
IPR PROTECTION STRATEGIES IN GLOBAL SPACE INDUSTRY – A COMPARATIVE ANALYSIS

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ABSTRACT

The space industry, which is ever-growing, makes it crucial for the companies to protect their innovative ideas and technologies through intellectual property (IP) protection. Drone, supersonic, unmanned aerial systems and jet packs and such others, are some of the new inventions which are underway in the space industry. Intellectual property rights in their actual sense provide vital protection and safeguard in the form of patents, trademarks, trade secrets, copyrights, licensing agreements, which are essential for the protection of composite materials which are required in areas of advancements. By analysing legal framework combined with enforcement and litigation strategies the complex nature of the industry makes it essential to bring about an advancement in the industry, since the research and development investment stakes are high and the involvement of the private sector which leads to misappropriation and intellectual property theft as well. This research paper explores a comparative analysis regarding the IPR protection strategies which are employed by various countries worldwide and by analysing the international framework such as the TRIPS agreement, WIPO standards and the respective national regimes it is noted that the geopolitical as well as the institutional factors are brought into concern while framing the regulations to protect these volume based portfolios. This paper identifies the challenges which the cross-border enforcement brings about as there are varying legal systems to adapt to the corporate industry dynamics. It draws its conclusion by offering recommendations for creating a harmonized forefront for global IP enforcement while also eradicating the technology theft, IP litigation and fragmented protection regimes.

Keywords: intellectual property, cross-border enforcement, patents, trademarks, space industry.

STATEMENT OF PROBLEM:

Upon the rapid expansion of the global space industry which was driven by the government space agencies, private corporations, and international collaborations has created new challenges in protecting intellectual property rights (IPR). Space technologies which often involve dual-use innovations, sensitive data and high value patents and designs which must be safeguarded across multiple jurisdictions. Due to the lack of uniform international legal framework coupled with an overlap around the national laws and treaties such as, outer space treaty (1967) which complicates the enforcement of IPR in outer space. This leads to the uncertainties over the patent recognition, ownership of space-derived innovations, licensing and technology transfer. Thus, a comparative study of IPR protection strategies across different jurisdictions which is essential to identify gaps, best practices and the potential pathways for harmonization.

RESEARCH QUESTIONS:

1. What are the current IPR protection mechanisms available for space-related technologies at the national and international levels?
2. How do different jurisdictions approach IPR in the space industry?
3. How do international treaties such as the outer space treaty, TRIPS, and other bilateral agreements influence IPR protection in space exploration and commercialization?
4. What are the comparative insights can be drawn to formulate a more harmonized framework for IPR protection in the global space industry ?

RESEARCH OBJECTIVES:

1. To examine the scope and application of IPR in the context of space technology and commercialization.
2. To analyse the existing legal framework which governs IPR protection in key spacefaring nations.
3. To evaluate the effectiveness of international treaties and agreements in addressing IPR disputes in the space sector.
4. To provide a comparative analysis of IPR strategies adopted by different jurisdictions.

INTRODUCTION:

Intellectual property rights are the rights that are given to persons over their creation of minds. They are usually given as an exclusive right over the use of his/her creation for a certain period of time. The commercialization of space activities has highlighted the growing need for intellectual property rights (IPR) protection, particularly as the involvement of private entities has increased by the need for more economic incentives. The need arises because commercial actors seek to protect their investments and their products of their work in outer space, mirroring terrestrial business practices. IP Protection would not be a problem, which was one of the main issues with the protection of creations in space was laid during the cold war era, since space amounts to national interest, whereas intellectual property aims to protect the interests of the private owners, entities and creators within nations. These creations are economically exploited in space, hence the owner of the creation has the right for legal recourse. Incorporating IPR into space ultimately indicates that the state is willing to be a party and is capable of providing protection to creations wherein it is economically exploited in space. Although there are a few variety of public policy measures which could be used to entice the private sector to participate, the intellectual property protection will be a critical area to cover in the future growth of space activities. There exists a variety of public policy measures that would be used to encourage the private sectors to participate, and during this recourse, building essential public and private space business models. Given the increase in relevance to intellectual property rights and their infringement and the activities that concern the intersection of joint ventures between private and governments in the space sector it is critically important that the current legal framework and infrastructure for IP protection has to be developed. During the initial stages of space exploration, the US played a dominant role in the regulation of these activities. However these efforts played are no longer adequate to deal present issues relating to the use of outer space, largely for their failure to keep abreast with the rapid technological advances. These technological advances raises issues affecting the rights of states and the right of individuals¹. One among the major key issues of protection of intellectual creations with regard to the inventions in outer space is that national IPR's are territorial in nature and the outer space lacks territorial claims. While international law would cover conventions like the Berne conventions on copyrights, the rights under this convention

