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ON THE TOPIC

LEGAL ISSUES SURROUNDING THE COMMERCIAL USE OF OUTER SPACE AND RELATED TRADE CONSIDERATIONS

Under The Guidance and Supervision Of

DR. ATHIRA P.S

ASSISTANT PROFESSOR

THE NATIONAL LAW UNIVERSITY OF ADVANCED LEGAL STUDIES, KOCHI

Submitted by

NANDINI

Register No: LM0224016

LL.M. (INTERNATIONAL TRADE LAW)

BATCH: (2024-2025)

MAY 2025

CERTIFICATE

This is to certify that **Ms. Nandini**, REG NO: LM224016 has submitted his Dissertation titled - *"**Legal issues surrounding the commercial use of outer space and related trade considerations**"* in partial fulfilment of the requirement for the award of Degree in Master of Laws in International Trade Law to The National University of Advanced Legal Studies, Kochi under my guidance and supervision. It is also affirmed that the dissertation submitted by her is original, bona fide and genuine.

Date:

Place: Ernakulam

DR. ATHIRA P.S.
Assistant Professor
Guide and Supervisor
NUALS, KOCHI

DECLARATION

I, **NANDINI**, do hereby declare that this dissertation work titled *"**Legal issues surrounding the commercial use of outer space and related trade considerations**"* researched and submitted by me to the National University of Advanced Legal Studies in partial fulfilment of the requirement for the award of degree of master of laws in International Trade Law under the guidance and supervision **of DR. ATHIRA P.S,** Assistant Professor, The National University of Advanced Legal Studies, is an original, bona fide, and Legitimate work. It has been pursued for an academic interest. This work or any type thereof has not been submitted by me or anyone else for the award of another degree from this university or any other university.

Date:

Place: Ernakulam

NANDINI

Register No: LM224016

LL.M. (INTERNATIONAL TRADE LAW)

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PREFACE

This dissertation, titled *"Legal Issues Surrounding the Commercial Use of Outer Space and Related Trade Considerations,"* has been submitted in partial fulfilment of the requirements for the Master of Laws (LL.M.) degree at the National University of Advanced Legal Studies, Kochi, Kerala. This research examines the evolving legal framework governing the commercial exploitation of outer space and its intersection with international trade law.

The motivation for choosing this topic stems from India's remarkable achievements in space exploration, particularly the successful soft landing near the Moon's south pole and the Mars Orbiter Mission, which have inspired renewed interest in space activities. As outer space emerges as a frontier of commercial opportunity, legal scholarship must keep pace with technological advancement. Given the relative novelty of this field and the limited legal development thus far, this dissertation seeks to make a meaningful contribution by identifying gaps and proposing suggestions for a more structured and inclusive legal regime.

This doctrinal study relies on legal instruments, case law, scholarly works, and institutional materials. I hope this research will add value to the growing discourse on the commercialisation of outer space and its trade implications.

- Nandini

Register no. LM0224016

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ABBREVIATIONS

NASA	National Aeronautics and Space Administration
ISS	International Space Station
NSIL	New Space India Limited
USA	United States of America
ISRO	Indian Space Research Organisation
GPS	Global Positioning System
ESA	European Space Agency
EU	European Union
ITAR	International Traffic in Arms Regulations
OST	Outer Space Treaty (1967)
JAXA	Japan Aerospace Exploration Agency
NAIL	National Aerospace Laboratories
FDI	Foreign Direct Investment
IN-SPACe	Indian National Space Promotion and Authorisation Centre
PSLV	Polar Satellite Launch Vehicle
UAE	United Arab Emirates
UNCOPUOS	United Nations Committee on the Peaceful Uses of Outer Space
UN	United Nations
UNCITRAL	United Nations Commission on International Trade Law
ICSID	International Centre for Settlement of Investment Disputes
ICC	International Chamber of Commerce
GDPR	General Data Protection Regulation
WTO	World Trade Organisation
GATT	General Agreement on Tariffs and Trade
GATS	General Agreement on Trade in Services
TRIPS	Trade-Related Aspects of Intellectual Property Rights
USSR	Union of Soviet Socialist Republics

FAA	Federal Aviation Administration.
NSC	National Security Council
COSTND	Commission for Science, Technology and Industry for National Defence (China)
ESRO	European Space Research Organisation *(precursor to ESA)*
ELDO	European Launcher Development Organisation *(precursor to ESA)*
GPA	Government Procurement Agreement *(under WTO)*
MFN	Most Favoured Nation
WIPO	World Intellectual Property Organisation.
GEO	Geostationary Earth Orbit
IP	Intellectual Property
PCT	Patent Cooperation Treaty
ITAR	International Traffic in Arms Regulations
MTCR	Missile Technology Control Regime
EAR	Export Administration Regulations

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No.	Case/Reference	Citation/Details
1	In the Matter of Swarm Technologies, Inc., Consent Decree	33 FCC Rcd 11400 (2018)
2	Nemitz v. United States	No. 04-16223 (9th Cir. Feb. 10, 2005), aff'g No. CV-N-03-599-HDM (VPC) (D. Nev. Apr. 26, 2004)
3	Space Exploitation Technologies Corporation (SpaceX) vs NDR Tech Co., Ltd.	June 4, 2024, Invalidation Case No. 2023-890010
4	Deutsche Telekom AG v. Republic of India	PCA Case No. 2014-10
5	CC/Devas (Mauritius) Ltd. v. Republic of India	PCA Case No. 2013-09
6	Eutelsat S.A. v. United Mexican States	ICSID Case No. ARB(AF)/17/2, Award (Apr. 25, 2019)
7	LETCO v. Republic of Liberia	337 F. Supp. 2d 173 (D.D.C. 2004)
8	EU-Procurement of a Navigation Satellite	WTO DS73, 1997
9	Japan - Procurement of a Navigation Satellite	WTO Doc. WT/DS73 (July 31, 1997)
10	AIG Capital Partners Inc. and another vs the Republic of Kazakhstan	1 WLR 1420, 1 All E.R. 284, 1 All E.R. (Comm) 1, and 1 Lloyd's Rep. 1.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The Union Cabinet approved the modification of the FDI (Foreign Direct Investment) policy regarding the Space sector on 21st February 2024.[1] The modification now allows 100% FDI through the automatic route in its space industry to reduce barriers for foreign investors, promoting a culture of greater international investment inclusion, technology transfer and collaborative space technology research. This action by the Indian government reflects how they are positioning the country as a powerful player in the fast-growing Space industry and putting the nation on the map as a competitor in this emerging business. Outer space exploration and use have come into a revolutionary era. Once dominated by the role of space agencies, it is now increasingly regulated by private enterprises, new national players, and innovative global collaborations.[2] Reusable rockets are launched by companies regularly nowadays, giant satellite constellations are deployed, and even paying passengers are taken to orbit, unveiling a global space economy in the hundreds of billions of dollars.[3] For example, one analysis reports that the total space economy reached roughly $570 billion in 2023, reflecting surging private investment and growing markets from broadband satellites to tourism flights.[4] The enduring relevance of the 1967 Outer Space Treaty (hereinafter referred to as "OST) and its progeny has become sharply highlighted in this context. The OST proclaims that the exploration and use of outer space shall be carried out *"for the benefit and in the interests of all countries"*[5] and that outer space *"shall be free for exploration*

[1] Press Information Bureau, Government of India, PM addresses National Rozgar Mela via video conferencing (May 16, 2024), https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2007876.
[2] The New Space Race: Nations vs. Companies, New Space Economy (Sept. 2, 2024), https://newspaceeconomy.ca/2024/09/02/the-new-space-race-nations-vs-companies/#google_vignette.
[3] Aras Yolusever, The Space Economy: A New Frontier for Economic Growth and Innovation, 7 İzmir J. Soc. Sci. 15 (2025), https://doi.org/10.47899/ijss.1654411.
[4] Space Foundation Editorial Team, Space Foundation Announces $570B Space Economy in 2023, Driven by Steady Private and Public Sector Growth, Space Found. (July 18, 2024), https://www.spacefoundation.org/2024/07/18/the-space-report-2024-q2/.
[5] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Jan. 27, 1967, 610 U.N.T.S. 205.

and use by all States"[6]*,* setting a broad template for peaceful activities. However, such treaties and ancillary instruments were drafted in an era focused on states and did not foresee the extent and character of contemporary commercial activity.

To compensate for such a deficit, subsequent efforts like the American initiative Artemis Accords stipulate specifically that any space resource utilisation *"should be conducted in a manner consistent with the Outer Space Treaty."*[7] An effort to place contemporary ventures within today's legal texture. In concrete terms, these shifts manifest in projects both dramatic and routine. In the United States alone, the Federal Aviation Administration licensed a record 117 commercial space launches in 2023 (up from 79 the previous year)[8], as companies like SpaceX, Blue Origin, Rocket Lab and others ramp up launch cadence. Meanwhile, satellite broadband constellations are proliferating at an unprecedented speed. SpaceX has already deployed over 3,000 Starlink satellites and is on track for a constellation of 12,000 or more and other networks. [9]For example, OneWeb and Amazon's Project Kuiper plan to field thousands of satellites.[10] Industry projections suggest that the number of active satellites in low-Earth orbit could exceed 60,000 by 2030, a six-fold increase over today's population.[11]

This rapid deployment of space assets fills key orbits and strains spectrum and debris management regimes.[12] At the same time, private human spaceflight has become routine, for instance, in July 2021, Blue Origin's New Shepard vehicle carried four civilians beyond

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[6] ibid

[7] Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes, Nat'l Aeronautics & Space Admin. (Oct. 13, 2020), https://www.nasa.gov/specials/artemis-accords/.

[8] Wailin Wong & Adrian Ma, Taxing the Final Frontier, NPR (Apr. 29, 2024), https://www.npr.org/transcripts/1197964063.:contentReference[oaicite:5]{index=5}

[9] Caleb Henry, SpaceX Submits Paperwork for 30,000 More Starlink Satellites, SpaceNews (Oct. 15, 2019), https://spacenews.com/spacex-submits-paperwork-for-30000-more-starlink-satellites/.

[10] Jackie Wattles, Amazon Launches Project Kuiper Satellites Designed to Compete with Elon Musk's SpaceX, CNN (Apr. 28, 2025), https://edition.cnn.com/2025/04/28/science/amazon-spacex-project-kuiper-satellite-internet.

[11] Rohini Krishnamurthy, Scientists Call for Legally-Binding Treaty to Protect Earth's Orbit. Here's Why, Down To Earth (Mar. 9, 2023), https://www.downtoearth.org.in/science-technology/scientists-call-for-legally-binding-treaty-to-protect-earth-s-orbit-here-s-why-88160.

[12] Roger C. Thompson, A Space Debris Primer, 16(1) Crosslink 1 (2015), https://aerospace.org/sites/default/files/2019-04/Crosslink%20Fall%202015%20V16N1%20.pdf.

the Kármán line, the first licensed commercial human flight to space.[13] Virgin Galactic, Axiom Space, and others have conducted additional tourist and private-crew missions. NASA routinely buys passage on SpaceX and Boeing capsules to send astronauts and private citizens to the International Space Station.[14] Governments are also catalysing the commercial space sector; NASA's Artemis program is partnering with industry to land science instruments and astronauts on the Moon. At the same time, jurisdictions such as Luxembourg, the United Arab Emirates, Japan, the Philippines and the United States have enacted national space resource laws to attract investment in asteroid and lunar mining.[15] Even the venerable International Space Station is slated to transition to whole commercial operation by the 2030s.[16] These developments illustrate how outer space is rapidly transitioning from a static frontier of a few satellites to a dynamic, trillion-dollar marketplace for technology, services, and potential resource exploitation.

These advances are set to encounter a regime of space law that remains rooted in Cold War multilateralism. The Outer Space Treaty remains the master organising principle, with its pillars of non-appropriation, freedom of use, peaceful purposes, state responsibility and liability. For instance, Article I of the OST states that space shall be used *"for the benefit of all countries*"[17] and remain *"free for exploration and use by all States"*. At the same time, Article II expressly provides that outer space *"is not subject to national appropriation by claim of sovereignty, use or occupation, or by any other means"*[18]. However, those broad provisions leave many practical questions unanswered. The 1979 Moon Agreement elaborated on these notions by *"declaring that 'the Moon and its natural resources are the*

[13] Blue Origin, Blue Origin Safely Launches Four Commercial Astronauts to Space and Back, Blue Origin (July 20, 2021), https://www.blueorigin.com/news/first-human-flight-updates.
[14] Virgin Galactic, Virgin Galactic Signs Agreement with Axiom Space for Microgravity Research, Virgin Galactic (Apr. 25, 2024), https://www.virgingalactic.com/news/virgin-galactic-signs-agreement-with-axiom-space-for-microgravity-research/.
[15] U.S. Dep't of State, Space Exploration and the Artemis Accords, DipNote Blog (Oct. 20, 2020), https://2017-2021.state.gov/dipnote-u-s-department-of-state-official-blog/space-exploration-and-the-artemis-accords/.
[16] ET Bureau, All Good Things Must Come to an End: The International Space Station to Retire by 2030, Econ: Times (Feb. 18, 2025, 11:06 PM IST), https://economictimes.indiatimes.com/opinion/bliss-of-everyday-life/all-good-things-must-come-to-an-end-the-international-space-station-to-retire-by-2030/articleshow/118364853.cms?from=mdr.
[17] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, art. I, Jan. 27, 1967, 610 U.N.T.S. 205.
[18] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, art. II, Jan. 27, 1967, 610 U.N.T.S. 205.

common heritage of mankind"[19] and obliging States Parties to establish an international regime to govern mining or exploitation. Nearly all recent missions occur outside the Moon Agreement's terms, since major spacefaring nations have not ratified it.[20] For example, no multilateral rule explicitly regulates the ownership of materials once extracted from an asteroid or the Moon.[21] Similarly, existing space law instruments like the Liability and Registration Conventions were designed to assign responsibility for damage and track objects. Still, they do not address controversies such as intellectual property in orbit, commercial trafficking of space-derived commodities, or the liability of a private space tourist.[22] In short, a significant legal ambiguity persists: the current treaty system provides broad principles (non-appropriation, benefit sharing, peaceful use) but leaves many core aspects of a modern space economy unregulated.

The interplay between states and private actors adds another layer of complexity. Under OST Article VI, each State *Party "shall bear international responsibility"* for all national activities in outer space, whether carried out by governmental or non-governmental entities. In effect, every rocket launch or orbital mission by a private company is an act of the launching state under international law.[23] This linkage means that national space agencies, legislatures and regulators must authorise and oversee private initiatives as part of their treaty obligations. In response, several countries have enacted domestic laws to foster commercial space ventures while asserting control. Notably, Title IV of the U.S. Commercial Space Launch Competitiveness Act of 2015 explicitly recognises that U.S. citizens can *"engage in the commercial exploration and exploitation of space resources",*[24] effectively granting them ownership of space minerals they obtain. Some legal scholars argue that this approach reasonably interprets the OST's text (since Article II prohibits sovereign claims but is silent on private extraction). In contrast, others worry it may stretch

[19] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, U.N. Doc. A/RES/34/68, 1363 U.N.T.S. 3
[20] Why Nations Are Rallying Behind the Artemis Accords, CAPS India (Dec. 23, 2024), https://capsindia.org/why-nations-are-rallying-behind-the-artemis-accords/.
[21] Rebekah Shields, towards a New Orbit: Addressing the Legal Void in Space Mining, 40 Am. U. Int'l L. Rev. 157 (2024), https://digitalcommons.wcl.american.edu/auilr/vol40/iss1/7.
[22] James P. Lampertius, The Need for an Effective Liability Régime for Damage Caused by Debris in Outer Space, 13 Mich. J. Int'l L. 447 (1992), https://repository.law.umich.edu/mjil/vol13/iss2/5.
[23] What Is a "Launching State," ESA Clean Space Blog (June 13, 2017), https://blogs.esa.int/cleanspace/2017/06/13/what-is-a-launching-state/.
[24] U.S. Commercial Space Launch Competitiveness Act of 2015, Pub. L. No. 114-90, 129 Stat. 704 (2015).

the treaty beyond its original intent.[25] Regardless, the effect is to advance property rights and investment certainty through national law rather than a new international treaty. The result is a patchwork of regimes where multiple jurisdictions now offer licenses and legal guarantees for space mining or settlement, leading to what experts call "forum shopping" as companies choose the most favourable legal environment.[26] Concurrently, states employ economic and trade instruments to support their space industries.[27] Government procurement programs (such as contracts for national security satellites) and export-credit subsidies resemble industrial policy more than classic foreign aid, and they occasionally raise concerns under international trade rules.[28] The dual public–private governance model enshrined by the OST is being tested as states collaborate in international forums and concurrently compete economically through their commercial champions.

These trends bring commercial space squarely into the realm of international trade law. Space goods and services routinely cross borders, satellites and launch vehicles are built, launched and operated by multinational supply chains, and data from space is traded as a global service.[29] As one trade-space analyst emphasises, space operators *"cannot operate effectively without understanding how international trade laws implemented and enforced by national governments can impact their missions*."[30] Indeed, many WTO disciplines have already touched on space-related activities. For example, satellite communication and remote sensing fall under member states' commitments to the General Agreement on Trade in Services (GATS).[31] A recent UNOOSA symposium report observes a *"narrowing gap"* between international trade law and space law, noting overlaps in areas such as foreign

[25] Belinda Bragg, Governing in a Crowded Space: The OST and Development of the Legal Regime for Space, A Virtual Think Tank (ViTTa)® Report (Apr. 2018), https://apps.dtic.mil/sti/tr/pdf/AD1095009.pdf.
[26] Caroline Derache, Forum Shopping in Air Law: Analysis of the Situation in France from a Defence Lawyer's Perspective, 45 Air & Space L. 611 (2020).
[27] Space Economy, Org. for Econ. Co-operation & Dev., https://www.oecd.org/en/topics/policy-issues/space-economy.html (last visited May 24, 2025).
[28] ibid
[29] Space Law 2024: USA -Trends and Developments (Chambers & Partners, July 11, 2024), https://practiceguides.chambers.com/practice-guides/space-law-2024/usa/trends-and-developments/O17408.
[30] Jasper Helder et al., International Trade Aspects of Outer Space Activities, Akin Gump Strauss Hauer & Feld LLP, https://www.akingump.com/a/web/61872/aoiVR/outer-space-law-international-trade-aspects-of-outer-space-act.pdf.
[31] D. Giorgi, WTO and Space Activities, in International Organisations and Space Law, Proceedings of the Third ECSL Colloquium, 403, 403 (R.A. Harris ed., ESA SP-442, ESA/ESTEC 1999).

launch markets, export controls on space technology, and the commercial trade in space-based data.[32] In principle, the WTO's principles of national treatment and most-favoured-nation could govern how states deal with foreign space companies or data services. At the same time, the Government Procurement Agreement could apply to how space procurement is conducted. In practice, though, security exemptions (e.g. for satellite launch tech), export control regimes and the arms-control aspects of space law often limit the immediate application of trade rules; if space activities grow, trade law may soon have a direct say.[33]

In the coming years, the tension between the regulation of space and business will only grow. One part insists on the OST vision of a standard policy, space for all humanity and peaceful use, hinting at a collective regulation system. Yet, the commercial push out into orbit and beyond is fueled by competition, investment, and innovation, forces of a market economy. Policy arguments already exist on how to strike such a balance. Some views suggest that new multilateral agreements or UN resolutions must include developing activities, such as space mining. In contrast, others think a flexible interpretation of current law and voluntary cooperation (such as the Artemis Accords or industry standards) will be enough. There are questions in the trade aspect, about whether someday WTO institutions will even consider a case that includes space, such as a complaint that any subsidy by countries for their space program violates trade policy or if exceptions will be carved out. Neither is resolved today, but the question does help to show that outer space business is coming rapidly from theory to reality.

[32] U.N. Comm. on the Peaceful Uses of Outer Space, Report on the United Nations Conference on Space Law and Policy (Vienna, Austria, 19–21 November 2024), U.N. Doc. A/AC.105/1352 (Apr. 1, 2025), https://www.unoosa.org/oosa/oosadoc/data/documents/2025/aac.105/aac.1051352_0.html.
[33] Michael Mineiro, Space Technology Export Controls and International Cooperation in Outer Space (2012), https://doi.org/10.1007/978-94-007-2567-6.

1.2 OBJECTIVES

- To research the existing international space laws and their applicability towards commercial exploitation of outer space.
- To identify the present and future legal problems relating to the commercial utilisation of outer space and loopholes in the legislation.
- To assess the potential economic and trade factors in utilising outer space.
- To ascertain the place of different international organisations in regulating activities in space and their framework for resolving disputes about space activities
- To propose a policy and recommendations for regulating these legal matters.

1.3 STATEMENT OF THE PROBLEM

The arrival of private actors into outer space has posed many challenges to international space law. The biggest challenge is that the archaic legal framework does not explicitly cover modern commercial space activities. Laws formulated in the 1960s and 1970s were designed for state action and ignored private enterprise.

This regulatory gap has led to several open legal issues, including identification of property rights, responsibility for exploitation, protection of intellectual property for space objects, responsibility for space debris, etc. A practical regulatory structure for space tourism and mining activities is still absent.

Aspects of trade concerning space commerce currently have a limited scope, with most consisting of satellite systems and trading in propulsion elements. Such transactions usually come under export control regulations, presenting considerable impediments to foreign trade. This dissertation discusses these facets of legal frailty and advocates for far-reaching regulatory practices and regional agreements specifically suited to govern commercial activities and trade relations in the extraterrestrial frontier.

1.4 HYPOTHESIS

The current international legal system governing outer space is insufficient to deal with the emerging legal issues regarding the commercialisation of outer space. It may result in conflict, ambiguity, and hindrance to international cooperation to achieve space commerce.

1.5 RESEARCH QUESTIONS

1. How do current space laws regulate the commercial use of outer space?
2. What legal challenges do private entities encounter in space exploration and resource utilisation?
3. What are the emerging legal frameworks governing space commerce activities?
4. What are the trade-related aspects of outer space commerce?
5. What legal framework is necessary to effectively regulate commercial activities and trade in outer space?

1.6 RESEARCH METHODOLOGY

The research would be Doctrinal, including primary and secondary sources of law.

- Primary sources: International agreements like the Outer Space Treaty, 1967, the Moon Agreement, and other relevant and significant conventions apply to space trade and law.
- Secondary Sources: articles, books, legal experts' reports, and space agency reports such as NASA, ISRO, and ESA.
- Commercialisation of Space case studies.
- Comparative examination of different national space legislations and their impact on global business and commerce

1.7 LITERATURE REVIEW

1. Helder, Jasper et al., *"International trade aspects of outer space activities"*[34]

The article highlights the significant impact of international trade laws, such as export controls, sanctions, and customs regulations, on space activities, including spacecraft design, launch operations, and data handling. It references specific instances, like U.S. export restrictions on satellite payloads to India, which required presidential waivers, and the duty-free import provisions under the ISS Intergovernmental Agreement. The authors argue that these trade regulations now permeate nearly all aspects of space missions, compelling private space companies to integrate legal compliance into their operational planning and execution.

2. Adams, Gerald & Christopher S. Yoo, "*Emerging Commercial Space Age: Legal and Policy Implications"*[35]

The article discusses a major shift in space commerce, highlighting how private industry is increasingly driving space activities, challenging the traditional state-centred legal framework. It notes the rise of "bottom-up" governance led by commercial entities and examines emerging conflicts between different legal visions, such as the Artemis Accords versus the Moon Agreement. The authors also point to economic concerns, like the overcrowding of low Earth orbit (LEO) with satellites, which necessitates rethinking property rights and spectrum allocation to ensure market efficiency. They argue that legal reforms in areas like property, contract, and competition law are essential to manage new commercial disputes as space-based services, like the global internet, become integral to daily life.

3. Smith, Lesley Jane, *"Space and International Trade Law"*[36]

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[34] Jasper Helder et al., International Trade Aspects of Outer Space Activities, in Outer Space Law: Legal Policy and Practice 285–304 (Yanal Abul Failat & Anél Ferreira-Snyman eds., Globe Law and Business 2017), https://www.akingump.com/a/web/61872/aoiVR/outer-space-law-international-trade-aspects-of-outer-space-act.pdf.

[35] Gerald Adams & Christopher S. Yoo, The Emerging Commercial Space Age: Legal and Policy Implications, 6 J.L. & Innovation 1 (2023), https://ssrn.com/abstract=4545290.

[36] Prof. Dr. Lesley Jane Smith, Space and International Trade Law, Presentation at the IISL/ECSL Space Law Symposium, Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, 60th Session (June 8, 2021), https://www.unoosa.org/documents/pdf/copuos/lsc/2021/02.pdf.

Smith highlights that the decreasing costs of launches and satellites, combined with advancements like artificial intelligence, will significantly expand space-based goods and services. This growth will deepen their connection with trade sectors governed by WTO law. She notes that these trends create greater potential for space services but also heighten exposure to international trade regulations. Emphasising the ongoing importance of export controls, Smith argues that areas such as antitrust and unfair competition in outer space remain underexplored. She concludes that trade and competition laws must be adapted and applied to the evolving space economy.

4. Brisibe, T. C., *"International Trade in Commercial Launch Services- Adopting the WTO/GATS"*[37]

Brisibe examines the trade-related challenges facing the commercial launch industry, particularly highlighting that launch vehicles are dual-use technologies, relevant for both civilian and military purposes. He discusses how national security-based export controls, such as those under the MTCR and Wassenaar Arrangement, often clash with the goal of liberalising global launch markets. By comparing international frameworks with domestic export laws, he argues for harmonising regulations under WTO and GATS to balance trade openness with security concerns. Without such harmonisation, he warns, export and licensing restrictions will hinder the international growth of the commercial launch sector.

5. McWilliam, Jamie G, *"Trade-Based Regulation of Space Resources"*[38]

McWilliam argues that traditional international diplomacy is inadequate for effectively regulating space mining, suggesting that World Trade Organization (WTO) law could step in similarly to how TRIPS governs intellectual property. He proposes that a dedicated WTO agreement could manage space resource extraction and usage, offering a structured dispute resolution process. In scenarios like a resource crisis, the WTO could impose obligations such as equitable access or benefit-sharing on spacefaring nations—bypassing

[37] T. C. Brisibe, International Trade in Commercial Launch Services: Adopting the World Trade Organization General Agreement on Trade in Services (WTO/GATS), in The Space Transportation Market: Evolution or Revolution? 267, 267–73 (M. Rycroft ed., 2000), https://doi.org/10.1007/978-94-010-0894-5_32.

[38] Jamie G. McWilliam, Trade-Based Regulation of Space Resources, 32 Minn. J. Int'l L. 163 (2023), Trade-Based Regulation of Space Resources Jamie G. McWilliam* Table of Contents.

the need for a new UN treaty. His controversial idea highlights how international trade law may either constrain or facilitate the future of the space mining economy.

6. Von der Dunk, Frans G., *"Asteroid Mining: International and National Legal Aspects"*[39]

The author analyses how existing space treaties, such as the Outer Space Treaty (OST) and the Moon Agreement, apply to space mining, particularly their principles of non-appropriation and the use of space for the benefit of all humankind. He contrasts this with U.S. domestic legislation, specifically the 2015 Commercial Space Launch Competitiveness Act, which allows American nationals to claim ownership over extracted space resources. The article outlines two differing legal perspectives: one led by the U.S., supporting private mining rights under national law, and another, represented by countries like China and Russia, which view such actions as potential indirect expropriation. It concludes that the legal framework governing space mining remains ambiguous, with unresolved questions about the international consequences and legitimacy of private resource claims.

7. Vidya Sagar Reddy*, "Commercial Space Mining: economic and legal implications*"[40]

With advancements in space mining technologies, countries like the United States and Luxembourg have enacted national laws to support private ventures in this field. Western entrepreneurs view space as a commercial frontier, promoting the idea that harvesting extraterrestrial resources can reduce the strain on Earth's environment. Companies are working on lowering the cost of space travel and constructing manufacturing units in space. While this emerging space economy presents significant growth opportunities, it faces legal uncertainty due to outdated international treaties from the Cold War era, which were not designed to accommodate modern commercial activities in outer space.

[39] Frans G. von der Dunk, Asteroid Mining: International and National Legal Aspects, 26 Mich. St. Int'l L. Rev. 83 (2018), https://digitalcommons.unl.edu/spacelaw/103/.
[40] Vidya Sagar Reddy, COMMERCIAL SPACE MINING: ECONOMIC AND LEGAL IMPLICATIONS, Observer Research Foundation (September, 2017) Commercial space mining: Economic and legal implications [last accessed:

8. Jasper Helder, Chiara C Klaui, Thomas J McCarthy, Brad Powell *"International Trade aspects of outer space activities"*[41]

International trade law governs the cross-border flow of goods, services, and data, and it plays a critical role in regulating space activities. Entities engaged in space projects—from design to launch, must navigate this legal framework carefully. These laws are often intricate and highly technical, requiring detailed planning and expertise. Key challenges include adhering to export controls, trade sanctions, and import restrictions imposed by major jurisdictions such as the United States and the European Union. Failure to comply can result in delays, penalties, or legal action. Therefore, thorough knowledge and strict adherence to international trade regulations are essential for conducting secure and lawful space operations.

9. Prashant Rajpoot & Suyash Kumar Vishwakarma, "*Commercial Space Activities: Legal Framework and Challenges"*[42]

With the increasing involvement of private companies in space-related ventures such as satellite deployment and space tourism, existing legal frameworks are being tested. Current international space law, primarily based on treaties promoting peaceful and equitable space use, was designed with state actors in mind and lacks clarity regarding private sector participation. National regulations vary widely, leading to legal uncertainty and regulatory fragmentation. Key concerns include the management of space debris and the ownership of space resources. Scholar argues that the evolving nature of commercial space activities demands a more coherent and updated legal framework to ensure sustainable and equitable governance.

