Agreement. States Parties must ensure that non-governmental participation within the jurisdictional limits of such state shall undertake ventures on the Moon only under the supervision and operational control of the jurisdiction concerned. It is accepted among jurisdictions that arrangements regarding responsibility for loss caused upon the surface of the Moon, in addition to OST and the Liability Convention are predicated upon more intensive activities on the Moon. Similar to present contemporary international space law instruments, the Moon Agreement 1979[75] had also been drafted keeping in mind the predominance of state parties and not the private sector. However, the provisions of the agreement can have interesting implications[76] from the space security viewpoint. For instance, it is debatable the extent of international space security liability the attempts at appropriation of space asteroids would generate if private actors were to engage in mining of such debris and the paradigm shift[77] in customary international law such a phenomenon can have. This anomaly is further exacerbated by the fact that contemporary literature suggests the

[75] René Lefeber, *Relaunching the Moon Agreement* 41(1) J. AIR & SPACE L. 41, 41-48 (2016).
[76] LauraDelgado-López, *Beyond the Moon Agreement: Norms of responsible behavior for private sector activities on the Moon and celestial bodies* 33(1) SPACE POL'Y., 1, 1-3 (2015).
[77] Abigail Pershing, *Interpreting the Outer Space Treaty Non-Appropriation Principle: Customary International Law from 1967 to Today* 44(1) YALE J. INT'L. L., 169, 149-178 (2019).

agreement was not signed by many jurisdictions[78], thereby implying that consensus over the agreement and implications for space security can be detrimental.

United Nation Principles and Declarations

Aside from the UN Conventions, treaties and agreements, there is an abundance of principles adopted by the UNGA[79] which are critical components of space security. For instance, the *Declaration of Legal Principles*[80], mentions about activities pertaining to outer space including celestial bodies that are to be carried out in accordance with common interest of mankind, principles of sovereignty and international law. Further, nation states must undertake full responsibility towards any outer space activity executed by state and non-state entities. In the interest of space security and national sovereignty, the declaration pertinently mentions about consultations with nation states in case of damaging consequences from outer space activity threatening sovereignty of states and space security. From a liability perspective, every state from whom an outer space activity is launched or a jurisdiction which launches or procures launch of a space object, should be made accountable for injury to another state as a result of such activity.[81]

Another prominent principle[82] is the *Principles of Remote Sensing*[83], which tries to promote and protect natural resources, usage of land and environment by launch and processing electro-magnetic waves emitted by remotely sensed objects from space. Important benchmarks have been identified such as carrying out of such activities for common benefit of countries involved regardless of their

[78] Alexander W. Salter, *Settling the Final Frontier: The ORBIS Lease and the Possibilities of Proprietary Communities in Space* 84(1) J. AIR L. & COM., 109, 85-114 (2019).
[79] UNGA stands for United Nations General Assembly.
[80] Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space, General Assembly resolution 1962 (XVIII) of 13 December 1963.
[81] See Principle 8, Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space,1963.
[82] LOH Ing Hoe & Roslan UMAR et al *Evaluation of Remote Sensing Principles 1986: The Unsolved Problems* 7(7) INT'L J. ACAD. RES. BUS. SOC. SCI. 475, 475-490 (2017).
[83] the Principles Relating to Remote Sensing of the Earth from Outer Space, General Assembly resolution 41/65 of 3 December 1986.

technological, scientific, economic or social progress, remote sensing activities as per the international law.

To promote equitable participation among all stakeholders, Principle XII makes a reference to reasonable and non-discriminatory access to states whose remote sensing data from space objects have been analysed within their respective jurisdiction. Along with this, since remote sensing activities are helpful in averting natural disasters, the principles promote information symmetry between participating countries to reduce scope for violation of space security and state sovereignty criteria. Principle XIV expressly mentions about international liability in accordance with Article VI of the Moon Agreement[84] for remote sensing activities implemented by government, non-government entities or international organizations where states are parties.

The *Nuclear Power Sources Principles*[85] constitute the next important principles relating to space security especially given the rise of emerging nuclear power industry usages pertaining to space applications. It lay particular emphasis on the concept of 'launching state' to mean a country exercising jurisdiction over a space object comprising of nuclear power sources. Such a definition is crucial to determine international accountability of a state in case of a mishap. Further, 'general-concept-of-defence-in-depth' refers to safeguards in place to tackle system malfunctions which can have ramifications for space security if because of such malfunctions there is a violation of state sovereignty. Principle III delineates the guidelines and parameters for safe use of nuclear power sources to reduce negative impacts of radioactive material in outer space[86].

