

THE BIG BANG OR A BLACK HOLE? THE NEXUS BETWEEN OUTER SPACE PATENT LAW AND COMMERCIAL INVESTMENT IN OUTER SPACE

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INTRODUCTION

Everyone has looked up into the dark, quiet night sky to see the vast expanse of space lit up by hundreds of billions of stars.¹ Observant people may have further noticed a satellite or two, which can be seen as dots of light floating across the sky.² Perhaps then only the occasional observant and curious patent lawyer might wonder, who, if anyone, has the patent rights to the technology on board that satellite?³

Currently, national-level law regimes and international agreements govern objects and patentable inventions in outer space.⁴ This multi-jurisdictional patchwork of legal systems creates confusion, uncertainty, and jurisdictional ambiguities.⁵ Uncertainty as to the application of patent law beyond Earth's atmosphere may hinder

1. See Elizabeth Howell, *How Many Stars Are in the Universe?*, SPACE.COM (May 18, 2017), <https://www.space.com/26078-how-many-stars-are-there.html> (providing that there are an estimated ten trillion galaxies in the universe, each with approximately 100 billion stars). Therefore, according to these estimates, there are approximately 1,000,000,000,000,000,000,000,000 stars in the observable universe. *Id.*

2. See Corey S. Powell, *Spotting Satellites in the Night Sky*, DISCOVER (Sept. 26, 2013), <http://discovermagazine.com/2013/oct/22-satellite-spotting> [<https://perma.cc/F58A-PQ3A>] (discussing what a satellite looks like in the night sky).

3. See Matthew J. Kleiman, *Patent Rights and Flags of Convenience in Outer Space*, 23 AIR & SPACE L. 4, 5–6 (2011) (discussing the confusion concerning patent rights in outer space).

4. See *id.* (discussing how space law is governed by a mix of national law and international law).

5. See Theodore U. Ro, Matthew J. Kleiman & Kurt G. Hammerle, *Patent Infringement in Outer Space in Light of 35 U.S.C. § 105: Following the White Rabbit Down the Rabbit Loophole*, 17 B.U. J. SCI. & TECH. L. 202, 206 (2011) (“[P]atent law is inherently and traditionally territorial and that a nation’s borders do not extend into outer space, commercial space patent litigation raises some important questions . . . finding the answer to these questions becomes an adventure through a thicket of statutory law, case law, and international treaties. The adventure is much like Alice’s in Wonderland, which began when she chose to follow the ‘white rabbit down the rabbit hole,’ with the answer to one question only leading to more questions.”).

current and future opportunities for commercial investment in outer space.⁶ This issue is especially relevant today as the role of space use and exploration has dramatically shifted from governments to private entities.⁷ To accommodate the increasing privatization of space and further promote commercial investment in space, a system of patent law with increased certainty and unity in outer space is necessary.⁸ Humans are becoming an increasingly space-faring civilization, and space will likely be a major part of the future.⁹ Now, more than ever, a more robust system of patent law in outer space is necessary to enable humans to explore and master the final frontier.¹⁰

6. See S. COMM. ON THE JUDICIARY, INVENTIONS IN OUTER SPACE, S. Rep. No. 101-266, at 5 (1990) (“U.S. inventors may have difficulty establishing priority of invention if the activities determining conception of the invention, reduction to practice, and diligence took place in outer space. Second, activities in outer space relevant to the prior art of a patent application could not be raised in an interference proceeding. Finally, the holder of a valid U.S. patent would be unable to enjoy or collect damages for infringing activities conducted in outer space. Uncertainty as to the application of the patent law in these areas may chill prospects for commercial investment in outer space research and manufacturing.”).

7. See WORLD INTELL. PROP. ORG., INTELLECTUAL PROPERTY AND SPACE ACTIVITIES 4 (2004) (“Despite the fact that space technology is always one of the most advanced technical area, and outer space activities are, in fact, the fruit of intellectual creations, it is only in recent years that intellectual property protection in connection with outer space activities has raised wider attention. One of the reasons is that the space activities are increasingly shifting from state-owned activities to private and commercial activities.”); Mathew Smith, *Commercialized Space and You*, HARV. UNIV. (June 11, 2018), <http://sitn.hms.harvard.edu/flash/2018/commercialized-space-and-you/> [<https://perma.cc/4KYW-4BUS>] (describing the shift away from the twentieth century model of space exploration by governments to private sector space exploration and investment); Monica Grady, *Private Companies Are Launching a New Space Race – Here’s What to Expect*, PHYS.ORG (Oct. 3, 2017), <https://phys.org/news/2017-10-private-companies-space.html> [<https://perma.cc/2233-UDLQ>] (discussing the increasing impact that private enterprises are having on outer space endeavors).

