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REGULATING SPACE TRAFFIC IN INDIA: IDENTIFYING LEGAL GAPS IN PREVENTING SATELLITE COLLISIONS

~ Riddhima Bhalotia

Abstract

Since there has been seen a rapid growth in the Indian space sector, the satellites being launched by the government and private entities are also increasing in number. Due to such growth, it has increased the risk of collisions between satellites and other space objects, which may cause damage to space infrastructure and create space debris. Even though we have general principles laid down under international space law and Indian space policies for peaceful use of outer space and responsibility for space activity, but still India lacks a specific and comprehensive law or framework regulating Space Traffic management.

This paper aims to examine the existing framework and provide a proper regulatory framework for adequately addressing the prevention of satellite collisions, thereby identifying the legal responsibilities of satellite operators, the role of regulatory authorities, rules applicable to information sharing, collision avoidance, and responsibility and liability in the event of collision, especially with the growing participation of private sector companies.

This study adopts a doctrinal research method analysing the relevant international space treaties, international guidelines and standards along with Indian space policies, legislation and regulatory mechanisms and examining selected approaches that may be adapted in the Indian framework. Hence, this paper suggests for a clearer and comprehensive Space Traffic Management framework promoting safer and more sustainable growth of India's expanding space sector.

***Keywords*:** Space Traffic management, satellite collisions, liability, collision avoidance, statutory framework

Introduction

Over the past decades, Outer space has significantly evolved and has become an important domain for technological advancement, economic growth, communication, navigation, scientific exploration, and national security, specifically after the launch of Sputnik which marked the state of the Space Age.[1] Consequently, because of these developments and expansion in space activities, it has led to increase in the number of artificial objects occupying Earth's orbit, also increased orbital congestion and the possibility of collisions between operational satellites, defunct satellites, rocket bodies, and other space debris and fragments from past collisions and anti- satellite (ASAT) tests.[2] Hence, it raises concerns regarding the long-term sustainability of outer space activities. Outer space now holds thousands of active Satellites. But these satellites can be disabled even by a centimetre- sized fragment as objects in the orbit travel at extremely high speeds, so even small fragments can cause severe damage during collisions.[3] Satellites play a significant role in providing essential services such as weather forecasting, disaster management, remote sensing and global positioning. So, due to this growing dependence of modern societies on space- based infrastructure, increases the importance of ensuring safe and uninterrupted operation of Satellites in Earth's orbit.

NASA scientists Donald J. Kessler and Burton G. Cour– Palais proposed a concept "Kessler Syndrome" in 1978, which is today considered as one of the biggest long -term threats to space exploration, space communication, weather forecasting, and global navigation systems.[4] Kessler Syndrome is a theoretical scenario in space science which explains that collisions between artificial satellites could further generate additional debris, which potentially increases the probability of subsequent collisions and result in a self – sustaining accumulation of orbital debris and space debris. Thus, this phenomenon demonstrates that satellite collisions are not isolated accident but it can be a major threat or create a continuing risk to the space environment and future space operations, and could also make some orbits unusable. The main cause of this syndrome is increasing amount of space debris and the growing number of satellites and spacecraft orbiting Earth, which further raises the concerns of collisions in space. Even old

[1]NASA History Office, 'Sputnik and the Dawn of the Space Age' (NASA History). Sputnik 1 was launched by the USSR on 4 October 1957.

[2]See ESA Space Debris Office, *ESA's Annual Space Environment Report* (latest edition) for current catalogue and fragmentation statistics; NASA Orbital Debris Program Office, 'Orbital Debris Quarterly News' (periodic).

[3]NASA Orbital Debris Program Office, 'Frequently Asked Questions' (NASA ODPO) (on the lethality of debris of about 1 cm and larger).

[4]Donald J Kessler and Burton G Cour-Palais, 'Collision Frequency of Artificial Satellites: The Creation of a Debris Belt' (1978) 83(A6) *Journal of Geophysical Research* 2637.

rocket bodies left in orbit; fuel leaks, battery failures, or leftover energy in inactive spacecraft; missile tests that internationally destroy satellites; and large satellites networks launched by companies such as SpaceX and OneWeb can cause explosions and collisions and increase orbital congestion.[5] Consequently, the absence of a strong international system to regulate satellite movements increases the risk of accidents.

Following events of collisions, such as the collision between the American telecommunications satellite Iridium 33 and the defunct Russian satellite Cosmos 2251 on 10 February 2009 at an approximate altitude of 790 kilometres, at a relative velocity of 11.6 kilometres per second , creating further quantities of orbital debris illustrating the importance of maintaining safe operation of space objects to avoid damage of operational infrastructure and creation of additional hazards for other satellites.[6] Even India deliberately destroyed it's own defunct satellite in Low Earth Orbit using an anti- satellite missile test know as Mission Shakti, which generated additional space debris.[7] This events raises serious concerns and further necessitates an organised system of coordination, monitoring, information sharing and legally enforceable responsibilities among States and satellite operators.

Space Traffic Management (STM) emerged as an important concept in addressing the arising challenges of space activities. It is a crucial system or set of technical and regulatory provisions for ensuring that the expanding orbital population operates safely and efficiently, avoiding collisions and radio frequency interference while ensuring proper facilitation of increasing space activities. Unlike air traffic management which operates through established rules and systems, outer space presently does not have a universally accepted and comprehensive traffic management system.[8] Consequently, the absence of a universally binding framework governing these activities raises concerns and creates uncertainty in determining the responsibilities of operators when a collision occur and who pays for the damages caused due to the collisions, who must share data, and which authority can compel compliance. It also

[5]On fragmentation sources and the contribution of large constellations, see ESA Space Debris Office, *ESA's Annual Space Environment Report* (latest edition).

[6]NASA Orbital Debris Program Office, 'Satellite Collision Leaves Significant Debris Clouds' (2009) 13(2) *Orbital Debris Quarterly News* 1. [Check figures: NASA reports an altitude of about 789 km and a relative speed of about 11.7 km/s; the text gives 11.6 km/s. Conform the text to whichever source you adopt.]