¹ Upadhyay, P. (n.d.). A Comparative Study of Intellectual Property Rights Issues in Space Activities in U.S.A., Canada and India. *Manupatra*. <https://docs.manupatra.in/newsline/articles/Upload/DFC0906E-2C8A-45EF-8553-8604077E1D49.pdf>

are also territorial and would also not seemingly extend to outer space wherein the nor the sovereignty or the jurisdiction applies. This article discusses about the jurisdictional issues and the boundaries of outer space through historical evolution of international space law and the fundamentals with regard to the fundamental principles of intellectual property law and its intersection with outer space.

The global space industry has undergone a transformative shift from government-dominated activities to a vibrant commercial ecosystem worth over \$630 billion in 2023, projected to reach \$1.8 trillion by 2035. This unprecedented growth, driven by private companies and international collaboration, has brought intellectual property rights (IPR) protection to the forefront of space policy discussions. The challenge lies in adapting terrestrial IP frameworks to the unique environment of outer space, where traditional concepts of jurisdiction and territoriality face fundamental obstacles.²

THE EVOLUTION OF SPACE IP LANDSCAPE:

The space sector has experienced a remarkable evolution from the early days of state-monopolized space activities to today's "New Space" economy. Patent filing trends reveal this transformation dramatically – global space technology patent families increased from approximately 1,400 in 2011 to over 9,000 in 2023, representing a compound annual growth rate of 15% since 2010. This acceleration coincides with the emergence of private space companies like SpaceX, which alone holds 202 patents globally with 88% active status.³ The shift toward commercialization has fundamentally altered the IP landscape. Unlike traditional government-led space programs where knowledge sharing was prioritized, today's private companies require robust IP protection to secure investments and maintain competitive advantages. This transformation has exposed significant gaps in existing legal frameworks, which were designed primarily for state-sponsored activities rather than commercial ventures.

Jurisdictional complexities in space:

The primary challenge in space IPR protection stems from the territorial nature of intellectual property law colliding with the “global commons” principle governing outer space. The 1967

² Tran, B. (2025, August 22). Global Space industry growth in 2024: 50+ Key Stats You Must Know. *PatentPC*. <https://patentpc.com/blog/global-space-industry-growth-in-2024-50-key-stats-you-must-know>

³ *SpaceX Patents - Insights & stats (Updated 2024)*. (2025, September 4). Insights; Gate. <https://insights.greyb.com/spacex-patent/>

outer space treaty establishes that outer space “is not subject to national appropriation by claim of sovereignty”, creating a fundamental tension with the IP rights that traditionally depend on territorial jurisdiction. The doctrine of “quasi-territoriality” has emerged as the primary solution, whereby space objects registered in a particular country remain under that nation’s jurisdiction. The doctrine of “quasi-territoriality” has emerged as the primary solution, whereby space objects registered in a particular country remain under that nation’s jurisdiction. This approach extends the registering state’s laws, including IP laws, to the space object and the activities which are conducted within it. However, this solution has limitations, particularly for activities occurring outside registered space objects or involving multiple jurisdictions.

COMPARATIVE ANALYSIS OF NATIONAL STRATEGIES:

The United States has established the most comprehensive legal framework for space IP protection through the Patents in Space Act of 1990 (35 U.S.C. § 105). This legislation provides that "any invention made, used or sold in outer space on a space object or component thereof under the jurisdiction or control of the United States shall be considered to be made, used or sold within the United States."⁴

KEY FEATURES OF THE US APPROACH:

- **Comprehensive coverage:** the law extends to manufacturing in space, including 3D printing and assembly operations.
- **Registration-Based Jurisdiction:** space objects registered in the U.S. remain under the U.S patent law.
- **Strategic Filing Requirements:** companies are advised to file in multiple jurisdictions, prioritizing spacefaring nations.
- **Product vs. Method claims:** Emphasis on product claims over method claims to strengthen enforceability.