8. See S. Rep. No. 101-266, at 5 (discussing that a system of patent law with certainty in patent rights is necessary to promote commercial investment).

9. See Joshua Hampson, *The Future of Space Commercialization*, NISKANEN CTR. (Jan. 25, 2017), <https://niskanencenter.org/blog/news/future-space-commercialization/> [<https://perma.cc/KFD7-U7AT>] (discussing the future of space commercialization and how the United States government can promote innovation and growth in outer space).

10. See Dan L. Burk, *Application of United States Patent Law to Commercial Activity in Outer Space*, 6 SANTA CLARA COMPUT. & HIGH-TECH. L.J. 295, 329 (1991) (discussing issues with ambiguities that arise regarding territorial jurisdictions governing patent law in outer space); see also Gennady M. Danilenko, *Outer Space and the Multilateral Treaty-Making Process*, 4 HIGH TECH. L.J. 217, 223 (1989) (discussing that international cooperation is necessary in the promulgation of new and effective space law).

Part I of this Comment explores the development of patent law in outer space as well as how the international community has addressed jurisdictional ambiguity and patent law at the international level.¹¹ Part II of this Comment analyzes the negative impact of current outer space patent law on private-sector investment and pursuits in space activities.¹² Part III of this Comment proposes various solutions to the problems presented by current outer space patent law, including the framework for a unified system of outer space patent law that will provide a more cost-effective and desirable system of outer space patent law.¹³

I. OUTER SPACE PATENT LAW AND INTERNATIONAL COOPERATION ON EARTH

For hundreds of years, countries around the world have recognized patent law in some form.¹⁴ The idea of protecting and excluding others from information gained through another's hard work dates back to at least the Roman era.¹⁵ The legal concept of granting exclusive rights to an inventor for an invention goes back more than half a millennium to fifteenth-century Italy.¹⁶ Therefore, mankind, at least in part, has historically recognized the importance of having a system in place that ensures that hard work, risk-taking, and innovation are rewarded.¹⁷ Many societies throughout history have seemingly seen this system as both necessary for promoting

11. See *infra* Part I (discussing the history and development of outer space law as well as how the international community has addressed global patent and jurisdictional issues).

12. See *infra* Part II (discussing issues with the current system of outer space patent law).

13. See *infra* Part III (discussing both short-term and long-term solutions that will boost the confidence of commercial entities interested in investing in outer space endeavors).

14. See Edward C. Walterscheid, *The Early Evolution of the United States Patent Law: Antecedents*, 76 J. PAT. & TRADEMARK OFF. SOC'Y 697, 706 (Sept. 1994) (discussing the history of patent law).

15. See *id.* at 703 ("The argument has convincingly been made that the idea of intellectual property arose from the recognition by the guilds that craft knowledge in and of itself had commercial value and as a result ought to be protected[] [s]ince guilds existed in the Roman era.").

16. See *id.* at 705–06 ("[I]t appears that the concept of the state granting some form of exclusive rights in their inventions to inventors, which would ultimately come to commonly be known as patents of monopoly, originated first in Italy, primarily in Venice, during the early part of the fifteenth century.").

17. See *id.* at 703–06 (discussing the various systems of patent law that have been created over human history and the motivations behind their creation).

technological and economic development and central to the idea of fundamental fairness within a society.¹⁸

Patent law, whether in outer space or on Earth, is territorial and governed by its respective jurisdiction.¹⁹ Human endeavors in outer space, such as the International Space Station where scientists are conducting research and making discoveries, present unique challenges to the territorial nature of patent law.²⁰ These issues present complex and troubling scenarios to businesses seeking to invest in outer space.²¹ Outer space is becoming an increasingly integral

18. See *id.* at 706 (discussing that in the sixteenth century the concept of a government granting some form of exclusive rights to inventors for their inventions, which would later be known as patents of monopoly, spread rapidly through Germany, France, the Netherlands, and England); see also Adam Smith, AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS 330 (Anthony Uyl ed., Devoted Publ'g 2016) (1776) (“When a company of merchants undertake, at their own risk and expense, to establish a new trade with some remote and barbarous nation, it may not be unreasonable to incorporate them into a joint-stock company, and to grant them, in case of their success, a monopoly of the trade for a certain number of years. It is the easiest and most natural way in which the state can recompense them for hazarding a dangerous and expensive experiment, of which the public is afterwards to reap the benefit. A temporary monopoly of this kind may be vindicated, upon the same principles upon which a like monopoly of a new machine is granted to its inventor, and that of a new book to its author.”).