[7]Ministry of External Affairs (India), 'Frequently Asked Questions on Mission Shakti, India's Anti-Satellite Missile Test conducted on 27th March, 2019' (27 March 2019). [Check: the MEA describes the target as an Indian satellite in LEO; confirm whether "defunct" is the correct description.]

[8]Air traffic is governed by, among others, the Convention on International Civil Aviation (adopted 7 December 1944, entered into force 4 April 1947) 15 UNTS 295 (Chicago Convention) and its Annexes administered by ICAO; no equivalent exists for orbital traffic.

raises questions regarding the legal consequences, if anyone fails to undertake reasonable collision avoidance measures. As the satellites in space operates at different altitudes and velocities and also their ownership and operational control is distributed among different governmental and private entities. Also the coordination between satellite operators, regulatory authorities and States is necessary for an effective STM framework.

India has also overtime developed and gained significant capabilities in satellite technology and space exploration through ISRO. Through reforms in the Indian space sector and the introduction of the Indian Space Policy 2023, it has led to the increasing participation of even private entities in various space activities.[9] According to the ISRO's Indian Space Situational Assessment Report (ISSAR) 2024, 136 Indian spacecraft belonging to private entities and institutions have been launched by 31 December 2024.[10] During this period , it analysed that more than 53,000 conjunction alerts were issued by the United States Space Command for Indian orbiting satellites and ten collision avoidance manoeuvres were carried out for the operational satellites in low and geostationary orbits.[11] This demonstrates that even for India's space programme, collision risk management is a serious concern and requirement. Thus, even though ISRO has developed technical capabilities for safe and sustainable Space Operations Management, but due to the increasing participation of different operators and non – governmental entities, still there is a need for a more structured regulatory mechanism to prevent collision and ensure uniform compliance. This issue was also addressed in the Parliamentary Standing Committee on Science and Technology, Environment, Forests and Climate Change in its 410th report, presented in March 2026.[12] The committee addressed the issue that the three is a need for a comprehensive legislative framework for India's space activities.

In the International space law, there are general principles concerning state responsibility, liability, cooperation, and the peaceful use of outer space. Similarly, the Convention on

[9]Department of Space, Government of India, *Indian Space Policy-2023* (2023).

[10]ISRO System for Safe and Sustainable Space Operations Management (IS4OM), ISRO, *Indian Space Situational Assessment Report (ISSAR) 2024* (ISRO 2025). [Add page/section pinpoints for each figure cited from this report.]

[11]ISSAR 2024 (n 10). On the source of the alerts, see US Space Force/Space Command, Space-Track.org conjunction data message service.

[12]Department-related Parliamentary Standing Committee on Science and Technology, Environment, Forests and Climate Change, *410th Report on Demands for Grants (2026-27) of the Department of Space* (Parliament of India, March 2026). [Add Rajya Sabha/Lok Sabha presentation date and the paragraph numbers of the recommendations relied on.]

International Liability for Damage Caused by Space Objects, 1972 establishes the liability of states for damage caused by the space objects launched by them.[13] But these instruments do not provide a detail operational standards concerning mandatory collision avoidance, data exchange of the responsibilities of individual satellite operators. The major issues or legal problem is not the complete absence of space- related regulation in India, but the absence of a detailed and enforceable legal framework addressing the concerns raised by the increasing outer space activities.

This research examines the existing International and Indian legal frameworks in regulating Space Traffic Management, while focusing on preventing satellite collisions. It further analyses the legal responsibilities of states and satellite operators, the regulatory role of IN-SPACe and ISRO, and identify the gaps in the Indian framework. It also examines the selected foreign regimes that can be adapted by the India's domestic legal framework. The aim of this paper is to bridge the gap between India's growing technical capabilities in outer space and the development of corresponding legal safeguards by requiring the need of an effective Space Traffic Management framework to ensure private sector participation and long term sustainability of outer space activities.

Conceptual Framework of Space Traffic Management

After the launch of Sputnik, satellites and other artificial objects in the Earth's orbit has increased. This created the need for an organised system to regulate and coordinate space activities, which led to the emergence of Space Traffic Management (STM) as an important concept in addressing the arising challenges of space activities. Earlier Space activities was primarily undertaken by limited governmental agencies, where collision risks were not considered a major threat. But after the expansion of commercial satellite services and other private entities, particularly communication and Earth observation constellations has made significant changes in the orbital environment. This further led to launch of large satellites which increased the number of objects in space requiring continuous monitoring and coordination. Subsequently the United Nations Committee on Peaceful Uses of Outer Space adopted the guidelines for the Long- term sustainability of outer space activities in 2019.[14] These guidelines recognised the importance of improving the safety of space operations

[13]Convention on International Liability for Damage Caused by Space Objects (opened for signature 29 March 1972, entered into force 1 September 1972) 961 UNTS 187 (Liability Convention).

[14]Report of the Committee on the Peaceful Uses of Outer Space, 62nd session (12–21 June 2019), UN Doc A/74/20, Annex II (Guidelines for the Long-term Sustainability of Outer Space Activities).

through information exchange, registration, conjunction assessment and cooperation between States.[15] The development of Space Situational Awareness systems and the adoption of space debris mitigation guidelines represented important steps towards mitigating these risks. Therefore, the increasing involvement of private entities and large number of satellites being launched creating space debris, has made the development of Space Traffic Management (STM) particularly important and it has become a broader issue of international governance and legal regulation.

Space Traffic Management is a combination of technical, operational and regulatory provisions or measures to coordinate the movements and operation of space objects for ensuring that the expanding orbital population operates safely and efficiently, avoiding collisions and radio frequency interference while ensuring proper facilitation of increasing space activities.[16]

Unlike air traffic management which operates through established rules and systems, outer space presently does not have a universally accepted and comprehensive traffic management system or a central authority which would control the movement of all space objects. As the satellites and objects are in different altitudes and velocities and they travel at extremely high speeds due to which even a small object may intersect and cause major damages and create further risk of collisions.