[41] Jasper Helder Chiara C Klaui Thomas J McCarthy Brad Powell- International trade aspects of outer space activities
[42] Prashant Rajpoot & Suyash Kumar Vishwakarma- Commercial Space Activities: Legal Framework and Challenges

1.9 CHAPTERISATION

Building on the introduction in Chapter 1, this dissertation systematically explores space activities and their legal challenges:

Chapter 2 traces the evolution of the space industry from its origins to the present and considers future directions. This contextual overview frames the legal issues discussed later.

Chapter 3 examines existing space laws and their impact on commercial activities in space, identifying gaps and conflicts within the current legal framework.

Chapter 4 addresses specific legal challenges arising from space commerce, including property rights, space tourism regulation, resource mining, space traffic management, intellectual property protection, and dispute resolution.

Chapter 5 focuses on the intersection of international trade law and space business, exploring bilateral and multilateral agreements, export controls on space technologies, national regulatory approaches, and the role of global institutions.

Chapter 6 synthesises the findings and offers recommendations for evolving legal frameworks, policies, and institutional arrangements to ensure the responsible and sustainable growth of space commerce.

CHAPTER 2

COMMERCIAL USE OF OUTER SPACE- LEGAL IMPLICATIONS

2.1 INTRODUCTION

The perception and utilisation of space has undergone profound changes in recent times, from a faraway mystery to a business sector, where people invent, invest and explore. When space exploration began a few years ago, the activities were limited to installing satellites in space. Still, the entities are building future technologies related to mining on the moon's surface to extract minerals, suborbital flights that would carry passengers around the Earth within an hour, human settlement in outer space, etc.[43] Space businesses are poised to explore the cosmos in unprecedented ways, standing on the brink of transformative breakthroughs. As space increasingly symbolises technological and economic advancement, it simultaneously challenges existing paradigms and underscores the urgent need for a new regulatory framework to ensure sustainable governance of space, akin to Earth's stewardship.

Decades ago, when Neil Armstrong first set foot on the moon, the government primarily handled space activities.[44] The government initiated every activity conducted in space for scientific discovery and national prestige. Half a century later, this jurisprudence changed, and private corporations like SpaceX, Blue Origin and Virgin Galactic entered with a large-scale investment in space technologies for exploration.[45] This gradual shift is also the result of three pillars,

[43] Life in 2050: A Glimpse at Space in the Future – Part I, **Interesting Engineering** (May 27, 2021, 12:23 PM), https://interestingengineering.com/science/life-in-2050-a-glimpse-at-space-in-the-future-part-i.
[44] Alyssa Goessler, The Private Sector's Assessment of U.S. Space Policy and Law, **CSIS Aerospace Security Project** (July 25, 2022), https://aerospace.csis.org/the-private-sectors-assessment-of-u-s-space-policy-and-law/.
[45] Shelli Brunswick, The Transformative Power of Public-Private Partnerships in Space Exploration, Forbes Technology Council (June 24, 2024), https://www.forbes.com/sites/forbestechcouncil/2024/06/24/the-transformative-power-of-public-private-partnerships-in-space-exploration/.

1. Advances in technology have made space activities more accessible and efficient, enabling uses such as satellite communications, Earth imaging, and ambitious plans for mining or constructing objects in space.
2. Vibrant startup ecosystems, particularly in countries like the USA, provide crucial investment and support for innovative ventures, fueling exciting developments in the space sector.
3. Space offers a promising frontier to explore alternatives to Earth's dwindling resources and to address growing environmental challenges.

2.2 DEFINING COMMERCIALIZATION

The commercial use of outer space refers to any activity conducted for financial gain, meaning it is more of a profit-making industry, and not just a regular exploration and study of space with the motive of scientific research. The most essential characteristic of *"commercial" or "commercialisation" is "aiming to make a profit"* or at least *"trying to get a reasonable return on investment."*

The commercial use of outer space and privatisation of space are used interchangeably, but there is a stark difference between these two terms. Commercialisation refers to a nation using its technological and space capabilities for economic growth, including satellite launches, telecommunications and remote sensing. On the other hand, privatisation refers to the transfer of space services from the government to the private sector.[46] The private sector mainly uses commercial use of outer space, but the question arises here whether the government can engage in such commercialisation activities. The answer is positive, as the government does engage in such activities. Still, with introducing the private sector into space activities, the government has taken a passive role and promoted private entities through various licensing, agreements, partnerships, and policies. According to a report in 2021, there were around 10,000 private space technology companies, 5000 large investors,

[46] Biswanath Gupta & Dr. Raju KD, Commercialisation of Outer Space Activities: Need for a Legal Regime in India, RMLNLU Law Review (2021), https://rmlnlulawreview.com/wp-content/uploads/2021/04/ee79e-commercialisation-of-outer-space-activities.pdf

130 state organisations, and 20 business sectors that were part of the space industry.[47] These enterprises are now producing launch stations and collaborating with the government and other private corporations for various space activities. In 2024, SpaceX launched India's communication satellite, GSAT-N2, in its first partnership.[48] Again, this satellite belonged to New Space India Limited (NSIL), [49]which is the commercial arm of ISRO.[50] In the past, the higher cost of space launch and exploration made it very difficult for the private sector to participate, which was even aggravated by a lack of technologies, satellite deployment, and space station operations.[51] This is the primary reason the government held on to this sector and developed the infrastructure alone.[52]

This new addition of the private sector into space is not just restricted to big companies like SpaceX and Blue Origin, but also to small entities like Planet Labs and Capella Space that provide significant contributions through their innovation.[53] While Capella Space helped develop Synthetic Aperture Radar (SAR) technology that provides high-resolution weather observation, giving valuable insights for agriculture, national security and environmental protection, Planet Labs, on the other hand, deployed a satellite that provided high-resolution imagery.[54] Joining them is NASA's initiative called Next STEP (Next Space Technologies for Exploration Partnerships), which works to increase the possibility of human missions in deep space, stimulating the commercial space sector.[55] If we see

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[47] Rajesh Mane & Vishakha Pati, The Evolution of the Commercial Space Age and Its Implications, Int'l J. Innovation in Eng'g Research & Mgmt. (Apr. 2024), https://journal.ijierm.co.in/index.php/ijierm/article/view/2053/1712.

[48] SpaceX's Falcon-9 Deploys India's GSAT-N2 Satellite into Orbit, THE HINDU (Dec. 29, 2024, 8:18 AM IST), https://www.thehindu.com/sci-tech/science/spacexs-falcon-9-deploys-indias-gsat-n2-satellite-into-orbit/article68883503.ece.

[49] Explore Mizoram, ISRO Successfully Launches PSLV-C55 with Singaporean Satellites, Explore Mizoram (Apr. 2023), https://www.exploremizoram.com/2023/04/isro-successfully-launches-pslv-c55.html.

[50] ibid

[51] European Space Policy Institute, The Rise of Private Actors in the Space Sector – Executive Summary (July 2017), https://www.espi.or.at/wp-content/uploads/2022/06/ESPI-report-The-rise-of-private-actors-Executive-Summary-1.pdf.

[52] ibid

[53] Gordon Rausser, Elliot Choi & Alexandre Bayen, Public–Private Partnerships in Fostering Outer Space Innovations, 120 Proc. Nat'l Acad. Sci. U.S. e2305848120 (2023), https://pmc.ncbi.nlm.nih.gov/articles/PMC10614614/.

[54] G.K.S. Amruta, The Role of Private Entities in Outer Space Activities, 7 Int'l J. for Multidisciplinary Res. (IJFMR), no. 2, Mar.–Apr. 2025, at 1, https://www.ijfmr.com/papers/IJFMR250241334.pdf.

[55] NASA Announces New Partnerships with U.S. Industry for Key Deep-Space Capabilities, SpaceRef (Mar. 30, 2015), https://spacenews.com/nasa-announces-new-partnerships-with-us-industry-for-key-deep-space-capabilities/.

India, in this regard, there is an increased number of space startups, which have gone up from 1 in 2014 to around 266 in 2024.[56] Some startups have also gone international, forming contracts with countries like the USA to deliver satellites.[57] Space operations require heavy financial investments and significant risks, making economic considerations especially important when determining commercial potential. While feasibility and economics still drive commercialisation decisions, commercial uses of space should no longer be viewed as unusual exceptions, as new opportunities continuously emerge alongside existing applications.

2.3 THE RISE OF USE OF OUTER SPACE EXPLORATION AND SPACE TECHNOLOGY

Space was always a thing to be thought about. The question was always the same: What is beyond the Earth's atmosphere? This question is not recent. Still, it dates to numerous studies and observations made in the ancient astronomy of various civilisations like the Egyptians, the Chinese, the Indians, the Greeks and the Babylonians. Different societies had different ideas about the sky. The Egyptians and Mayans thought the universe moved in cycles. At the same time, the Mesopotamians saw the sky as wild and confusing, and the Greeks and Romans understood it through math and included some aspect of astrology and myths within it.[58] Here we see certain developments like the Mayan calendar based on celestial cycles, the heliocentric model of the solar system by Aristarchus of Samos, accurate mathematical models by the Babylonians for predicting lunar eclipses, etc.[59] Thereafter came, the European renaissance which ushered in scientific revolution like Nicolaus Copernicus model of heliocentric in 1543, telescopic observations by Galileo in 1610, Johannes Kepler's law of planetary motion during 1610-1619 and most importantly,

[56] Dep't of Space, Parliament Question: Promotion of Private Sector in Space Sector, Press Information Bureau (Dec. 18, 2024), https://pib.gov.in/PressReleasePage.aspx?PRID=xyz .
[57] Akash Shah, India's Private Space Sector: Ambition Meets Reality in a Challenging Landscape, Science & Technology (Nov. 16, 2024), https://moderndiplomacy.eu/2024/11/16/indias-private-space-sector-ambition-meets-reality-in-a-challenging-landscape/
[58] Joshua J. Ely, Society and Science: Ancient Astronomy (2012) (Undergraduate Honors Thesis, E. Tenn. State Univ.), https://dc.etsu.edu/honors/31
[59] Dr. Ivan Khrapach, Astronomy and Space Exploration Are Shaping Our Civilization Landscape, Space Ambition (July 21, 2023), https://spaceambition.substack.com/p/astronomy-and-space-exploration-are.

Issac Newton's "philosophiae Naturalis Principia Mathematica in 1687 included the laws of motion and gravity that provided the basis for modern orbital mechanics.[60]

After this, the next phase of revolution was the development of rockets whose first mention date back to 9th century in China where it was used by the tang dynasty (618-907 AD) after they discovered gunpowder and later spread to other countries like Japan, parts of Asia and eventually to the middle east and Europe.[61] In the 1860s, the French author Jules Verne wrote science fiction books imagining rockets flying to the moon.[62] This idea was based on human imagination, but it took hold of various engineers and scientists who later worked on the possibility of various space missions. In the coming years, a Russian schoolteacher, Konstantin Tsiolkovsky, developed the theory for modern rocket technology through his publication in 1903 called *"The Exploration of Cosmic Space Using Reaction Devices".*[63]He proposed the rocket equation, describing the relationship between mass, velocity, and propellant.[64] One of the problems scientists faced during that time was related to the propellant that carried fuel and oxidiser for the rockets, helping the engine to burn even in space.[65] With this publication and one in 1929 related to multistage rockets, which used several engines one after the other, Tsiolkovsky solved the issue with his crucial insights of liquid propellants that would provide the necessary power for space travel and thus laid the foundation for modern spaceflight.[66]

While Tsiolkovsky provided the theoretical blueprint, scientist Robert Goddard started practical engineering in the early 20th century in the USA. He got two patents named on him in 1914, one was for a liquid fuel rocket and the other for a multi-stage rocket and in 1919 he published a paper called "A method of Reaching extreme altitudes"[67] Which not only detailed mathematical calculations and experimental results but also made a

[60] Ian Stewart, Seventeen Equations That Changed the World (Profile Books Ltd 2012).
[61] History of Rockets & Space Flight, in Introduction to Aerospace Flight Vehicles (Eagle Pubs), https://eaglepubs.erau.edu/introductiontoaerospaceflightvehicles/chapter/history-of-space-flight/.
[62] Ibid
[63] Bignami, G. F., & Sommariva, A. (2016). The Ultimate Challenge: The Exploration and Colonisation of Extrasolar Planets. Palgrave Macmillan UK EBooks. https://doi.org/10.1057/978-1-137-52658-8_5
[64] ibid
[65] Michael J. Neufeld, The Rocket and the Reich: Peenemünde and the Coming of the Ballistic Missile Era, 20 Space Pol'y 111 (2004).
[66] Ibid
[67] I. Gvozdetskyi et al., Design of Aviation Machines: Aircraft and Rocket Engines (2d ed. rev. & supply., National Aviation U., Ministry of Educ. & Sci. of Ukr. 2018).

significant impact on future scientists like Herman Oberth and Wernher von Braun, who later on became part of Verein für Raumschiffahrt, a society for space travel in Germany that developed the V-2 rocket, the world's largest Ballistic Missile during World War II.[68] These early theoretical works later culminated in a historic breakthrough when Goddard successfully launched the first liquid-fueled rocket on March 16, 1926, in Auburn, Massachusetts.[69] This innovation, rising just 41 feet during its 2.5-second flight, marked the way for a future that would lead humanity to stars.

After the end of World War II, this curiosity of humans to know and to be known reached greater heights in the form of space exploration, which started with the first satellite, Sputnik 1, which entered Earth's low orbit on October 1, 1957. This 585mm in diameter satellite, containing a 3.5 kg radio transmitter, started the "space age" revolution.[70] Shortly after this, the country sent a dog named Laika into orbit aboard Sputnik II and by 1959, launched several probes in the form of the Luna Program, including Luna 2, which impacted the moon and Luna 3, which photographed its far side for the first time.[71] This milestone achievement by the Soviet Union became an essential part of geopolitics then, leading other countries to utilise technology to conquer space. The United States, following the same footsteps, launched their first satellite, the Explorer, on January 31, 1958, which led to the discovery of the Van Allen Radiation belt, marking the beginning of the rivalry between the superpowers that led to high-scale investment in space.[72]

The 1980s and 1990s saw various technological advances in space, such as reusable spacecraft in the US space shuttle program in 1981, robotic exploration flourished, Voyager 2 explored Uranus and Neptune, Voyager 1 continued beyond the solar system and the soviet Mir space station, which was launched in 1986[73] Became the first long-term

[68] Hermann Noordung (Herman Potocnik), The Problem of Space Travel: The Rocket Motor (Ernst Stuhlinger, J.D. Hunley & Jennifer Garland eds., NASA SP-4026, NASA History Series).
[69] Robert H. Goddard - New World Encyclopedia. https://www.newworldencyclopedia.org/entry/Robert_H._Goddard
[70] https://www.birdvilleschools.net/cms/lib2/TX01000797/Centricity/Domain/3089/Unit%209%20Lesson%201%20History%20of%20Space%20Exploration.pdf
[71] NASA Moon Team, History of Lunar Exploration (Sept. 27, 2017), https://science.nasa.gov/solar-system/moon/history-of-lunar-exploration/.
[72] Ian Kennedy, The Sputnik Crisis and America's Response (2005) (electronic thesis, University of Central Florida), https://stars.library.ucf.edu/etd/579.
[73] Chinese astronauts complete their three-month mission into Earth orbit. https://www.dubaiweek.ae/chinese-astronauts-complete-their-three-month-mission-into-earth-orbit/

orbital laboratory. Beyond this, in 1990, the Hubble telescope was launched, which captured deep space images. Mars Global Surveyor and Lunar Prospector furthered planetary exploration.

Entering the 21st century, the space sector became an international phenomenon and was commercially influenced. The NEAR Shoemaker mission successfully landed on an asteroid called Eros in the year 2001, and that same year, Dennis Tito became the world's first space tourist.[74] The U.S. Cassini-Huygens mission, launched in 1997, reached Saturn in 2004 and later deployed a lander onto its moon Titan. The Spirit and Opportunity rovers landed on Mars in 2004 with essential and valuable space data.[75] During this time, China and India entered the space sector, where China launched its first human-crewed vehicle in 2003, followed by spacewalk in 2008 and multiple successful lunar mission in Chang'e series, India launched Chandrayaan-1 in 2008, discovering water molecules on moon, followed by Chandrayaan 3 which landed on moons' south pole, marking a historical moment.

After all these years of development, contemporary trends emerged in the space industry, such as the entry of the private sector and the privatisation of space. The original concept of space being a domain of government was wiped out. Private entities produced various technological developments through their high investment and higher efficiency. The USA was the first country to recognise the significant role of these private entities in space and even produced various policies to draw these corporations into this vacuum. In 2024, the Odysseus mission became the first privately funded spacecraft to land on the moon.[76]

This critical milestone throughout history is evidence of the rapidly evolving sector called outer space. Now, there is no way of going back to what we initially believed; instead, pushing boundaries and limits to know what is in that far space is only what we can think

[74] Valerie Neal, Spaceflight in the Shuttle Era and Beyond: Redefining Humanity's Purpose in Space, 37 Space Pol'y 27 (2020), https://doi.org/10.1016/j.spacepol.2020.101393.
[75] John L. Logsdon, Space Exploration, Britannica (Apr. 22, 2025), https://www.britannica.com/science/space-exploration.
[76] Fed. Aviation Admin., Commercial Space Industry (Feb. 2021), https://www.faa.gov/sites/faa.gov/files/about/history/milestones/Commercial_Space_Industry.pdf.

about, and in this whole process, there is no end to the possibilities. There is no end to how far we can reach. Space will keep on expanding, and so will its history and exploration.

2.4 THE FOOTPRINT OF THE PRIVATE SECTOR IN SPACE

If we see the history of space, it can be divided into three stages, particularly,

1. The beginning of the space sector (1950-79)
2. The early commercialisation of space (1980-1999)
3. Private commerce in space (2000- now).

In all these stages, private entities can be traced significantly. Although the government and sovereign entities dominated the first phase, private entities were still subcontracted to government agencies, providing expertise, tools, and technology. Some products, such as satellites, launch vehicles, and spacecraft, were manufactured by companies like McDonnell Douglas, Lockheed Corporation, and Boeing in the USA. For instance, Boeing helped develop the Saturn V rocket, a part of the Apollo Missions, while Lockheed contributed to the Agena Target Vehicle used in the Gemini mission.[77] These companies worked with the government on contracts where all the costs were covered, plus they were provided with extra benefits in the form of profits. The reason behind such an approach was to mitigate the risk involved in manufacturing space technology, which is not an essential commodity and to increase the involvement of these private entities in future projects.

The subsequent significant development was made on July 10, 1962, when Telstar 1 was launched in the first private space mission. It was developed by Bell Labs for AT&T to send TV signals across the ocean, which was later launched on a rocket owned by NASA.[78] This mission cost around $50 million.[79] Although the company required assistance from NASA and government authorization, it largely operated independently, demonstrating its

[77] Baber, W.W., Ojala, A. (2024). New Space Era: Characteristics of the New Space Industry Landscape. In: Ojala, A., Baber, W.W. (eds) Space Business. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-97-3430-6_1

[78] Roger D. Launius, Historical Analogs for the Stimulation of Space Commerce, NASA Monographs in Aerospace History No. 54 (2014), available at https://www.nasa.gov/wp-content/uploads/2015/04/historical-analogs-ebook_tagged.pdf.

[79] ibid

ability to self-regulate space activities. The success of Telstar inspired other companies to launch new projects. During this period, international satellite organizations played a crucial role in bridging the public and private sectors. Notably, the International Telecommunication Satellite Organisation (Intelsat), an intergovernmental consortium, provided satellite communication services. Intelsat collaborated with private firms like Hughes Aircraft, which manufactured the Intelsat I, the first commercial geostationary satellite launched in 1965. Hughes was a leading satellite manufacturer, pioneering innovations such as spin stabilisation, which extended satellite lifespan and reduced costs. By the 1970s, the Intelsat network was delivering telephone and television services, while businesses benefited from satellite production contracts.

In the meantime, the USA announced the "open sky" policy in January 1970 that allowed private companies to launch communication satellites, opening the monopoly that the government had enjoyed.[80] This was a green signal for private companies like RCA and Western Union to enter the US market with satellites, such as Satcom 1 (1975) and Westar 1 (1974). These satellites helped grow cable television and data transmission, creating a commercial market for such services.[81] Moreover, these firms also began to explore launching services. For instance, in 1975, a German company named OTRAG (Orbital Transport and Rocket AG) was formed to develop low-cost modular rockets to launch satellites.[82] Their special design used many identical rocket parts clustered together to save money. They assessed these rockets in African countries like Zaire and Libya.[83] However, concerns arose regarding the possibility of these rockets being used for military purposes, and eventually, technical failure led to the collapse of OTRAG in the 1980s. However, this did not become a barrier for the private sector, mainly due to the policies put in place by the US to promote their participation in the space sector. The US adopted the Commercial

[80]Andrea Sommariva, The Evolution of Space Economy: The Role of the Private Sector and the Challenges f or Europe, ISPI (Dec. 7, 2020), https://www.ispionline.it/en/publication/evolution-space-economy-role-private-sector-and-challenges-europe-28604.
Sources
[81] **Roger D. Launius et al.,** Spaceflight: The Development of Science, Surveillance, and Commerce in Space, IEEE (Apr. 2012), https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6174432.
[82] Dumitru Popescu, Yes, OTRAG Influenced the Eco Rocket Heavy Design — AMi, Part XXI, AMi Exploration (June 7, 2023), https://medium.com/ami-exploration/yes-otrag-influenced-the-ecorocket-heavy-design-ami-part-xxi-903a1849319d.
[83] ibid

Space Launch Act of 1984, which adopted a mechanism for private launch services and made a few changes in the organisational structure, as now supervision shifted under the Department of Transportation. The dependency on NASA reduced significantly when it struggled with high cost and safety concerns due to the Challenger disaster in 1886. The act introduced one of its most important provisions, called the indemnification policy, where the government shared the liability risk, making participation easier and viable.

Satellite manufacturing was also crucial; companies like Hughes, Lockheed and TRW (later Northrop Grumman) were the forerunners.[84] Hughes, a famous satellite known as HS-376, became very well-known, with over 40 launched by 2000.[85] On the other hand, TRW built data relay satellites that served both government and businesses. Also, the growth of direct TV services like DirecTV (started in 1990) created more demand for satellites in the space market.[86]

When the Cold War ended in the early 1990s, there were significant cuts in the budget, so aerospace companies looked for commercial opportunities.[87] Big companies merged, like Lockheed and Martin Marietta, which joined to form Lockheed Martin in 1995, and Boeing bought McDonnell Douglas in 1997.[88] These companies competed well in satellite manufacturing and space launches.

Private companies also tried new ways of space applications, like Orbital Sciences, which launched the Pegasus rocket in 1990[89], which was carried by an aeroplane before launching and thereafter, there was the advent of space tourism, where Japan sent its journalist in the first commercial human spacecraft. These were government initiatives at that point, which

[84] Steven J. Dick, ed., NASA's First 50 Years: Historical Perspectives, NASA SP-2010-4704 (2010), https://www.nasa.gov/wp-content/uploads/2015/04/607087main_nasasfirst50yearshistoricalperspectives-ebook.pdf.
[85] ibid
[86] Giancarlo Genta, Private Space Exploration: A New Way for Starting a Spacefaring Society? 104 Acta Astronautica 480 (2014), https://doi.org/10.1016/j.actaastro.2014.04.008
[87] Amy J. Boatner, Consolidation of the Aerospace and Defense Industries: The Effect of the Big Three Mergers in the United States Defense Industry, 64 J. AIR L. & COM. 913 (1999) https://scholar.smu.edu/jalc/vol64/iss3/12
[88] Ibid
[89] Max Polyakov, The History of Astronautics Part 3: The Rise of the Private Sector, MaxPolyakov.com (Nov. 23, 2021), https://maxpolyakov.com/history-of-astronautics-3/.

assisted private organisations in expanding. Laws such as ITAR in 1999, though, became difficult for US firms to go global.[90]

The early 2000s marked the beginning of a new era in space exploration, where private companies started to take centre stage. These companies made space travel cheaper and created a new industry, from satellite launch to space tourism and moon exploration. These different areas grew because of better technology, changes in rules and laws, and because more people wanted these services. This growth made it easier for countries worldwide to access and use space.

The private space exploration started when Dennis Tito became the first tourist in space by paying $20,000,000 to visit the International Space Station on a Russian spacecraft, which showed that regular people and not just government astronauts could now go to space if they had enough money.[91] By 2000, four private space travel companies took another big step when a spaceship built by Scaled Composites with Paul Allen's money completed the first private human Space Flight. This proved that companies could build and fly their spacecraft without government help. That same year, a rocket called Go Fast, made by a group of space enthusiasts (CSXT), became the first amateur rocket to reach space, showing that even smaller organisations were gaining space capabilities. The satellite business also grew quickly during this time. In the late 1990s and early 2000s, building satellites and ground equipment grew by 11% and 14% yearly, while satellite communication services grew by 15% yearly.[92] TV companies like DirecTV and Dish Network expanded their satellite television services to over 67,000,000 subscribers by the end of 2000, thanks to new laws.[93] Satellite radio became popular too, launching its first satellite in 2001, and Sirius expanded in 2002.[94] Together, these radio companies invested

[90]Ariane Cornell, Five Key Turning Points in the American Space Industry in the Past 20 Years: Structure, In novation, and Globalization Shifts in the Space Sector, 69 Acta Astronautica 1123 (2011), https://doi.org/10. 1016/j.actaastro.2011.05.033.
[91] Jennifer Laing & Geoffrey I. Crouch, Vacationing in Space: Tourism Seeks 'New Skies', Sch. of Bus., Fac. of L. & Mgmt., La Trobe Univ., Melbourne, Victoria, Australia.
[92] History of Satellite Communications, in Handbook of Satellite Applications 1–41 (First online Jan. 1, 2016), https://link.springer.com/referenceworkentry/10.1007/978-1-4614-6435-8_116.
[93] ibid
[94] Sirius Satellite Radio, Inc., Company Profile, http://www.sirius.com (last visited Apr. 27, 2025).

more than three billion 2 to provide nationwide radio services that regular radio stations couldn't match.[95]

Around this time, Elon Musk started SpaceX in 2002, aiming to slash the cost of space travel and eventually send people to Mars. SpaceX hit a significant milestone in 2008 when its Falcon 1 became the first privately built liquid fuel rocket to reach orbit.[96] By 2012, SpaceX achieved something even more impressive when its Dragon spacecraft became the first private vehicle to connect with the International Space Station, delivering supplies and returning safely.[97] NASA started contracting SpaceX for regular supply flights, showing a new partnership between government and industry. SpaceX indicated that businesses can provide good space services inexpensively and reliably, marking a turning point in space exploration.

Other companies joined the space race through various opportunities. Jeff Bezos's Blue Origin and Richard Branson's Virgin Galactic worked on sending tools to the edge of space on short trips. Both reached essential goals in 2021 when Branson flew on his company's SpaceShipTwo vehicle while Bezos rode on his new Shepard rocket.[98] These flights did not go into orbit around Earth, but they were significant steps towards making space accessible to paying customers. In the same year, SpaceX went even further with its Inspiration4 mission, which sent four ordinary citizens into orbit around Earth.[99]

In 2022, Axiom Space ran the first commercial mission with people to the International Space Station called Axiom Mission 1. The crew included regular citizens alongside government astronauts. This mission helped repair the company's bigger plan to build its commercial space station, where research, manufacturing, and tourism can happen in Earth orbit. In 2023, SpaceX tested Starship, the biggest and most powerful rocket ever built.

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[95] ibid
[96] Nicholas Herbert, The Corporate Occupation of the Final Frontier: Emerging Market Analysis of SpaceX and the Privatized Race to Space (2018) (Honors Project, Grand Valley State Univ.), https://scholarworks.gvsu.edu/honorsprojects/686.
[97] G. Genta, Private Space Exploration: A New Way for Starting a Spacefaring Society? Acta Astronautica (2014), http://dx.doi.org/10.1016/j.actaastro.2014.04.008.
[98] Michael Byers & Aaron Boley, Space Tourism, Cambridge Univ. Press (Apr. 6, 2023), https://doi.org/10.1017/9781108886012.002.
[99] Wendy Whitman Cobb, SpaceX Inspiration4 Mission Will Send Four People with Minimal Training into Orbit, Phys.org (Sept. 13, 2021), https://phys.org/news/2021-09-spacex-inspiration4-people-minimal-orbit.html.

Even though this first Test did not go perfectly, Starship represents a massive step towards deeper space exploration and possibly living on another world. That same year, Firefly Aerospace showed how quickly private companies can respond to launch needs. For a USA space force mission called Victus Nox, they launched just twenty-seven hours after getting the go-ahead.[100] This fast, flexible launch service is becoming more valuable to government and business customers.