However, the U.S system faces challenges from the “flags of convenience” loophole, where competitors can potentially avoid U.S patent by registering space objects in countries without

⁴ Davidson, K. (2023, August 20). *Extraterrestrial Law: Protecting patents in outer space and on celestial bodies*. IPWatchdog.com | Patents & Intellectual Property Law. <https://ipwatchdog.com/2023/08/20/extraterrestrial-law-protecting-patents-outer-space-celestial-bodies/id=164862/>

similar IP protections.⁵

EUROPEAN UNION: INSTITUTIONAL INTEGRATION

The European Space Agency (ESA) has developed a sophisticated IP framework that balances member state interests with collective European competitiveness. The ESA's IP policy underwent significant revision in 2001, shifting from a public – access approach to one that encourages active commercial exploitation.

ESA'S Strategic Elements:

- **Balanced Portfolio:** ESA maintains approximately 450 patent applications and patents, filing 15-20. New inventions annually.
- **Technology Transfer:** Active licensing programs to promote European industry competitiveness.
- **Security Integration:** the EU Space Programme includes robust security provisions protecting classified information and controlling technology transfer.
- **Unitary Patent system:** the new European Unitary Patent provides streamlined protection across 24 member nations.⁶

The EU approaches emphasizes strategic autonomy while maintaining international cooperation, particularly evident in the EU Space Strategy for Security and Defence adopted in March 2023.

CHINA: RAPID DEVELOPMENT AND STRATEGIC FOCUS

China has emerged as a major player in space IP, with Chinese organizations dominating patent holdings. The Chinese Academy of Sciences leads to globally with over 2,120 patent with families in space technologies, which focuses primarily on the communication and security applications. China's approach combines state- directed research with increasing private sector

⁵ Davidson, K. (2023b, August 20). *Extraterrestrial Law: Protecting patents in outer space and on celestial bodies*. IPWatchdog.com | Patents & Intellectual Property Law. <https://ipwatchdog.com/2023/08/20/extraterrestrial-law-protecting-patents-outer-space-celestial-bodies/id=164862/>

⁶ Celerio, C. (2023). EU Space Policy and Strategic Autonomy: Tackling legal complexities in the enhancement of the 'Security and Defence dimension of the Union in Space.' *European Papers*. <https://doi.org/10.15166/2499-8249/669>

participation⁷.

The Institutional concentration which uses major universities and state research institution which drive patent activity and heavy emphasis on the satellite communication and the security technologies. The role of bilateral IP arrangements over the multilateral frameworks and the developing trade secret protection and evolving framework for protecting confidential information⁸.

JAPAN: RESOURCE- FOCUSED INNOVATION

Japan has taken a unique approach by becoming the fourth country to enact space resource legislation through the Space resource legislation through the Space Resources Act. This law explicitly addresses IP issues related to space mining and resource extraction. The institutional framework of the space resources act, provides legal framework for private ownership of extracted Space Resources Act. This law explicitly addresses IP issues which is related to space mining and resource extraction. Space Resource Act: Provides legal framework for private ownership of extracted space resources and a close cooperation with the United States through the various agreements which focus on human- machine interfaces and the automation technologies. IP strategic programme 2024, is a comprehensive national IP strategy addressing space technologies.⁹

INDIA: EMERGING FRAMEWORKS

India which is known to be a developing country which represents a rapidly developing space power seeking which seeks to establish a comprehensive IP frameworks. The Indian Space Research Organisation (ISRO) has filed over 370 patents with 226 currently active globally. However, India lacks in specific IP legislation, which creates a vulnerability for commercial partnerships. Indian Development proposed space activities under development with specific IPR provisions and strong ISRO portfolio with patents but with limited commercial licensing. The part of International collaboration with active engagement in multilateral space initiatives.

⁷ WIPO Technology Trends Technical Annex: Future of Transportation in Space - Top patent owners. (n.d.). *WIPO Technology Trends Technical Annex: Future of Transportation in Space*. <https://doi.org/10.34667/tind.57970>

⁸ Muehlfeld, K., & Wang, M. (2022). Intellectual Property Rights in China—A literature review on the public's perspective. *Frontiers in Sociology*, 7. <https://doi.org/10.3389/fsoc.2022.793165>

⁹ *Space Law 2025 - Japan | Global Practice Guides | Chambers and Partners*. (n.d.). <https://practiceguides.chambers.com/practice-guides/space-law-2025/japan/trends-and-developments>

The capacity was built which focuses on legal awareness and IP education in space sector.