Consequently, the absence of a universally binding framework governing these activities raises concerns and creates uncertainty in determining the responsibilities of operators when a collision occur and who pays for the damages caused due to the collisions, orbital data exchange, and which authority can compel compliance. It also raises questions regarding the legal consequences, if anyone fails to undertake reasonable collision avoidance measures. As the satellite's ownership and operational control is distributed among different governmental and private entities. Even in the study of International Academy of Astronautics (IAA)on Space Traffic Management, it emphasised the need for an internationally coordinated approach regarding the data or information collected and exchanged, operational practices and

[15]LTS Guidelines (n 14), Section B (Safety of space operations), including guidelines B.1–B.4 on registration, information sharing and conjunction assessment. [Verify guideline numbering against Annex II.]

[16]The definition is drawn from International Academy of Astronautics, *Cosmic Study on Space Traffic Management* (Corinne Contant-Jorgenson, Petr Lála and Kai-Uwe Schrogl eds, IAA 2006), which defines STM as the set of technical and regulatory provisions for promoting safe access to, operations in and return from outer space free from physical or radio-frequency interference.

institutional mechanisms to ensure safe conduct of space activities.[17] STM not only track satellites or predict collisions , it also established legal obligations concerning the conduct of satellite operators, coordination between different entities and the allocation of responsibilities when collision risk arises. Therefore, for the coordination between satellite operators, regulatory authorities and States; and to prevent collisions; for operational and technical measures, an effective STM framework is necessary.

Space Traffic Management is a combination of mainly three interconnected elements: technical, operational and regulatory elements. Technical element includes monitoring space objects, identifying potential collision risks or probabilities; Operational element includes coordinating satellites, information exchange and collision avoidance measures; and regulatory element includes establishing binding rules, defining responsibilities of operators and mechanisms for monitoring and enforcement. Regulatory element is crucial for India because it ensures uniform compliance by governmental and private satellite operators.

Certain major components of Space Traffic Management that are to be considered for an effective Space Traffic Management before examining the legal responsibilities associated with collision prevention. The first component is Space Situational Awareness (SSA) which identifies, observe, track and understand the space environment.[18] It mainly detect and monitor objects in Earth's orbit; determine the identity, characteristics and orbital information of tracked objects; and analyse orbital congestion, debris distribution and other conditions that may affect the safety of space activities. Space Traffic Management uses the information provided through SSA to coordinate space activities and prevent collisions. But this raises concerns regarding who is responsible for providing accurate orbital information, reporting of manoeuvres, facilitation of a centralised information- sharing mechanism. The second component is Conjunction Assessment which evaluates whether two space objects may approach each other sufficiently closely to create a potential collision risk by analysing their tracking data to estimate their relative positions, velocities and closest point of approach.[19] It therefore allows operators to determine whether further investigation, communication or a collision avoidance manoeuvre is necessary. But the absence of uniform legal thresholds of

[17]IAA, *Cosmic Study on Space Traffic Management* (2006).

[18]On SSA as the foundation of STM, see ESA, 'Space Safety: Space Situational Awareness' (ESA programme documentation); and LTS Guidelines (n 14), guidelines on sharing of space-object tracking information.

[19]On conjunction data messages and screening practice, see Consultative Committee for Space Data Systems (CCSDS), *Conjunction Data Message*, CCSDS 508.0-B-1 (2013).

reporting and responding to high risk conjunctions creates inconsistencies between satellite operators, which raises serious concerns.

The third component is collision avoidance which refers to the measures taken to reduce the possibility of a collision between two or more space objects. But a collision avoidance measures or manoeuvres may consume fuel, affect the satellite's operational life and services and create additional risks and also create disagreements regarding which operator should undertake the manoeuvre as two satellites are operated by different entities, due to lack of a universal binding legal framework. The fourth component is debris space mitigation refers to prevention of creation of additional debris such as non- functional, abandoned or fragmented human- made objects remaining in Earth's orbit, even fragments resulting from explosions and collisions, that no longer serve a purpose.[20] It is s significant concern as satellites and objects are in different altitudes and velocities and they travel at extremely high speeds due to which even a small object may intersect and cause major damages and create further risk of collisions.

The fifth component is information sharing and international coordination. Information sharing is an important requirement to identify every potential collision risk by giving timely access to location, trajectory and planned manoeuvres other space objects. International coordination is also crucial as satellites belonging to different States may approach one another. Thus, this emphasised the need of a standardized and mandatory information sharing obligation and cooperation beyond regulatory systems through regulatory framework.

Consequently, this addresses the major Challenges in implementing Space Traffic Management such as increasing orbital congestion; inaccuracy and uncertainty in orbital information; lack of uniform International standards; coordination between Governmental and private entities; allocation of responsibility during collision avoidance; cooperation beyond regulatory systems; and common information sharing system. Therefore, India's regulatory approach should not be restricted to strengthening satellite tracking infrastructure or adopting debris mitigation guidelines. It should establish a comprehensive mechanism through which information obtained through SSA is translated into coordinated and legally accountable operational decisions. Hence, Space Traffic Management should form an integral part of India's broader space governance framework and it's development will help bridge the gap between India's technical capabilities and it's legal obligations. It will ensure that the safety

[20]Inter-Agency Space Debris Coordination Committee (IADC), *IADC Space Debris Mitigation Guidelines*, IADC-02-01 (first issued 2002, as revised); and UN General Assembly Resolution 62/217 (22 December 2007), endorsing the COPUOS Space Debris Mitigation Guidelines.

and sustainability of outer space is not compromised due to expansion of commercial space activities.

The Indian Space Research Organisation (ISRO) has long operated a collision avoidance process for its own assets. It has built an SSA capability through the Network for space object Tracking and Analysis (NETRA) project and a control centre at Bengaluru, and it publishes periodic assessment reports on SSA and manoeuvres.[21] ISRO has also announced a target of debris free space missions by 2030.[22] These are significant institutional strengths, but they have been developed for ISRO's own missions and activities undertaken in outer space and not as a regulatory system binding all Indian operators.