19. See R. CARL MOY, MOY’S WALKER ON PATENTS § 12.1 (4th ed. 2017) (explaining that the United States only has authority over patent infringement occurring within its jurisdiction, whether that be within its borders, on the high seas, or in space).

20. See Elizabeth L. Winston, *Patent Boundaries*, 87 TEMP. L. REV. 501, 501 (2015) (“As the limits of technology and geography increase, the delineation of the patent boundaries of the United States becomes increasingly important.”).

21. See Leo B. Malagar & Marlo Apalisok Magdoza-Malagar, *International Law of Outer Space and the Protection of Intellectual Property Rights*, 17 B.U. INT’L L.J. 311, 363 (1999) (“Because intellectual property rights are generally based on territoriality, their application to situations in outer space may cause problems, because outer space can not be the subject of national appropriation.”); Winston, *supra* note 20, at 532–35 (discussing the difficulties in determining which patent law regime applies in space and the issues associated with jurisdictional ambiguities and patent law).

component of society.²² Consequently, laws regarding the use of outer space have a larger impact on society than ever before.²³

A. The Origins and Development of Space Law from an International Perspective

The earliest detailed writings on space law appeared only in the early part of the twentieth century.²⁴ The international community largely dismissed writings and opinions on space law during this time because there was no human activity in outer space yet.²⁵ Not until 1957 when *Sputnik*, a Soviet satellite, was the first manmade object to enter Earth's orbit did the international community feel an urgency to develop space law.²⁶ The urgency to develop laws regulating the use of space was heightened against the back drop of the Cold War, where the United States found itself competing directly with the Soviet Union in a battle to prove which system—capitalism or communism—was supreme.²⁷

22. See, e.g., Smith, *supra* note 7 (describing the increased investment of money and resources in outer space by the commercial sector and the promulgation of policies by the U.S. government to encourage continued investment and growth of the commercial sector in outer space); see also Alexandro Pando, *Space Industry Booms Thanks to Investors*, FORBES (Oct. 30, 2017, 8:30 AM), <https://www.forbes.com/sites/forbestechcouncil/2017/10/30/space-industry-booms-thanks-to-investors/#2cd3bf7e55d3> [<https://perma.cc/MBP2-TVNX>] (“From just 125 private space agencies in 2011, the industry has expanded to almost 1,000, and it is projected that by 2026 this figure will rise to 10,000.”).

23. See Pando, *supra* note 22.

24. See Malagar & Magdoza-Malagar, *supra* note 21, at 319 (“In 1932, Vladimir Mandl, in his work, *Das Weltraumrecht - Ein Problem der Raumfahrt*, touted as the earliest literature of space law, argued that it was not premature to examine the legal problems which space travel would pose.”).

25. See *id.* at 320 (“While it was acknowledged that Outer Space is a legal entity and that future space activities would have implications in relations among states which need to be defined under international law, discussions on the matter were dismissed as largely speculative, and therefore, not a matter of urgency.”).

26. See *id.*; Steven J. Dick, *50 Years of NASA History*, NASA, https://www.nasa.gov/50th/50th_magazine/historyLetter.html [<https://perma.cc/Y86B-TJD5>] (last visited Nov. 11, 2019) (discussing the launch of *Sputnik* and its historical importance).

27. See Dick, *supra* note 26 (“Like all historical events, the birth of NASA must be placed in the context of its times. Following World War II, the United States was in direct competition with the Soviet Union . . . for the hearts and minds of people around the world. It was not for the most part a shooting war, but a ‘Cold War’, a test of two very different systems of government.”).

The international community engaged in a cooperative effort to develop space law during the Cold War era.²⁸ The international community also largely believed that a global effort was necessary to develop space laws because the nature of space is such that it transcends and blurs international boundaries.²⁹ International efforts took place through the United Nations (U.N.), which was largely responsible for the development and implementation of early space laws.³⁰ The establishment of effective laws to encourage the peaceful use of outer space was seen as particularly important during the heightened tension of the Cold War.³¹ In an effort to establish effective laws particular to outer space, the U.N. General Assembly established the Committee on the Peaceful Uses of Outer Space (COPUOS).³² The purpose of COPUOS was to review and study ways in which outer space laws could ensure international cooperation between nations and the peaceful use of outer space.³³

The effort to establish outer space laws began in 1962 when COPUOS developed the *Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space*.³⁴ This declaration established fundamental principles and basic

28. See Malagar & Magdoza-Malagar, *supra* note 21, at 328 (“It has been established from the very beginning that the regulation of outer space activities requires the cooperation of all members of the international community.”).