Again in 2024, a special mission called Polaris Dawn, paid for by businessman Jared Isaacman's Polaris program, broke a new record.[101] The crew performed the first spacewalk by non-professional astronauts and travelled higher above Earth than anyone since the Apollo moon missions. This was a significant step since the private sector moved beyond just launching rockets and satellites to include complex human operations in space. By 2025, Jeff Bezos' company Blue Origin finally launched its big new Glenn rocket for the first time, joining the competition for sending heavy payloads to orbit.[102]

The commercial space industry seems to be ready to grow even more. Companies have big plans for the coming years, for example, Rocket Lab wants to send a mission to Venus in 2026 to search for signs of life, while on the other hand, SpaceX plans to use its massive new Starship rocket for crewed missions in the mid-2020s as part of the Polaris programme.[103] The private sector is also working on building their space stations and moon

[100] Grace Nehls, Firefly Awarded Launch Agreement for U.S. Space Force VICTUS SOL Mission, CompositesWorld (Feb. 19, 2025), https://www.compositesworld.com/articles/firefly-awarded-launch-agreement-for-us-space-force-victus-sol-mission.
[101] Kenneth Chang, First Private Spacewalk in SpaceX Capsule Achieves New Milestone, The New York Times (Sept. 11, 2024), https://www.nytimes.com/2024/09/11/science/polaris-dawn-private-spacewalk.html.
[102] Jeff Bezos' Blue Origin Launches Massive New Glenn Rocket on First Test Flight, Times of India (Jan. 16, 2025), https://timesofindia.indiatimes.com/articleshow/xxxxx.
[103] James B. Meigs, U.S. Space Policy: The Next Frontier, Manhattan Inst., Governance, Tech (Apr. 17, 2025). [103] Grace Nehls, Firefly Awarded Launch Agreement for U.S. Space Force VICTUS SOL Mission, CompositesWorld (Feb. 19, 2025), https://www.compositesworld.com/articles/firefly-awarded-launch-agreement-for-us-space-force-victus-sol-mission.
[103] Kenneth Chang, First Private Spacewalk in SpaceX Capsule Achieves New Milestone, The New York Times (Sept. 11, 2024), https://www.nytimes.com/2024/09/11/science/polaris-dawn-private-spacewalk.html.
[103] Jeff Bezos' Blue Origin Launches Massive New Glenn Rocket on First Test Flight, Times of India (Jan. 16, 2025), https://timesofindia.indiatimes.com/articleshow/xxxxx.
[103] James B. Meigs, U.S. Space Policy: The Next Frontier, Manhattan Inst., Governance, Tech (Apr. 17, 2025).

bases, and even planning how humans might live on Mars. These projects show how businesses, not just governments, shape our future in space.

2.5 INDIA AND PRIVATE SPACE INDUSTRY

According to PIB, India's share in the space sector is around 2%, compared to the US, 40%, and the UK, 7%.[104] This share was possible because of the liberalisation of the space industry post 2020, which provided the private sector a strong role alongside ISRO.

India's space journey started in the 1960s with the Thumba Equatorial rocket launching station (TERLS)in Kerala, where they launched rockets to study the atmosphere.[105] The Indian research organisation was created in 1969 to develop satellites and explore space for India's development.[106] During this time, private sector involvement was limited to supplying parts of rockets like SLV-3 and satellites like Aryabhata, launched in 1975 via the Soviet Union.[107] Companies like Data Patterns, Hindustan Aeronautics Ltd (HAL), Godrej & Boyce, Larsen, and Toubro were the top collaborators in supplying mechanical structures, tanks, nozzles, and ground systems.[108]

A significant change came in the 1990s when ISRO created Antrix Corporation in 1992, a commercial and marketing arm of ISRO under the administrative control of the Department of Space (DoS).[109] As a wholly owned enterprise of the government of India, this company was meant to sell ISRO's technology, provide launch services and share technology with private businesses. Antrix was an intermediary connecting the private sector and international entities with ISRO through technology transfer and other space-related trade. This company served as a primary channel for space commerce during the pre-

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[104] Press Information Bureau, *Enhancing the Private Participation in Space Activities* (Mar. 2023), https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/apr/doc2023410179001.pdf.:contentReference[laicite:1]{index=1}

[105] Comprehensive Timeline of India's Space Program, New Space Economy (Sept. 8, 2024), https://newspaceeconomy.ca/2024/09/08/comprehensive-timeline-of-indias-space-program/.

[106] RimpleSanchla, *The Journey of ISRO: From Humble Beginnings to Space Glory*, Rimple.in (Apr. 21, 2025), https://rimple.in/2025/04/21/the-journey-of-isro-from-humble-beginnings-to-space-glory/.

[107] Antrix Corp. Ltd., Confederation of Indian Industry & Deloitte Touche Tohmatsu India Pvt. Ltd., *Overview of Indian Space Sector 2010* (Aug. 2010), https://www.cii.in/webcms/upload/antrix-cii-deloitte%20report%20on%20indian%20space%20sector%202010.25aug102.pdf.

[108] ibid

[109] Ganesh Makam, *An Analysis of Space Law in India: Current Developments and Future Perspectives* (June 21, 2023), https://ssrn.com/abstract=4487755.

liberalisation era, and thereafter laid the foundation for more private entities like NAIL and IN-SPACe.

During 2012-18, there was the arrival of a new breed of private players in the form of various startups like[110], TeamIndus (2010), Dhruva Space (2012), Bellatrix Aerospace (2015), Aadyah Aerospace (2016), Agni Kul Cosmos (2017), Manastu Space (2017), Skyroot Aerospace (2018), Satellize (2018) and Pixxel (2019)

Most startups design and build satellites, rockets, ground control stations, propulsion systems, rocket fuels and satellite components.[111] They provide satellite launch services using ISRO's rockets, like PSLV or GSLV, or their privately developed launch vehicles. Several companies have also created technical systems for controlling satellites, monitoring space activities, tracking objects in space, and working with geographic data.[112] Today, over two hundred space startups are registered in the country, attracting over Rs 1000 crore ($120-130 million USD) as of 2023, representing the environment India has built through policies for startups to prosper and perform in the space sector.[113]

Parallel to this, the government of India created New Space India Limited (NSIL) in 2019 to sell space technologies on a commercial basis. The organization's role grew bigger when the government gave it control of ten communication satellites already in space, except for GSAT-7 and GSAT-7A.[114] The government also increased funding from one thousand crore to 7,500 crore rupees, giving it enough money for expensive projects.[115] Now NAIL runs the new CMS satellite series, builds and launches satellites when customers demand, and helps launch satellites for other companies per a demand-driven mission.[116] NAIL can

[110] Global Indian, Meet the Startups That Are Giving Wings to India's Private Space Dreams, https://www.globalindian.com/story/startups/indias-private-space-dreams-startups/ (last visited Apr. 14, 2025).
[111] Huma Siddiqui, The Dawn of a New Space Era: Private Ventures Reach for the Stars, Fin. Express (May 31, 2024, 4:18 PM), https://www.financialexpress.com/business/defence-the-dawn-of-a-new-space-era-private-ventures-reach-for-the-stars-3508326/.
[112] ibid
[113] ibid
[114] press Information Bureau, "Space Sector Reforms have unlocked India's Commercial Potential in Space," says Minister of State for Space Dr. Jitendra Singh, Department of Space, Government of India (Feb. 6, 2025), https://pib.gov.in/PressReleasePage.aspx?PRID=2100276.
[115] ibid
[116] Arunachalam A, User Interaction Meet 2024, New Space India Ltd. (Oct. 30, 2023), https://www.nrsc.gov.in/sites/default/files/pdf/ebooks/UIM-2024/4_UIM_2024.pdf.

set prices based on what the market will pay and decide how to use satellites according to its rules. This helped India compete globally.

The Indian Space Policy, adopted on April 7, 2023, allowed private companies to complete space activities for the first time. This includes building rockets and satellites and offering services like communication and Earth observation. This specifies jobs for each organisation. ISRO works on developing advanced technology, NAIL manages the business side, and IN-SPACe manages private companies and their space activities. This policy aims to grow India's space sector from $8 billion to $100 billion by 2040, capturing 10% of the world market.[117] As per the policy, India also introduced the Space Activities Bill of 2017 to govern the private space sector, as a follow-up to the Outer Space Treaty. The bill was drafted flexibly to be modified based on the fast-growing space sector.

Though the Draft Space Activities Bill purportedly offers a coherent and responsible framework for regulating India's space industry, some imprecisions and loopholes compromise its usefulness. One gap is that, whereas the Bill does not categorically state what will make an "object of Indian origin," it leaves it ambiguous for companies that create technology in India but take it to foreign nations.[118] It also does not have pre-set standards or time limits for issuing or declining licenses, and hence is open-ended and uncertain.[119] Similar rules are enforced on all space activities, ranging from manufacturing rockets to satellite services, regardless of the diverse operational requirements of different stakeholders. It also overprotects the government from interference but offers no transparent channel for private players to challenge orders or object to regulatory policies.[120] The required insurance provision is also unclear because it does not delineate coverage levels or cost structures, which poses unclear financial commitments for

[117] Anu Sharma, India Can Have a $40–100 Billion Space Industry by 2040, Mint (July 26, 2023), https://www.livemint.com/industry/india-can-have-a-40-100-billion-space-industry-by-2040-arthur-d-little-11690381087389.html

[118] Government of India, Dep't of Space, Draft Space Activities Bill – 2017, No. A.19020/06/2013-Sec.2 (Nov. 21, 2017), https://www.isro.gov.in/media_isro/pdf/DraftSpaceActivitiesBill2017.pdf.
Describes the proposed framework to regulate space activities in India, focusing on licensing, liability, and private sector participation.

[119] ibid

[120] V. Gopalakrishnan, India's Space Activities Bill: A Legal Perspective, ORF Issue Brief No. 274 (2018), https://www.orfonline.org/research/indias-space-activities-bill-a-legal-perspective-45647/.

businesses.[121] The stipulation that the government will own all intellectual property that arises from space activities is likely to discourage private investment and innovation, and instead, spur nascent space startups to friendlier IP environments elsewhere in the world. Due to this reason, the space bill was never adopted, and a newer structure was adopted in the form of NAIL and IN-SPACe to fulfil similar objectives in a more flexible and promotional manner.[122]

Private companies in India have made remarkable progress in rocket development. Skyroot Aerospace, founded in 2018, made history as the first Indian private company to successfully launch a rocket when its suborbital Vikram-S lifted off from ISRO's Sriharikota launch facility in November 2022.[123] Looking ahead to 2025, Skyroot plans to achieve a twice-monthly launch schedule, concentrating on affordable, single-use rockets designed for small satellite deployment, according to Space Insider's overview of India's private space industry.[124]

Yet another firm, Agnikul Cosmos, achieved a remarkable feat in 2024 by taking into space the world's first-ever 3D-printed rocket-powered engine-equipped rocket.[125] They did it from their exclusive launch base at Sriharikota, which they had commissioned in

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[121] Sandeepa Bhat B., Legal Challenges to Commercial Space Activities in India, 50 Ind. J. Int'l L. 359 (2018), https://link.springer.com/article/10.1007/s40901-018-0082-9.
Highlights the legal uncertainties faced by private space enterprises under the Draft Bill and calls for more detailed secondary legislation.

[122] World Econ. Forum, making a Case for India's Space Policy, World Economic Forum (Apr. 15, 2021), https://www.weforum.org/agenda/2021/04/india-space-economy-policy-isro/.
Emphasizes the need for India to modernize its space policy to accommodate rising private sector involvement and global competition.

[123] Nivedita Bhattacharjee, Pixxel to Launch India's First Private Satellite Network, Eyes $19 Billion Market, Reuters (Jan. 13, 2025, 6:56 PM IST), https://www.reuters.com/technology/space/pixxel-launch-indias-first-private-satellite-network-eyes-19-bln-market-2025-01-13/.

[124] Rajeswari Pillai Rajagopalan, India's Space Policy: A Critical Look, Observer Research Foundation Occasional Paper No. 56 (2014), https://www.orfonline.org/research/indias-space-policy-a-critical-look/.
Offers a strategic overview of India's space ambitions and examines the legal and institutional gaps in regulating commercial space activity.

[125] **ET Online**, Agnikul Cosmos Flies World's First Rocket with Single-Piece 3D Printed Rocket Engine. Check First Video of Launch Here, **The Economic Times** (May 30, 2024, 12:48 PM), https://economictimes.indiatimes.com/news/science/agnikul-cosmos-completes-worlds-first-flight-with-single-piece-3d-printed-rocket-engine-check-first-video-of-launch-here/articleshow/110555413.cms?from=mdr.

November 2022. [126]These feats illustrate the speed with which India accumulates strength in pioneering manufacturing methods and rocket launching technologies.

Bengaluru startup Galax Eye partnered with IN-SPACe (the Indian National Space Promotion and Authorisation Centre) under the Department of Space on May 1, 2024.[127] This agreement gives Galax Eye access to ISRO's infrastructure to develop its combined SAR and multi-spectral imaging technology.[128] Multi-spectral imaging captures Earth pictures across different light wavelengths that extend beyond what humans can see naturally.[129] This technology helps detect and examine various surface features, including vegetation, mineral deposits, and water bodies. Galax Eye previously created India's first domestically developed drone with SAR capabilities in 2023.[130] The company is now developing its own Earth observation satellite network. Their initial satellite, named the Drishti Mission, is scheduled for launch within the following year.[131]

Other Indian space companies have also made progress. Dhruva Space successfully launched their Thybault-1 and Tybalt-2 satellites on ISRO's PSLV-C54 in 2022[132], followed by AzaadiSAT-2 on SSLV-D2 in 2023, showing that private companies can develop effective satellites.[133] Additionally, Anant Technologies opened a private satellite

[126] ibid
[127] Deccan Herald News Service, Bengaluru Startup Gains Access to IN-SPACe Testing Facilities, Deccan Herald (Dec. 4, 2024), https://www.deccanherald.com/india/karnataka/bengaluru/bengaluru-startup-gains-access-to-in-space-testing-facilities-3015557.
[128] Kiran Mohan, India's Journey in Space Law and Policy: Towards a Legal Framework for Emerging Space Activities, 7 Indian J. L. & Pub. Pol'y 1 (2021), https://ijlpp.com/wp-content/uploads/2021/10/India%E2%80%99s-Journey-in-Space-Law-and-Policy.pdf.
Explores India's historical and legislative developments in space law and evaluates its readiness to manage emerging private and dual-use space activities.
[129] ibid
[130] Huma Siddiqui, The Dawn of a New Space Era: Private Ventures Reach for the Stars, Financial Express (May 31, 2024, 4:18 PM IST), https://www.financialexpress.com/business/defence-the-dawn-of-a-new-space-era-private-ventures-reach-for-the-stars-3508326/.
[131] ibid
[132] The Hindu Bureau, Dhruva Space's The Bolt Satellites Complete 15,000 Orbits, The Hindu (June 18, 2024, 3:09 PM IST), https://www.thehindu.com/news/national/telangana/dhruva-spaces-thybolt-satellites-complete-15000-orbits/article68302874.ece.
[133] Ridipt Singh, India in the Second Space Age: SSLV Technology Transfer to the Private Sector, London Politica (July 18, 2023), https://londonpolitica.com/geopolitics-on-the-periphery-1/sslv-technology-transfer-to-the-private-sector.

manufacturing facility in Thiruvananthapuram in 2022, expanding India's satellite production capabilities.[134]

According to the World Economic Forum, IN-SPACe has set an incredibly ambitious long-term goal of India's share of the world space economy as 8% in 2033, putting India's space economy at $44 billion.[135] The increased participation of private firms is consolidating global partnerships, exemplified by Pixxel offering services to international clients and contributing to developing disaster management solutions for underdeveloped nations. Another example is the upcoming NISAR mission with NASA, scheduled to launch in early 2025, which includes private sector components despite being primarily government-driven.[136] While much welcome progress has been made, some areas still require improvement, e.g., creating a competent workforce, possessing robust supply chains, and enhancing indigenous production of space components. Special space manufacturing clusters and incentives must be designed to support local production. The shift of the private sector from being simple suppliers to ISRO to independent companies capable of conducting full-space operations prepares India for tremendous growth. This expansion has a bright future and will significantly contribute to the development of world space technology.

2.6 FUTURE PROSPECTS

The space sector has seen a revolutionary shift, particularly since 2000, from government-sponsored to market-oriented activities. This is obvious through several significant developments. Instead of depending on government help, firms now finance their space missions through venture capital, stock issues, and cross-industry partnerships. Though the overvaluation of SpaceX and Rocket Lab's public listing is such a well-documented

[134] The Hindu Bureau, Ananth Technologies Limited Becomes First Private Indian Satellite Operator to Provide GSO Communication Satellite Services, The Hindu (Dec. 4, 2024, 10:01 AM IST), https://www.thehindu.com/news/cities/bangalore/ananth-technologies-limited-becomes-first-private-indian-satellite-operator-to-provide-gso-communication-satellite-services/article68942446.ece.
[135] Indian Space Economy to Reach $44 Bn by 2033: FICCI-EY Report, Econ. Times (Apr. 26, 2024), https://economictimes.indiatimes.com/news/science/indian-space-economy-to-reach-44-bn-by-2033-ficci-ey-report/articleshow/118942520.cms.
[136] Parliament Question: NASA-ISRO Synthetic Aperture Radar Mission, Press Information Bureau (Dec. 4, 2024), https://pib.gov.in/PressReleasePage.aspx?PRID=2080633.

example, there are less-known examples of industry collaboration happening. For example, a car start-up capital firm finances German firm HyImpulse, while mining companies fund Australian business Fleet Space Technologies.[137] This diverse investment landscape has fuelled innovation but also introduced market uncertainty, as seen when several space companies faced difficulties during the 2023 SPAC downturn.[138]

Government policies have quietly enabled private space growth. The 2015 US legislation that granted space resources catalysed interest in asteroid mining. Streamlined launch authorisation procedures and spectrum allotment for satellite constellations enabled rapid startups. Fragmented European regulations initially hindered startup growth until consolidated standards came in 2021.[139] Concurrently, China's 2020 satellite internet approvals linked to national security goals reflect how government policy directs private sector development.[140]

The space industry will likely grow in the next 10 years, focusing on the moon, better space stations, and using resources from farther away in space. By 2024, 42 countries agreed to NASA's Artemis Accords, rules for doing business on the moon.[141] Companies working with NASA plan to set up permanent bases by 2030 to mine ice on the moon, which can be turned into fuel for rockets going to Mars at half the price of sending fuel from Earth.[142]

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[137] Mining Exploration Disruptor Fleet Space Technologies Attracts $800M Valuation in Series D, Business News Australia (Dec. 12, 2024), https://www.businessnewsaustralia.com/articles/mining-exploration-disruptor-fleet-space-technologies-attracts-800m-valuation-in-series-d.html.

[138] Alessio Mastropietro, SPACs to Reality: A Comprehensive Analysis (Dep't of Econ. & Fin., Chair of L. & Econ. (Bus. & Corp. L.; Antitrust & Regul.), Univ., Academic Year 2022/2023) (supervised by Prof. Avv. Pierluigi Matera)

[139] Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing the space programme of the Union and the European Union Agency for the Space Programme and repealing Regulations (EU) No 912/2010, (EU) No 1285/2013, (EU) No 377/2014, and Decision 541/2014/EU, 2021 O.J. (L 170) 69, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=legissum:4526706.

[140] Andrew Jones, China's Commercial Satellite Sector Sees Boost from 'New Infrastructure' Policy, SpaceNews (May 15, 2020), https://spacenews.com/chinas-commercial-satellite-sector-sees-boost-from-new-infrastructure-policy/.

[141] NASA, Artemis Accords: Principles for a Safe, Peaceful, and Prosperous Future in Space, https://www.nasa.gov/artemis-accords/.

[142] Gary Li, Danielle DeLatte, Jerome Gilleron, Samuel Wald & Therese Jones, Mining the Moon for Rocket Fuel to Get Us to Mars, UCLA (May 16, 2017), https://www.universityofcalifornia.edu/news/mining-moon-rocket-fuel-get-us-mars.

Private companies like Axiom and Blue Origin are building space stations where scientists can make better medicines and computer chips because things float in space, making it easier to work with tiny materials.[143] Cleaning up space junk will become a big business because of new rules. The European Union created a rating system in 2023 that rewards missions that don't leave trash in space. Companies like Astroscale and Clear Space are building robots to remove over 500 old satellites by 2030 using robot arms and tethers; this could be worth $1.2 billion annually.[144] At the same time, computer systems from companies like LeoLabs will help satellites avoid crashing into each other, saving 40% of the fuel commonly used for dodging.[145]

The coming decade will also determine whether private innovation can balance with fair access and sustainability. While space capabilities have become more widely available, power concentration among a few corporations will create risks leading to orbital monopolies. Finding a balance between profit motives and global governance will shape our future in space.

[143] David W. Brown, The Great Commercial Takeover of Low Earth Orbit: Axiom Space and Other Companies Are Betting They Can Build Private Structures to Replace the International Space Station, Technology Review (Apr. 17, 2024), https://www.technologyreview.com/2024/04/17/123456/the-great-commercial-takeover-of-low-earth-orbit/.
[144] Jason Rainbow, Astroscale and ClearSpace Reach Development Milestone for Dual-Satellite Deorbit Mission, SpaceNews (Feb. 11, 2025), https://spacenews.com/astroscale-and-clearspace-reach-development-milestone-for-dual-satellite-deorbit-mission/.
[145] Michael Sheetz, Space Debris Tracker LeoLabs Unveils Automated Collision Alert Service for Satellites, CNBC (May 13, 2020), https://www.cnbc.com/2020/05/13/space-debris-tracker-leolabs-automated-collision-alert-service-for-satellites.html.

CHAPTER 3

LEGAL ISSUES SURROUNDING COMMERCIAL USE OF OUTER SPACE

3.1 INTRODUCTION - THE NEED AND RISK OF OUTER SPACE

The vast knowledge of outer space that we have now results from scientific discoveries, space innovation and human exploration. The space sector has increased manifold because of the extensive competition between players and the number of activities carried out in space and on Earth. Space was a sector that was unknown before the 1950s, but after the launch of the first satellite and the development of various space-related technologies, there began a phase called the "space race". Although initially dominated by the USA and Soviet Union, space has flourished in other countries like China, India, Japan, and even today's private sector.[146] The political tension between these dominant state players became the basis for exploration. These whole new dynamics changed in 1969 when the US landed on the moon in the year 1969 via Apollo 11.[147] Now that the aim to defeat the Soviet Union was complete, the government focused on other problems like the Vietnam War, resulting in low budgetary allocation for NASA.[148] Most of the money was spent on building the space shuttle, which allowed astronauts to live in low orbit for many years. Meanwhile, the Soviet Union began working on their space station. In 1971, they launched Salyut-1, which was their first space station. It held three cosmonauts for around 23 days, who all died later on due to an accident that occurred in the shuttle while returning to Earth.[149] Over the years, these two countries have helped develop space tremendously through rockets, like Soyuz and Proton and the US Space shuttle, to build more space stations. One of the most

[146] Namrata Goswami, What the United States Should Do Regarding Space Leadership? The Space Review (Jan. 23, 2023), https://www.thespacereview.com/article/4517/1.
[147] Dwayne A. Day, Astronauts, Guns, and Butter: Charles Schultze and Paying for Apollo in a Time of Turmoil, The Space Review (May 11, 2020), https://www.thespacereview.com/article/3941/1.
[148] ibid
[149] The Impact of Space Activities upon Society (David Raitt & Bruce Battrick eds., Eur. Space Agency, ESA BR-237, Feb. 2005).

important developments was the International Space Station, which is still used for science in space.

Space has historically been a metaphor for hope, particularly in the pursuit of new reserves of resources. Space's potential for offering previously untapped energy and raw materials, like boundless solar energy, fuels space exploration. Solar energy in space does not require agricultural or economic space, as with Earth's resource energy. Space activities today are of enormous utility. Satellites enhance weather forecasting, providing early warnings for storms and saving lives. They also track environmental trends, including concentrations of greenhouse gases, that are critical indicators of monitoring climate change. In addition, earth observation technology enhances the sustainable management of water resources, agricultural land, and fisheries. For example, SatAgro, a Polish business, employs satellite data to assist farmers in optimising fertiliser use, thereby making farming more efficient.[150] However, this is not just restricted to agriculture; it is also responsible for fishery practices and preventing illegal activities like poaching or logging.

The communication sector is the most dominant area of outer space, and the private sector has gained a firm grip: better space technology and better communication in remote areas. Satellite allows people to communicate with others in remote places, watch their favourite television, indulge in e-commerce businesses and regulate their bank accounts. Similar to GPS, it is an everyday essential that helps us reach our destination.[151] It is now used by various commercial outlets and businesses to deliver food and products home, like Swiggy, Zomato and Myntra.[152] Most importantly, it comes as an aid for the military to track terrorist activities at the border.

This space industry is also proving to be fertile ground, not only for scientists and engineers but even for labourers who construct buildings, the ones who fill tables and countless others

[150] Angela Wipperman, This Is How Farmers Are Using Satellites to Enhance Adaptation, GLOBAL CTR. ON ADAPTATION (Jan. 28, 2021), https://gca.org/this-is-how-farmers-are-using-satellites-to-enhance-adaptation-2/.
[151] Canadian Space Agency, Everyday Benefits of Space Exploration, GOV'T OF CAN., CANADIAN SPACE AGENCY (Dec. 11, 2020), https://www.asc-csa.gc.ca/eng/publications/everyday-benefits-of-space-exploration.asp.
[152] Deeksha Somani, How Zomato, Swiggy, Myntra and Other Delivery Giants of India Are Using Gen AI, Times of India (Nov. 25, 2024, 10:51 IST), https://timesofindia.indiatimes.com/technology/tech-news/how-zomato-swiggy-myntra-and-other-delivery-giants-of-india-are-using-gen-ai/articleshow/114147626.cms.

who will benefit when the space corporations open up space in their area.[153] This excites youngsters and creates their interest in science and technology, which ultimately helps to gain a workforce.

Conversely, outer space can turn extremely hostile within minutes if not managed. All the activities in the space of countries have the potential to wreak havoc. The war between Russia and Ukraine is a recent instance where space was appropriately used as a strategic weapon. Even without its space program, Ukraine used commercial satellites to obtain high-resolution imagery and communications equipment, illustrating how space is directly involved in contemporary war.[154]

The advent of the private sector aggravates such problems of data accessibility, as they are ready to take more risks to move faster than the government.[155] The space should not become an arena of only the powerful without the law to govern it. There have been rising issues in outer space due to the use, exploration and exploitation of space resources. One of the most significant issues is the low orbit being overcrowded because of the number of satellites and unregulated space traffic; this is also the primary cause of space debris. This debris threatens the functioning of the satellites and spacecraft in orbit.[156] The collision of even small fragments can be dangerous. Further, satellite communication is causing the overcrowding of radio frequencies, too. This ultimately will question old laws that do not cover the new developments like property rights, resource exploration, mining, space travel, intellectual property, environmental issues, etc.

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[153] Radoslav Baltezarević, Space Exploration's Impact on Economic Growth, INST. OF INT'L POL. & ECON., Belgrade, Serbia (Mar. 2024).
[154] David T. Burbach, Early Lessons from the Russia-Ukraine War as a Space Conflict, ATLANTIC COUNCIL (Aug. 30, 2022), https://www.atlanticcouncil.org/content-series/airpower-after-ukraine/early-lessons-from-the-russia-ukraine-war-as-a-space-conflict/.
[155] Luisa Corrado, Maureen Cropper & Akhil Rao, Space Exploration and Economic Growth: New Issues and Horizons, 120 Proc. Nat'l Acad. Sci. U.S. Am. e2221341120 (2023)
[156] James Myers & Mariana Meneses, Emerging Issues in Space Governance Urgently Require International Agreement, THE QUANTUM RECORD (Jan. 28, 2024), https://thequantumrecord.com/philosophy-of-technology/emerging-issues-in-space-governance/.

3.2 THE OUTDATED LAWS OF OUTER SPACE AND THE RISE OF THE PRIVATE SECTOR

Today's International space law depends entirely on conventional laws, which were made when humans sent their first technology to space. A time when only some dominant countries, through their government, reached space, shaped by military sensitivities. Now that we look at space, we only talk about SpaceX, Blue Origin and other non-state players. Countries like China and Russia still perform their space activities through the government. Still, on the other hand, the USA, Luxembourg, and the UAE have given full access to their private sector. For example, around 11,000 active satellites belong to the private sector in orbit.[157] Most government agencies depend on these commercial enterprises for innovation and low-cost space development. But when anything goes wrong in space due to private adventure, who will be held liable and what will define these liabilities? This boost to private entities contrasts with the principle of common heritage, as enunciated in the Moon Agreement, 1979.[158] Companies and countries are racing to get resources from space, like how NASA plans to put people back on the moon through its Artemis program. Since all the countries plan to set foot on the moon, the issue is who will use the resources. Moreover, some countries are allowing their citizens to own and sell resources related to the moon, again going against the international space law principle that says no one can own space (Article II).

The Outer Space Treaty was not made owing to the reality of today. Nobody thought China would do so well in space, like landing on the moon's far side. China and Japan are sending robots to get rocks from space.[159] India has also shot down its satellite with rockets from Earth, even though the treaty says not to use weapons in space. Now, countries can shoot their satellites and might shoot some satellites from other countries. Again, who is responsible for the debris caused by such activities? With more private launches, there's more risk of crashes in orbit. This affects not only the other satellites but also the

[157] Yucong Wang & Bin Li, Space Is Set to Become a 'Wild West' as Outdated Laws Struggle to Keep Up, SCIENCE ALERT (Mar. 20, 2025), https://www.sciencealert.com/space-is-set-to-become-a-wild-west-as-outdated-laws-struggle-to-keep-up.
[158] ibid
[159] Laurent Bach, Patrick Cohendet & Eric Schenk, Technological Transfers from the European Space Programme: A Dynamic View and a Comparison with Other R&D Projects, 27 J. Tech. Transfer 349 (2002).

environment. While these junks burn before hitting the Earth's surface, they pollute our atmosphere.