International Legal Framework Governing Space Traffic Management and satellite collisions

The Outer space exploration is not governed by any domestic law of any state, it's use and activities are primarily governed through International space law which establishes the rights, obligations and responsibilities of States undertaking activities beyond Earth's atmosphere. The international legal framework was developed during the 1960s- 70s, where space activities was primarily dominated and controlled by governmental space agencies and it recognised the need to establish common principles governing the peaceful exploration and use of outer space, state responsibility and liability for damage caused by space objects.[23] Among the various instruments of the United Nations space treaties, the Outer Space Treaty; Liability Convention ; and Registration Convention are particularly relevant to satellite collisions prevention and determination of legal responsibility. But these treaties establish only the foundational principles, and do not provide a comprehensive operational mechanism or framework for Space Traffic Management. It examines the relevant provisions and evaluates to what extent the existing legal framework addresses the challenges associated with satellite collisions.

[21]ISSAR 2024 (n 10); ISRO, 'Project NETRA' (ISRO programme documentation). [Add the specific ISRO/Department of Space source for the NETRA control centre.]

[22]ISRO, 'Debris Free Space Missions (DFSM) by 2030' (ISRO announcement); see also ISSAR 2024 (n 10). [Add exact title/date of the ISRO document.]

[23]For the five UN space treaties and their status, see UNOOSA, *Status of International Agreements relating to Activities in Outer Space* (latest annual edition, UN Doc A/AC.105/C.2/…).

1. The Outer Space Treaty 1967

It is regarded as the foundation of international space law.[24] India ratified the Outer Space Treaty in 1982.[25] The treaty does not expressly uses the term Space Traffic Management, but some of the provisions have direct relevance to collision prevention, state responsibility and the conduct of satellite operators such as:

Article I: It recognises the outer space shall be free for exploration and use by all states without discrimination in accordance with international law and it such freedom is restricted to be carried out for the benefit and in interest of all countries, irrespective of their degree of economic or scientific development.[26]

Article VI: It states that State Parties bear international responsibility for national activities in outer space, whether carried out by Governmental or non- governmental entities. The appropriate state has the responsibility to authorise and continuously supervise all the activities of non- governmental entities. It serves as a legal basis for domestic authorisations and state responsibility for private entities.[27]

Article VII: It states that every State Party from whose territory or facility a space object is launched, is internationally liable for damage caused by that object or its component parts.[28]

Article VIII: the state of registry retains jurisdiction and control over the object[29]

Article IX: It states that the State Parties shall conduct their activities in outer space activities with due regards to the corresponding interests of all other State Parties.[30]

The State must undertake appropriate international consultations where they have reason to believe that an activity planned by them or their nationals could potentially harm the peaceful

[24]Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (opened for signature 27 January 1967, entered into force 10 October 1967) 610 UNTS 205 (Outer Space Treaty).

[25]UNOOSA, *Status of International Agreements* (latest edition). [Confirm India's date of ratification against the current status table.]

[26]Outer Space Treaty (n 24) art I.

[27]Outer Space Treaty (n 24) art VI. See Bin Cheng, *Studies in International Space Law* (OUP 1997) ch 23 on the meaning of "national activities" and "continuing supervision".

[28]Outer Space Treaty (n 24) art VII. The article also extends liability to a State Party that launches or procures the launching of the object.

[29]Outer Space Treaty (n 24) art VIII (jurisdiction and control over a registered object and any personnel thereof).

[30]Outer Space Treaty (n 24) art IX.

exploration and use of outer space by other States.[31] It creates the basis for Space Traffic Management by imposing due regard, prior consultation and a duty to avoid harmful interference but it doesn't specify what "due regard" is. Hence, it provides principles rather than rules.[32]

2. The Liability Convention 1972

It was adopted to develop the principles of international liability established under Article VII of the Outer Space Treaty. It was developed to provide compensation for the damage caused by the collision of the space objects and ensure determining the party responsible. The convention on International Liability for Damage Caused by Space Objects was ratified by India in 1982.[33] It's main features of provisions are:

Article I: It states that the definition of launching state and damage.[34] Launching state is defined as a state which launches or procures the launching of a space object o a state from whose territory or facility a space object is launched. It is important as multiple States may fall within this definition, as a satellite may be manufactured by one country, launched by another and procured by a third country. Whereas damage includes loss of life, personal injury or other impairment of health, as well as loss of or damage to property belonging to States, natural persons, judicial persons, or international inter governmental organisations.

Article II: It states that a launching state will have absolute liability to pay compensation for damage caused by its spa e objects on the surface of Earth or to aircraft in flight.[35]

Article III: It establishes fault based liability for damage occurring elsewhere on the surface of the Earth, such a collision in orbit. The launching State will be liable for such damage only if it is due to their fault or fault of the persons for whom it is responsible.[36]

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[31]Outer Space Treaty (n 24) art IX (international consultations before proceeding with an activity or experiment that would cause potentially harmful interference).

[32]See Stephan Hobe, Bernhard Schmidt-Tedd and Kai-Uwe Schrogl (eds), *Cologne Commentary on Space Law*, vol 1 (Carl Heymanns 2009) on art IX; Frans G von der Dunk (ed), *Handbook of Space Law* (Edward Elgar 2015).

[33]Liability Convention (n 13); UNOOSA, *Status of International Agreements* (latest edition). [Confirm India's date of accession/ratification.]

[34]Liability Convention (n 13) art I(a), (c).

[35]Liability Convention (n 13) art II.

[36]Liability Convention (n 13) art III. Note that art III applies to damage caused "elsewhere than on the surface of the earth" to a space object of one launching State, or to persons or property on board it, by a space object of another. The text's phrase "elsewhere on the surface of the Earth" should be conformed to the treaty wording.

Article IV and V: It establishes joint and several liability where two or more states jointly launch an object or when two objects belonging to different states collide, which result into the damage to a third state with approtionment according to fault.[37]

As per Article VIII to X, it states that claims are to presented by a sate through diplomatic channels, and it should be presented within one year of the damage without prior exhaustion of local remedies.[38] But if the parties fail to settle within a year, a Claims Commission may be established, whose award will be final and binding if the parties agree to the award, or if otherwise mandatory according to Article XIV to XX.[39]

This Convention has been formally enforced once in the Cosmos 954 claim by Canada against the USSR in 1978- 79. It was further settled by negotiation.[40] But it has never been used for an orbital collision between satellites.[41]

3. The Registration Convention 1975 and the Rescue Agreement 1968

It was adopted to improve the identification of objects in space and facilitate the application of international space law.[42] It mainly recognises the jurisdiction and control of the State on the space objects or satellites in the Earth's orbit. India is also a part to this convention.