29. See *id.* (“The UN was quick enough to realize the international importance of the prospect of conquest of outer space and the need for international cooperation in an arena that clearly transcends national boundaries.”).

30. See Joanne Irene Gabrynowicz, *Space Law: Its Cold War Origins and Challenges in the Era of Globalization*, 37 SUFFOLK U.L. REV. 1041, 1041–46 (2004).

31. See Malagar & Magdoza-Malagar, *supra* note 21, at 328 (discussing how the intensification of the Cold War spurred an arms race between the United States and the USSR).

32. See *id.* at 314 (discussing the establishment of COPUOS and its role in developing space law).

33. See *id.* at 328 (“The intensification of the Cold War between the two superpowers had spurred an arms race that extended to space. It was against this backdrop that the UN General Assembly established the COPUOS. The COPUOS was tasked to review the area of international cooperation and to study practical and feasible means for giving effect to programs in the peaceful uses of outer space which could appropriately be undertaken under the auspices of the UN.”).

34. See G.A. Res. 1962 (XVIII), Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (Dec. 13, 1963); Michael J. Listner, *The Ownership and Exploitation of Outer Space: A Look at Foundational Law and Future Legal Challenges to Current Claims*, 1 REGENT J. INT’L L. 75, 76 (2003).

foundations on which future space laws and treaties were based.³⁵ One such treaty, the Outer Space Treaty, was the first international space treaty.³⁶ Article VIII of the Outer Space Treaty provides guidance on which country maintains jurisdiction over manmade space objects.³⁷ Essentially, a nation maintains jurisdiction over persons and equipment launched into space from its territory on Earth.³⁸

The Convention on Registration of Objects Launched into Outer Space (Registration Convention) further expanded upon Article VIII of the Outer Space Treaty.³⁹ The Registration Convention provides that the launching state must register a space object with the U.N. Secretary General before it is launched.⁴⁰ The launching state must also provide basic details about the object, such as its orbital parameters and the general function of the object.⁴¹ Where there are two or more launching states with respect to a single space object, Article II of the Registration Convention provides that the launching states may, through agreement, determine which country the space object will be registered to.⁴² The registration of a space object does not affect other agreements that countries have regarding jurisdiction

35. See Listner, *supra* note 34, at 76 (discussing the basic principles that the Declaration of Principles Governing the Activities of States in the Exploration and Use of Outer Space provided and how these principles were adopted in subsequent treaties).

36. See generally 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, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

37. See *id.* at art. VIII (“A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body.”).

38. See *id.*

39. See generally Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention] (expanding upon Article VIII of the Outer Space Treaty). The Registration Convention provides more details regarding which country has control over manmade objects in outer space. See *id.* at art. II.

40. See *id.*

41. See *id.* at art. IV. This Article requires the launching state to provide the U.N. Secretary General the name of the launching state or states; an appropriate designator of the space object or its registration number; date and territory or location of the launch; basic orbital parameters including the nodal period, inclination, apogee, and perigee; as well as the general function of the space object. See *id.* Additionally, the launching state is to notify the U.N. Secretary General once an object is no longer in Earth’s orbit. See *id.*

42. See *id.* at art. II (discussing that launching states may determine which country a space object will be registered to).

and control of a space object.⁴³ Therefore, a manmade space object will by default be under the jurisdiction and control of the country it is registered to unless expressly provided otherwise in an agreement between launching states.⁴⁴

Agreements between launching states are becoming more common with the increase in multinational space endeavors.⁴⁵ A good example of a multinational space endeavor is the International Space Station (ISS).⁴⁶ The ISS was constructed by fifteen nations and is the largest spacecraft built to date.⁴⁷ The elements, or modules, making up

43. *See id.* (explaining that when there are two or more launching states with respect to a single manmade space object, they must jointly determine which launching state the object will be registered to “without prejudice to appropriate agreements concluded or to be concluded among the launching [s]tates on jurisdiction and control over the space object and over any personnel thereof”).