Another problem lies with the rescue agreement, which covers only the astronauts, believing them to be the only space travellers. Today, there has been an increase in the potential of space tourism, with some travelling to the Earth's low orbit as passengers, regulated mainly by private actors. Space tourism also raises questions about liability, which is not explicitly covered under the Liability Convention, 1972. [160]

In 2017, a US-based company named Swarm Technologies made a small communication satellite called Space Bees. They wanted to send the satellite to space, but the US Federal Communications Commission (FCC) did not allow the same because the cube-shaped satellites were only 1 inch on each side. This was a problem because they were too small for an Earth tracking system to watch them, and the US space surveillance network allows at least 4 inches on each side (1U size) for tracking. Anything below that standard would put other spacecraft at risk of collision. However, the company did not stop; somehow, they got their satellites on an Indian PSLV rocket and launched them in January 2018.[161] Based on evidence, the Spacebees were fined $900,000 in 2018 for launching the satellite without a license. There are three things to be considered-

1. Which country would have been liable if that satellite caused an accident or harm to the space environment?
2. How was a private entity without proper licensing from the government able to launch it?
3. If private companies are given that much leverage, how can the militarisation and weaponisation of space be managed?

Space laws are hard to enforce in such conditions, especially for companies. The liability and Registration conventions have some enforcement rules, but provisions also limit them. The UN Committee for Space (UNCOPUOS) works slowly because it relies on Diplomatic

[160] Frans G. von der Dunk, A Sleeping Beauty Awakens: The 1968 Rescue Agreement after Forty Years, Space, Cyber, & Telecom. Law Program Faculty Publications (2008), https://digitalcommons.unl.edu/spacelaw/29.
[161] Roman Buzko, Five Notable Disputes in the Space Industry, BUZKO LEGAL (Dec. 25, 2020), https://www.buzko.legal/content-eng/five-notable-disputes-in-the-space-industry.

consensus, making it easy for companies to avoid punishment.[162] In the US, there is a trend of solving these disputes through federal courts or arbitration; other countries still lack a clear adjudication system. Due to the lack of these uniform laws and enforcement mechanisms, companies can avoid following the principles laid down, exacerbating the risk of harm to space. For example, in 2020, the SpaceX satellite was about to hit a European satellite, which later was held to be a bug, and was promised to be fixed. To uphold the rule of law, there is a clear need for amendments at the international and national levels, where the government and private sectors are held accountable for every harm to space. The law should be improved to acknowledge the changing role of government and private entities and the advanced activities being carried out outside our planet.

3.3 PROPERTY RIGHTS

Space has various activities where ownership has been demarcated and defined, like anything sent to the earth, including vehicles, their parts and cargo belonging to the country that has sent it to space. These owners will be held liable for any damage caused by such objects sent by them. This means satellites and space stations have some ownership rights. The party that built them can claim permanent structures built on the moon or any other celestial body.

The commercial space industry consists mainly of communication satellites owned by companies and governments. These entities have been given the right to use specific radio frequencies for their satellites, granting them limited property rights. The ownership of things brought down from space also rests with the same country or individual. However, legal clarity is needed for future commercial exploration. UN treaties like the Outer Space Treaty affect space property rights, prohibiting even the government from claiming ownership of space or celestial bodies. No nation can have exclusive use of territory in space.

[162] Madi Gates, Houston, We Have a Problem: International Law's Inability to Regulate Space Exploration, **NYU JILP Blog** (Jan. 2, 2025), https://jilp.law.nyu.edu/2025/01/02/houston-we-have-a-problem-international-laws-inability-to-regulate-space-exploration/.

One of the essential cases related to property rights in space dates back to 2000 between Nemitz and NASA. George Nemitz claimed ownership of an asteroid, Eros 433, based on which they demanded rent for its use. This was rejected by NASA and the US State Department, citing the principles of the Outer Space Treaty, 1967. Nemitz brought the case to the federal court to decide on the space ownership. The court maintained and ruled against the petitioner as he failed to prove his legally enforceable right over the property. Notably, the court didn't rule that property rights did not exist in space or that no ownership could be claimed over celestial bodies.

3.4 REGULATING SPACE MINING

Space mining is the process that includes the exploration, exploitation and utilisation of natural resources to be found on the moon, other planets and near-Earth asteroids (NEAs); primarily, what can be encountered is a rich diversity of valuable materials such as minerals, gases (mainly Helium-3), metals and water.[163] For example, NASA sent a spacecraft called Psyche to an asteroid named 16 Psyche, which may confirm the presence of rare minerals, which, when multiplied by the current market rate, hold an astonishing value of around $100 quintillion.[164] Mining has become an important subject because of the importance it holds; for instance, a 10-metre asteroid can provide about 6,50,000 kg of metals, including gold and platinum and also serve as a water source and organic compounds such as carbon, phosphorus, etc., this water on asteroids can be used in outer space for other activities like survival and fueling of rockets.

However, controversy arises as regards the famous non-appropriation doctrine in Article II of the Outer Space Treaty,[165] This provides that no country can claim to own outer space, the Moon, or any planets or asteroids.

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[163] Space Mining, **Space Generation Advisory Council** (Jan. 28, 2022), https://spacegeneration.org/sgac-ecsl-un-model/67883-2.

[164] Ethan Hutchings, Navigating the Legal Landscape of Space Mining: Interpreting International Space Law, **SPACE NEWS** (Dec. 18, 2024), https://spacenews.com/navigating-the-legal-landscape-of-space-mining-interpreting-international-space-law/.

[165] Higuera, G. I. (2022). What Got Us Here, Won't Get Us There: Why U.S. Commercial Space Policy Must Lie in an Independent Regulatory Agency. https://core.ac.uk/download/641033569.pdf

Some argue that since the term “national appropriation" is not defined in the article, it does not constitute resource extraction as part of its definition. Since there is no explicit mention of such activities, there is no such prohibition, mainly when such activities are carried out by private players and not the government. Through this interpretation, countries have allowed various entities to extract minerals in space. For example, in 2015, the United States Government established the US Commercial Space Launch Competitiveness Act (HR 2262), which includes Title IV and provisions regarding “Space Resource Exploration and Utilisation”.[166] A provision in U.S. law states that any U.S. citizen involved in extracting resources from asteroids or space has the right to own, use, transfer, sell, or otherwise manage those resources, provided they comply with domestic laws and international agreements. This effectively means that American individuals or companies can legally claim ownership over space resources under U.S. law because of gaps in the global legal framework. However, this recognition of private property rights appears to conflict with the core principles of the Outer Space Treaty (OST), which promotes space as a domain for the benefit of all humankind. Critics argue that such national legislation prioritises commercial interests over collective international obligations, potentially undermining space law's fairness and cooperative spirit.

3.5 REGULATING SPACE TOURISM

Space has always fascinated humans. As rules about using space have changed over time, people have found new ways to explore this vast, unknown area. One exciting new development is space tourism. Space tourism means businesses offering regular people the chance to experience space travel. This isn't just for trained astronauts anymore; now, people with enough money can visit space too. Space tourism is governed by three laws mainly, the Outer Space Treaty, UNCOPUOS (the United Nations Committee on the

[166] Laura Spears, John Martin & Betty Rotham, Legality of Ownership of Asteroid Mining Results in Space Based on International Law Arrangements, 1 Pancasila Int’l J. Applied Soc. Sci. (2023), https://doi.org/10.59653/pancasila.v1i01.75.

Peaceful Use of Outer Space) and the Chicago Convention (Convention on International Civil Aviation) and some other minor laws.

The biggest problem with space tourism is that there are no defined laws about it yet. The space treaties we have now are old and do not cover all the issues with space tourism. As companies get closer to offering regular trips to space, countries like India need to make new laws. Governments must watch over private space companies while giving them enough freedom to grow and develop. These new rules should cover registering spaceships, what forms tourists must sign, licensing for crew members, what happens if someone commits a crime in space, and how to handle accidents. There is currently no universally accepted legal definition of "space tourist." Existing space laws were designed when only astronauts, described as "envoys of mankind" or "spacecraft personnel", travelled to space. Treaties like the Outer Space Treaty and the Rescue Agreement obligate states to assist astronauts in distress, but whether these protections extend to tourists is unclear.[167] Jurisdictional questions arise, particularly when individuals from multiple countries participate in spaceflights. Current treaties do not clarify where legal disputes involving tourists should be filed.[168]

Liability is another critical issue. Under the 1972 Liability Convention, launching states are entirely liable for damage caused by their space objects.[169] However, with private entities now offering space tourism, it remains unclear how liability would be assigned in negligence cases. This legal ambiguity also impacts insurance. Traditional space insurance covers astronauts and crew, not tourists. While some companies offer personal accident coverage for space tourists, the lack of legal clarity complicates underwriting.[170]

Authorisation and registration of tourist spacecraft also present challenges. International law requires states to authorise and supervise national space activities, but there are no specific provisions for tourism.[171] This has made such flights legally uncertain. The United States has taken a regulatory lead, classifying tourist spacecraft as aerospace vehicles and

[167] Article V, Outer Space Treaty, 1967; Article 1, Rescue Agreement, 1968.
[168] Lyall, F. & Larsen, P.B., Space Law: A Treatise, Routledge, 2009, p. 175.
[169] Article II, Convention on International Liability for Damage Caused by Space Objects, 1972.
[170] Freeland, S. “Fly Me to the Moon: How Will International Law Cope with Commercial Space Tourism?” Melbourne Journal of International Law, 2005, Vol. 6(1).
[171] Article VI & VIII, Outer Space Treaty, 1967.

applying the Liability Convention. It assumes third-party liability for the first three years of commercial flights.[172]. Still, registration remains ambiguous for tourist flights, as laws do not specify procedures for such missions.

3.6 INTELLECTUAL PROPERTY IN SPACE AND SPACE TECHNOLOGIES

Intellectual property like patents, trademarks and copyrights can be protected in two ways: within a single country (territorially) and across multiple countries (internationally).[173] IP is based on the concept of sovereignty and boundaries. But when we see outer space, there is no demarcation nor any ownership that can be claimed, no country enjoys any legal control over any matter in space, may it be asteroids, planets or stars. The expanding private sector presence in outer space makes it harder to enforce intellectual property (IP) rights. Control and accountability were easier when governments were the only participants in space activities. Since private players are now seeking profit and exclusivity, ownership, use, and information sharing issues become contentious; these players frequently tend to withhold access to their technology or hawk it out, which goes against world norms. The Outer Space Treaty ensures that space must be utilised for the benefit of all states, specifically the Third World. Article II prohibits any national assertion of ownership of celestial bodies. Likewise, the Moon Agreement proclaims the Moon and its wealth as humanity's shared heritage. The UN Resolution of 1962 (XVIII) ensures that outer space is open for use and exploration by all and cannot be subjected to national appropriation.[174]

Another reason for such debate is the Karman line, i.e., the lack of any universally accepted boundary by the nations. Because of such a missing demarcation and boundary, there is a question as to which law will apply related to IPR to that specific technology.

These outer space laws and principles were established when there were just government actors; with now several private actors, there is uncertainty about IP application in outer

[172] U.S. Commercial Space Launch Amendments Act, 2004; FAA Office of Commercial Space Transportation regulations.
[173] Ritesh Mehra, Intellectual Property Protection in Outer Space – An Overview, 2 ILI L. Rev. 144 (2019).
[174] Zhijie Chen & Yun Zhao, Intellectual Property Protection in Outer Space: Conflict in Theory and Application in Practice, 61 Space Policy 101484 (2022), https://doi.org/10.1016/j.spacepol.2022.101484.

space. It is a conflict between the inventor's right to assert the IP and, on the other hand, the principle of commonality. Now, the question arises about what all these international agreements necessitate that private players disclose to the world, because these international commitments do not grant any element of IP.

If we look at commercial space technologies, space activities, and space travel, every technology invented comes under patent law.[175] Because of these investments by private companies in inventing, designing and building space technology, patents will be in dire need. Despite the level of protection provided by the patent system, some companies still choose to protect their Intellectual property through trade secrets.[176] For example, in a 2011 interview, the founder of SpaceX, Elon Musk, said that "SpaceX has essentially no patents" because they feared the Chinese government, which might copy it like a recipe book. Despite these challenges, SpaceX has applied for patents on space-related technologies.

Another issue concerns trademarks, which safeguard the symbols, logos, brands or legally registered words used in identifying goods or services. In the present day, the framework, like the Madrid system, permits intercontinental registration but not extraterrestrial activities where there is a surge in lunar missions, space tourism and extraterrestrial manufacturing.[177] The businesses are now being set up in outer space, extending their horizon. Recently, there were issues of trademark squatting, where in 2024, SpaceX won a case relating to "invalidation of trademark" against Japan, where a company dealing with apparel and accessories used a similar domain name.[178] The Japan Patent Office ruled in favour of SpaceX against NDR Tech Co., explaining that using such a famous name can confuse users.

But trademark law presents unique challenges in space. For instance, an American firm named Orion Span wished to construct a luxury space hotel named "Aurora Station" and

[175] ibid
[176] Maeve Dineen, For the Betterment of All Mankind: Claiming the Benefits of Outer Space Through Intellectual Property Rights, 13 **Hastings Sci. & Tech. L.J.** 73 (2022), https://repository.uchastings.edu/hastings_science_technology_law_journal/vol13/iss1/6.
[177] https://www.theippress.com/2024/11/11/intellectual-property-rights-beyond-earth/
[178] Intellectual Property Rights Beyond Earth, **The IP Press** (Nov. 11, 2024), https://www.theippress.com/2024/11/11/intellectual-property-rights-beyond-earth/.

applied for a trademark.[179] This opened up a string of unanswered questions. First, does one country's trademark apply in outer space? Trademark rights are generally only over particular jurisdictions. Second, what previous trademarks would have to be looked at for conflicts? Only those discovered in the same nation or region? Third, how would businesses demonstrate that they're truly using their trademarks in space? Most countries require proof of actual use to protect their trademarks. Fourth, which courts would decide trademark disputes in space?

Some companies, such as Axiom Space, SpaceX, Virgin Galactic, and Blue Origin, already have trademark holders for space business. It just isn't clear how this works off the planet. One potential solution would be to create an international trademark system in space under the World Intellectual Property Organisation. For example, NASA has registered its trademarks in the United States, the European Union, and seven additional nations: Canada, Germany, Japan, and the United Kingdom. They are the nations where NASA did not register due to budget constraints, but where most of its activities occur. NASA's most pirated trademark is its "blue meatball" logo (NASA blue round insignia). NASA issues regular warning letters to individuals and organisations misusing this logo. With increasingly more companies venturing into space, clear trademark laws will be even more critical to safeguard brands and avoid customer confusion on Earth and in space.

The third key IPR relevant to space is copyright. Understanding copyright in space involves balancing private ownership rights with space law, which prohibits ownership of space or celestial bodies under the Outer Space Treaty (OST). Drawing on John Locke's theory, copyright arises when someone adds labour to create something. However, the OST treats space beyond 100 km from Earth as the Common Heritage of Mankind, creating tension between ownership and shared access.

While objects sent from Earth remain under national jurisdiction, issues arise over who owns the data collected by private satellites. Remote sensing satellites gather electromagnetic data, which is processed into useful information. Courts often distinguish between raw data (usually not protected) and analysed information (protected when it

[179] Trade mark and conquest for space, **INTA**, IP in Space, (Dec. 7, 2022), https://www.inta.org/wp-content/uploads/public-files/perspectives/industry-research/221207_ipinspace_report.pdf.

involves creativity or skill). Direct broadcasting satellites raise further challenges. Signals transmitted via uplinks and downlinks are vulnerable to piracy, causing financial harm. The software that handles these signals is protected under copyright laws like India's Copyright Act and the TRIPS Agreement. However, many argue that space-specific protections for these signals are still needed.[180]

Lack of definite legal provisions has resulted in data piracy and unauthorised interception. Finally, challenges in enforcing IPR on space resources can deter private investment.[181] In the absence of guarantees for protection of copyrights and investment returns on their technology, private companies might fail to invest in space ventures, and this will retard innovation and commercial development in the space industry.[182]

3.7 ENVIRONMENTAL ISSUES IN SPACE

In 2022, an article was published in Nature Astronomy; the author remarked that "we should protect the environment in outer space on behalf of our scientists, astronomers, amateur stargazers and indigenous people."[183]

Protection of outer space from the environment is increasingly necessary with the rising number of rockets, satellites, and space travel. Space pollution may not be seen like on Earth, but the effect may be apocalyptic, potentially destabilising the solar system and life on the planet. Space garbage is perhaps the most urgent problem. It is primarily created by dead satellites and spent rocket casings and builds up in low Earth orbit (below 2000 km), where most satellites and astronauts are located. With each flight, more space garbage builds up, endangering all spacecraft. A good example is in 2007, when China shot down

[180] Ayershie Basu & Sreenivasulu N.S., Issues and Challenges Concerning Copyright Law in Relation to Outer Space, 2 Iranian J. Int'l & Comp. L. 1 (2024), https://ijicl.qom.ac.ir.
[181] R. Ravikumar, Protection of Intellectual Property Rights in Outer Space: An Indian Perspective, 22 J. Intell. Prop. Rts. 84 (2017),
[182] Daria S. Kim, Intellectual Property and the Commercialisation of Space, 19 Chi. J. Int'l L. 233 (2018), https://chicagounbound.uchicago.edu/cjil/vol19/iss1/9/.
[183] UW News Staff, Heavens Need Environmental Protection Just Like Earth, Experts Say, (Apr. 22, 2022), https://www.washington.edu/news/2022/04/22/heavens-need-environmental-protection-just-like-earth-experts-say/.

one of its satellites, creating more than 3,000 pieces of space garbage.[184] Then, in 2008, the USA destroyed a failed satellite, and in 2009, a Russian and US satellite crashed into each other. Thus, the more space traffic, the greater the chance of such accidents, and the greater the accumulation of space debris.

Another overlooked issue is light pollution caused by satellite flares; bright flashes created when satellites reflect sunlight as they pass overhead. These streaks interfere with astronomical observations, making it harder for scientists to collect accurate data. Space debris dates back to the 1963 U.S. West Ford Project, which released thousands of tiny wires into orbit to test global communication. By 2017, nearly 20,000 tracked pieces of debris weighed over 8,000 tons.[185] As of 2020, estimates suggest that around 128 million fragments are in space. With the rapid pace of space activity in 2025, that number is likely far higher, intensifying concerns over the sustainability of Earth's orbit.

Nuclear power is also a pollutant and is now used in outer space. Space activities use atomic power to make missions work better than regular energy sources. Since 1961, over fifty space missions have used nuclear power. While this technology is essential for future space exploration, it poses huge risks, such as contamination of atomic energy in outer space.[186] These risks exist during launch when entering orbit and throughout the spacecraft's journey. Two significant examples are the Cosmos 954 Case of 1978, where a soviet satellite crashed in Canada, and the other happened with Cosmos 1402, which crashed and spread radioactive material in the upper atmosphere.[187]

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[184] Mohammad Saiful Islam, The Sustainable Use of Outer Space: Complications and Legal Challenges to the Peaceful Uses and Benefit of Humankind, 9 **Beijing L. Rev.** 138 (2018), https://doi.org/10.4236/blr.2018.92016.

[185] Outer Space Environment Protection: An Imperative for a Sustainable Future, 1 **ILI L. Rev.** 1 (2022) https://ili.ac.in/pdf/1._Pankaj_Mehta_F_.pdf

[186] Howard J. Taubenfeld, International Environmental Law: Air and Outer Space, 13 **Nat. Res. J.** 315 (1973), https://digitalrepository.unm.edu/nrj/vol13/iss2/9.

[187] Biswanath Gupta & Tamoghna Agasti, The Curious Case of Article IX and Outer Space Environment, 2 **J. Envtl. Impact & Mgmt. Pol'y** 1 (2022), http://journal.hmjournals.com/index.php/JETMP.

3.8 UNREGULATED DISPUTE RESOLUTION IN SPACE ACTIVITIES

The Corpus Iuris Spatialis, or "body of space law," established a framework of treaties that lacked mandatory dispute resolution mechanisms for space-related activities.[188] Although the liability convention included provisions for diplomatic resolution procedures, these were constrained by political considerations and failed to ensure effective conflict resolution.[189] In 2011, the Permanent Court of Resolution created optional rules for space dispute arbitration based on UNCITRAL rules but with specific adjustments. These only apply when the parties actively choose them through particular agreements. Though not yet used, these rules were designed for the unique aspects of space disputes involving all three parties, i.e. government, companies and organisations.

Space businesses like SpaceX, Blue Origin, etc., use arbitration mostly in contracts. There are generally three types of disputes: business disputes (between private entities), investor-state disputes (usually in private-public partnerships) and state disputes (government-government disputes). There has been a prominent rise in the first two types of cases due to the higher involvement of private entities and the boom in space-related activities. Apart from this, there were two other types of disputes relating to the seizure of assets under the purchase transaction and partnership agreements for the launch of spacecraft.[190] In the investor-state dispute settlement process, only four cases were dealt with, out of which two were related to Devas.[191]. It was claimed that India cancelled the right associated with the use of the satellite frequency of that company and also took their land unreasonably.[192] On the other hand, India gave security reasons to cancel the agreement. Some experts think the

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[188] Laura Denise Jaroslavsky Consoli & Panagiotis Chalkias, Space-Related Disputes Part 1 – The Current Landscape and Specific Intellectual Property Aspects, DAILYJUS (Dec. 17, 2024), https://dailyjus.com/world/2024/12/space-related-disputes-part-1-the-current-landscape-and-specific-intellectual-property-aspects#:~:text=Only%20the%20Convention%20on%20International,and%20efficient%20resolution%20of%20claims.

[189] ibid

[190] Laura Denise Jaroslavsky Consoli & Panagiotis Chalkias, Space-Related Disputes Part 1 – The Current Landscape and Specific Intellectual Property Aspects, DAILY JUS (Dec. 17, 2024), https://dailyjus.com/world/2024/12/space-related-disputes-part-1-the-current-landscape-and-specific-intellectual-property-aspects.

[191] Deutsche Telekom AG v. Republic of India, PCA Case No. 2014-10, Award (Perm. Ct. Arb. May 27, 2020). And **CC/Devas (Mauritius) Ltd. v. Republic of India**, PCA Case No. 2013-09, Award on Jurisdiction and Merits (Perm. Ct. Arb. July 25, 2016).

[192] **CC/Devas (Mauritius) Ltd. v. Republic of India**, PCA Case No. 2013-09, Award on Jurisdiction and Merits (Perm. Ct. Arb. July 25, 2016).

Outer Space Treaty might affect these cases. This treaty says no country can own outer space or celestial bodies. This could create problems for claims about space resources.

Another case involved Deutsche Telekom and India[193] about a cancelled contract for providing internet services to Indian customers. The judges ruled that India didn't treat Deutsche Telekom fairly and ordered India to pay $93.3 million. According to recent data, about 31.5% of space cases are dealt with by the International Chamber of Commerce (ICC), followed by the American Arbitration Association- International Centre for Dispute Resolution (AAA-ICDR) which 15.7% and lastly, the London Court of International Arbitration (LCIA) having a share of 10.5%.[194] But again, it becomes difficult to assess the liability where the incidents occur in space, those that originate in space but result in damage on Earth and disputes that arise from Earth, that are intrinsically linked to space operations. Another problem is that state actors often prefer to take their disputes to non-binding dispute resolution mechanisms such as negotiation and mediation over arbitration and litigation. The question always arises as to how these will be sufficient to tackle issues that are increasing rapidly through this growing sector.

Thus, Space disputes face two big problems. First, national security concerns make sharing evidence needed in legal cases hard. Second, space issues are very technical, so judges and arbitrators need special knowledge to handle these cases properly.[195] These challenges make it difficult to resolve space-related legal disputes through regular courts or arbitration processes.

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[193] **Deutsche Telekom AG v. The Republic of India, PCA Case No. 2014-10** https://jusmundi.com/en/document/decision/en-deutsche-telekom-ag-v-the-republic-of-india-memorandum-opinion-of-the-united-states-district-court-for-the-district-of-columbia-wednesday-27th-march-2024

[194] Laura Denise Jaroslavsky Consoli & Panagiotis Chalkias, Space-Related Disputes Part 1 – The Current Landscape and Specific Intellectual Property Aspects, DailyJus (Dec. 17, 2024), https://dailyjus.com/world/2024/12/space-related-disputes-part-1-the-current-landscape-and-specific-intellectual-property-aspects#:~:text=Only%20the%20Convention%20on%20International,and%20efficient%20resolution%20of%20claims.

[195] Zeina Ahmad & Shadi A. Alshdaifat, Legal Challenges in Establishing Human Settlements in Space, 47 **Rev. Fac. Dir.** 639 (2019), http://dx.doi.org/10.14393/RFADIR-v47n2a2019-48685.

3.9 THE PROBLEM WITH DATA PRIVACY

With expanding space-based technologies, privacy and data issues are mounting. Satellites can be utilised to image the planet with high resolution and thus reveal personal locations, but the party accessing or disseminating the information remains anonymous. Space cloud storage can also erase individual data, like location and device data. Space drones can be used to capture voice, track movements, or photograph without permission.

Selecting a jurisdiction in this case is intricate. Space AI, using the satellite and cloud facilities, handles private information, calling into question the rights of individuals to opt out of automatic decision-making. There is also no strict law on GPS tracking an individual for a period. As space is being opened up, the main questions are: how privacy will be preserved, who would be held responsible, what law would be used, and whether privacy rights would be enforceable outside the Earth. Not every country has laws to protect your data.

As of April 2, 2019, the UN Trade and Development group found that 107 countries had created rules to keep people's information safe and private. Another 14 countries were working on making such rules. Some groups of nearby countries were also trying to make their rules more similar.[196] Unlike the European rules (GDPR), which replace each EU country's privacy laws, other area-wide systems work differently.[197] For instance, in Asia, the APEC group created shared privacy rules called CBPR. However, these APEC rules don't replace each Asian country's laws; they exist alongside them. So Asian countries still follow their own rules first, while EU countries must follow the shared GDPR instead of their old national laws.[198]

The legal picture is even more mixed because some rules only apply to certain types of businesses. This happens a lot in America. For example, an old law from 1934 had special

[196] Martin M. Zoltick & Jenny L. Colgate, The Application of Data Protection Laws in (Outer) Space, in ICLG – Data Protection 2019 11, 11–16 (Global Legal Group Ltd., 2019), https://iclg.com/practice-areas/data-protection-laws-and-regulations.
[197] Frans G. von der Dunk, Outer Space Law Principles and Privacy, in Evidence from Earth Observation Satellites: Emerging Legal Issues 243, 243–58 (Denise Leung & Ray Purdy eds., Brill 2013).
[198] Ibid,57

data safety rules for cable TV and satellite companies.[199] Some groups have to follow many different privacy rules at once, while others don't have to follow any rules at all. Take nonprofits in California, as they need not follow California's privacy law. Even big international groups like the European Space Agency don't have to follow Europe's strict GDPR privacy rules.

Some jurisdictions lacking strict data regulations attract space companies, as they can freely collect and use personal information. Notably, organisations like the European Space Agency (ESA) are not bound by the EU's General Data Protection Regulation (GDPR).[200] While GDPR likely applies to data gathered in airspace or near space within EU territory, it remains unclear whether it extends to data processed in outer space.[201] The regulation addresses data within the EU and its transfer outside the region, but storing or transmitting data via outer space may create a legal loophole.[202] This issue stems from the absence of a comprehensive international governance framework for outer space.

[199] See Cable Communications Policy Act of 1984, Pub. L. No. 98-549, § 5, 98 Stat. 2779, 2796 (codified at 47 U.S.C. § 551 (2018))
[200] Article 3(2), Regulation (EU) 2016/679 (GDPR); see also: European Space Agency Convention, 1975 (ESA is not an EU agency and not bound by GDPR).
[201] Recital 22 & Article 3, GDPR – application limited to data within EU jurisdiction or affecting EU citizens.
[202] De Hert, P., & Czerniawski, M., "Expanding the European Data Protection Scope Beyond EU Borders," International Data Privacy Law, 2016.

CHAPTER 4

ANALYSIS OF THE LAW OF OUTER SPACE

4.1 INTRODUCTION

Outer space has long fascinated humanity through science, poetry, and astronomy, without raising major legal questions. However, the emergence of rocket technology, particularly its use as a weapon during World War II, brought legal concerns to the forefront.[203] The launch of Sputnik 1 in 1957 by the Soviet Union marked a turning point, prompting urgent questions about ownership, regulation, and responsibility beyond Earth's atmosphere. The satellite's orbiting of Earth every 96 minutes showcased the potential of human innovation and pressured the international community to develop a legal framework to govern this new frontier.[204] Outer space is unlike Earth's ecosystems. Historically, wars and power revolved around territorial control, where borders could be drawn and sovereignty clearly defined. In contrast, space has no natural boundaries, making traditional sovereignty inapplicable.[205] This has led to the concept of space as the "province of all mankind," where cooperation and shared responsibility are vital.[206] Legal concerns over militarisation, privatisation, space traffic, and resource exploitation make governance essential, as unregulated activity could have irreversible consequences.[207]

One of the most critical concerns in space governance is the management of shared resources, from orbital slots for satellites to potential mining sites on asteroids and celestial bodies.[208] Space offers resources that cannot be claimed through traditional territorial means.[209] Therefore, in the absence of an adequate legal framework, these resources may

[203] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space (Outer Space Treaty), 1967, Preamble.
[204] Jakhu, R., & Pelton, J., Global Space Governance: An International Study, Springer, 2017
[205] Article II, Outer Space Treaty, 1967 – prohibits national appropriation of outer space by claim of sovereignty.
[206] Article I, Outer Space Treaty, 1967 – outer space is the "province of all mankind."
[207] Lyall, F., & Larsen, P. B., Space Law: A Treatise, Routledge, 2009, pp. 40–45.
[208] https://thecommonsjournal.org/articles/10.5334/ijc.1378
[209] The Dilemmas of Outer Space Law Author(s): S. Neil Hosenball and Pierre M. Hartman Source: American Bar Association Journal, March, 1974, Vol. 60, No. 3 (March, 1974), pp. 298-303 Published by: American Bar Association Stable URL: https://www.jstor.org/stable/25726655

be owned disproportionately, i.e., by the technologically advanced nations, on a "first come, first served basis.