According to its Article II, IV, and VIII, it states that space objects need to be registered in a national registry by the launching state and furnish information related to such objects to the UN Secretary- General, including basic orbital parameters.[43] Through this principles, it helps guide to identify the state having the proper jurisdiction and can be held liable under

[37]Liability Convention (n 13) arts IV–V. Art IV deals with damage caused to a third State by a collision between space objects of two launching States (joint and several liability, apportioned by fault); art V deals with joint launching.

[38]Liability Convention (n 13) arts VIII–XI. Presentation through diplomatic channels is dealt with in art IX, the one-year limit in art X, and the absence of any requirement to exhaust local remedies in art XI.

[39]Liability Convention (n 13) arts XIV–XX, esp art XIX(2). [Check: under art XIX(2) the award is final and binding only if the parties have so agreed; otherwise the Commission issues a final and recommendatory award to be considered in good faith. The text's "if otherwise mandatory" should be corrected.]

[40]Protocol between Canada and the USSR on Settlement of Canada's Claim for Damages Caused by "Cosmos 954" (signed 2 April 1981) (1981) 20 ILM 689; Canada's claim is reproduced at (1979) 18 ILM 899.

[41]See Lyall and Larsen, *Space Law: A Treatise* (2nd edn, Routledge 2018) ch 2 on the Liability Convention's limited practice.

[42]Convention on Registration of Objects Launched into Outer Space (opened for signature 14 January 1975, entered into force 15 September 1976) 1023 UNTS 15 (Registration Convention).

[43]Registration Convention (1975) arts II (national registry), IV (information to be furnished to the UN Secretary-General: name of launching State, designator, date and territory of launch, basic orbital parameters, general function). [Verify the reference to art VIII; it should be checked against the treaty text.]

International law. But it is limited due to inconsistent and delayed registrations and the lack of detail on Operational status and disposal and proper information sharing.[44]

4. Soft law: debris mitigation and long- term sustainability

Some of the non binding instruments providing technical aspects such as :

- IADC Space Debris Mitigation Guidelines (2002): it focuses on limiting debris related during normal operations and incorporating debris mitigation considerations from the planning and design stage itself, rather than treating them at the end of mission requirements, and ensuring appropriate disposal after the end of mission. It basically provide technical recommendations through out the lifecycle of space objects for reducing the generation of debris.[45]
- UN COPUOS Space Debris Mitigation Guidelines (2007): it applies the IADC principles voluntarily at the state level. It was endrosed by General Assembly Resolution 62/217.[46]
- UN Guidelines for the Long-term Sustainability of Space Activities (2019): It laid down 21 guidelines including regulatory framework, registration, information sharing and safety of operations. Ensures the sustainability of outer space through responsible conduct of States, international cooperation, scientific research, and development of appropriate regulatory frameworks. It supports Indian to develop a comprehensive statutory framework regulating the conduct of governmental and non- governmental satellite operators.[47]
- ISO 24113 and related standards: it laid downs technical requirements for debris mitigation that can be incorporated by reference in national licensing.[48]

[44]See UN General Assembly Resolution 62/101 (17 December 2007), 'Recommendations on enhancing the practice of States and international intergovernmental organizations in registering space objects'.

[45]IADC, *Space Debris Mitigation Guidelines*, IADC-02-01 (2002, as revised) .

[46]UNGA Res 62/217 (22 December 2007) UN Doc A/RES/62/217, para 26; COPUOS, *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space* (UN 2010). [Verify paragraph number.]

[47]LTS Guidelines (n 14), Section A (policy and regulatory framework) and Section B (safety of space operations). Guideline A.1 calls on States to adopt, revise and amend national regulatory frameworks as necessary.

[48]ISO 24113, *Space systems — Space debris mitigation requirements* (current edition).

These are not legally binding, but it set as a guideline for reasonable conduct of act and may inform the standard of fault under the Liability Convention. When a state enforce them through domestic licence conditions, such instruments are effective .[49]

5. Rescue Agreement, 1968

It deals with the notification, recovery and return of space objects or component parts which are found within the territory of another state, it is notified to the launching authority and facilitates in the recovery and return of such objects.[50] India had acceded to it in 14 July, 1980.[51]

6. The International Telecommunication Union Framework

It regulates the allocation of radio spectrum and satellite orbital positions through filing and coordination procedures.[52] It does not address physical collision risk but shapes constellation design. In India is administered through Department of Telecommunications.

Therefore, International framework provides the foundational guidelines for state responsibility for private entities, duty of due regard and consultation and liability for damage or to seek compensation for such damage. But there is still need of a binding international Space Traffic Management framework as there are no universally binding rules for conduct of act for safe and sustainable use of outer space. Even there is no international body empowered to regulate and coordinate and issue warnings, it is left upon the domestic law or States. Hence, India should develop a framework which complies with its international treaty obligations, and enables a safe and sustainable participation in the global space economy.

Existing Indian Legal and Institutional Framework

India's space governance relied on policies, institutional regulations, technical infrastructure and international obligations. The space sector was opened to non governmental entities

[49]On the relationship between soft law and the standard of fault, see Lyall and Larsen (2nd edn 2018) ch 2; Hobe, Schmidt-Tedd and Schrogl (eds) (2009).

[50]Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (opened for signature 22 April 1968, entered into force 3 December 1968) 672 UNTS 119 (Rescue Agreement), esp art 5.

[51]UNOOSA, *Status of International Agreements* (latest edition). [Confirm date and whether India's status is ratification or accession.]

[52]Constitution of the International Telecommunication Union (Geneva, 22 December 1992) 1825 UNTS 1, art 44 (rational, efficient and economical use of the radio-frequency spectrum and the geostationary-satellite orbit); ITU, *Radio Regulations* (current edition).

through Indian Space Policy, 2023 for providing rules for safety of operations and prevention of collisions due to increasing commercial activities.[53]

Although ISRO monitors space objects through IS4OM and Project NETRA, but these does not alone create binding legal duties for operators to exchange information and execute collision avoidance manoeuvres. It analyses the various Indian frameworks existing.