To ensure a smooth implementation of the aforesaid guidelines, it is imperative for a launching state to conduct a safety audit covering aspects such as different

[84] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, adopted by the General Assembly in its resolution 34/68, opened for signature on 18 December 1979, entered into force on 11 July 1984.

[85] Principles Relevant to the Use of Nuclear Power Sources in Outer Space, General Assembly Resolution 47/68 of 14 December 1992.

[86] Steven Aftergood, *Space Nuclear Power and the UN: A Growing Fiasco,* 8 (1) Space Policy, 10, 9-12 (1992), cited in Jericho W. Locke et al., *Analysis of International Treaties and Policies Related to Space Nuclear Power and Propulsion*, in the Proceedings of the International Astronautical Congress, IAC (2019).

mission phases, nuclear power sources, among other such standards. Articles VI and VII of the Moon Agreement, 1979 play a key role in determining state accountability for activities in outer space having nuclear sources, and the nature of compensation for damage created by virtue space parts. Further, the quantum of damages must also be analysed accordingly with provisions of the Liability Convention, 1972.

The International Telecommunication Union (ITU)

Exploration into space commenced when most prolific scientific research and exploration were undertaken from a military perspective.[87] Within the domain of the space sector, there must be information symmetry to facilitate the smooth conduct of outer space operations and therefore a seamless telecommunication medium constitutes the backbone of such operations. The outer space collaborations commence when states approve to the creation of acceptable benchmarks that promote uniformity. It is the classification of lesser complicated cooperation due to the methodologies that epitomize it are subtle tools of minimizing the probability of environmental damage, that coerces the states to consensually acknowledge the area of taking similar decisions with regard to minimal incentive to engage in stepping down from the same.[88]

The ITU is a facilitator in the aforesaid, having been established under the International Telecommunication Convention.[89] The objective of the organization is to promote international cooperation for standardized telecommunication services. In this regard, the ITU is instrumental in electromagnetic spectrum allocation and registration of radio frequency assignments to prevent unwarranted disruption among different jurisdictional radio stations. Furthermore, the regulatory functions extend to appropriate standard setting for frequency allocation and offering scientific advisory services pertaining to the aforesaid. While the ITU-T ("T" for Telecommunications Standardization) seeks the

[87] M. Matheswaran, *Emerging Contours of Space Security: Options for India* 11(1) INDIAN FOREIGN AFF. J., 31, 31-50 (2016).

[88] Allen Eric Rotter, International Security And The Space Domain: Applying Traditional Theories Of International Relations to the Astropolitical Environment (2020) (unpublished LL.M Dissertation, Department of Political Science, The Graduate School of Alabama) (on file with The Graduate School of Alabama).

[89] Constitution and Convention of the International Telecommunication Union (Geneva 1992).

maximum media attention, its contemporary, ITU-R ("R" for Radio) also has a pertinent (though arcane) standard development role in international spectrum management.[90] The discussion in the below mentioned paragraphs shall be divided under two classifications, namely the ITU constitution and the standard setting achieved through resolutions and administrative regulations.

ITU Administrative Regulations

The Radio Regulations, 2020 (hereinafter, the 2020 Regulations) make explicit references of communications in terms of outer space which need to be looked into from the context of outer space and space security. The Preamble advocates that the regulations are founded on principles such as equitable access to orbits and frequencies for member states giving special regard to developing countries, lack of harmful interference in radio communications of other member countries, regulation and enforcement of new radio-communications technologies. The following discussion shall entail an analysis of provisions having a bearing on space security.

There is emphasis[91] on equitable distribution of rights between terrestrial and space radio communication along with specifications of frequencies for different stations. Further, space stations are mandated[92] to be equipped with instruments to execute stoppage of radio emissions as and when imperative and prohibits interference from non-geostationary-satellite systems. Space stations belonging to different member countries need not comply about longitudinal positions as long as there is no unnecessary interference with another existing satellite network.

There are elaborate provisions[93] to report violations of the Constitution[94] as the founding document, Convention or Radio Regulations to the member country which shall have jurisdiction over the matter. This ensures information symmetry and transparency and coordination among all stakeholders for a holistic outlook.