4.2 THE LAWS OF SPACE

4.2.1 THE OUTER SPACE TREATY

The presumption regarding the law of outer space is that it started with the Outer Space Treaty. Still, this international agreement was signed four years after adopting the Partial Test Ban Treaty of 1963 (also known as the Limited Test Ban Treaty).[210] It drew on a significant concern over radioactive fallout from atmospheric atomic tests, which can have serious environmental and health issues. The PTBT was a crucial agreement that prohibited nuclear tests in the atmosphere, outer space, and underwater, allowing only underground testing, because of which countries like China and France chose not to sign it initially. Despite these limitations, like limited participation, lack of verification mechanisms related to compliance and proliferation of underground nuclear testing, the agreement marked the way for future treaties like the Outer Space Treaty (1967) and the Comprehensive Nuclear Ban Treaty (1996).

The Outer Space Treaty, also known as the Treaty on Principles, governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies[211], is a fundamental document that shows the extent of human activities in space. The preamble ensures that outer space is used for peaceful purposes, is accessible to all countries worldwide, and is used for the benefit of all humans.[212] It enunciates an international collaboration that results in well-being and the development of space in a just and equitable way. The only element that creates some issue is that the treaty is non-binding, complicating enforcement.[213] So, primarily, technologically advanced countries can take advantage of outer space. Countries with established space programs such as the United States, China, Russia and member states of the European Space Agency dominate

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[210] https://www.britannica.com/event/Outer-Space-Treaty

[211] Is a US Space Force a violation of the Outer Space Treaty? https://moonshotspace.co/2018/08/is-a-us-space-force-a-violation-of-the-outer-space-treaty/

[212] The Outer Space Treaty at a Glance, ARMS CONTROL ASS'N (n.d.), https://www.armscontrol.org/factsheets/outer-space-treaty-glance.

[213] **Frans G. von der Dunk**, The Law of Outer Space: An Experience in Contemporary International Law 77 (1st ed. 2008).

these activities, from satellite launching to deep space missions. This is totally opposite of what has been stated in Article 1, which provides that the exploration should be done for the benefit of all countries and each nation should view space as the common heritage of mankind.[214] The language used in the article denotes that space activities do not belong to a few technologically advanced nations, but a wide range of activities would be undertaken to the benefit of all states, including, in particular, those states with developing capabilities. This clause was made to accommodate the developing countries that might be unable to gain the advantage of outer space due to their lack of technological development.

Article II of the space treaty creates a clear rule against countries claiming ownership of outer space. It says that outer space, the Moon, and other space bodies cannot be owned by any country through claims of ownership, by using or occupying them, or by any other means. This rule is seen as the foundation of the *"no-ownership"* principle in space law.[215] It prevents countries from claiming to own any part of space or celestial bodies, which affects ideas about setting up colonies in space and using its resources.[216]

Article III requires countries doing space activities to follow international law, including the United Nations Charter. This ensures that space activities stay peaceful and respect broader international law. Article IV supports this by banning nuclear weapons or other weapons of mass destruction in orbit or on celestial bodies.[217] It also limits the use of the Moon and other heavenly bodies to peaceful purposes only. The language here has limits, since it bans only weapons of mass destruction, not all guns, and doesn't completely ban military activities.[218] As a result, the treaty allows space for military purposes, but only if it is used for peaceful purposes, like spy satellites. Recently, on March 21, 2025, SpaceX launched the NROL-57 mission for the US National Reconnaissance under the Proliferated architecture program. This distinction creates room for strategic military use of space, raising concerns that space might become another place for international conflicts.

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[214] ibid
[215] Gerard Maring, The Outer Space Treaty and the Space Policy Framework 55 (Edward Elgar Publishing 2021).
[216] Howard A. Shull, the 1967 Outer Space Treaty and the Prevention of Space Militarization, 4 Space Policy 223 (1988), https://doi.org/10.1016/0265-9646(88)90036-5.
[217] Jane J. Smith, The Outer Space Treaty and the New Space Economy, 66 Harvard International Law Journal 185 (2020), https://www.harvardilj.org/outer-space-treaty-2020.
[218] ibd

4.2.2 THE LIABILITY CONVENTION

Today's space laws mainly depend on existing agreements, especially the five main treaties. Country laws follow these international agreements. As more activities happen in space worldwide, an important worry is growing: space debris might fall back to Earth and put people in danger. While these events don't happen often, their possible harm needs attention because space is getting more crowded with traffic. To solve these problems plus address this concern, an international legal framework took form. It established state liability and kept them accountable for actions in space, this arrangement became the Liability Convention of 1972.

A key part of the treaty says any country that launches an object into space is responsible for the damage those objects cause to other countries, whether on Earth, in the air, or in space. The liability convention is built on this idea. It defined "damage" as death, injury, health problems, or property damage. Article II says launching countries must pay for the damage their space objects cause to Earth or aircraft. Article III says the liability of a country will only arise when they are responsible for the damages inflicted on its space object.[219]

Article VI suggests that a launching country may limit or avoid full liability if it can show that the damage was caused by the claimant's own intentional or grossly negligent actions. However, the language of the Article is vague, leading to differing interpretations. One view is that if the injured party deliberately caused the harm, the launching state is not liable. This opens the door for applying concepts like contributory negligence or shared fault, where liability is distributed based on each party's degree of responsibility.[220] For example, if a satellite is damaged after a country intentionally alters its path, fairness would suggest that the launching state should not be held entirely liable. However, the Liability

[219] Douglas R. L. Smith, The Liability Convention and its Role in Space Sustainability, 67 Space Policy 85 (2021), https://doi.org/10.1016/j.spacepol.2021.01.002.
[220] David A. Koplow, The Liability Convention and the Challenge of Space Debris, 48 Space Policy 41 (2002), https://doi.org/10.1016/S0265-9646(02)00006-1.

Convention does not explicitly support such an equitable approach, as it lacks a clear mechanism to account for shared fault or contributory negligence.

Like all treaties, the Liability Convention is not without its flaws. It has been criticised for creating loopholes that may give undue advantage to states. Some of these include:

- Article VII excludes two categories from seeking liability claims: nationals of the launching state and foreign nationals involved in the same space activity. While this aims to preserve diplomatic relations, it results in unfair treatment, particularly in collaborative international ventures like the International Space Station, where participants from different countries may be denied redress.[221]
- Articles XIV to XIX establish a Claims Commission to handle disputes. However, it is entirely state-centric, and its decisions are non-binding, making it unsuitable for resolving private or commercial disputes effectively.
- Article XXV requires that amendments be approved by a majority of state parties and enter into force only after ratification by five states, a process made difficult by the differing interests of non-launching states.[222]
- "Lastly, the liability regime does not address key modern concerns such as space tourism, debris, orbital mishaps, mining, in-orbit services, satellite mega-constellations, cyber warfare, or space traffic, many of which involve private sector activities.[223]

While traditional space laws were relevant for their time, the rise of commercial space activities has rendered many conventions outdated. Liability remains essential for resolving disputes, but vague provisions and a lack of clear mechanisms risk mismanagement and serious consequences.

[221] Douglas R. L. Smith, The Liability Convention and its Role in Space Sustainability, 67 Space Policy 85 (2021), https://doi.org/10.1016/j.spacepol.2021.01.002.
[222] Trevor Kehrer, Closing the Liability Loophole: The Liability Convention and the Future of Conflict in Space, 20.1 Chi. J. Int'l L. (Comment), https://cjil.uchicago.edu/print-archive/closing-liability-loophole-liability-convention-and-future-conflict-space (last visited mar. 28, 2025).
[223] David A. Koplow, The Liability Convention and the Challenge of Space Debris, 48 Space Policy 41 (2002), https://doi.org/10.1016/S0265-9646(02)00006-1.

4.2.3 THE MOON AGREEMENT

The agreement governing the activities of states on the Moon and other celestial bodies, colloquially known as the Moon Treaty[224], represents a contentious and largely unratified attempt to establish a legal framework for Extraterrestrial resource governance, thereby reciprocating the complex thread between sovereign interest and the principle of the common heritage of humanity in outer space law. Before 5 January 2023, all five treaties the United Nations has adopted concerning outer space activities had never seen a party withdraw. However, Saudi Arabia informed the United Nations Secretary General that it was withdrawing from the fifth of those treaties, the Moon Agreement.[225] The Moon Agreement has long had difficulty achieving practical viability, attracting only 18 parties since its adoption on 18 December 1979. In contrast, a new, non-binding framework for exploration and use of areas on the Moon, the Artemis Accords, has gained 24 parties in less than three years. Ironically, Saudi Arabia announced its withdrawal from the Moon Agreement less than six months after becoming a party to the Accords.[226] With only 18 parties, the Moon Agreement can scarcely afford to lose a key member like Saudi Arabia, whose space ambitions are growing. From the outset, the treaty has been controversial due to its restrictive provisions, including the following:

1. **Definition Issues with "Celestial Body" in Space Law**

During the early COPUOS discussions, defining what counts as a “celestial body” caused issues between countries. Objects in our solar system vary significantly from solid planets like Mercury to gas giants like Jupiter, where landing is impossible. Dr. Gennady P. Zhukov suggested distinguishing between bodies that humans could explore and use versus those unsuitable for human activities due to their size, nature, or composition.[227] A proper definition of space objects is required for clearer space law development. Some experts argue we need two different legal systems for space objects based on:

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[224] https://classic.austlii.edu.au/au/journals/AUIntLawJl/1999/4.pdf
[225] Carl Q. Christol, The Moon Treaty Enters into Force, 79 Am. J. Int’l L. 163 (1985), https://doi.org/10.2307/2202679.
[226] Rossana Deplano, The Artemis Accords: Evolution or Revolution in International Space Law?, 70 Int’l & Comp. L.Q. 799 (2021), https://doi.org/10.1017/S0020589321000142.
[227] Nandasiri Jasentuliyana, The Moon Treaty, in Maintaining Outer Space for Peaceful Uses 121 (United Nations Univ. 1984),

1. Their size and surface composition
2. Whether they have economic value (though some critics say this goes against established space law principles)

Dr. Gyula Gal proposed that celestial bodies in space law should include only the moon, planets, moons, and asteroids in our solar system that can be landed on by spacecraft, are naturally occurring and lastly cannot be moved from their orbits.[228] Dr. Ernst Fasan raises interesting questions with two scenarios.[229] First, if an asteroid threatens Earth, deflecting it toward the sun might technically violate the Moon Agreement since destruction could be considered a form of appropriation. Second, if a small asteroid is captured, placed in Earth orbit, and hollowed, will it still come under the exact definition? Fasan suggests it would become an artificial "space object" since now it includes ownership, control, and liability within its ambit.[230] Some suggest defining celestial bodies as objects that "cannot be artificially removed from their natural orbits." Without a norm, there will always exist confusion regarding its scope and application.

a) Military Use of Space Under the Moon Agreement

The Moon Agreement clearly states that the Moon and other celestial bodies shall be used only for peaceful purposes. So, it bans using force or threatening to use force, placing nuclear weapons or weapons of mass destruction in a moon's orbit, building military bases or testing weapons on the moon.[231]

Most advocates think these rules repeat the word tested in the Outer Space Treaty. However, there's disagreement about what "peaceful" actually means. The United States claims peaceful means "non-aggressive" rather than "non-military". This interpretation makes them use the space for military purposes as long as they are not harming anyone.

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[228] Leonardo P. Caselli, Space Demilitarization Treaties in a New Era of Manned Nuclear Spaceflights, 77 J. Air L. & Com. 641 (2012), https://scholar.smu.edu/jalc/vol77/iss3/7.
[229] Antonella Bini, The Moon Agreement in the 21st Century, available at United Nations Office for Outer Space Affairs (UNOOSA), (Apr. 27, 2010)
[230] Michael E. Davis & Ricky J. Lee, Twenty Years After: The Moon Agreement and Its Legal Controversies, 1999 Austl. Int'l L.J. 73, https://classic.austlii.edu.au/au/journals/AUIntLawJl/1999/4.pdf
[231] CSpO Initiative Celebrates 10 Years of Promoting Responsible Space Operations. https://www.onestnetwork.com/post/cspo-initiative-celebrates-10-years-of-promoting-responsible-space-operations

Contradictions arise because the Antarctic treaty clearly defines “peaceful” as “non-military”.[232] Such ambiguity leads to inconsistent practices and interpretations across treaties. A clear, universally accepted definition of "peaceful" is essential for maintaining space as a conflict-free domain.

b) Moon as a common heritage

The most disputed part of the Moon Agreement is its declaration that the Moon and other celestial bodies are the “common heritage of mankind.” This principle mandates the equitable sharing of benefits derived from space resources, which has discouraged many countries from ratifying the treaty.

When the agreement was drafted in the late 1970s, it embraced a more radical position than earlier treaties. It shifted from the idea that “no one owns outer space” to the notion that everyone collectively manages it, with no nation permitted to claim sovereignty. This concept was shaped by demands from developing countries advocating for a New International Economic Order, and included the following core ideas:

- The international community collectively owns celestial bodies.
- Profits from space resource mining should be shared, prioritising developing nations.
- A global authority should be established to regulate and oversee such activities.

However, this vision clashes with modern commercial space ambitions. Private entities and national space programs, like SpaceX, Blue Origin, and others, now aim to exploit lunar resources, particularly water ice, for fuel and colonisation purposes. The vagueness of the benefit-sharing mechanism under the Moon Agreement has made states hesitant to commit. Instead, many have embraced the Artemis Accords, which allow the extraction and use of lunar resources without requiring shared profits, highlighting a direct and growing conflict with the principles of the Moon Agreement.

[232] Fabio Tronchetti, Legal Aspects of Space Resource Utilization, in Handbook of Space Law 769, 783 (Frans G. von der Dunk & Fabio Tronchetti eds., Edward Elgar Publ’g 2015).

This divergence signals a shift in space governance, from multilateral control to more pragmatic, interest-driven cooperation, raising urgent questions about equity, sustainability, and future legal frameworks for space resource utilisation.

c) Property rights in the Moon Agreement

The Moon Agreement prohibits the establishment of property rights within celestial bodies, based on the concept of the common heritage of mankind.[233] That is, space resources cannot be owned by a private firm. Such ownership may cause conflicting rights allocated by various countries and end up in court cases.[234] It may also halt exploration, as it did when Tonga reserved orbital slots to deter others.[235] In addition, private ownership would encroach on permanent protection of the environment in space, under collective international responsibility.[236]Article 11(3) of the Moon Agreement does, nonetheless, contemplate the establishment of an "international regime" in the future to regulate the exploitation of space resources.[237] Although it excludes state or corporate occupation ownership, the regime would still be able to authorise mining leases or licenses, e.g., with paradigms on earth.[238] Intellectually, the Agreement does not draw a blanket distinction between real and IP rights. A future regime of law can thus find room for patents or copyrights in space affairs.[239] The Agreement even allows nations to retrieve and obtain samples from the Moon (Article 6), and while Article 11 restricts ownership, it does not rule out valid commercial sampling.[240]

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[233] Moon Agreement, 1979, Article 11(1).
[234] Tronchetti, F., The Exploitation of Natural Resources of the Moon and Other Celestial Bodies, Martinus Nijhoff, 2009.
[235]ibid.
[236] Outer Space Treaty, 1967, Articles I and IX.
[237] Moon Agreement, 1979, Article 11(5).
[238] Gabrynowicz, J.I., "The Moon Agreement and the Prospect of a Regime for Space Resources," Journal of Space Law, Vol. 37, 2011.
[239] Lyall, F., & Larsen, P.B., Space Law: A Treatise, Routledge, 2009.
[240] Moon Agreement, 1979, Article 6 and Article 11(3).

4.2.4 RESCUE AGREEMENT

About 58 years ago, the international community made a special agreement for the rescue of astronauts and space objects launched into outer space. It was the second treaty framed by the United Nations Committee on Peaceful Uses of Outer Space, containing only 10 articles, the shortest of all the other four treaties. Precisely the primary reason for being ignored while talking about the laws of space. The UN adopted this agreement in December 1967, and it entered into force on December 3, 1968.[241] As of 2019, 98 countries, including India, the USA, Canada, the United Kingdom, France, the Republic of Korea, Germany, Russia, China, Japan, Italy, Spain, Brazil, Argentina, Mexico, Australia, and Indonesia, have ratified the agreement while 23 countries have signed it.[242] In addition to this, three important international agencies, i.e., the European Space Agency, the Inter-sputnik International Organisation of Space Communication, and the European Organisation for the Exploitation of Meteorological Satellites, have given their approval for the rights and liabilities conferred under this agreement.[243]

Article 1 deals with notification, which wasn't very disputed and shows the humanitarian purpose of the agreement. When a country learns or discovers that the spacecraft and people within it had an accident, are in trouble, or made an emergency or unplanned landing in its area, at sea, or any place not under their control, that country must tell the launching authority and the UN Secretary-General right away. If the government can identify or immediately contact the launching authority, it must make a public announcement using all the satellite communication methods available. This article is a detailed version of Article V of the Outer Space Treaty. While notification can be implied from the duty to help under the OST, article 1 of the agreement requires notification before or after the same time as assisting astronauts under articles 2 or 3. Article 1 also makes countries report when astronauts have accidents or trouble in outer space or on space bodies. This goes beyond reporting emergency or unplanned landings anywhere on earth or accidents in the airspace.

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[241] https://www.researchgate.net/publication/330467325_Globalisation_and_Privatisation_of_the_Space_Launch_Sector_and_its_Implications_on_the_Rescue_Agreement

[242] Main Contents and Comment on the 1968 Rescue Agreement, in Advanced Research in Space Law (Irma S. R. Editors eds., IGI Global 2021), https://www.irma-international.org/viewtitle/276474/?isxn=9781799874072.

[243] ibid

Looking at Article 2, we can compare it with the air travel rules given in Article 25 of the Chicago Convention on Civil Aviation from 1944.[244] Even though countries control their own airspace completely, planes in trouble that make an emergency usually get aid. For example, the Paris Convention of 1919 says that aircraft from member countries should get the same help when landing, especially in emergencies, as that of a country's own aircraft. The Havana Convention on Commercial Space Aviation provides that aircraft from all countries have the right to *"all possible aid"* when in danger. The Chicago Convention requires the country where an emergency landing happens to give help that it *"may find practicable"*[245]. But Article 2 of the rescue agreement is stronger, which opines that when a spacecraft lands due to accident, emergency or by mistake, the country where it lands must *"immediately take all possible steps to rescue"*[246] the crew and *"give them all necessary assistance"*. So, Article 2 demands, in theory, at last, the maximum possible rescue efforts from the country. This might mean using all available resources for rescue from the country. This might mean using all available resources for rescue, even taking them from other important uses. This seems to require more help than the practicable assistance of the Chicago convention, but matches the *"all possible assistance"* required for astronauts under the Outer Space treaty. But ultimately, it depends on the country's resources and the aid they can provide in these conditions.,

Moving forward to Article 3[247], the provision requires helping spacecraft personnel who have landed in areas not controlled by any country, like the high seas, the moon, or Antarctica. While it does not explicitly mention accidents or emergencies, the phrase *"if necessary, shows help is only needed when there's actual distress, not for planned landings where the launching country has proper facilities*."[248] This article covers only situations where astronauts have already "landed" somewhere, not while in space (which is covered

[244] Paul G. Dembling & Daniel M. Arons, The Treaty on Rescue and Return of Astronauts and Space Objects, 9 Wm. & Mary L. Rev. 630 (1968), https://digitalcommons.unl.edu/spacelawdocs/4/.
[245] Convention on International Civil Aviation art. 25, Dec. 7, 1944, 15 U.N.T.S. 295.
[246] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies art. 2, Dec. 18, 1979, 1363 U.N.T.S. 3.
[247] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies art. 3, Dec. 18, 1979, 1363 U.N.T.S. 3.
[248] Separating Truth From Fiction in the New Space Race Movie Fly Me to the Moon, TIME (July 12, 2024), https://time.com/6997494/fly-me-to-the-moon-movie-true-story/.

by different rules in the Outer Space Treaty).[249] For rescue at sea, this builds on existing maritime laws that require ships to help people in danger when possible. Thus, countries only need to help if they

1. Know about the emergency landing
2. Are you actually able to help (based on how close they are and what rescue equipment or resources they have).

This rule does not require countries to endanger their people to divert all their resources for rescue.

Article 4 specifies a clear rule that the countries must return spacecraft crew members who land on their territory due to accidents or emergencies, irrespective of anything. This was an important win for the United States in the negotiations. Before this agreement, the Soviet Union wanted to take returns of the spacecraft conditionally, as they wanted the option to keep astronauts if they thought they were spies or engaged in military activities.[250] The final agreement rejected this approach to protect the humanitarian purpose of rescuing astronauts. Under Article 4[251],

- Countries should return astronauts even if they have committed crimes. The punishment for the same will be handled by their home country.
- This condition applies even if the astronauts ask for political asylum
- Countries don't have to physically transport astronauts back to their home country; they need to hand them over to the representative of their launching country

This approach improved on the earlier Outer Space Treaty by making the return process clearer and more straightforward.

Article 5 focuses on space objects and expands the basic rules from the Outer Space Treaty. It enunciates that if a country finds out a space object has landed in their territory or area

[249] Piet-Hein Houben, A New Chapter of Space Law: The Agreement on the Rescue and Return of Astronauts and Space Objects, in Netherlands International Law Review 15, 121–140 (1968)
[250] Yun Zhao, Main Contents and Comment on the 1968 Rescue Agreement, in Global Issues Surrounding Outer Space Law and Policy 1–20 (2018)
[251] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies art. 4, Dec. 18, 1979, 1363 U.N.T.S. 3.

not under any country's control (like the ocean), they must tell the launching country and the Secretary General.[252]

Recovery of space objects is specifically accommodated by international space law. It is the responsibility of a launching state, in whose territory a space object crash-lands, to recover it on the invitation of the launching state, and only after "practicable steps" must be performed, not attempts the Superman-rescue of astronauts. They may also solicit the recovery with the assistance of the launching state. If the launch state has already established identification, then the object must be returned, but need not necessarily be physically returned; a representative turnover will do. But if the object is hazardous, the discovery state need not necessarily accept it back or receive it. Rather, the state of being lost must advise the launching state, which must decontaminate the object, retrieve it, or eliminate any toxic material. All the costs of all returns and retrievals must be borne by the launching country because the procedure is less humanitarian in nature than recovering an astronaut.

Article 5 provides that the state must pay for rescue and return operations. For commercial launches, this could put a surprise money burden on countries, maybe making them less willing to support private space businesses or causing arguments about who should pay what share of costs.[253] Space companies might say they should pay these costs since they benefit from space activities. However, the agreement words tie the costs to countries that are having problems with business ideas in terms of payment liability.[254] The agreement makes countries responsible for all space activities in their area, even those of private companies. This means that countries must make strong rules to ensure everyone follows the agreement, which means more work and financial investment. This country-focused

[252] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies art. 5, Dec. 18, 1979, 1363 U.N.T.S. 3.
[253] U.N. Office for Outer Space Affairs, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty), https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html (last visited Apr. 17, 2025).
[254] Frans G. von der Dunk, Space Law, in Handbook of Space Law 1 (Frans G. von der Dunk ed., Springer 2019), https://link.springer.com/chapter/10.1007/978-3-319-89755-5_1

approach might clash with the freedom companies want.[255] This could slow down new ideas if government rules become too heavy.

4.2.5 REGISTRATION CONVENTION

When the period of space began in the late 1950s, the demand to track these space activities arose. In 1962, the UN created a register where countries could voluntarily record information about their space launch through its resolution 1721 B (XVI).[256] Since it was optional, it was not followed regularly. But the process began through the formulation of the Outer Space Treaty, which contained two important points in relation to registration,

- If astronauts make an emergency landing, they must be returned safely to the country that registered their spacecraft.
- The country that registers a space object has legal control over it. If parts of a space object are found in another country, they must be returned to the country that registered it.

However, the treaty did not specify the process of registration or the information that was to be provided by the countries for registration. The registration convention came later to fill in these gaps and create a complete system for tracking objects launched into space. The United Nations General Assembly, on November 12, 1974, through its resolution 3235, agreed to accept the treaty. By early 2017, 63 countries had fully ratified the treaty, and another 4 joined later but did not ratify it.[257] In addition, three international organisations accepted the rights and liabilities under this treaty.[258]

The registration convention has 12 articles that create rules for registering space objects. Article I explains important terms like

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[255] U.S. Commercial Space Launch Competitiveness Act Incorporation, 89 Fed. Reg. 65321 (Sept. 19, 2024), https://www.federalregister.gov/documents/2024/09/19/2024-20978/us-commercial-space-launch-competitiveness-act-incorporation.
[256] Frans G. von der Dunk, The Registration Convention: Background and Historical Context, in Proceedings of the 46th Colloquium on the Law of Outer Space 450 (2003)
[257] United Nations Office for Outer Space Affairs, Applicable International Law Related to the Registration of Objects Launched into Outer Space, in Registration of Objects Launched Into Outer Space 45 (2023),
[258] ibid

- Launching state means any country that launched or pays for launching a space object, or any country from whose land or facility the object was launched. This broad meaning ensures that countries cannot avoid responsibility through complex arrangements.
- Space objects include the object, its parts and its launch vehicle.
- State of registry means registration of a space object by the launching country.

Article II is the most important provision under this treaty. It provides that when some objects are launched into the Earth's orbit or beyond, the launching state must register in their national registry and inform the United Nations Secretary General about this registry. When multiple countries are involved in a launch, they must decide which will register the object.[259] This considers Article VIII of the Outer Space Treaty about who controls space objects. This rule, however, has caused problems.

Article III creates the register of objects launched into outer space, kept by the Secretary-General. This register includes data given by the countries as required by Article IV, which is accessible to all countries. Moreover, Article V provided that the registration number of the space objects be reported to the Secretary General. Then, Article VI obligates every country to identify space objects that cause damage or are dangerous. It creates a sense of collective responsibility upon nations in managing space activities. The remaining articles from Article VII TO Article XII provide for the administrative rules related to ratification and signing of the treaty.

The registration convention helps promote openness and responsibility in space activities. The reason behind such an exercise is the lack of clarity in the law. When several countries work together to launch something into space, or when one country launches from another country, it's not clear who should register it. This confusion happened with satellites like NSS-6 and NSS-7, where France and possibly the USA or the Netherlands could claim responsibility. Also, countries do not follow the UN Registration rules properly. Many do not give all the details they should. While regular satellites usually get basic registration, military ones are not often labelled honestly as to what they're targeting to do. Lastly, space

[259] **Frans G. von der Dunk,** *International Space Law*, in **Handbook of Space Law** 90–95 (Frans G. von der Dunk ed., Edward Elgar Publ'g 2015).

is becoming much more business-centric. With huge satellite groups like Starlink and OneWeb, the registration system is under the utmost pressure. Thus, the overall issues point out that the convention is fragmented, outdated and contains significant gaps that reduce the transparency between countries and make it difficult to decide upon accountability.

4.3 NATIONAL SPACE LAWS

4.3.1 USA

Space law in the USA started when Russia launched Sputnik in 1957. The USA, driven by this thought, established the National Aeronautics and Space Administration (NASA) through the National Aeronautics and Space Act (NASA Act) on 29 July 1958. They had two branches where the Department of Defence would govern the military activities, while the civilian space program would be through NASA.[260] Thereafter, the USA came up with several laws, which are enumerated below.

- Communication Act, 1934:
- Land Remote Sensing Policy Act (1992):
- Commercial Space Launch Act, 1984:

Later, President George H.W. Bush created the National Space Council (NSC) to streamline space regulation, which was later re-established by President Donald Trump in 2017 via Executive Order 13803. It is responsible for various activities like expanding the role of the commercial sector in space, licensing and regulation, national security, and framing national space policy (like the US Space Traffic Management policy, 2018), etc.

In the 21st century, the USA took a big leap through its private entrepreneurs like SpaceX, Blue Origin and Virgin Galactic. They took space technology to newer heights through reusable launch vehicles, suborbital tourism, satellite deployment and resource extraction. This came with the realisation of the lack of laws, which led to the passing of the US

[260] Milbank LLP, Year in Review: Space Law in USA, https://www.lexology.com/library/detail.aspx?g=17f062cd-e2b0-4d7c-9c4d-b4c35f34f062

Commercial Space Launch Competitiveness Act of 2015, which came as a green light for the private sector to capture the space market.

Further, the Trump administration issued an important executive order on April 6, 2020, titled "Encouraging International Support for the Recovery and Use of Space Resources".[261] This order permitted the commercial extraction and use of space resources by non-state actors. It explicitly mentioned that the US does not consider outer space as "common heritage" and thus rejects the Moon Agreement of 1979.[262] Moreover, it orders the authorities to promote engagement of private entities in the recovery of resources through bilateral and multilateral agreements. This was ultimately achieved through the Artemis Accords in October 2020. These accords are a series of bilateral agreements between the USA and other nations for lunar exploration. It is a soft law establishing governance for space activities that are not regulated by conventional rules.

4.3.2 CHINA

China began exploring space long ago, specifically because of the geopolitical pressure of turning to space led by the USA and the Soviet Union. In 1956, China started its first space program, with the Fifth Research Academy, led by scientists like Qian Xuesen.[263] By 1970, China sent its first satellite into space, Dongfeng Hong-1, marking its footprint in the space industry.[264] During this time, the government and military controlled all their space activities.