44. *See id.*

45. *See, e.g.,* Malagar & Magdoza-Malagar, *supra* note 21, at 363 (explaining that multinational space endeavors, such as the International Space Station, are raising new issues regarding the protection of industrial property); *see also* 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, 399, 409 (1999) (“[O]uter space research and exploration are increasingly multinational undertakings.”); Eric Berger, *Kazakhstan Chooses SpaceX Over a Russian Rocket for Satellite Launch*, ARS TECHNICA (Nov. 6, 2018, 6:36 PM), <https://arstechnica.com/science/2018/11/kazakhstan-chooses-spacex-over-a-russian-rocket-for-satellite-launch/> [<https://perma.cc/CBB9-RT9N>] (explaining that Kazakhstan will launch a satellite using the Falcon 9 rocket, which is built by SpaceX, a private company based in the United States); Ellen Stofan, *When We Explore Space, We Go Together*, SLATE (Mar. 7, 2017, 10:21 AM), <https://slate.com/technology/2017/03/space-exploration-requires-international-collaboration.html> [<https://perma.cc/9VLB-77FY>] (discussing a variety of space endeavors that will be undertaken through international cooperation).

46. *See* Mark Garcia & Brian Dunbar, *International Cooperation*, NASA, https://www.nasa.gov/mission_pages/station/cooperation/index.html [<https://perma.cc/45WD-GR2X>] (last visited Nov. 11, 2019) (“The International Space Station (ISS) Program’s greatest accomplishment is as much a human achievement as it is a technological one—how best to plan, coordinate, and monitor the varied activities of the Program’s many organizations. An international partnership of space agencies provides and operates the elements of the ISS. The principals are the space agencies of the United States, Russia, Europe, Japan, and Canada. The ISS has been the most politically complex space exploration program ever undertaken.”).

47. Winston, *supra* note 20, at 535 (discussing the characteristics of the ISS). Besides being the largest spacecraft ever built, the ISS orbits the Earth at an altitude of 250 miles. *Id.*

the ISS come from the various space agencies of the United States, Russia, Europe, Japan, and Canada.⁴⁸

The Intergovernmental Agreement (IGA) governs activities on the ISS.⁴⁹ The purpose of the IGA is to establish long-term cooperation between nations on the ISS and to enhance the use of the ISS with regards to science, technology, and commercial use.⁵⁰ Consistent with the Registration Convention, the IGA states that nations are responsible for registering their own physical modules or components on the ISS.⁵¹ This provision of the IGA provides that nations will retain control and jurisdiction for their physical portions of the ISS.⁵² Specific to patent law, Article 21 of the IGA provides that activity that occurs in a registered module will be deemed to have occurred in the nation the module is registered to.⁵³ Article 21 further provides that the temporary presence of any object in another jurisdiction other than the

48. See NASA, REFERENCE GUIDE TO THE INTERNATIONAL SPACE STATION 27–42 (Utilization ed. 2015) (describing the different modules that make up the International Space Station). A module can be defined as “[a]n internally pressurized element intended for habitation.” *Id.* at 114. “The International Space Station modules serve as a habitat for its crew and provide ports for docking and berthing of visiting vehicles. The station functions as a microgravity and life sciences laboratory, test bed for new technologies, and platform for Earth and celestial observations.” *Id.* at 26; see also Garcia & Dunbar, *supra* note 46 (discussing the international cooperation involved in constructing the International Space Station).

49. See generally Agreement Among the Government of Canada, Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station, Jan. 29, 1998 [hereinafter Intergovernmental Agreement] (governing activities of the ISS).

50. See Shoemaker, *supra* note 45, at 409 (“The IGA is meant to establish a long-term international cooperative framework . . .”). The IGA also seeks to “enhance the scientific, technological, and commercial use of outer space.” Consistent with this notion, the stated goal of the ISS is to “afford scientists, engineers, and entrepreneurs an unprecedented platform on which to perform complex, long-duration, and replicable experiments in the unique environment of space.” *Id.*

51. See *id.* at 416 (discussing how the IGA addresses space objects in a way that is similar to the Registration Convention).

52. See generally *International Space Station Legal Framework*, EUROPEAN SPACE AGENCY, https://m.esa.int/Our_Activities/Human_and_Robotic_Exploration/International_Space_Station/International_Space_Station_legal_framework [<https://perma.cc/NQ7B-DTR7>] (last visited Nov. 11, 2019) (discussing how the IGA addresses control and jurisdictional issues on board the ISS).