Enforcement challenges in enforcing IP rights in space presents unique challenges due to the remote nature of space activities and the difficulty of monitoring infringement. Unlike terrestrial patent enforcement wherein the infringement can be observed and documented, space-based activities which often occur beyond direct observation.

Some of the enforcement strategies include;

- Ground-Based Focus: concentrating enforcement efforts on Earth-based manufacturing, testing, and launch activities.
- Contractual Agreements: comprehensive IP clauses in launch service agreements and international partnerships.
- International cooperation: collaborative monitoring through space situational awareness programs.
- Blockchain solutions: emerging proposals for blockchain- based IP registration and tracking systems.¹⁰

TRADE SECRETS Vs. PATENTS IN SPACE APPLICATIONS:

The space industry presents unique considerations for choosing between patent protection and trade secret strategies. Companies like SpaceX has notably relied heavily on the trade secrets which is rather than patents, with Elon Musk famously stating that “patents are for the weak.” This approach reflects the particular challenges of space technology IP protection. Some of the advantages of trade secrets and patent advantages in space;

Trade Secret Advantages:

- Indefinite protection: No expiration date unlike 20- year patent terms.
- No disclosure: Avoid public disclosure of sensitive technologies.
- Reduced vulnerability: less susceptible to “flags of convenience” loopholes.
- Cost efficiency: lower initial costs to global patent filing strategies.

¹⁰ Prasad, G. G. a. P. (2025b, June 10). *When India is Shooting for the Stars-Who Owns the Star? IPR Law Beyond Borders - Bridge Counsels*. Bridge Counsels. <https://bridgecounsels.com/when-india-is-shooting-for-the-stars-who-owns-the-star-ipr-law-beyond-borders/>

Patent Advantages:

- Positive Rights: active exclusion of competitors rather than defensive secrecy.
- Investment Attraction: patent provide tangible asset value for investors.
- Licensing Opportunities: Revenue generation through licensing agreements.
- Enforcement Tools: Legal remedies against infringement.¹¹

The choice between patents and trade secrets often depends on the specific technology type, detectability of infringement and business model of the company involved.

INTERNATIONAL FRAMEWORKS AND TREATIES:

The Artemis Accords: The Artemis Accord, signed in October 2020, which represents a significant development in space governance with 29 signatory nations as of 2024. While not which creates binding IP law, the accords which recognize IP as a critical issue requiring bilateral treaty provisions.

Key IP-Related Provisions:

- Bilateral treaty provision requirements such as the agreements between the signatories must address “liability, intellectual property, and the transfer of goods and technical data”.
- Safety zones which proposed safety zones around lunar installations could provide basis for IP jurisdiction.
- Commercial activities must provide a framework supporting private commercial activities requiring IP protection.
- Resource rights which provides implicit support private commercial space activities requiring IP protection.

WIPO initiatives and Future frameworks: The WIPO has started addressing issues through various initiatives and publications. WIPO’s 2024 indicators report highlights the growing importance in global patent landscapes.

Proposed WIPO solutions: Madrid system expansion which extends trademark protection to

¹¹ Catchpole, S. (2024, September 18). *Intellectual Property Strategies for space Technologies – patent or trade secret?* - Space East. Space East. <https://spaceeast.co.uk/intellectual-property-strategies-for-space-technologies-patent-or-trade-secret/>

designated space territories and OSIPO (outer space IP office) which proposes a specialized office for space IP registration.

International Space Station Model: The International Space Station Intergovernmental Agreement provides the most successful example of multilateral space IP governance. Article 21 establishes clear principles for IP created or used aboard the ISS, treating different modules as extensions of their registering nations' territories.

ISS IP Framework Features:

- Modular Jurisdiction: Each pressurized element governed by registering nation's laws.
- Activity- Based Determination: IP rights determined by location of activity.
- Traditional protection: patents, trade secrets and copyright all recognized.
- Enforcement mechanisms: provides clear procedures for resolving IP disputes.¹²

Technological Sector Analysis: Communication technologies dominate space IP portfolios, representing the largest category of patent filings. Companies like Qualcomm and Nokia have significantly expanded their space-related patent portfolios, recognizing the growing importance of satellite communications.¹³

Key Developments: satellite internet and Starlink and similar mega- constellations driving patent activity and 5G integration space-terrestrial network integration creating new IP opportunities. Quantum communications which emerges quantum satellite technologies by requiring specialized protection. Cybersecurity by increasing focus on protecting space-based communication systems.