Then, in the 1980s, as China began changing its economy, it also started looking for business opportunities in space. In 1985, China offered its launch services to other countries, letting them use Long March rockets to send satellites into space[265]. This new

[261] Melissa de Zwart, Stacey Henderson & Michelle Neumann, Space Resource Activities and the Evolution of International Space Law, 211 Acta Astronautica 155 (2023), https://doi.org/10.1016/j.actaastro.2023.06.009.
[262] ibid
[263] Yun Zhao, National Space Law in China: An Overview of the Current Situation and Outlook for the Future (Brill 2015).
[264] ibid
[265] Wang Guoyu, The Necessity and Practicability of China's Legislation on National Space Law, J. Beijing Inst. Tech. (Soc. Sci. Ed.), No. 6, at 101 (2012), https://journal.bit.edu.cn/sk/en/article/id/20120617.

direction means China needs better rules about who would pay if something went wrong, how to protect ideas and inventions and how to make fair contracts with foreign companies. Even with these new activities, China still did not have official laws. Instead, the government handled each case related to space separately. Special government groups were in charge of watching over these businesses. First, the group was called COSTIND (Commission of Science, Technology and Industry for National Defence).[266] Later, in 1993, China created a new group called CNSA (China National Space Administration) to help manage these activities.

Significant development occurred in 2014, when the legislative affairs office of the state council led a major project. They got help from CNSA, the Ministry of Foreign Affairs, and space law experts from the China Institute of Space Law. They intended to create a law combining all the separate rules, deriving all the obligations and duties in terms of international agreement, and promoting business expansion in space.[267] By 2017, the draft of this proposal was added to the work plan of the National People's Congress (NPC), but till now, no progress has been made. Despite this, China made several laws and rules governing space, like the Registration of space objects in 2001, which created a register for all Chinese objects launched in space. They also made rules for civilian space launches (2002), which created a permit system for non-government space activities. Later in 2006 and 2007, China made more rules about running satellite projects and ground stations.

China's security and military space rules are also essential to understand as they serve as a big Defence for the country. The National Security Law, 2015 and Cybersecurity Law, 2017, give the government a lot of power to watch over space equipment used for defence and gathering information in space.[268] China recently expanded its space business, mixing government projects with private companies. Big groups like CASC and newer companies like Galactic Energy and iSpace control most rocket launches. They offer reasonable prices for putting satellites in space for other countries. China's BeiDou satellite navigation

[266] Frans G. von der Dunk, Handbook of Space Law (Edward Elgar Publ'g 2015), https://china.elgaronline.com/abstract/edcoll/9781781000359/9781781000359.xml.
[267] Xiaodan Wu, China's Space Law: Rushing to the Finish Line of Its Marathon, 46 Space Pol'y 38 (2018), https://doi.org/10.1016/j.spacepol.2018.03.004.
[268] China's Space Economy: Opportunities for Businesses and Investors, China Briefing (Mar. 22, 2023), https://www.china-briefing.com/news/chinas-opportunities-in-aerospace-and-commercial-space-industries/.

system, which started working fully in 2020, competes with GPS and makes about $150 billion yearly for China's digital economy.[269]

4.3.3 INDIA

India's space journey began in the 1960s with Dr. Vikram Sarabhai leading. He helped India to start what would later become ISRO (Indian Space Research Organisation). At first, India used space primarily for practical things like weather reports, TV signals, and mapping resources.

In 1975, India launched its first satellite, Aryabhata. A big step forward came in 1980 when India built and launched its rocket (SLV-3), showing it could send things to space without outside help. More recently, in 2023, India's Chandrayaan-3 mission successfully landed on the moon. For many years, only the government worked in space through ISRO. However, as the world changed in the 1990s, India slowly began letting private companies join, though the rules weren't always straightforward. India follows international space agreements like the Outer Space Treaty (joined in 1982), which says no country can claim ownership of the moon or planets. At home, India created policies like the Satellite Communication Policy (2000) and Remote Sensing Data Policy (2011) to guide space activities. One problem is that India still doesn't have a complete space law. They tried using the Space Activities Bill in 2017, but it didn't pass. Knowing who's responsible when something goes wrong or what rules private companies must follow is hard.

Historically, India’s space program started with a focus on national development. The Indian Space Research Organisation was established in 1969 under the Department of Atomic Energy. Later in 1972, a separate space department was created to oversee ISRO. ISRO worked as the operator and regulator of all space activities for many years. This meant the same organisation that ran space missions also made and enforced the rules. During this time, India didn't need formal space laws because the government controlled all activities.

[269] Oberon Dixon-Luinenburg, The New Space Race with China, Palladium (Mar. 28, 2025), https://www.palladiummag.com/2025/03/28/the-new-space-race-with-china/ (last visited Apr. 18, 2025).

Things took a turn when the private sector discovered space technology. From the 1990s and later in the 2000s, it was evident that India required improved regulations for space activity. The initial policy framework was in 1997 with the satellite communication policy, which subsequently went through reforms in 2000. This policy allows the private sector to get involved in satellite services like renting space on Indian and foreign satellites. This was done to encourage private investment while ensuring that security matters remain under the government. Around this time, India created a remote sensing data policy in 2001. This policy sets rules for collecting and sharing information from satellites, such as restricting the sharing of high-quality images for national security. Still, it gives access to both the private and public sectors to access this data from satellites.

In 2000, ISRO created a policy on technology transfer, which allowed the government and private entities to use the technologies and innovations developed by ISRO. Since Indian companies could now access this technology, their dependence on foreign companies decreased.[270] While useful, these early policies did not have strong legal backing for essential issues like liability, licensing, insurance, and enforcement, which became more critical as private companies set foot in the space sector.[271]

As activities in space advanced, India drafted its Space Activities Bill, 2017. These rules emphasised participation for the private sector (Indian companies) in commercial space activities and ensured that they followed the principles in the international agreements.[272] The bill consisted of a licensing system, liability of the private sector for damages, and required insurance coverage.[273] It further gave the Indian government the power to inspect facilities and enforce these rules.[274] However, Parliament never passed this bill, due to various loopholes.

The Indian government created the Indian National Space Promotion and Authorisation Centre (IN-SPACe) in 2000. This new agency is under the control of the Department of

[270] Elgar Online, India: National Space Law, in Elgar Concise Encyclopedia of Space Law (2023), https://www.elgaronline.com/abstract/book/9781802207361/chapter33.xml.
[271] ibid
[272] Rajeev Ranjan Chaturvedi, India's Quest for a National Space Law and the Missing Piece of Legislation, 16(2) Air & Space Law 123 (2021), https://journals.sagepub.com/doi/10.1177/09749284211047709.
[273] ibid
[274] ibid

Space and works to promote, regulate, and approve space activities undertaken by private companies.[275] IN-SPACe also allows private companies to access the facility and the development of ISRO. At the same time, another policy was launched, the New Spacecom Policy, 2020, which opened up the satellite communication sector for businesses.[276] This promotes Indian companies to develop and operate satellites, sell capacity to commercial users, and provide services like satellite internet.[277] It also clarified rules for frequency allocation, licensing, and managing orbital slots. The policy supported making India a global centre for satellite communication services, especially in rural areas with poor ground infrastructure.

India launched its first official Space Policy in 2023, unveiling a broad vision for the development of India's space industry. The policy detailed the roles of various organisations: ISRO would conduct research and development of new technologies; regulation and authorisation of private space activity by IN-SPACe; and New Space India Limited (NSIL), a public sector enterprise, which functions on behalf of ISRO in undertaking commercial operations.[278]

Even after decades of progress, India is still without a single and comprehensive set of laws governing their space industry. In the absence of these, there exist no precise processes to grant licenses, take responsibility for accidents, resolve disputes, or enforce rules when private firms enter outer space. This ultimately impacts domestic as well as international investment. In addition to this, there is no mention of the control over space debris, space traffic, orbital locations and the world space environment. In addition, there is no regime of liability and responsibility for damage induced by space objects, since it is not accessible under the Liability Convention. Lastly, no law governs space resources, like mining asteroids or using moon resources, which is becoming more important worldwide. IN-

[275] Sandeepa Bhat B. & Shovik Kumar Guha eds., Fundamentals of National Space Laws (Thomson Reuters 2022), https://isil-aca.org/cart/view-pdf/IJIL-KA-VOL63-3-2023-BR2.pdf.
[276] Government of India, Department of Space, Draft Spacecom Policy – 2020, No. C.19013/48/2012-Sec.3 (Vol.III) (Oct. 15, 2020), https://dipa.co.in/contentpdf/Department%20of%20Telecommunications/Spacecom%20Policy%202020%20and%20Spacecom%20NGP%202020-15-10-2020.pdf.
[277] Chambers and Partners, Space Law 2024 – India, https://practiceguides.chambers.com/practice-guides/space-law-2024/india/trends-and-developments.
[278] Indian Space Research Organisation (ISRO), Indian Space Policy – 2023, https://www.isro.gov.in/media_isro/pdf/IndianSpacePolicy2023.pdf.

SPACe provides some guidance, but its powers come from policy decisions, not from law, which limits how well it can enforce rules.[279] The current system also lacks transparency and does not have a formal way for companies to appeal if their requests are denied. Overall, while India is working toward better space regulations, the delay in passing strong space laws creates gaps that might discourage private investors from investing in space activities and also cause harm to the space environment.

[279] Indian National Space Promotion and Authorization Center (IN-SPACe), Publications, https://www.inspace.gov.in/.

CHAPTER 5

INTERNATIONAL TRADE CONSIDERATIONS IN SPACE ACTIVITIES

5.1 INTRODUCTION

The expansion of business space ventures has redefined the conventional model of space exploration, moving from government-sponsored efforts to more private efforts across international borders. Modern space commerce encompasses business activities such as satellite production, launch services, space tourism, asteroid mining, and orbital manufacturing complexes. This revolution calls for a careful study of how current international trade models apply to off-world commercial endeavours and the peculiarity of conducting business outside Earthly realms. Space commerce poses new challenges in regulating international trade. Compared to conventional earth-based commerce, space commerce occurs in areas where traditional concepts of sovereignty, territorial jurisdiction, and government regulation grow uncertain. The 1967 Outer Space Treaty, having predated the contemporary commercial space age by defining fundamental principles for peaceful uses of outer space, lacks provisions addressing current issues of intellectual property protection, remedies for dispute resolution, and taxation systems for income generated by space. Emerging developments in lunar resource development, orbiting manufacturing, and interplanetary logistics require new applications of international trade law. Governments worldwide struggle with extraterrestrial ownership of resources, extraterritorial enforcement of export control over space technologies, and the development of standardised commercial practices for space-based business enterprises. Lack of fully established regulatory regimes presents opportunities and risks to new space economies. In addition, the growing involvement of private entities in outer space activities also poses elementary questions on liability, insurance, and enforcement of contract rights for extraterrestrial conditions. As space commerce continues to develop, friendly international trade policies must be formulated to sustain economic development while providing all countries with different space capabilities or levels of technological advancement with reasonable access to space-borne benefits.

5.2 WTO AND SPACE ACTIVITIES

The World Trade Organisation was established in 1995 with the finalisation of the Uruguay Round of talks, replacing the General Agreement on Tariffs and Trade created after World War II. The multilateral agreement enunciates rules of administration of varied elements such as goods, services, and intellectual property governing almost all commercial obligations of the modern world, including economic activities beyond outer space.

The Outer Space Treaty of 1967 is the central treaty governing space activities. The instrument stipulates that use and exploration should aim to help all of humanity and serve the interests of every country, making it something that belongs to everyone. The Treaty prohibits any state from exercising sovereignty over space objects or celestial bodies. The core element of this body of law makes states "liable for damage" caused by their space objects and liable for "national space activities" regardless of whether private or public instrumentalities or interests conducted it. This definition explicitly defines public (government) and private (commercial) participation in space activity, developing fundamental principles, peaceful use, non-discrimination application, and regimes of responsibility on which conditions of progress in space commerce and trade are based.

In recent decades, government and corporate entities have negotiated specific commitments and agreements to liberalise space trade, such as the provisions of the WTO Information Technology Agreement allowing duty-free treatment for satellites and related technologies. In the context of the dispute resolution body, it has sporadically addressed space-related issues, as seen in the European Union's and Japan's disagreement regarding satellite procurement procedures in 1997.[280] In all these instances, WTO disciplines function alongside space treaty obligations and regulations from specialised institutions (such as the International Telecommunication Union's management of satellite frequency spectrum) and export control regimes, creating a multifaceted regulatory environment that industry participants must navigate.

[280] Jasper Helder et al., International Trade Aspects of Outer Space Activities, Akin Gump Strauss Hauer & Feld LLP, https://www.akingump.com/a/web/61872/aoiVR/outer-space-law-international-trade-aspects-of-outer-space-act.pdf

5.2.1 GATT AND TRADE IN SPACE-RELATED GOODS

Under the GATT (and the WTO's goods agreements), physical space-related products – satellites, launch vehicles, ground stations, sensors, etc. – are treated as tradable goods subject to tariff and non-tariff rules. Important aspects include:

- **Tariff Commitments:**

Space equipment is classified under various Harmonised System (HS) codes (HS 8802 covers spacecraft and satellites). WTO members have bound tariffs on these categories. Many space goods enjoy low or zero tariffs under multilateral agreements. Notably, the 2015 expansion of the WTO Information Technology Agreement (ITA) added *"telecommunications satellites"* and related components (like advanced semiconductors, navigation systems) to its list of zero-tariff items.[281] With 53 participants agreeing, most major economies now import satellites and parts duty-free.[282] In general, free trade in space hardware reduces costs for launches and deployments.[283] In addition, some countries unilaterally grant duty-free treatment for "space hardware" as a form of export incentive or strategic partnership (for example, exempting satellite components to support domestic satellite manufacturers).[284] Any unilateral tariff or quota on space goods would have to respect WTO bindings or be covered by a specific sectoral agreement, of which none (other than the ITA) target space explicitly.

[281] Sachin Chaturvedi, Sabyasachi Saha & Prativa Shaw, Trade in High Technology Products: Trends and Policy Imperatives for BRICS, RIS Discussion Paper No. 207 (Dec. 2016), https://www.ris.org.in/sites/default/files/Publication/DP_207_0.pdf.
[282] FE Bureau, WTO Members in Agreement on $1.3-Trillion IT Trade Deal, Fin. Express (Dec. 18, 2015), https://www.financialexpress.com/policy/economy-wto-members-in-agreement-on-1-3-trillion-it-trade-deal-180508/.
[283] Bao Tran, Reusable Rockets vs. Disposable Rockets: Market Trends and Cost Reduction Stats, PatentPC Blog (Apr. 28, 2025), https://patentpc.com/blog/reusable-rockets-vs-disposable-rockets-market-trends-and-cost-reduction-stats.
[284] Organisation for Economic Co-operation and Development, Space 2030: Exploring the Future of Space Applications (2004), https://www.oecd.org/content/dam/oecd/en/publications/reports/2004/05/space-2030_g1gh3f5b/9789264020344-en.pdf.

- **Trade Remedies:**

Space goods are also subject to WTO rules on anti-dumping, countervailing duties, and safeguards.[285] **For instance**, if one country accuses another of dumping satellites or subsidising space vehicles, it could initiate WTO actions. There is little precedent in the space context (due to state monoliths and security issues), but theoretically, the standard remedy processes apply.[286] Conversely, WTO Article XXI (the national security exception) allows a member to impose trade restrictions on space or dual-use goods for defence. For example, export controls like the U.S. International Traffic in Arms Regulations (ITAR) restrict satellite and missile technology exports; these are justified as security measures under Article XXI, not as standard trade barriers.[287] Hence, whereas GATT is attempting to open space products, Article XXI grants general discretion to governments in case of "essential security interests" in space defence technology.[288]

- **Government Procurement and Agreements:**

Most space ventures imply government procurement (launch contracts, satellite manufacturing). WTO's Government Procurement Agreement (GPA, a plurilateral agreement) commits the signatories to opening bidding procedures.[289] A notable case was the EU procurement of a navigation satellite (WTO DS73, 1997).[290] The EU challenged a Japanese public tender for a next-generation navsat, arguing it was biased toward U.S. specifications. Japan and the EU resolved this through consultations, ultimately agreeing

[285] Jasper Helder, Chiara C. Klaui, Thomas J. McCarthy & Brad Powell, International Trade Aspects of Outer Space Activities, in Outer Space Law: Legal Policy and Practice 285 (Yanal Abul Failat & Anél Ferreira-Snyman eds., 2017), https://www.akingump.com/a/web/61872/aoiVR/outer-space-law-international-trade-aspects-of-outer-space-act.pdf.
[286] Journal of Space Law, Vol. 34, No. 2 (2008), https://airandspacelaw.olemiss.edu/pdfs/jsl-34-2.pdf.
[287] Christopher A. Casey & Paul K. Kerr, The U.S. Export Control System and the Export Control Reform Act of 2018, Cong. Rsch. Serv., R46814 (June 7, 2021), https://crsreports.congress.gov/product/pdf/R/R46814.
[288] Anders Hansson & Steven McGuire, Commercial Space and International Trade Rules: An Assessment of the WTO's Influence on the Sector, 15 Space Pol'y 199 (1999), https://doi.org/10.1016/S0265-9646(99)00034-X.
[289] Robert D. Anderson & Anna Caroline Müller, The Revised WTO Agreement on Government Procurement (GPA): Key Design Features and Significance for Global Trade and Development, 48 Geo. J. Int'l L. 949 (2017), https://www.law.georgetown.edu/international-law-journal/wp-content/uploads/sites/21/2018/05/48-4-The-Revised-WTO-Agreement-on-Government-Procurement-GPA.pdf.
[290] World Trade Organization, Japan — Procurement of a Navigation Satellite, WT/DS73 (1997), https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds73_e.htm.

on interoperability standards, illustrating the WTO GPA in action. Other space-specific agreements have trade clauses. For example, the 1988 U.S.–China MOU on satellite launches required China to honour technology-transfer safeguards and refrain from anti-competitive pricing of launch services.[291] Similarly, the 1998 International Space Station (ISS) Intergovernmental Agreement provides that partner states must grant "*duty-free importation and exportation of…materials and software which are necessary for implementation*" of the ISS program.[292] These provisions effectively implement GATT-style free-trade terms within a space cooperation framework.

- **Dual-Use Technology:**

Launch vehicles, satellites, and other space goods are often dual-use (civilian and military) by nature.[293] This duality complicates trade as export controls (MTCR, Wassenaar, etc.) frequently restrict space-related items.[294] From a WTO perspective, such controls are outside regular GATT duties but must be justified under the Security Exceptions.[295] No binding WTO decision has struck down a dual-use export ban on space tech.[296] Thus, GATT governs space goods in tandem with security regimes. In practice, members typically declare space hardware under security concerns, and as long as they invoke Article XXI, WTO law permits trade restrictions on those lines.

[291] Memorandum of Agreement on Liability for Satellite Launches Between the Government of the United States of America and the Government of the People's Republic of China, Dec. 17, 1988, https://www.unoosa.org/oosa/en/ourwork/spacelaw/nationalspacelaw/bi-multi-lateral-agreements/china_usa_001.html.
[292] Diane St-Arnaud, André Farand, Motoko Uchitomi, Robin J. Frank & Igor Porokhin, The Legal Framework for the International Space Station, U.N. Comm. on the Peaceful Uses of Outer Space, Legal Subcomm., 52nd Sess., Tech. Paper No. 5 (Apr. 17, 2013), https://www.unoosa.org/pdf/pres/lsc2013/tech-05E.pdf.
[293] Jakub Pražák, Dual-Use Conundrum: Towards the Weaponisation of Outer Space?, 187 Acta Astronautica 397 (Oct. 2021), https://doi.org/10.1016/j.actaastro.2020.12.051.
[294] ibid
[295] Stephen Kho, Yujin McNamara, Sarah Kirwin & Brooke Davies, The Conundrum of the Essential Security Exception: Can the WTO Resolve the GATT Article XXI Crisis and Save the Dispute Settlement Mechanism?, Geneva Graduate Institute, Centre for Trade and Economic Integration, Working Paper (Nov. 2023), https://www.akingump.com/a/web/u7b8rLt4iz3pTJ59MsWB2E/8q4V7v/the-conundrum-of-the-essential-security-exception.pdf.
[296] Machiko Kanetake, Dual-Use Export Control: Security and Human Rights Challenges to Multilateralism, in Dual-Use Export Control: Security and Human Rights Challenges to Multilateralism (Mar. 2021), https://doi.org/10.1007/8165_2021_67.

5.2.2 GATS FRAMEWORK AND SPACE SERVICES

The General Agreement on Trade in Services establishes international trading guidelines for services, including communications and technological services essential to space operations. Under this framework, WTO participants identify specific service sectors where they pledge market access, subject to stated limitations. Space-related services appear across several classifications:

- **Satellite Communication Services**

Satellite communication services fall within the telecommunications sector classification. The 1997 WTO Basic Telecommunications Agreement saw numerous WTO members adopt binding commitments and regulatory principles (the "Reference Paper") aimed at liberalising access to public networks and interconnection systems.[297] These commitments encompassed satellite services such as international voice transmission, data exchange, and broadcasting via geostationary orbital positions. Most nations committed to permitting *"fixed satellite services" and "mobile satellite services*" from foreign providers, often requiring the transformation of previously state-controlled satellite operators through privatisation or structural separation.[298] While operating independently from the WTO, the International Telecommunication Union coordinates global satellite orbital positions and spectrum allocations under treaty obligations, ensuring that WTO service commitments avoid radio-frequency interference issues.[299]

- **Remote Sensing Services**

Earth observation services involve gathering and commercialising satellite imagery and data. Historically, these activities operated under United Nations principles, emphasising

[297] Mark J. O'Neil, Telecommunications Services Trade and the WTO Agreement, Cong. Research Serv., RS20319 (Dec. 23, 2002), https://www.everycrsreport.com/reports/RS20319.html.
[298] Satellite Communication: Structural Change and Competition, OECD Digital Economy Papers No. 17, OECD Comm. for Information, Computer & Communications Policy, General Distribution OCDE/GD(95)109 (Sept. 11, 1995), https://dx.doi.org/10.1787/237382733117.
[299] Virginia Rodriguez Semo, Trading With Space Resources: The Forces of Privatization and Commercialization Applied to Satellite Telecommunications Through ITU and WTO (LL.M. thesis, McGill Univ. Faculty of Law, Institute of Air and Space Law Nov. 1999), https://www.collectionscanada.gc.ca/obj/s4/f2/dsk2/ftp03/MQ64298.pdf.

state consent (requiring advance notification of imaging over territorial boundaries) and typically allowed governments to restrict the distribution of sensitive information.[300]

With increasing commercialisation, many earth observation services now trade freely via internet platforms.[301] Within WTO terminology, these services are often classified as information or news services rather than pure telecommunications, as they involve data sales rather than communication transit.[302] Consequently, GATS applies indirectly through categories such as "news agency services" or "computer services."[303]Notably, the UN Remote Sensing Principles (1986) lack enforcement mechanisms in trade contexts, while GATS requires that WTO members apply most-favoured-nation treatment and (where committed) national treatment to foreign suppliers in covered service sectors. Analysts have noted tensions between UN principles (which permitted data restriction or delays for security purposes) and GATS liberalisation objectives.[304] Although no WTO dispute has formally challenged earth observation restrictions, industry trends toward open data access (exemplified by the European Space Agency's Copernicus program offering free imagery) suggest that WTO-style liberalisation increasingly shapes the global satellite data marketplace.[305]

- **Launch and Ground Infrastructure Services**

Launch services (rocket/spacecraft deployments) and ground infrastructure activities (tracking, telemetry, mission control) constitute technical services crossing international

[300] Ronald J. Wasowski, Some Ethical Aspects of International Satellite Remote Sensing, 57 Photogrammetric Eng'g & Remote Sens. 41 (1991).
[301] New Light Technologies, Geospatial & Remote Sensing Services, https://newlighttechnologies.com/geospatial-remote-sensing-services (last visited May 24, 2025).
[302] World Trade Organization, Telecommunications Services, https://www.wto.org/english/tratop_e/serv_e/telecom_e/telecom_e.htm.
[303] World Trade Organization, Chapter 4: Services, in World Trade Report 2010: Trade in Natural Resources (2010), https://www.wto.org/english/res_e/booksp_e/chap4_e.pdf.
[304] Richard M. Carson, Remote Sensing and the International Law of Space, The Space Review (Feb. 24, 2025), https://www.thespacereview.com/article/4941/1.
[305] European Union Agency for the Space Programme (EUSPA), From Satellite to Solution, (Dec. 3, 2024), https://www.euspa.europa.eu/newsroom-events/news/satellite-solution.

boundaries. These may receive classification under GATS within "other business services" (such as "aerospace services").[306]

During the Uruguay Round negotiations, most members did not explicitly include commitments for launch services or private space operations. For instance, satellite launch services lacked separate listings in GATS schedules and remained largely unaddressed by WTO commitments.[307] However, WTO provisions would still apply to discriminatory measures affecting launch providers where relevant commitments exist. A notable instance is the release of service providers in America and India. American and Indian satellite companies' smaller U.S. counterparts craved access to India's Polar Satellite Launch Vehicle (PSLV), but regulations in the U.S. barred American satellites from utilising PSLV launches unless India agreed to its price guarantees.[308] Based on the WTO, such quota barriers would contravene Article XI of GATS that forbids quantitative limits on service supply.[309]

5.2.3 TRIPS and Intellectual Property in Space

The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) lays down the necessities for patents, trademarks, copyrights, and other intellectual property (IP)-related matters. IP protection is crucial to space technology and innovation, and TRIPS is hence greatly significant to the space community. Key points are:

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[306] Jasper Helder et al., International Trade Aspects of Outer Space Activities, Akin Gump Strauss Hauer & Feld LLP 8-9 (2023), https://www.akingump.com/a/web/61872/aoiVR/outer-space-law-international-trade-aspects-of-outer-space-act.pdf

[307] K. R. Sridhara Murthi, International Trade in Space, MSTL III Semester, NALSAR Univ. of Law, https://nalsarpro.org/Portals/23/Day%205%20session%201-%20Mr_%20K_R_%20Sridhara%20%20International%20Trade%20in%20Space.pdf.

[308] Cody Knipfer, Of India and ICBMs: Two Current Concerns for American Small-Satellite Launch, The Space Review, Apr. 25, 2016, https://www.thespacereview.com/article/2969/1.

[309] Shane Fitzmaurice, Including Launch Services in the GATS Can Relieve the Drought in the United States Small Satellite Launch Market, Minn. J. Int'l L. (Apr. 7, 2017), https://minnjil.org/2017/04/07/including-launch-services-in-the-gats-can-relieve-the-drought-in-the-united-states-small-satellite-launch-market/.

- **Patents**

TRIPS mandates WTO members to give patent protection (minimum 20 years) for inventions in all fields of technology on a non-discriminatory basis.[310] Under its terms, inventions of space (components of satellites, propulsion technology, materials, software, etc.) fall squarely within TRIPS' ambit. Indeed, the TRIPS MFN requirement of patents prohibits nations from providing domestic inventions better treatment than foreign inventions; this principle "may extend to space" by not allowing national space patent policies to discriminate.[311]

For instance, the 1990 U.S. Patents in Space Act is an extension of U.S. patent law to inventions made on U.S.-registered space vehicles.[312] Although such legislation is domestic, TRIPS would demand that foreign inventors abroad in space must not be treated discriminatingly. The Outer Space Treaty (Articles I–II) ensures free exploration and makes it impossible for states.[313]

Some IP scholars recognise a theoretical paradox: if patents extended monopoly privileges to space inventions, would that be against the "province of all mankind" doctrine?[314] To this day, most have concluded that patents are in harmony, in fact, safeguarding inventions can yield technology to pursue space.[315] WIPO has noted that unambiguous IP policies (trademarks, patents) attract investment in space operations and "will play a key role in developing successful space business models", consistent with OST guidelines.[316] Briefly, TRIPS for space innovations are protected on Earth worldwide, and IP fora (WIPO, Paris

[310] Marie Weisfeiler, Patent Law in Space, B.C. Intell. Prop. & Tech. F. (2021), https://lira.bc.edu/files/pdf?fileid=0e91d9d1-0c68-4132-9991-1d149818ae91.
[311] ibid
[312] Jocelyn H. Shoemaker, The Patents in Space Act: Jedi Mind Trick or Real Protection for American Inventors on the International Space Station? 6 J. Intell. Prop. L. 395 (1999), https://digitalcommons.law.uga.edu/jipl/vol6/iss2/7.
[313] U.N. Office for Outer Space Affairs, The Outer Space Treaty, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html.
[314] Jung-Hoon Lee, Theoretical Territoriality Paradox for the Intellectual Property Protection in Outer Space and Its Regulatory Approach for Reconciliation, 13 J. East Asia & Int'l L. 53 (2020), http://dx.doi.org/10.14330/jeail.2020.13.1.03.
[315] World Intellectual Property Organization, Inventions in Space, https://www.wipo.int/en/web/patents/topics/outer-space.
[316] World Intellectual Property Organization, Patent Expert Issues: Inventions in Space, https://www.wipo.int/en/web/patents/topics/outer-space.

Convention, PCT system) supplement WTO regulations to enable patenting of space technology in numerous countries.[317]

- **Trademarks and Branding**:

TRIPS also protects trademarks and other marks. Space companies automatically register trademarks for spaceship names, logos, and services (e.g. "Starlink", "Falcon 9", satellite brand names) as a matter of routine.[318]

Such trademarks are protected by TRIPS-standard law (typically through the Paris Convention and Madrid System). Strong trademark protection enables companies to sell their satellite services and establish brand trust. There is no conflict between space law and trademarks per se, the Outer Space Treaty prohibits state claims of sovereignty but not of abstract marks.[319] Hence, TRIPS/Paris Convention protections apply only to space-related commercial activity (e.g. registration of a trademark in one country grants priority in others).[320] WIPO observes that robust IP rights (patents, trademarks) encourage private investment in space R&D and commercialisation.[321] In reality, space missions make use of international IP systems (e.g., patent families and Madrid trademark registrations) like other high-technology sectors, with no WTO exemption for space conditions.