1. Indian Space Policy, 2023

It is a principal policy document which is enacted to govern the India's space sector. It establishes frameworks to promote greater private participation while also defining and assigning different roles to the Department of Space (DoS), ISRO, IN-SPACe, and NSIL.[54] Under this framework, NGEs is permitted to undertake broad range of space activities and develop SSA capabilities. It is a vision which is needed to translate into reality by providing the necessary legal framework by the government for safe and sustainable operations in compliance with international obligations and principles. Thus, it is a policy statement and provides broad objectives but do not contain detail binding and enforceable duties on collision avoidance.

2. IN-SPACe and Authorisation of Space Activities

The Indian National Space Promotion and Authorisation Centre is an autonomous, government organisation functioning under the DoS which acts as a single window nodal agency i.e. acting as an interface between the ISRO and private companies, and other agencies and it set out authorization procedures for different space activities such as establishment and operation, launching objects and satellites, etc.[55] It is an important development released in 2024 by the publication of the Norms, Guidelines and Procedures for Implementation of Indian Space Policy 2023, providing detailed operational requirements for applicants seeking authorisations and coordinate with IS4OM and communicate with other satellite operators to resolve collision risks.[56] But there are certain limitations to this framework, it only binds the operators through administrative conditions rather than a comprehensive Statutory legal framework applicable uniformly, including foreign operators. Consequently, it also allows to indemnify the

[53]Indian Space Policy-2023 (n 9).

[54]Indian Space Policy-2023 (n 9) (roles of DoS, ISRO, IN-SPACe and NewSpace India Limited).

[55]Department of Space, Government of India, Resolution establishing IN-SPACe (June 2020); Indian Space Policy-2023 (n 9). [Add the Gazette/Cabinet reference.]

[56]IN-SPACe, *Norms, Guidelines and Procedures for Implementation of Indian Space Policy-2023 in respect of Authorization of Space Activities* (IN-SPACe 2024). [The Recommendations section refers to these as "IN-SPACe Norms, Guidelines and Procedures, 2025"; conform the year.]

government and obtain third party insurance, but does not establish standards of due care or negligence liability.[57]

3. ISRO, IS4OM and Project NETRA

ISRO play a crucial role in protecting Indian space assets and in promoting sustainable space operations. ISRO has therefore taken two main initiatives:

IS4OM: it was established in 2022. It main role is to observe, identify and monitor the objects in orbit and it's characteristics, help in detecting threat and assessing risks related to collision, data sharing and catalogue development.[58]

Project NETRA: The Network for Space Objects Tracking and Analysis project, it strengthens and expands the tracking of objects via Operational SSA Control Centre in Bengaluru. It generates collision avoidance recommendations , in which by early 2026, it has spent 67.77 crore of its 509.01 crore budget.[59] But despite the advancement in technological capabilities through these technical bodies, yet, it lacks regulatory framework to penalise non- compliant operators and determine civil liability.

4. Telecommunications Act, 2023

It is an additional legal framework which is relevant to satellite based communication.[60] It does not address physical collision risks, but it is vital for preventing harmful radio frequency interference, spectrum management by governing satellite communication services and spectrum assignment. Whereas, consequently it cannot be treated as a comprehensive framework to regulate Space Traffic Management or for orbital traffic coordination.

5. Proposed Space Activities Bill

Earlier in 2017, draft Space Activities Bill have been circulated which was a dedicated legislation governing space activities and also other revised bills had also known to have been

[57]IN-SPACe NGP (n 56) (provisions on indemnity and insurance). [Add paragraph numbers.]

[58]ISRO, 'ISRO System for Safe and Sustainable Space Operations Management (IS4OM)' (ISRO). See also ISSAR 2024 (n 10).

[59][Source needed for the expenditure figures (₹67.77 crore of ₹509.01 crore): cite the specific Lok Sabha/Rajya Sabha question and answer, or the 410th Report (n 12) if the figures appear there.]

[60]Telecommunications Act 2023 (Act 44 of 2023), s 4 and First Schedule (administrative assignment of spectrum for satellite-based services). [Verify section and entry numbers.]

reported by the Department of Space,.[61] Yet, no act has still been enacted by the parliament as of November, 2026.

Even in the Parliamentary Standing Committee on Science and Technology, in 410th Report published in March 2026 has explicitly pointed out the lack of a dedicated comprehensive legislative framework on Space activities, instead of relying on policies and guidelines.[62] Such legislation must mandate orbital data sharing, collision risk warnings or notifications, disposal after end of mission, and proper penalties for non- compliance, statute establishing liability for private operators, mandatory third party insurance or a liability cap.

Legal gaps in Indian Space Traffic Management Framework

India has strong institutional and technical foundations for Space Traffic Management by these policies and technical infrastructure and the Debris Free Space Mission which targets zero debris by 2030. However, the framework are fragmented and still there is a need for unified statute and a binding statutory law to enforce compliance and determine liability while still ensuring private sector growth. Even though international treaties lay down duties of due regard and liability, but domestic law still lacks clear rules on operator duties, data sharing standards, enforcement, and negligence. Hence, one of the major legal gap is absence of a dedicated and uniform statutory framework. Since policy only sets reasonable conduct and a vision but it does not create legally binding duties, or prescribe penalties throughout the entire lifecycle till disposal like a statute.

Another major legal gap is uncertainty in IN-SPACe's Legal Authority and Enforcement Powers. Even though IN-SPACe acts as an interface between the ISRO and private companies under the Indian Space Policy 2023 and 2024 guidelines, but still a dedicated statutory foundation is a requirement.[63] To effectively prevent collisions, continuous supervision and coordination is necessary. But there is no statute clearly defining IN-SPACe's jurisdiction, inspection powers, penalties or appeal mechanisms, which was also addressed in the Parliamentary Standing Committee's 410th report.[64]

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[61] Department of Space, Government of India, *Draft Space Activities Bill, 2017* (circulated for public comments, 2017).

[62] 410th Report (n 12). [Insert the paragraph number of the relevant observation or recommendation.]

[63] Indian Space Policy-2023 (n 9); IN-SPACe NGP (n 56).