---

[90] PATRICK SPAULDING RYAN, THE FUTURE OF THE ITU AND ITS STANDARD-SETTING FUNCTIONS IN SPECTRUM MANAGEMENT (Sherrie Bolin ed., Sheridan Books, 2005).

[91] Article 21 of The International Telecommunication Regulations, 2012.

[92] Article 22 of The International Telecommunication Regulations, 2012.

[93] Article 15 of The International Telecommunication Regulations, 2012.

[94] Sarah M. Mountin, *The Legality and Implications of Intentional Interference with Commercial Communication Satellite Signals*, 90 INT'L L. STUD. 135, 101-197 (2014).

Further, member states must extend utmost cooperation and assistance, and take into account technical parameters such as frequency alignment, traits of transmission and receiver antennas, time sharing, modification of channels within multichannel transmissions.

This cooperation is also reflected under Article 16 wherein there is a requirement to establish an international mechanism for monitoring which can comprise of organizations from member states, or such states themselves to share information in a timely and accurate manner. However, private monitoring arrangements entered into by governments, international organizations and private or public enterprises shall be exempted from the aforesaid. Article 18 provides for procedural requirements to obtain license in accordance with the 2020 Regulations along with confidentiality obligations under Article 17.

The discussion on the aforesaid are a testimony to a few things. Firstly, as space traffic is changing from being predominantly military to being mostly civilian, the nature of space traffic management is changing from having a predominantly national security purpose to predominantly addressing the civil issue of public safety.[95] Secondly, with the proliferation of different instruments and stakeholders such as the ITU, International Organization for Standardization, there is rising interest by nation states in the development of multilateral approaches. Simultaneously, there is no single international organization that is fully obligated to remediate the obstacles and threats to space assets.[96]

International Organization for Standardization (ISO)

The International Organization for Standardization (ISO) is a global standard formulating entity having wider implications for standard setting in diverse areas including space communications. The objective of this non-governmental international organization is to ensure development of market relevant international standards for innovation. In the space sector, some of the pertinent standards are relating to Information Technology, Security Techniques and Check

[95] Paul B. Larsen, *Space Traffic Management Standards* 18(3) J. AIR L. & COM., 362, 359-387 (2018).

[96] Theresa Hitchens, *Space Security-Relevant International Organizations: UN, ITU and ISO* in HANDBOOK ON SPACE SECURITY 507 (Kai Uwe Schrogl et al. Eds., 2nd ed., Springer 2014).

Character Systems[97], space data and information exchange systems: security framework for space data mechanisms[98] and the space data and information transfer systems: space data link and security protocol.[99]

The first standard delineates prescribed standards for internal communication and information systems and the security measures needed for the same. The second standard provides for a robust security framework for space data systems through discussions on conceptual framework for data and security for space systems, a holistic information system for space missions, and a risk assessment mechanism within space data systems capable of being conveyed. The third standard explores the procedural safeguards for data authentication and confidentiality.

VI. CONCLUSION

It is an inevitable conclusion that space security perspectives are undergoing a paradigm shift in terms of technological developments and their impact on interpretation of existing legal instruments, development of industry standards and determination of liabilities under the international space law regime. The scope for harmonization is narrow at the moment considering the significant lack of jurisprudence around the aforesaid emerging issues. It must be noted that the dimensions of state liability from an orbital debris perspective will keep evolving as the legal framework tries to bridge the gap between itself and industry developments through certainty in interpretation, accurate enforcement of the extant legal instruments and a responsive regulatory approach. Finding the appropriate harmony in this scenario is therefore contingent upon the relevant stakeholders such as states, corporations, regulators engaging in convergence and not divergence. Further, with the rising influx of more companies into the space sector, the aforesaid issues are bound to take new dimensions from a state liability perspective and hence the researcher advocates for the following suggestions keeping in mind the aforesaid developments.

Existing definitions of ‘weapons’ and ‘peaceful purpose’ under the OST must be amended to include cyber weaponry to aid in certainty in interpretation and affixing liability.

[97] ISO/IEC 7064:2002.
[98] ISO 20214:2015.
[99] ISO 21324:2016.

The mechanisms of determining 'fault' liability under the Liability Convention, 1972 must incorporate criteria to identify such liability like extent of involvement by private corporations and states, differentiating between good faith mistakes and deliberate acts, among others.

Each of the five main international instruments on outer space law must incorporate best practices taking into account existing trends in legal development around issues of state liability, commercialization and technological progress. This shall add a layer of certainty to the challenges in enforcement of the provisions.