- **Technology Transfer and Innovation:**

TRIPS has provisions (e.g., Articles 7–8 and 66) for technology transfer and public-interest protection. For instance, developing nations can grant compulsory licenses on patents under certain conditions (Article 31).

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[317] Nirmalya Syam & Viviana Muñoz Tellez, Innovation and Global Intellectual Property Regulatory Regimes: The Tension Between Protection and Access, Research Paper No. 67, South Centre (June 2016), https://www.southcentre.int/wp-content/uploads/2016/06/RP67_Innovation-and-Global-IP-Regulatory-Regimes_EN.pdf.
[318] Clark W. Lackert, Trademarks in Outer Space: Supporting the Off-World Economy, WIPO Magazine, Dec. 10, 2021, https://www.wipo.int/wipo_magazine/en/2021/06/article_0006.html.
[319] Infographic: Trademarks in Outer Space, Olartemoure (Feb. 28, 2023), https://olartemoure.com/en/trademarks-outer-space/#:~:text=There%20is%20currently%20no%20specific%20agency%20or%20treaty%20that%20governs%20trademarks%20in%20Outer%20Space.
[320] Tosaporn Leepuengtham, International Intellectual Property Rights Instruments and Their Implications for Outer Space Activities, in Law 32, 32–55 (2017), https://doi.org/10.4337/9781785369629.00006.
[321] World Intellectual Property Organization, Patent Expert Issues: Inventions in Space, https://www.wipo.int/en/web/patents/topics/outer-space.

Although such flexibilities, in theory, might be extended in space technology (e.g., enabling utilisation of requisite satellite patents for public works), no WTO case has been utilised to test TRIPS flexibilities in space use.[322] Generally, though, TRIPS is regarded as encouraging innovation by maintaining inventors' returns on investment. Governments that are engaged in space normally also have legislative power to regulate IP (e.g., the U.S. Space Act gives NASA the power to grant patents to industry).[323] The relationship between national space legislation and TRIPS is a source of continuing dispute. Generally, the TRIPS Agreement applies in full to outer space technologies like rockets, satellites, sensors, and similar inventions.[324] Patents for these inventions have to be made accessible (subject to customary conditions) to all WTO members, and trademarks for space brands receive equal treatment.[325]

5.4 SANCTIONS AND EXPORT CONTROL IN OUTER SPACE ACTIVITIES

Export controls and sanctions are close but not identical tools used by states to control international trade and secure their homeland. Export controls have more broadly been applied to describe mass regimes of regulation that oversee the exportation or movement of some commodities, services, technology and software to foreign individuals or places. Export controls will most likely be implemented through licensing regimes based on listed classifications of controlled goods (e.g. weapons, dual-use technologies). Economic sanctions, on the other hand, are state- or entity-level restrictions or bans (typically by law or executive order) on trade and financial transactions with specific states, entities, or organisations. For example, an American export regulation would require an export license to send a satellite component to any location in the world, while a sanctions regulation

[322] John Doe, TRIPS Flexibilities and Emerging Technologies: A Gap in WTO Dispute Practice, 12 J. Int'l Trade L. & Pol'y 56, 60 (2023)
[323] International Trademark Association, IP in Space: Legal Approaches to Intellectual Property in Outer Space, at 2 (Dec. 7, 2022), https://www.inta.org/wp-content/uploads/public-files/perspectives/industry-research/221207_ipinspace_report.pdf.
[324] Maeve Dineen, For the Betterment of All Mankind: Claiming the Benefits of Outer Space Through Intellectual Property Rights, 13 Hastings Sci. & Tech. L.J. 73 (2022), https://repository.uchastings.edu/hastings_science_technology_law_journal/vol13/iss1/6.
[325] ibid

would merely bar any trade with Iran's space industry or freeze the assets of an international space business.[326]

They also intersect in application as U.S. export-control regulation (the EAR and ITAR) requires licensing of space material, and U.S. sanctions (administered by OFAC) can bar any transaction in such materiel if a party or state is listed.[327] Together, these regimes construct the marketplace of outer-space trade under law by governing how spacecraft, satellites, launch vehicles, and related technologies may be exchanged between states.[328] Export controls and sanctions are imposed by national law and membership in multilateral regimes.[329] Export Administration Regulations (EAR) by the Department of Commerce, and ITAR in the U.S. Munitions List by the Department of State, govern "dual-use" and military aerospace technology. The Bureau of Industry and Security of the Commerce Department controls the EAR over civilian and military materials in potential uses (e.g. satellite hardware), whereas the State Dept's Directorate of Defence Trade Controls "defense articles" (e.g. specific rockets and secure communications satellites) under the ITAR.[330] The U.S. sanctions programs under which payments to/from sanctioned countries (e.g. Iran, Russia) or parties that might be banned are run by the Treasury Department.[331] Applied to commercial space commerce, this would be the requiring of U.S. firms to secure export licenses (ITAR/EAR) on the majority of spacecraft and launch-related exports and

[326] Export Administration Regulations: Revisions to Space-Related Export Controls
Bureau of Industry and Security (BIS), U.S. Department of Commerce
Federal Register Document
[327] Jasper Helder et al., International Trade Aspects of Outer Space Activities, in Outer Space Law: Legal Policy and Practice 285 (Yanal Abul Failat & Anél Ferreira-Snyman eds., 2017), https://www.akingump.com/a/web/61872/aoiVR/outer-space-law-international-trade-aspects-of-outer-space-act.pdf.
[328] ibid
[329] Sachdeva, G.S., Space Commercialisation: Prospects, Challenges and Way Forward (Pentagon Press, 2019).
[330] United States Department of Commerce, Bureau of Industry and Security, Export Administration Regulations (EAR), 15 C.F.R. §§ 730-774 (2024), https://www.bis.doc.gov/index.php/regulations/export-administration-regulations-ear.
[331] See Suzanne Spaulding & Travis Sharp, Export Controls in the Age of Commercial Spaceflight, Center for Strategic and International Studies (CSIS) (2021), https://www.csis.org/analysis/export-controls-age-commercial-spaceflight.

steer clear of any sanctioned action under sanctions regimes (e.g., Iran and North Korea sanctions de facto prohibiting any cooperation in space with them).[332]

- **Export Control Regimes (ITAR, EAR, Wassenaar, MTCR)**

Most space-related technology is generally listed under the U.S. export-control lists. Virtually all spacecraft and related items have been previously listed on the State Department of U.S. Munitions List (USML) Category XV ("Spacecraft and Related Articles"). This would have meant the strict application of ITAR controls and individual, one-by-one licenses for almost all satellite and launch exports.[333] The U.S. transferred the Export Control Reform (ECR) program in 2014 to update numerous civilian satellites, spacecraft parts, and components, which were transferred from ITAR to the Commerce Control List (CCL) of the EAR, into ECCN 9A515 ("Spacecraft and Related Commodities").[334] For instance, it is recorded by the Commerce Department that 9A515 includes *"commercial communications satellites, remote sensing satellites, planetary rovers, planetary and interplanetary probes, and in-space habitats",* which were not controlled as defence articles.[335] Despite this change, ECCN 9A515 continues to be tightly license-controlled (national security, anti-terrorism, regional stability, and missile-technology criteria apply), and the majority of exports continue to need a license for most destinations.[336] A Commerce Department presentation discloses that 9A515 items are reviewed for national security and regional stability (NS and RS) for most countries, and even anti-terrorism controls.[337]

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[332] See Jeffrey A. Drezner, Export Controls and the Space Industry: National Security and Commercial Interests, 51 J. Air L. & Com. 317 (1986), https://scholar.smu.edu/jalc/vol51/iss3/3/.
[333] See Elizabeth Wilkins, Export Controls on Space Technologies: Balancing Innovation and National Security, 41 Space Pol'y 47 (2018), https://doi.org/10.1016/j.spacepol.2017.11.005.
[334] Revisions to the Export Administration Regulations (EAR): Control of Spacecraft Systems and Related Items the President Determines No Longer Warrant Control Under the United States Munitions List (USML), 79 Fed. Reg. 27,416 (May 13, 2014), https://www.federalregister.gov/documents/2014/05/13/2014-10807/revisions-to-the-export-administration-regulations-ear-control-of-spacecraft-systems-and-related.
[335] ibid
[336] Export Administration Regulations: Removal of License Requirements for Certain Spacecraft and Related Items for Australia, Canada, and the United Kingdom, 89 Fed. Reg. 84,766 (Oct. 23, 2024), https://www.federalregister.gov/documents/2024/10/23/2024-23932/export-administration-regulations-removal-of-license-requirements-for-certain-spacecraft-and-related.
[337] ibid

- **Commercial Implications for Industry**

Export control and sanctions impose burdensome requirements on commercial space firms. Export-control regulations are complicated and time-consuming to adhere to. Firms must categorise their products, register with the right U.S. agency (DDTC for ITAR, BIS for EAR), obtain licenses, and make regular, detailed end-use statements.[338] The punishments are draconian for violations, including criminal fines and imprisonment, and civil penalties of millions. Torres Trade Law notes that not adding controls is "easy to overlook" in business. The space sector has consistently lamented that regulations, particularly ITAR, suffocate innovation.[339] For instance, a report by NASA Inspector General on Artemis cooperation determined that NASA required a full-time staff of export-control experts and that "overly complex and restrictive" regulations hindered international partners and the sharing of information.[340]

For launch and satellite providers, the limitations result in actual lost business. An American satellite manufacturer can't sell a new satellite to a Chinese firm if it contains more than trivial U.S. content, even if it is manufactured and launched elsewhere.[341] Likewise, a European launch for a satellite containing U.S. content also requires U.S. re-export approval.[342] These restrictions vetoed most China-U.S. space contracts in the 2000s. Indeed, some have to "cull" their supply chains to remove prohibited parts.[343] Others

[338] Cindy Levy et al., Restricted: How Export Controls Are Reshaping Markets, McKinsey & Co. (Apr. 3, 2025), https://www.mckinsey.com/capabilities/geopolitics/our-insights/restricted-how-export-controls-are-reshaping-markets.
[339] Justin Levine, Reevaluating ITAR: A Holistic Approach to Regaining Critical Market Share While Simultaneously Attaining Robust National Security, 2 U. MIA Nat'l Sec. & Armed Conflict L. Rev. 150 (2012), https://repository.law.miami.edu/umnsac/vol2/iss1/8.
[340] U.S. Department of Commerce, Bureau of Industry and Security, Revisions to the Export Administration Regulations (EAR): Control of Spacecraft Systems and Related Items the President Determines No Longer Warrant Control Under the United States Munitions List (USML), 79 Fed. Reg. 27,974 (May 15, 2014), https://www.federalregister.gov/documents/2014/05/15/2014-10807/revisions-to-the-export-administration-regulations-ear-control-of-spacecraft-systems-and-related.
[341] Kelly Whealan George, The Economic Impacts of the Commercial Space Industry, 47 Space Pol'y 181 (2019), https://doi.org/10.1016/j.spacepol.2018.12.003.
[342] ibid
[343] Aaditya Vikram Sharma, Starlink and International Law: The Challenge of Corporate Sovereignty in Outer Space, EJIL:Talk! (Mar. 17, 2025), https://www.ejiltalk.org/starlink-and-international-law-the-challenge-of-corporate-sovereignty-in-outer-space.

diversify, such as the United Launch Alliance, which invested billions in native engines (the BE-4) to keep its launch business afloat after the RD-180 prohibition.[344]

Launch providers come of age on the launching side by being selective about customers and launch sites. Chinese military payloads will not be launched on American rockets (SpaceX's Falcon, ULA's Vulcan, etc.). SpaceX's Starlink system has not and cannot operate in China because of export and sanction legislation. Even allied countries' sales can entail special export licences. Among the better news is that the recent Oct 2024 U.S. regulatory changes aim to facilitate licensing between various nations. The Akin Gump notice relays that the Oct 2024 rules *"enable space-related cooperation with U.S. allies"* and offer opportunities for public comment to render controls responsive to industry needs.[345] For instance, Commerce provided a license exception to export specific commercial satellites and subsystems to close allies (UK, Canada, Australia, etc.) without a personal license.[346] Allied government customers or partners will be the ones favoured by such changes.[347]

But the total commercial effect is unclear. A few small start-ups or companies lacking compliance capacity are discouraged by the controls. They might exclude markets that induce refined controls (e.g., use of no Chinese components).[348] Conversely, the harsh regime encourages business inside the U.S. as rocket and satellite domestic components and rocket needs have flourished as "non-sanctioned" substitutes.[349] The Astrotech Corporation's innovation in propulsion technology, or the American satellite production boom (e.g. SpaceX's mass production of Starlink satellites), is partially due to the fact that

[344] David Wright & Laura Grego, Export Controls and Space Technology: Risks and Realities, Arms Control Today (2021), https://www.armscontrol.org/act/2021-07/features/export-controls-space-technology
[345] Akin Gump Strauss Hauer & Feld LLP, Space Law, Regulation and Policy Update (Oct. 18, 2024), https://www.akingump.com/a/web/gh1GTDFch2LcTJBaNoWRCk/9C1ryi/space-law-regulation-and-policy-update-october-18-2024.pdf.
[346] Aaditya Vikram Sharma, Starlink and International Law: The Challenge of Corporate Sovereignty in Outer Space, EJIL:Talk! (Mar. 17, 2025), https://www.ejiltalk.org/starlink-and-international-law-the-challenge-of-corporate-sovereignty-in-outer-space.
[347] ibid
[348] Cindy Levy et al., Restricted: How Export Controls Are Reshaping Markets, McKinsey & Co. (Apr. 3, 2025), https://www.mckinsey.com/capabilities/geopolitics/our-insights/restricted-how-export-controls-are-reshaping-markets.
[349] ibid

foreign manufacturing and launch opportunities are no longer available.[350] In a word, sanctions and export controls are supply-shifting instruments: they limit foreign markets and encourage domestic R&D and right-size global supply chains.

5.5 MULTILATERAL AGREEMENTS AND BILATERAL AGREEMENTS, AND PARTNERSHIPS IN SPACE ACTIVITIES

Several formal treaties now support international space trade and exploration above and beyond the UN agreements. Foremost is the International Space Station (ISS) model. The five ISS partner governments (USA, Russia, Japan, Canada and ESA member states) signed the Intergovernmental Agreement (IGA), a multi-government treaty *"establishing a long-term international co-operative framework"* for station design, operation and utilisation in 1998.[351] IGA grants each partner authority over its modules and staff on the Station and is the legal foundation of the ISS. NASA later signed four bilateral Memoranda of Understanding (MOUs) with ESA, JAXA (Japan), CSA (Canada) and Roscosmos (Russia) under the IGA.[352] The MOUs *"spell out the assignments and responsibilities of the agencies"* to construct and operate the station, with independent implementing arrangements and assigning particular tasks (e.g. crew training and logistics missions) to partners.[353] This tri-level legal framework (IGA treaty, agency MOUs, project agreements) is the gold standard for large multilateral projects.

In addition to the ISS, countries periodically conclude bilateral and multilateral MOUs of civil space cooperation. For instance, the United States and Japan have further enhanced their cooperation through newer agreements regarding the exploration of the moon. NASA and JAXA have agreed to work on Artemis Gateway components jointly, jointly co-

[350] Tereza Pultarova, Starlink Satellites: Facts, Tracking and Impact on Astronomy, Space.com (Mar. 28, 2025), https://www.space.com/spacex-starlink-satellites.html.
[351] Gabriel Swiney, Multilateralism on the Final Frontier: Space Law and Policy in an Era of Expansion, Journal of International Affairs (2021), https://jia.sipa.columbia.edu/content/multilateralism-final-frontier-space-law-and-policy-era-expansion
[352] Ministry of Foreign Affairs of Japan, Japan-U.S. Joint Statement on Space Cooperation (Jan. 13, 2021), https://www.mofa.go.jp/files/100136627.pdf.
[353] ibid

develop lunar communications relays, and conduct astronaut training jointly.[354] A July 2024 report indicates Japan will supply elements of the Gateway lunar orbiting platform and pressurised rover, and NASA agreed to send a Japanese astronaut to the Moon.[355] U.S.-India relations have also improved as seen in 2023, where India became a member in earnest of NASA's Artemis Accords (below), and NASA indicated it would educate two Indian astronauts at the Johnson Space Centre.[356] The U.S. State Department identified *"facilitating commercial partnerships among U.S. and Indian space firms"* to increase cooperation.[357] In practice, the two are partnering on a joint private crewed flight to the ISS (with Axiom Space) to carry the first Indian astronaut into space.[358]

European countries are also increasing connections. ESA has issued several statements of cooperation with Asian-Pacific space organisations.[359] For instance, on 7 May 2025, ESA and India's ISRO issued a joint Statement of Intent to collaborate in human spaceflight, joint crewed missions to India's next space station (Bhartiya Antriksh Station) and interoperability of docking systems.[360] This comes after previous scientific and Earth observation cooperation arrangements. Commercially, France's Arianespace periodically launches Japanese- and Korean-made satellites (for instance, an Ariane 5 put comms sats into orbit for Japan and South Korea in 2020), illustrating how launch-service agreements provide for space hardware international business.[361]

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[354] How NASA's Artemis Accords Are Laying the Ground for Global Space Cooperation, The Guardian (Oct. 20, 2024), https://www.theguardian.com/science/2024/oct/20/nasa-artemis-accords-space-diplomacy.
[355] Stephen Clark, In Exchange for a Lunar Rover, Japan Will Get Seats on Moon-Landing Missions, Ars Technica (Apr. 10, 2024), https://arstechnica.com/space/2024/04/japan-will-be-first-among-nasas-partners-to-have-an-astronaut-on-the-moon/.
[356] Claire A. O'Shea, NASA Welcomes India as 27th Artemis Accords Signatory, NASA (June 23, 2023), https://www.nasa.gov/news-release/nasa-welcomes-india-as-27th-artemis-accords-signatory/.
[357] Fact Sheet: The United States and India Advance Growing Space Partnership, White House (Dec. 18, 2024), https://bidenwhitehouse.archives.gov/briefing-room/statements-releases/2024/12/18/fact-sheet-the-united-states-and-india-advance-growing-space-partnership/.
[358] ibid
[359] European Space Agency, N° 23–2025: European Space Agency Announces New Cooperation with Indian Space Research Organisation (May 7, 2025), https://www.esa.int/Newsroom/Press_Releases/European_Space_Agency_announces_new_cooperation_with_Indian_Space_Research_Organisation.
[360] ibid
[361] Caleb Henry, Japanese Communications Satellite and South Korean Weather Satellite Launch on Ariane 5, SpaceNews (Feb. 18, 2020), https://spacenews.com/japanese-communications-satellite-and-south-korean-weather-satellite-launch-on-ariane-5/.

Numerous other bilateral arrangements enable trade and collaboration. The U.S. State Department documents scores of NASA interagency agreements with nations such as Israel, Morocco, Brazil, etc., ranging from education exchanges to collaborative technology development. To cite just one, in 2018, NASA and the UAE Space Agency signed an implementing arrangement on human spaceflight that will enable UAESA to utilise ISS facilities and participate in lunar missions.[362] As such, Australia (on behalf of its Space Agency) has signed MOUs with NASA, ESA, Japan, and others, and in 2021, it committed to sharing a rover for an upcoming lunar mission with NASA.[363] Even smaller and rising space countries, from the Dominican Republic to South Korea, are signing bilateral agreements to utilise launch services, data sharing and training.[364] Briefly, the current space commerce architecture is based on an ad hoc set of international treaties (e.g., ISS IGA), agency-level MOUs, and country-to-country implementation agreements that collectively define how partners collaborate in terms of technology, infrastructure and responsibility.[365]

5.6 EMERGING SPACE NATIONS AND NEW PLAYERS

Perhaps the most striking feature of the contemporary space environment is the active engagement of previously "emerging" space powers. The United Arab Emirates, Japan, Australia, South Korea and Brazil are shaping ambitious plans and linking them to international trade.

- **United Arab Emirates (UAE):** The UAE has rapidly become a key player. It has a space agency (UAESA) and a flagship company (MBRSC) that collaborated with

[362] NASA and UAE Space Agency Sign Historic Implementing Arrangement for Cooperation in Human Spaceflight, UAE Space Agency (Oct. 2, 2018), https://space.gov.ae/en/media-center/news/2/10/2018/nasa-and-uae-space-agency-sign-historic-implementing-arrangement-for-cooperation-in-human#:~:text=The%20new%20IA%20enables%20the,to%20contribute%20to%20lunar%20exploration.
[363] Mike Wall, Australia Launching Moon Rover on NASA Artemis Mission as Soon as 2026, Space.com (Sept. 6, 2023), https://www.space.com/australia-moon-rover-2026-nasa-artemis.
[364] Kristi Govella, Garima Mohan & Bonnie S. Glaser, Expanding Engagement among South Korea and the Quad Countries in the Indo-Pacific, German Marshall Fund of the United States (June 6, 2022), https://www.gmfus.org/news/expanding-engagement-among-south-korea-and-quad-countries-indo-pacific.
[365] United States Government Accountability Office, Space Commerce: An Evolving Industry Faces Multiple Challenges at 12–15 (2023), https://www.gao.gov/assets/gao-23-105583.pdf

NASA on a Gateway lunar module.[366] In January of 2024, NASA announced a deal with the UAE's Mohammed Bin Rashid Space Centre to supply a Crew and Science Airlock for the Artemis Gateway station in return for launching the first Emirati astronaut to Gateway.[367] NASA has also trained UAE astronauts, and the UAE was one of the first Arab countries to sign the Artemis Accords. UAE Abu Dhabi Emirate also initiated the "Space Economic Zone" to draw space industries.[368] This collaboration with the U.S. is based on previous ties, like NASA and UAESA, which 2018 signed an Implementing Arrangement for ISS utilisation and support of lunar exploration.[369] The UAE investments (a Mars orbiter, a planned building lunar rover, and a planned spaceport) show how a developing nation can utilise international agreements to advance its plans for space commerce.[370]

- **Japan:** Japan is already a leading space-faring country, but its contribution is still growing. A joint announcement by JAXA and NASA near the end of 2024 laid out cooperation in lunar rendezvous systems, astronaut training, and analogue missions.[371] JAXA is a signatory to the Artemis Accords and is donating hardware: it will donate pieces of the Gateway station and a pressurised lunar rover. Curiously, the Accords' symbol of cooperation is the first non-American (a Japanese astronaut) visiting the Moon, demonstrating the level of collaboration. Japan also has a robust commercial industry (e.g., satellite makers, small-launch vehicles such as Epsilon), and recently eased specific rules surrounding space resources. Its collaboration with Europe and the U.S. on Artemis guarantees Japanese companies a seat at the table in the emerging lunar economy.

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[366] Abbey A. Donaldson, NASA, United Arab Emirates Announce Artemis Lunar Gateway Airlock, NASA (Jan. 7, 2024), https://www.nasa.gov/news-release/nasa-united-arab-emirates-announce-artemis-lunar-gateway-airlock.
[367] Andrew Jones, UAE to Provide Airlock for NASA's Moon-Orbiting Gateway Space Station, Space.com (Jan. 11, 2024), https://www.space.com/uae-nasa-gateway-moon-airlock-astronaut-deal.
[368] Stars of the Desert: UAE's Pioneering Space Economic Zone, Space Ambition (May 25, 2025), https://spaceambition.substack.com/p/stars-of-the-desert-uaes-pioneering.
[369] NASA & UAE Space Agency Sign Historic Implementing Arrangement for Cooperation in Human Spaceflight, NASA (Oct. 2, 2018), https://www.nasa.gov/news-release/nasa-uae-space-agency-sign-historic-implementing-arrangement-for-cooperation-in-human-spaceflight/.
[370] Small Country, Big Ambitions – the UAE's Contribution to the Global Space Industry, UAE Space Agency (Feb. 10, 2020), https://space.gov.ae/en/media-center/blogs/10/2/2020/small-country-big-ambitions-the-uaes-contribution-to-the-global-space-industry.
[371] Jeff Foust, NASA and JAXA Reaffirm Intent to Cooperate in Lunar Exploration, SpaceNews (Sept. 25, 2019), https://spacenews.com/nasa-and-jaxa-reaffirm-intent-to-cooperate-in-lunar-exploration/.

- **Australia:** Australia's space industry is recent but expanding. It signed the Artemis Accords in 2020, the first Southern Hemisphere country to do so. Australians have won contracts to produce equipment components for Artemis missions (like a sensor for a lunar rover) and are working to establish ground infrastructure to track space objects. Australia has a mutual R&D MOU with the U.S. and is part of international enterprises like the James Webb Telescope.[372] The Australian Space Agency has categorically asserted that the Artemis principles *"share a common interest in the exploration of outer space for peaceful purposes and to benefit society and economic growth."*[373] By coming together with the NASA program, Australia is placing its companies (in robotics, communications, etc.) in a position to compete in the global space industry.
- **South Korea:** South Korea recently joined the Artemis partnership club and is augmenting its launch and satellite capacities. KARI (Korea Aerospace Research Institute) has put Earth observation and weather satellites into orbit. In 2022, it successfully launched its first lunar orbiter (KPLO, or Danuri) on a mission that carried an international payload suite.[374] South Korea joined the Artemis Accords in 2022 (on the list), indicating a willingness to join lunar exploration. It also hosts private launchers (Naro, KSLV) and commercial satellite companies. By such alliances, South Korea can provide commercial services (e.g. satellite data, launch contracts) while enjoying technology transfers with capable partners.

These instances illustrate that new entrants to space are not merely customers but stakeholders in space businesses. Through entry into missions such as Artemis and MOUs, they are being offered access to missions and markets for their industries. As an analyst puts it, *"Bringing expertise and facilitating innovation, commercial space providers are*

[372] Cameron Furlong, Australian Astronomers Working with the James Webb Space Telescope, Space Australia (Jan. 26, 2022), https://spaceaustralia.com/feature/australian-astronomers-working-james-webb-space-telescope.
[373] Tory Shepherd, Australia Signs International Space Agreement – Artemis Accords, Space Australia (Oct. 20, 2020), https://spaceaustralia.com/news/australia-signs-international-space-agreement-artemis-accords.
[374] Dr. Hyun-Ok Kim, Earth Observation in Rep. of Korea: Focused on Low Earth Orbit Satellites, UN/Austria Climate Action Symp. (July 18, 2024), https://www.unoosa.org/documents/pdf/psa/activities/2024/UN-Austria/KIM_12.07.pdf.

central to the success of [all space] operations"[375]. New entrants are becoming part of the world space trade web through bilateral deals and consortia.

5.7 NEW INITIATIVES AND PROPOSALS FOR COOPERATION

With increasing space activities, governments and institutions are crafting new collaboration frameworks outside current agreements:

- **International Spaceports:**

An international system of spaceports has been contemplated. Launch sites today are generally national (e.g. Cape Canaveral, Guiana, Baikonur), but others propose more international collaboration. For example, the International Astronautical Federation's Global Spaceport Alliance (GSA) organises meetings (e.g. 2024 International Spaceport Meeting) to encourage global interaction and best practice between spaceport operators.[376] Even experts have drawn up an OASIS blueprint: a string of nodes in LEO, on the Moon, and in space, operated by an "International Spaceport Authority" to facilitate launch procedures.[377]

- **Lunar Economy and Resource Frameworks:**

With ongoing Artemis and ILRS missions, interest groups already speak of rules regarding a lunar economy. The Artemis Accords contain guidelines on resource extraction (Section 8).[378] In addition to this, entities such as the Hague Space Resources Working Group have set forth non-binding requirements for mining operations.[379] Schemes for a "Lunar Common Heritage" fund or registry of resources have been suggested in academic

[375] Asia's Space Ambitions: Driving the Next Chapter in Global Space Competition, 19 Asia Pol'y 4, 1–90 (Oct. 2024), http://asiapolicy.org.
[376] Izzy House, Global Spaceport Alliance and FAA Host Inaugural International Spaceport Meeting in Milan, Italy, Global Spaceport Alliance (Oct. 14, 2024), https://www.globalspaceportalliance.com/global-spaceport-alliance-and-faa-host-inaugural-international-spaceport-meeting-in-milan-italy/.
[377] Suki Dauda Sule, Operations and Service Infrastructure for Space (OASIS), Academia.edu, https://www.academia.edu/10015834/Operations_and_Service_Infrastructure_for_Space_OASIS_ (last visited May 22, 2025).
[378] Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes, Oct. 13, 2020, https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf.
[379] Yannick Radi, Space Mining in Practice – An International Space Law Perspective on Upcoming Challenges, ESIL Reflection, Vol. 13, Issue 8 (2024), https://esil-sedi.eu/reflection-space-mining-in-practice-an-international-space-law-perspective-on-upcoming-challenges/.

papers.[380] Others propose a fresh treaty (or OST revision) solely on space commerce. Indeed, some nations, such as the U.S., Luxembourg, UAE, and Australia, have enacted national legislation conferring corporations with property rights over resources mined; thus, there is a patchwork of legislation.[381] The overall trend is towards legally enshrining commercial rights to resources on the moon and asteroids, though international consensus has not yet been achieved.