Propulsion and Launch systems: Propulsion technologies represent a critical area for IP protection, with companies like SpaceX and Blue Origin heavily investing in reusable rocket technology. The technical complexity and high development costs make IP protection essential for maintaining competitive advantages.

Innovation Areas: Reusable rockets and revolutionary technologies which requires comprehensive patent protection and green propulsion which requires green propulsion and

¹² *Intellectual property rights and space activities.* (n.d.). <https://www.esa.int/esapub/bulletin/bullet79/balsano.htm>

¹³ WIPO Technology Trends Technical Annex: Future of Transportation in Space - Top patent owners. (n.d.-b). *WIPO Technology Trends Technical Annex: Future of Transportation in Space.* <https://doi.org/10.34667/tind.57970>

environmentally sustainable propulsion systems which gains importance in this growing age. In space- propulsion technologies which requires orbit changes and deep space missions through manufacturing innovations with 3D printing and in-space manufacturing techniques.

Space Manufacturing and Materials: The emerging field of space manufacturing by presenting a unique IP challenges, as a traditional concepts wherein inventions are “made” become a state unclear and the production occurs in orbit. The U.S. patents in Space Act explicitly address this by deeming space – based manufacturing which occurs within U.S. territory for registered objects.¹⁴ Manufacturing applications such as pharmaceutical production such as microgravity of drugs and biological materials and the materials which are unique in nature and is only possible in space conditions, specialized space – based electronic component production and in space assembly and construction methods.

CHALLENGES AND LIMITATIONS:

One of the most significant challenges in space IP protection is the potential for entities to evade patent restrictions by registering space objects in jurisdictions with limited IP protection. This "flags of convenience" approach mirrors similar issues in maritime law. some of the multilateral treaties such as agreements preventing flag-of-convenience and patent evasion and registration convention amendments which strengthens registration requirements and economic incentives by creating economic advantages for countries with strong IP frameworks and by providing standards for self- regulation through industrial associations. The tension between IP protection and the "province of all mankind" principle in space law creates ongoing challenges. Overly broad IP protection could conflict with the collaborative spirit of space exploration, while insufficient protection could discourage private investment. Compulsory licensing and mandatory licensing for essential space technologies and research exemptions for protection of scientific activities. Incentives for collaborative development and structures arrangements for balancing interests.

Future Directions and Recommendations:

The immediate focus must be on strengthening existing framework at the same while

¹⁴ Stubblefield, T., & Stubblefield, T. (2025, September 15). *Protecting Inventions for In-Space Manufacturing – How the Space Act and Patent Claim Strategy can help*. Knobbe Martens. <https://www.knobbe.com/blog/protecting-inventions-for-in-space-manufacturing-how-the-space-act-and-patent-claim-strategy-can-help/>

developing comprehensive international agreements. Some of the priorities include;

- National legislations must develop comprehensive frameworks.
- Expansion of bilateral treaties addressing IP issues.
- Industry standards and development of best practices for space IP protection.
- Training programs for IP professionals in space law.

CONCLUSION:

The protection of intellectual property rights in the global space industry represents one of the most complex legal challenges of our time. As the space economy continues its exponential growth, the tension between terrestrial IP frameworks and the unique environment of outer space becomes increasingly critical to resolve. The comparative analysis reveals significant variations in national approaches, from the United States' comprehensive Patents in Space Act to the European Union's institutional integration model and China's state-directed development strategy. Each approach offers valuable lessons, but none provides a complete solution to the fundamental challenges posed by space commercialization. The success of future space IP protection will depend on several key factors: international cooperation in developing unified standards, technological innovation in monitoring and enforcement, and careful balance between innovation incentives and collaborative exploration principles. The emerging frameworks, including the Artemis Accords and WIPO initiatives, provide important stepping stones toward more comprehensive solutions. As private companies continue to drive space innovation and governments seek to maintain strategic advantages, the development of robust, internationally coordinated IP protection mechanisms becomes not just beneficial but essential. The nations and companies that successfully navigate these challenges will likely emerge as leaders in the trillion-dollar space economy of the coming decades.

The path forward requires unprecedented cooperation between legal systems, space agencies, and private companies. While the challenges are significant, the potential rewards both economic and scientific justify the effort required to create a comprehensive, fair, and effective system of intellectual property protection for humanity's final frontier.

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