53. See Intergovernmental Agreement, *supra* note 49, at art. 21 (discussing intellectual property generally and patent law relating to the ISS).

one it is registered to, while in transit between Earth and the ISS, cannot form the basis for patent infringement proceedings.⁵⁴

International treaties laid the foundation upon which space law has been built.⁵⁵ International treaties and agreements continue to play a central role in determining a nation's authority and control in outer space.⁵⁶ However, a business seeking to invest in outer space endeavors must also consider national laws.⁵⁷

B. Outer Space Patent Law and Jurisdiction from a National Perspective

Patents designated to the United States are only effective within the United States.⁵⁸ Activities occurring outside of the United States are outside the scope of a patent designated to the United States.⁵⁹ In this context, "United States" includes its territories and possessions, meaning all land on Earth under the control of the United States, vessels at sea registered to the United States, and space objects under the jurisdiction or control of the United States.⁶⁰ The jurisdiction of other countries in outer space is determined in a similar manner.⁶¹ This system of national law in outer space developed and changed over time out of necessity.⁶²

54. See *id.* at 17 ("The temporary presence in the territory of a Partner State of any articles, including the components of a flight element, in transit between any place on Earth and any flight element of the Space Station registered by another Partner State or ESA shall not in itself form the basis for any proceedings in the first Partner State for patent infringement.").

55. See Malagar & Magdoza-Malagar, *supra* note 21, at 330–32 (discussing that international law laid the foundations for the further evolution of space law).

56. See Burk, *supra* note 10, at 296 (providing that international law continues to play a role in governing activities in outer space).

57. See Ro, Kleiman & Hammerle, *supra* note 5, at 206 (discussing how patent law in outer space involves the overlapping of international and national laws).

58. See MOY, *supra* note 19, at § 12:1 ("United States patents are effective throughout the United States of America.").

59. See *id.* (stating that "activities outside the United States are outside the scope of the patent").

60. See *id.* (stating that the United States "includes land areas under United States control, United States registered vessels at sea, and space vehicles and components thereof that are under United States jurisdiction or control").

61. See Malagar & Magdoza-Malagar, *supra* note 21, at 363 (discussing how international agreements in space create fictitious territory to extend over activities taking place on a certain element of the space station belonging to a certain country).

62. See Winston, *supra* note 20, at 526–37 (discussing development of space law from the perspective of the United States and from an international perspective);

The initial development of space law occurred against the backdrop of the Cold War, during which two nuclear superpowers, the United States and the Soviet Union, were competing for global supremacy.⁶³ The inherent danger to the human race during the cold war period caused lawmakers to be less concerned about creating patent laws for outer space and instead to be more concerned with creating laws that would secure the peaceful use of outer space.⁶⁴ Therefore, for most of the twentieth century there was no sense of urgency to promulgate patent laws regarding space activities.⁶⁵ However, the desire to increase the private sector's access to space in the late twentieth century spurred the development of national-level patent laws for outer space activity.⁶⁶

Since the early 1980s, the United States has attempted to encourage private entities to invest in the commercial development of space by enacting the Commercial Space Launch Act.⁶⁷ The Commercial Space Launch Act made it easier for commercial entities to obtain commercial launch licenses and government-developed space technology.⁶⁸ Scholars have also credited the Commercial Space Launch Act with increasing the private sector's use of space.⁶⁹

In furtherance of its goal to promote commercial activity in space, Congress passed the Patents in Space Act, which provided businesses with increased certainty that United States patent laws

see also Ro, Kleiman, & Hammerle, *supra* note 5, at 207–08 (discussing the influence the Cold War had on the development of space law).

63. *See* Ro, Kleiman, & Hammerle, *supra* note 5, at 207.

64. *Id.* (“The founding principles of current space law were largely developed during the height of the Cold War, when lawmakers were focused on regulating the major space-faring nations, rather than the activities of the private sector.”).

65. *See id.*

66. *See* Shoemaker, *supra* note 45, at 395 (discussing the desire of the United States to increase commercial activity in space).

67. *See id.* In 1984, the United States passed the Commercial Space Launch Act of 1984 “to encourage the United States private sector to provide launch vehicles and associated services by simplifying and expediting the issuance and transfer of commercial launch licenses; and facilitating and encouraging the use of Government-developed space technology.” *Id.*

68. *See* William C. Pannell, *Pirate Battles in Outer Space: Preventing Patent Infringement on the 8th Sea*, 46 U. MEM. L. REV. 733, 734 (2016) (explaining that the Commercial Space Launch Act allowed the private sector in the United States to launch spacecraft into outer space for the first time).