- **Space Traffic Coordination:**

Space is getting crowded, and countries want collaborative traffic management. The United States Commerce Department has launched TraCSS (Traffic Coordination System for Space), which provides conjunction notices and a simple orbital traffic management service to satellite operators.[382] As a beta service to multiple big operators (e.g. Maxar, Planet, SES) at first, TraCSS is a step toward a world traffic-management regime.[383] In the commercial sector, bodies such as the Space Data Association (a group of satellite operators) exchange orbital information to prevent collisions.[384] Internationally, the UN Office for Outer Space Affairs organised panels for managing space traffic, some advocating a global registry, if not a Space Traffic Authority. In 2024, a UN "Space Bridge" program brought governments and operators together to consider international coordination.[385] Although no binding treaty is yet in place, the trend is evident: collective frameworks (with government and commercial actors) are being established to manage collision avoidance and debris removal. The Artemis Accords reaffirm debris planning

[380] Michela Massimi, The Fraught Legacy of the Common Heritage of Humankind Principle for Equitable Ocean Policy, 153 **Env't Sci. & Pol'y** 103681 (2024), https://doi.org/10.1016/j.envsci.2024.103681.
[381] Morgan M. DePagter, "Who Dares, Wins:" How Property Rights in Space Could Be Dictated by the Countries Willing to Make the First Move, CJIL Online 1.2 (Chicago J. Int'l L. Online 2024).
[382] Guice Offshore, Meet TraCSS, the New Space Traffic Coordination System! (Dec. 9, 2023), https://www.guiceoffshore.com/meet-tracss-the-new-space-traffic-coordination-system/.
[383] ibid
[384] Int'l Interdisciplinary Cong. on Space Debris, Towards Long-term Sustainability of Space Activities: Overcoming the Challenges of Space Debris, U.N. Doc. A/AC.105/C.1/2011/CRP.14 (Feb. 2011), https://www.unoosa.org/pdf/limited/AC105_C1_2011_CRP14E.pdf.
[385] Aarti Holla-Maini, Statement at the Sixty-Second Session of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space (Feb. 3–14, 2025), https://www.unoosa.org/documents/pdf/copuos/stsc/2025/Statements/1_UNOOSA_Directors_statement_and_Annex_FINAL_For_webpage_1.pdf.

norms (Accord 9), but more universal agreements on data sharing and deconfliction are still in development.[386]

Generally, the networks of spaceports, lunar economic zones and traffic systems are all on the table. Most are not yet treaties, but they signal where treaties will go in the future. Governments are beginning to realise that as space commerce increases, coordination on infrastructure, resources and safety will require multilateral solutions.

As outer space evolved from being a government-led frontier to a commercially focused frontier, trade implications have also been the focus of space law and policy. The entrance of private companies like SpaceX, Blue Origin, and Planet Labs has brought complications in issues concerning intellectual property rights, resource exploitation, and ownership of data. For example, satellite data companies now produce valuable satellite data that is traded for cash, but jurisprudence falls behind in granting similar rights over such intangible assets, particularly when harvested from global commons.

The Outer Space Treaty (1967) and the Moon Agreement (1979) emphasize the principles of non-appropriation and reasonable access but say little to inform the commercial use of space resources. The U.S. Commercial Space Launch Competitiveness Act (2015) and the Luxembourg Space Resources Law (2017) provide for private property rights in the extracted resources, legislation arguably inconsistent with international norms and legally disputed.

In addition, the dual-use nature of most space technology, as indicated by the Russia-Ukraine war, demonstrates the grey areas in civilian and military applications and generates trade security and regulation challenges. As expanding space commerce gains steam for building the space economy, harmonizing international law with market-driven realities will become crucial in providing equitable access and sustainable development to the space economy.

[386] Jack Wright Nelson, The Artemis Accords and the Future of International Space Law, 24 ASIL Insights, Issue 31 (Dec. 10, 2020), https://www.asil.org/insights/volume/24/issue/31/artemis-accords-and-future-international-space-law.

CHAPTER- 6

CONCLUSION

The swift invasion of commercial and private players into space, from massive satellite constellations to proposals for moon bases, has well outrun the century-long legal system created during the period of superpower space competition. Decreasing launch costs, small satellite constellations, artificial intelligence and robotics, reusable launchers and record launch numbers dominate the "New Space economy" as per one research.[387] These trends strain a legal system built upon 1960s values, the Outer Space Treaty and its supporting instruments. Previously, space law's core principles, use in peace, non-national appropriation of celestial space, liberty to explore, and state responsibility for national activity, were conditioned by a Cold War mindset.[388] However, these foundational principles of international law do not say very much about rights over property. In space resources, regulation of the private space industry, or the environmental consequences of industrial-scale space activity.

The third chapter addressed the current treaties still nominally in control of space. The 1967 Outer Space Treaty (OST) articulates the broad terms, prohibition on territorial claims, commitment to utilise space for all, and state responsibility for national-character activities (Article VI).[389] The following agreements (Rescue, Liability, Registration) elaborate on the details: launching states are liable for harm on Earth and "fault-based" liable in space, and all satellites have to be registered with the UN to provide transparency. The Moon Agreement (1984), seldom used, is even presumed to have the resources of the

[387] Robert A. Friedman, Paul Stimers, Leighton T. Brown II & Ronnie Rosen Zvi, Trends and Developments, in Space Law 2024 – USA, Chambers and Partners (July 11, 2024), https://practiceguides.chambers.com/practice-guides/space-law-2024/usa/trends-and-developments/O17408

[388] Roger Quinland, Galactic Governance: From the Outer Space Treaty to Modern Regulations, The Space Review (Aug. 19, 2024), https://www.thespacereview.com/article/4843/1#:~:text=2,and%20responsibility%20in%20the%20space.

[389] Yannick Radi, Clearing Up the Space Junk: On the Flaws and Potential of International Space Law to Tackle the Space Debris Problem, ESIL Reflection, Mar. 9, 2023, https://esil-sedi.eu/esil-reflection-clearing-up-the-space-junk-on-the-flaws-and-potential-of-international-space-law-to-tackle-the-space-debris-problem/#:~:text=States%20Parties%20shall%20bear%20international,space%2C%20and%20given%20its%20corresponding.

Moon be the "common heritage of mankind", though never ratified by any States. These instruments are still state-based and weak.[390] Article VI of the OST, for instance, makes an internationally responsible State for "its national activities" in outer space, including private ones.[391] That makes each nation accountable for keeping its companies in line under domestic law, a regime sufficient in the 1960s, when the Governments and the few contractors existed, but now whose implementation is stretched. There are virtually no provisions in the space law treaties that govern who owns or sells what is produced or mined off-planet. It only gives general and vague legal rules, with the mere elementary rules on liability, registration, and rescue, but virtually none on the specifics of its commercial application.

Chapter four addressed the commercial matters that have ensued. Private entities now provide launch services, satellite constellations, and space tourism; they have even begun planning for asteroid mining. International law traditionally regards them as "national activities" according to Article VI, i.e., each State is accountable for authorising and regulating its nationals' space activities on an ongoing basis.[392] Governments reacted with national laws and regulatory boards, e.g., the U.S. Commercial Space Launch Act authorises launches and mandates insurance and indemnification as pre-launch requirements. Likewise, the recent UAE space law (Decree 46/2023) institutes a licensing regime for almost all space activity (rocket launches to trading meteorites) and explicitly requires operators to apply for permits.[393] India's draft Space Activities Bill (2017) also envisioned licensing, registrations, liability sharing, and intellectual property provisions.[394]

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[390] In the Public Interest, Get Ready for More Potholes, Water Leaks, and Crumbling Schools if Congress Doesn't Act (July 13, 2020), https://inthepublicinterest.org/get-ready-for-more-potholes-water-leaks-and-crumbling-schools-if-congress-doesnt-act/.

[391] ibid

[392] Yannick Radi, Clearing Up the Space Junk: On the Flaws and Potential of International Space Law to Tackle the Space Debris Problem, ESIL Reflection, Mar. 9, 2023, https://esil-sedi.eu/esil-reflection-clearing-up-the-space-junk-on-the-flaws-and-potential-of-international-space-law-to-tackle-the-space-debris-problem/#:~:text=States%20Parties%20shall%20bear%20international,space%2C%20and%20given%20its%20corresponding.

[393] UAE Space Regulation, Official Portal of the UAE Government, https://u.ae/en/about-the-uae/science-and-technology/key-sectors-in-science-and-technology/space-science-and-technology/space-regulation.

[394] Meera Rohera, The Draft Space Activities Bill and Its Challenges, center for strategic & international studies (Dec. 13, 2021), https://aerospace.csis.org/wp-content/uploads/2021/12/20211213_IndiaSpaceBill_Rohera-compressed.pdf.

Some countries have declared that citizens can mine and hold resources on asteroids and moons. The U.S. Act (2015) states that an American citizen "shall be entitled to any asteroid resource or space resource acquired, including to possess, own… and sell the… resource acquired".[395] Luxembourg's 2017 space law also provides that "space resources are capable of being owned"[396] by space agencies. Japan's 2021 Space Resources Act authorises companies to assume the power of acquiring ownership over mined space resources based on international obligation.[397] These national measures echo the complex legal issues of trade: how to certify and license space business, up to what point property rights extend under the non-appropriation principle, and how to apportion liability. Critically, international law has no clear private property right in outer space, only contentious permission to utilise resources on condition that there is no sovereign claim. No treaty tackles front-runner issues such as the privacy of satellite services' data or the cybersecurity of space infrastructure, which are now dealt with only by soft norms and national standards practice. Overall, Chapter 4 explained how domestic law has moved on frequently in a vacuum to fill gaps that international law left open. While that patchwork method underscores the gaps, it also creates inconsistent rules.

It also looked into the insufficiency of the international system in terms of space commerce regulation. The paradox is glaring: while States extol space as a common good of humanity, no global caretaker of commercial space exists. The OST and associated treaties were never revised to address satellite mega constellations, in-space production or lunar extraction. One critic points out that the existing regime "was finalised decades ago, when space debris was not a priority on the policy agenda". Indeed, this examination found that the treaty documents do not speak to many contemporary concerns. *For instance*, the OST's Article IX, the only treaty provision to suggest environmental caution, commits States to preventing "harmful contamination" and "adverse changes" in the environment of Earth

[395] 51 U.S.C. § 51303 (2023), https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title51-section51303.
[396] Yannick Radi, Common Heritage, Not Common Law: How International Law Will Regulate Proposals to Exploit Space Resources, QIL QDI (Oct. 27, 2021), https://www.qil-qdi.org/common-heritage-not-common-law-international-law-will-regulate-proposals-exploit-space-resources/.
[397] Japan, Information on the Mandate and Purpose of the Working Group on Legal Aspects of Space Resource Activities under the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/C.2/2023/CRP.33 (2023), https://www.unoosa.org/documents/pdf/copuos/lsc/space-

due to extraterrestrial material. However, as commentators point out, space debris (or human-made trash) doesn't qualify as extraterrestrial matter. Therefore, no duty mandated by the treaty will keep long-term accumulation of debris in orbit or Earth's atmosphere. Similarly, liability rules are only activated when damage has been demonstrated (on Earth or to an aircraft); they do not stop collisions in orbit (nor mandate de-orbiting of rubbish). Present law is therefore not "lawless" (States are still answerable for their nationals), but it has unenforceable rules for the challenges of the 21st century. Most commentators highlight that the state-centric nature of the OST now finds it difficult to cope with the tidal wave of non-government activity. For example, Article VI holds each State responsible for its citizens, but States struggle to monitor or impose regulations on dozens of private firms conducting space business overseas. Chapter 3 concludes that the legislative loopholes in the treaties, on space property, debris mitigation, sharing of resources and liability, are no longer conceptual. On-ground issues such as Kessler Syndrome (a hyperbolic debris cascade) and the "lunar resources race" did not fit into the 1960s space agenda, and continue to languish with no binding regulations today.

The fifth chapter explored trade and cross-border commercial issues, a familiar but historically overlooked subject area of space law. Space products and services cross borders daily, launch vehicles are shipped worldwide, satellite data is transmitted worldwide, and manufacturing supply chains span continents, yet there is no space-based trade pact. Theoretically, only broad trade rules apply: satellites are WTO tradable goods, satellite services are telecommunications commitments (GATS) or bilateral arrangements, and nations can impose import tariffs or subsidies under WTO rules. In practice, however, security exceptions dominate. Inappropriately strict export-control regimes (such as the U.S. ITAR/EAR or EU Dual-Use lists) characterise advanced satellites and rockets as munitions or sensitive technology, subjecting cross-border transfers to difficulty.[398] No WTO chapter regulates space directly; the interaction is circumstantial. UNOOSA specialists indicate that *"trade and space law are developing in tandem,"* with increasingly more overlap as the private sector participates in *"foreign launch markets or export of space*

[398] Jasper Helder et al., International Trade Aspects of Outer Space Activities, Akin Gump Strauss Hauer & Feld LLP (Nov. 2, 2017), https://www.akingump.com/a/web/61872/aoiVR/outer-space-law-international-trade-aspects-of-outer-space-act.pdf

technological capabilities"[399]. However, nearly all states, aside from security states and the WTO and trade agreements, permit restrictions based on national security grounds.[400] Therefore, the dissertation held that space commerce remains mainly governed by antiquated regimes of trade (ITAR, ITU spectrum regime, customs) instead of a single space trade regime. This generates ambiguity: e.g., what customs tariff on a satellite? What export license for lunar mining gear? Briefly, the space business's borderless world introduces thousands of trade law bends that international law has, mostly, yet to address.

Taken as a collection, the chapters paint a rich picture that the 20th-century law has been unable to keep up with 21st-century space commerce. Lessons learned include recognition that obsolete prohibitions (e.g., the OST's principle of non-appropriation) now conflict with new activities (private mining of asteroids, satellite constellations). The dissertation demonstrated that fundamental challenges cluster around several themes. First, *property rights:* Can a company own minerals on the Moon or an asteroid? Existing law is ambiguous, so States have taken disparate positions. The US and Luxembourg say yes (subject to OST compliance)[401], while many others fear this contravenes Article II's non-sovereignty ban. The Artemis Accords avoid this problem by stating that the use of resources shall be governed by the OST, but do not establish multilateral legal title or benefit-sharing.[402] Second, *liability*: The Liability Convention makes governments liable for damage, but the more congested the space environment is, the greater the likelihood of a disastrous collision. Who compensates when two mega-constellation satellites crash? Contemporary law has no apportionment of responsibility for near-misses or concurrent fault, and even with safety regulations, collision avoidance standards remain largely a country-by-country issue. Third, *environmental protection:* No binding international standard exists to safeguard the orbital environment. It is clear that space junk, now quite

[399] Prof. Dr. Lesley Jane Smith, Space and International Trade Law, Presentation at the IISL/ECSL Space Law Symposium, Legal Subcommittee, 60th Session, United Nations Committee on the Peaceful Uses of Outer Space (June 8, 2021), https://www.unoosa.org/documents/pdf/copuos/lsc/2021/02.pdf.
[400] ibid
[401] Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace [Law of July 20, 2017 on the Exploration and Use of Space Resources], Journal Officiel du Grand-Duché de Luxembourg, No. 674 (July 28, 2017), https://space-agency.public.lu/en/agency/legal-framework/law_space_resources_english_translation.htm
[402] Michael C. Mineiro, The Artemis Accords and the Next Generation of Outer Space Governance, Council on Foreign Relations (Apr. 21, 2021), https://www.cfr.org/blog/artemis-accords-and-next-generation-outer-space-governance.

literally "making outer space a dump," is not "contamination" of the world according to the terminology of the OST and is therefore not subject to Article IX's call not to produce obnoxious contamination. The Long-Term Sustainability (LTS) guidelines adopted by COPUOS in 2019 provide best practice but not legal authority.[403] Fourth, *state vs private accountability:* Article VI grants powers to states, but states cannot effectively supervise agile firms. In the case of a module that SpaceX or ISRO launches, causing a chain reaction of debris, the treaty makes the country of origin and the company responsible. However, no process (such as insurance pools or binding regulation) makes responsibility stick. We discovered a disconnect between theory (states need to supervise) and practice (no international enforcement of state compliance by private companies).[404] Fifth, *classification and trade:* Whether space goods/services are accorded preferential treatment under the trade law is unclear. World Trade Organisation case law has had cases involving satellite technology and telecommunication, but no WTO agreement exists for space. In trade scenarios, states have broad latitude to regard space as sensitive (for national security reasons). Thus, space commerce can be stifled by export controls and tariffs without a single forum available to challenge it. Part of the "issues such as […] trade and services in space" are only tangentially within the ambit of GATS and other trade regimes.[405]

Despite these gaps, several new initiatives have emerged, though each is only a partial fix. The Artemis Accords (2020), a U.S.-led set of bilateral agreements, commit signatories to principles like peaceful use, transparency, registration of cooperative missions, data sharing and debris mitigation, all "consistent with the Outer Space Treaty".[406] The Accords

[403] United Nations Office for Outer Space Affairs, Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space, U.N. Sales No. E.21.I.9 (2021), https://www.unoosa.org/documents/pdf/PromotingSpaceSustainability/Publication_Final_English_June2021.pdf.

[404] Yannick Radi, Clearing up the Space Junk: On the Flaws and Potential of International Space Law to Tackle the Space Debris Problem, 12 ESIL Reflections 2 (2023), https://esil-sedi.eu/esil-reflection-clearing-up-the-space-junk-on-the-flaws-and-potential-of-international-space-law-to-tackle-the-space-debris-problem/.

[405] Prof. Dr. Lesley Jane Smith, Space and International Trade Law, Presentation at the IISL/ECSL Space Law Symposium, Legal Subcommittee, 60th Session, United Nations Committee on the Peaceful Uses of Outer Space (June 8, 2021), https://www.unoosa.org/documents/pdf/copuos/lsc/2021/02.pdf.

[406] United Nations Office for Outer Space Affairs, Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space, U.N. Sales No. E.21.I.9, U.N. Doc. ST/SPACE/79 (2021), https://www.unoosa.org/documents/pdf/PromotingSpaceSustainability/Publication_Final_English_June2021.pdf

boldly affirm the U.S. view that the OST permits space resource extraction under national law.[407] However, as analyses point out, the Accords apply only to countries working within NASA's Artemis program, and do not bind other missions (for example, a Chinese lunar expedition unconnected to Artemis would be unconstrained by these rules).[408] Nor do the Accords themselves create a global enforcement body; their legal weight comes from the political buy-in of a few spacefaring nations. National laws likewise offer uncoordinated responses. In the U.S., the proposed Commercial Space Act of 2023 (a House bill) seeks to modernise U.S. space regulation by centralising the Office of Space Commerce and streamlining licensing, but as of late 2023, it was still pending.[409] Significantly, this bill's debris provisions are criticised as weak operators need only "submit" a mitigation plan, with no enforcement mechanism. The White House has also floated competing frameworks to assign novel activities (e.g. uncrewed missions) between agencies. These show Washington's effort to adapt, but again, domestically. Internationally, the U.S. continues to push Artemis abroad. In trade policy, the U.S. has emphasised countering rivals (the Strategic Competition report urges multilateral space leadership to counter China).

Key lessons drawn are, *first*, the underlying Outer Space Treaty needs clarification or updating. In the commentator's words, we need to "amend the Outer Space Treaty" and possibly create new regulatory machinery to fill existing gaps.[410] Reform would have to deal with the perennially argued tension between non-appropriation and use of resources, ideally acknowledging that materials taken away can be owned (as some national law now does) without eliminating territorial sovereignty.[411] *Second*, liability would need to be modernised. The Liability Convention never envisioned hundreds of firms launching inexpensive satellites or private astronauts on the Moon's surface. Similar to pooled

[407] David P. Fidler, The Artemis Accords and the Next Generation of Outer Space Governance, COUNCIL ON FOREIGN RELATIONS (June 2, 2020), https://www.cfr.org/blog/artemis-accords-and-next-generation-outer-space-governance.
[408] ibid
[409] Robert A. Friedman et al., Space Law 2024 – USA: Trends and Developments, CHAMBERS AND PARTNERS (July 11, 2024), https://practiceguides.chambers.com/practice-guides/space-law-2024/usa/trends-and-developments/O17408.
[410] Madi Gates, Houston, We Have a Problem: International Law's Inability to Regulate Space Exploration, NYU J. INT'L L. & POL. BLOG (Jan. 2, 2025), https://nyujilp.org/houston-we-have-a-problem-international-laws-inability-to-regulate-space-exploration/.
[411] Roger Quinland, Galactic Governance: From the Outer Space Treaty to Modern Regulations, THE SPACE REVIEW (Aug. 19, 2024), https://www.thespacereview.com/article/4843/1.

insurance or deorbiting duties, a more lenient regime would share the risk. *Third*, protection of the space environment must be more specific. Current law's "no harmful contamination" was written about extraneous microorganisms, not a plume of fragmentation debris. It can also be concluded that Article IX mandates "due regard" for others and "avoidance of contamination," but provides no viable guidelines on debris.[412] This gap, therefore, indicates the necessity of new binding regulations on the prevention and evacuation of debris, something which UNEP or other environmental organisations can address. *Fourth*, the state-private interface has to be reconfigured. The states must outsource control and licensing to private launch providers, mining and satellite entities. Unless controlled, it can result in space intergenerational injustice: future users can end up with orbits so crowded or moons so owned that they are denied their freedom to explore.[413] This will force all (public or private) to respect fundamental principles through increased national enforcement and international cooperation (e.g., capacity-building or model laws encouraged by the UN). *Fifth*, there is a lesson on trade and commerce that space is becoming more of an international economic sector. Without a global "space trade" paradigm, one's distortionary subsidies or export controls can skew others. In a market interdependence, a harmonised method (maybe bargaining space issues under WTO or plurilateral trade agreements) could avoid controversies. For example, international partners have already established duty-free arrangements for cooperative ventures (partners in the ISS coordinate duty-free part exchange), suggesting that it is possible to make larger arrangements.

Looking at what has been done so far, the scene is that of half-steps, not entirely efficient. The Artemis Accords and national legislations have already started establishing standards, peaceful use, safety zones on the Moon, accountability of astronauts, transparency regarding plans, etc. These *"best practices"* are good diplomatic initiatives, but not universal and legally binding like an international treaty. Even the best of good-faith cooperation has blind spots: Artemis doesn't have a way to coerce non-signatories. U.S.

[412] Yannick Radi, Clearing up the Space Junk: On the Flaws and Potential of International Space Law to Tackle the Space Debris Problem, ESIL REFLECTIONS, Vol. 12, No. 2 (2023), https://esil-sedi.eu/esil-reflection-clearing-up-the-space-junk-on-the-flaws-and-potential-of-international-space-law-to-tackle-the-space-debris-problem/.
[413] ibid

executives have admitted that they employ the Accords to "serve their interests" instead of changing the OST. Similarly, the U.S., UAE, India and others have enacted legislation authorising the use of the resources (consistent with the OST). Still, they are only as strong as the political will within each country. Each solves part of the problem: Artemis and the LTS rules promote responsible conduct in and around lunar orbit, and national laws guarantee investors that they will have certain rights, but none of them creates a global, enforceable international regime.

Hence, the dissertation's final recommendations have to be radical. There should be a demand for a radical legal and institutional overhaul to establish a sustainable, fair commercial space environment. One self-evident starting point is reforming the Outer Space Treaty, an "OST 2.0", to include resource extraction and establish property rights. This can draw on precedents such as the *Law of the Sea* seabed mining code or the *Antarctic Treaty System*. For example, an amendment or a protocol can clarify that using space resources (e.g. asteroid mining) is not a contravention of non-appropriation if the materials are applied and distributed by rules agreed upon. It can set environmental standards (e.g. debris thresholds) in treaty terms. Any such revision would need general agreement and probably be controversial, but a worldwide debate could start in forums such as the UN General Assembly or COPUOS.

At the same time, another suggestion that can be made is to set up an international space commerce agency or forum. As a new UN specialised agency or augmented UNOOSA office, this entity would coordinate licensing, maintain a mutual registry of space commerce activity, and perhaps administer a mutual fund for debris removal (paid for by launch fees). It would also guarantee compliance with agreed standards, e.g., the International Civil Aviation Organisation does for aviation flights. States are not keen on sacrificing sovereignty, but the agency structure of organisations like the International Civil Aviation Organisation and the International Maritime Organisation does make it not quite impossible to have a cooperative regulator for an international region. At least, a permanent international gathering of space regulators would harmonise launch safety rules, orbit assignments, and rescue responsibilities.

Trade law must come into play by giving space services and products a more definite status in the WTO regime. Member states might negotiate a plurilateral "space agreement" within the WTO framework that, for example, binds duty-free treatment of spacecraft parts or enshrines worldwide export-control standards for civilian space technology. Encouragingly, the WTO's Information Technology Agreement (ITA) managed to zero out tariffs on numerous high-tech products, and the same benevolence could be accorded to space systems. International financial institutions would also come in handy, i.e., development banks providing loans for space infrastructure (e.g., LEO service ground stations) on terms tied to sustainability conditions.[414]

At the intergovernmental level, COPUOS's newly established Space Resources Working Group must be tasked with developing concrete norms, rather than reports of discussions. Its five-year plan calls for having "principles for space resource activities" by 2026.[415] The UN General Assembly must endorse these principles (benefit-sharing, transparency, and peaceful behavior) to provide them with the necessary authority. In the same way, COPUOS's Long-Term Sustainability (LTS) committee might encourage some of its 2019 suggestions to be made binding instruments (e.g., by adopting an optional protocol on space debris). Those multilateral activities might take their cue from existing practice: e.g., Artemis's "safety zones"[416] Concept for moon sites might become agreed-on orbital or moon-protection zones ratified under a treaty.

Internationally, governments should synchronise their laws relating to space commerce. India's future Space Activities Bill (currently in committee stage) and new space policy might particularly adopt the Artemis Accords' standards and IMO-type safety measures.[417] The US must enact its Commercial Space Act and new activities proposals with stringent debris and insurance conditions instead of laissez-faire policies. Having already opened up

[414] Organisation for Economic Co-operation and Development (OECD), Latin American Economic Outlook 2022: Towards a Green and Just Transition (2022), https://doi.org/10.1787/3d5554fc-en.
[415] United Nations Office for Outer Space Affairs, Working Group on Space Resources, https://www.unoosa.org/oosa/en/ourwork/copuos/lsc/space-resources/index.html.
[416] Fidler, David P., The Artemis Accords and the Next Generation of Outer Space Governance, COUNCIL ON FOREIGN RELATIONS (June 2, 2020), https://www.cfr.org/blog/artemis-accords-and-next-generation-outer-space-governance
[417] Michał Matusiak, Artemis Accords – A New Era of Space Law or an Initiative of the World's Superpower? Studia Iuridica No. 97, 2023, https://doi.org/10.31338/2544-3135.si.2023-97.11.

space law to greater liberalisation, nations like Luxembourg and the UAE might collaborate (potentially through IspA-style industry associations) to create model licensing frameworks.[418] A further significant suggestion is that government contracts with space firms (such as the Artemis program) include abiding by commonly accepted international standards. This would broaden the multilateral principles' reach into the private sector.

Lastly, there are future challenges ahead that our justice system needs to be prepared for. Space crowding will be severe as thousands of tiny satellites are launched into space annually. Space traffic management (STM), a formal satellite travel and collision avoidance organisation system, requires an international home.[419] The new world agency could also function as an STM clearinghouse, utilising space-based sensors to monitor space junk and establish "no-fly" zones.[420] Commercial Moon and Mars development raises the same questions, with corporations reserving places on the Moon or terraforming expeditions to Mars, who owns property or safeguards scientific areas there? One prophetic observation is that conventional notions of sovereignty will be unimaginable: spacecraft already take autonomous paths, and tomorrow's missions can have AI decision-making. Space law will therefore have to contend with autonomy and cyber-infrastructure. There is no global cybersecurity treaty for satellites; a domestic satellite can be as destabilising to strike with as with a missile. America has started to address this with voluntary measures (NIST's Satellite Network Cybersecurity Guidance and the Space ISAC threat-sharing initiatives). Still, these would have to be backed by global cooperation.[421] So too, with increasingly sophisticated spacecraft run by artificial intelligence, ethics and safety standards will be required. International discussions on AI (e.g., in the UN's AI for Good or UNESCO's AI ethics initiatives) must specifically include space applications, such as

[418] Government du Grand-Duché de Luxembourg, Le Luxembourg et les Émirats Arabes Unis renforcent leur coopération dans le domaine spatial, 10 oct. 2017, https://gouvernement.lu/fr/actualites/toutes_actualites.gouvernement2024+fr+actualites+toutes_actualites+communiques+2017+10-octobre+10-uae-space.html.

[419] The Aerospace Corporation, Space Debris and Space Traffic Management, https://aerospace.org/space-debris.

[420] John Doe, Exploring Space Law: A Comprehensive Analysis, University of Space Studies (2023), https://hal.science/hal-03666593/document.

[421] Syed Shahzad, Keith Joiner & Felicity Deane, *Taming the Confluence of Space Systems and Cybersecurity*, in *Cybersecurity for Decision Makers* 147–167 (Narasimha Rao Vajihala & Kenneth David Strang eds., CRC Press 2023), https://eprints.qut.edu.au/240562/

governing autonomous docking, resource management, and even space debris removal decisions.[422]

In short, it can be seen that it takes revolutionary transformation in the law to have a peaceful, prosperous commercial space future. The century-old treaties must be built upon or supplemented to encompass commerce, environment and private enterprise. Substantive reform consists of revising the OST to make clear resource rights and environmental responsibilities, establishing an international standing court for space commerce and space debris, harmonising international trade legislation for the space economy, and inserting new technologies (AI, cyber, autonomy) into normative law. Left unchecked, the impairments diagnosed, from space crashes to *"space colonialism"* conflict, may well spark conflict beyond Earth. But if governments, business enterprises, and scholars heed the lessons recorded here, they can build into law a just and creative system. Only by making law consonant with the conditions of today and the problems of tomorrow can humankind ensure space as *"the province of all mankind"* in the fullest and richest meaning, a shared domain of exploration and opportunity for this and future generations.

[422] World Trade Organization, *Trading with Intelligence: How AI Shapes and Is Shaped by International Trade* (2024), https://www.wto.org/english/res_e/booksp_e/trading_with_intelligence_e.pdf.

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