[64] 410th Report (n 12).

International law under Article IX of the Outer Space Treaty requires "due regard" but does not provide operational standard for collision avoidance, and even Article III of the Liability Convention imposes fault based liability, but it does not define "fault".[65] So, it is uncertain and not clear what act or conduct of an operator will account to be negligent such as whether if the operator fails to manoeuvre, or fails to coordinate or creates additional or secondary collision risks, etc. Consequently , the another legal gap is absence of a uniform standard of care which can be overcome by establishing a statutory standard of reasonable orbital conduct.

Another legal problem is inadequate standardization of Orbital- Data Sharing as accurate and timely data is essential to prevent false alarms and collisions. Since, the 2024 guidelines only mandates conjunction assessments and emergency point of contacts.[66] There is a need for uniform statute prescribing data exchange formats, strict reporting timelines, and mandatory post- manoeuvres updates.[67] The importance of reliable information sharing was demonstrated through the ISRO's ISSAR Report, 2024 which reported more than 53000 alerts issued by the United States Space Command for Indian satellite in orbit analysed by more accurate orbital data. Even in 2024, ISRO reported ten collision- avoidance manoeuvres for their satellites.[68] Hence, India instead of relying on external surveillance networks, should integrate it's technical infrastructure with binding domestic obligations or domestic regulatory framework relating to data reporting.

Uncertainty regarding Liability, Insurance, and Financial Responsibility is one of the legal problems in Indian framework that should be addressed. According to the International obligations, India have strict as well as fault based liability as a launching state, even for private entities and academics institutions and agencies, and does not separately consider private operator liability or third party insurance.[69] Under the policy framework of IN-SPACe's, the policy on State Liability and third party insurance was still under consideration as intimated by government in August 2026 to the Parliament.[70] Thus, to mandate insurance, clarify

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[65]Outer Space Treaty (n 24) art IX; Liability Convention (n 13) art III. On the undefined standard of fault, see Lyall and Larsen, *Space Law: A Treatise* (2nd edn, Routledge 2018) ch 2; Bin Cheng, *Studies in International Space Law* (OUP 1997) ch 15.

[66]IN-SPACe NGP (n 56). [Add paragraph numbers for the conjunction-assessment and point-of-contact requirements.]

[67]On standard data formats, see CCSDS, *Conjunction Data Message* (2013) and CCSDS *Orbit Data Messages* (CCSDS 502.0-B).

[68]ISSAR 2024 (n 10).

[69]Liability Convention (n 13) arts II–III; Outer Space Treaty (n 24) arts VI–VII.

[70][Cite the Lok Sabha/Rajya Sabha question number, date (August 2026) and the Minister's reply.]

indemnification, and when damage is accused due to negligence or regulatory non- compliance, it should establish proper operator contribution mechanisms by implementing a comprehensive statute.

The existing framework should be assessed and prescribe rules and procedures on the entire operational life a satellite. A satellite should not only be supervised when it functioning, as risks can arise or damage can occur even during launch and early orbit operations, routine manoeuvres, loss of communication, satellite failure or end of life. There are guidelines in India regarding debris mitigation and post mission disposal but to address all such issues when satellite become unresponsive or is incapable of maneouvring or during launch or fuel reserves, etc, a statutory framework should be enacted, establishing clear and continuing obligations.[71] It should be considered as an important element of collision avoidance rather than as a separate environmental consideration as it may create additional risks for operational spacecraft if satellite has completed its mission or loss communication or incapable of maneouvring.

Further, there is absence of proper dispute resolution mechanisms for resolving disputes between operators, only general civil remedies and arbitration available.[72] Even there are no defined penalties, license suspension procedures, or inspection powers.

Although India is a part of the international treaty under Registration Convention, but there is no statutory registry, or no duty on operators to report changes in orbital status and no process for continuous supervision by the Indian authorities.[73]

Recommendations

Since we have seen that India had made considerable progress in developing it's space sector and it has also contributed towards improving the safety and sustainability of Indian space activities by introduction of Indian Space Policy, 2023; IN-SPACe Norms, Guidelines and Procedures, 2025; establishment of ISRO system, etc.[74] However, the increasing space activities requires a regulatory approach that goes beyond voluntary cooperation and general authorisation conditions. Therefore, there is a need for a comprehensive legal and institutional framework that may be incorporated into a dedicated Space Activities Act or integrated as an

[71]Compare IADC-02-01 on end-of-life disposal and passivation; LTS Guidelines (n 14), guideline B.7.

[72]Compare Permanent Court of Arbitration, *Optional Rules for Arbitration of Disputes Relating to Outer Space* (2011), which are designed for disputes involving States, international organisations and private entities.

[73]Registration Convention (1975) art IV(3), which requires States to notify the Secretary-General, to the greatest extent feasible, of objects no longer in Earth orbit.

[74]Indian Space Policy-2023 (n 9); IN-SPACe NGP (n 56).

amendment to the existing regulations. The proposed framework should be rooted in collision prevention , equal accountability for public and private operators , accurate and timely data, continuous supervision throughout the lifecycle, equitable liability allocation, and international cooperation and coordination. It should apply to both governmental and non governmental entities under the jurisdiction or control of India. It's objective should be to prevent collisions, minimise space debris, promote accurate and timely exchange of information, establish responsibility or liability of operators, facilitate coordination between governmental and private operators and ensure long term sustainability of outer space activities. It would make collision prevention, a legally recognised regulatory responsibility from general policies.

IN-SPACe should be empowered as a principal statutory regulator to regulate, maintain, coordinate, and authorise various space activities and prescribe mandatory standards and penalties.[75] Whereas ISRO and IS4OM should provide technical and scientific support to prevent overlapping through this separation. Also, the recommendations provided by these bodies should not automatically constitute a legally binding decision unless adopted by component authorities.

Further, the government should establish centralised National Space Traffic Coordination System for preventing satellite collisions under statutory supervision of ISRO. Although, India had developed it's technical infrastructure, but it still requires a structured mechanism for proper exchange of information, collision warnings, report incidents and to coordinate manoeuvres. The United State's Traffic Coordination System for Space (TraCSS) and the European Union's Space Surveillance and Tracking (EU SST) can act as useful comparative models.[76] Thus, it should set uniform standards for orbital data sharing and introduce statutory obligations requiring authorised satellite operators to provide relevant information to the National Space Traffic Coordination System as well as prescribe different reporting requirements depending on the nature and risk associated and considering other relevant factors.