69. Shoemaker, *supra* note 45, at 395 (“Partially as a result of [the Commercial Space Launch Act], the number of commercial space launch facilities has dramatically increased, as has the number of private space launches.”); *see* Pannell, *supra* note 68, at 734.

apply in outer space.⁷⁰ Before this statute was passed, even Congress was uncertain as to whether United States patent laws applied to activities in outer space.⁷¹ The Patents in Space Act explicitly extended the United States' jurisdiction, including its federal patent scheme, to all space objects owned by the United States.⁷² Currently, the United States and Germany are the only countries that have officially extended their federal patent law schemes to outer space.⁷³

According to the Patents in Space Act, there are three ways that an activity connected to a space object is considered to have occurred within the United States and therefore subject to United States patent law.⁷⁴ The first scenario is if the space object is unregistered but under the jurisdiction and control of the United States.⁷⁵ The second scenario echoes the principles of the Registration Convention and provides that activity connected to a space object is subject to United States patent law if that space object is registered to the United States.⁷⁶ Finally, the statute provides that an activity connected to the space object occurs within the United States if the object is registered to a foreign country,

70. See 35 U.S.C. § 105 (2018) (providing further clarification on the extension of United States patent law to activities occurring in outer space).

71. See OFF. OF TECH. ASSESSMENT, SPACE STATIONS AND THE LAW 5 (Aug. 1986) (providing that in 1986 “Congress [had] been trying to determine whether the patent laws of the United States already apply in space or whether additional legislation [was] needed”).

72. See Shoemaker, *supra* note 45, at 418 (discussing the extension of United States' jurisdiction and the federal patent law scheme to all objects owned by the United States in outer space).

73. See *Patents and Space-Related Inventions*, EUROPEAN SPACE AGENCY, https://m.esa.int/About_Us/Law_at_ESA/Intellectual_Property_Rights/Patents_and_space-related_inventions [<https://perma.cc/D97M-6Z2G>] (last visited Nov. 11, 2019) (explaining that the United States and Germany have extended their federal patent law schemes to outer space but that “[a]part from these two examples, the national patent laws of other countries do not contain provisions that would make national patent law applicable on board a spacecraft”).

74. See § 105 (discussing ways in which activity connected to a space object in outer space occurs within the United States).

75. *Id.* (“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 for the purposes of this title, except with respect to any space object or component thereof that is specifically identified and otherwise provided for by an international agreement to which the United States is a party, or with respect to any space object or component thereof that is carried on the registry of a foreign state in accordance with the Convention on Registration of Objects Launched into Outer Space.”).

76. See *id.* (discussing that activity connected with an object in space occurs within the United States if the object is registered to the United States); Registration Convention, *supra* note 39.

but there is an agreement between the foreign country and the United States that the object is made, used, or sold within the United States.⁷⁷

The purpose of the Patents in Space Act was to resolve jurisdictional ambiguity over which patent law system applies on space objects owned by the United States.⁷⁸ The hope was that by increasing certainty over intellectual property rights, private sector investment in space would become more attractive.⁷⁹ However, the increasing frequency of multinational research efforts in outer space, coupled with the fact that the United States Supreme Court has opined that there is a presumption against the extraterritorial extension of United States patent law, has limited the jurisdictional clarity that the Patents in Space Act was supposed to provide.⁸⁰

The expansion of global wireless information relay systems in Earth's orbit have brought further consideration to patent law jurisdiction in outer space.⁸¹ Satellites are often part of global systems whose applications extend past the borders of the United States.⁸² The emergence of these technologies forced the United States to abandon

77. § 105 (“Any invention made, used or sold in outer space on a space object or component thereof that is carried on the registry of a foreign state in accordance with the Convention on Registration of Objects Launched into Outer Space, shall be considered to be made, used or sold within the United States for the purposes of this title if specifically so agreed in an international agreement between the United States and the state of registry.”).

78. Shoemaker, *supra* note 45, at 418 (“The hope was that through [the Patents in Space Act], there would be no question as to which intellectual property scheme would apply on United States space objects, resolving issues of priority and ownership of patentable subject-matter.”).

79. *Id.* (“This certainty, in turn, would make the option of investment more attractive to private investors by assuring them of some return on their capital.”).