[75]For comparison of statutory licensing regulators, see Outer Space Act 1986 (UK), ss 3, 5 (licensing and licence conditions); Space Industry Act 2018 (UK); Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (France); 51 USC §§ 50901 et seq (US commercial space launch regime).

[76]US Department of Commerce, Office of Space Commerce, 'Traffic Coordination System for Space (TraCSS)' (OSC programme documentation); Decision No 541/2014/EU establishing a Framework for Space Surveillance and Tracking Support [2014] OJ L158/227, now continued under Regulation (EU) 2021/696 establishing the Union Space Programme [2021] OJ L170/69; see also the European Commission's proposed EU Space Act (COM(2025) 335). [Verify OJ references and the status of the EU Space Act proposal.]

Furthermore, it should introduce legally enforceable collision avoidance obligations and set standards for reasonable care to be undertaken to prevent collisions or establish duties such as duty to assess collision risks, to respond to critical collision warnings, to coordinate manoeuvres, to maintain manoeuvre capability and maintain records of such information, which should be considered during investigating an accident and identify liability.[77] Therefore, India should also incorporate a statutory standard for reasonable conduct in orbit. Its aim is to identify whether an operator has reached its obligations by considering the factors laid down for such breach. While determining breach of negligence, it should also assess and consider the technological capabilities available to the operator and circumstances at that relevant time.

The next recommendation is to establish a comprehensive financial responsibility framework for satellite operators. To mainly establish liability even for private satellite operators and seek compensation through third party insurance and introduce a mechanism through which government can recover appropriate amounts from an operator, where liability arises due to breach of statutory obligations by the operator.[78]

The comprehensive Space Traffic Management framework should also address the generation and accumulation of space debris. India should incorporate relevant recommendations of the United Nations Space Debris Mitigation Guidelines, 2007, and the COPUOS Guidelines for the Long-Term Sustainability of Outer Space Activities, 2019 into its domestic legislation.[79] The operator should submit a disposal plan before launch, if technically feasible, operator should passivate their spacecraft at the end of the mission, and should immediately report any loss of communication or control.[80]

It should further establish a formal mechanism or an independent authority for investigating satellite collision and other related accidents in the orbit and expressly prescribe in what circumstances an investigation can be conducted to identify the authority responsible.[81] The

[77]Compare LTS Guidelines (n 14), guidelines B.2–B.6 (conjunction assessment and manoeuvre coordination) and IADC-02-01.

[78]For comparative models of licensee insurance, indemnity and liability caps, see Outer Space Act 1986 (UK), ss 5, 10; 51 USC § 50914 (US) (maximum probable loss insurance and government indemnification above that amount); Loi n° 2008-518 (France), arts 13 and 15 (State guarantee and recourse against the operator). [Verify article numbers.]

[79]COPUOS Space Debris Mitigation Guidelines (2007) (endorsed by UNGA Res 62/217); LTS Guidelines (n 14).

[80]COPUOS Space Debris Mitigation Guidelines (2007), guidelines 4–6 (limit post-mission break-ups; limit the long-term presence of spacecraft in LEO and GEO). [Verify guideline numbers.]

[81]For an analogue in aviation, see Chicago Convention 1944, art 26 and Annex 13 (Aircraft Accident and Incident Investigation); for space, compare the mishap-investigation provisions in 51 USC § 50901 et seq and the regulations thereunder, 14 CFR pt 450.

main purpose should be to identify the cause of such accident or incident and recommend prevention measures.

Further, there is a need to establish a proper dispute resolution and compensation mechanism as operators may belong to different countries and different commercial entities. There is international mechanism, but an appropriate procedure for addressing disputes involving Indian satellite operators should be established domestically.[82] Whereas, India should strengthen international cooperation with the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), international space agencies and established SSA networks for international cooperation and better cross – border coordination.

Since satellite operators or defence- related satellites may possess commercially sensitive information or confidential information that cannot be disclosed publicly , so, India should adopt a differentiated information sharing system and establish secure communication channels and prescribe safeguards.[83]

Before implementing such legislation, it should consult and taken in consideration the private companies, start-ups, academic institutions, insurance providers, technical experts and relevant government departments and small satellite operators should be provided with reasonable compliance periods and access to government services.[84]

Conclusion

Due to rapid growth of outer space and increasing space activities and services, Space Traffic Management has became an essential element in today's modern space governance. Due to the increasing commercial activities and the introduction of private entities, have increased the number of satellites and objects in space which increases the risks of collisions and further accumulation of space debris. This ultimately creates a threat to the safety and sustainability of the outer space. Although International instruments provide foundational legal principles, but do not provide comprehensive framework for preventing satellite collisions and coordinating space traffic.

[82]Compare PCA, *Optional Rules for Arbitration of Disputes Relating to Outer Space* (2011); Liability Convention (n 13) arts IX–XX (inter-State claims only).

[83]Compare the tiered data-sharing approach of TraCSS and the EU SST framework, which separate basic conjunction services from restricted data.

[84]Compare LTS Guidelines (n 14), guideline A.1 and the Indian Space Policy-2023 (n 9) on stakeholder consultation and industry participation.

It also highlighted that India had made considerable progress in developing it's technical infrastructure and space sector by establishment of ISRO and through introduction of Indian Space Policy, 2023, IN-SPACe, 2024. But the lack of a dedicated uniform and binding statutory framework for Space Traffic Management creates legal gaps in the existing Indian legal framework concerning collision avoidance, orbital-data sharing, operator responsibilities, liability, insurance and space debris mitigation.

Ultimately, India should seek to establish a regulatory model that is technologically informed, legally enforceable and commercially sustainable. Such a framework would strengthen India's compliance with its international obligations, protect its growing space infrastructure and contribute to the development of a safer and more sustainable orbital environment. Such an approach would effectively balance the safety and sustainability of outer space and subsequently promote innovation and commercial activities in India's space sector.