80. *Microsoft Corp. v. AT&T Corp.*, 550 U.S. 437, 454–55 (2007) (“The presumption that United States law governs domestically but does not rule the world applies with particular force in patent law. The traditional understanding that our patent law ‘operate[s] only domestically and do[es] not extend to foreign activities,’ is embedded in the Patent Act itself, which provides that a patent confers exclusive rights in an invention within the United States.”); Shoemaker, *supra* note 45, at 398–99 (“The Patents in Space Act is, however, subject to international treaties of which the United States is a signatory. This is problematic because outer space research and exploration are increasingly multinational undertakings. Therefore, it is unclear how much protection the Act will really afford American inventors in practice.”).

81. *See* Ro, Kleiman, & Hammerle, *supra* note 5, at 208 (discussing confusion relating to the use of satellites in space that broadcast signals globally).

82. *See id.* (discussing the nature and use of many satellites orbiting around the Earth).

a strictly territorial approach to patent jurisdiction and instead adopt an extraterritorial approach to patent jurisdiction.⁸³

One of the leading cases that developed extraterritorial patent law in the United States is *Decca Ltd. v. United States*.⁸⁴ This case focused on a global navigation system operated by the United States government.⁸⁵ The navigation system consisted of components located in foreign countries, on vessels traveling across the high seas, and on planes traveling outside of United States' jurisdiction.⁸⁶ The court had to decide if the United States' global navigation system was subject to United States' jurisdiction and therefore able to infringe the claims of a United States patent.⁸⁷

The court developed a three-prong test to address this jurisdictional issue.⁸⁸ The first prong asks if the control of a system occurs within United States territory.⁸⁹ The second prong asks if a United States entity owns the system.⁹⁰ The third prong asks if there is a beneficial use for the system in the United States.⁹¹ Using the first prong of the test, the court noted that the construction, operation, and maintenance costs for the system were at the expense of the United States; the United States was responsible for any legal expenses for claims resulting from the operation of the system; and the equipment responsible for monitoring and controlling the system was located within the United States.⁹² Applying the second prong of the test, the

83. See Burk, *supra* note 10, at 324–27 (discussing how the United States abandoned a strictly territorial approach to patent jurisdiction to account for new technologies that transcend physical borders).

84. 544 F.2d 1070 (Ct. Cl. 1976).

85. See *id.* at 1074 (discussing the details of the global navigation system).

86. See *id.*

87. See *id.*; Ro, Kleiman, & Hammerle, *supra* note 5, at 209–10 (discussing the issue that the *Decca* court faced).

88. See *Decca*, 544 F.2d at 1083 (providing that whether a system is subject to the jurisdiction of United States “does not rest on any one factor but on the combination of circumstances here present, with particular emphasis on the ownership of the equipment by the United States, the control of the equipment from the United States and on the actual beneficial use of the system within the United States”).

89. See *id.* (providing the first prong of the test examines if the equipment is controlled from the United States).

90. See *id.* (providing the second prong of the test examines if the equipment is owned by the United States).

91. See *id.* (providing the third prong of the test examines whether there is a beneficial use of the equipment within the United States).

92. See *id.* at 1081–82 (describing different aspects of the global navigation system and why the system was under the control of the United States); see also Pannell, *supra* note 68, at 738 (“[The system] utilized three transmitting stations—

court opined that even though some equipment was under the sovereignty of a foreign nation, title to all of the system's equipment was to the United States.⁹³ Applying the third prong of the test, the court stated that the beneficial use of the global system occurs on a vessel or an airplane under the jurisdiction of the United States that receives its global position as a result of the global navigation system.⁹⁴ With all three factors of the test satisfied, the court determined that the United States' global navigation system was subject to the jurisdiction of the United States and therefore could infringe a United States patent.⁹⁵

The need for a robust system of patent law in outer space is necessary now more than ever due to the increasing utilization of outer space by the private sector.⁹⁶ Applying patent law in outer space, especially in a multinational context, can be complex and is a relatively recent endeavor.⁹⁷ However, the international community has already addressed similar multinational issues relating to jurisdiction and patent law on Earth.⁹⁸

two located in the United States and one located in Norway—to send signals to receivers on ships and aircraft.”).

93. See *Decca*, 544 F.2d at 1081–82 (providing that all of the systems equipment was owned by the United States).

94. *Id.* at 1081 (“[T]he beneficial use of the completed assembly actually occurs within the jurisdiction of the United States, when either a vessel or an airplane equipped with an Omega receiver and owned by the defendant receives and utilizes the signals in the manner claimed.”).

95. See *id.* at 1082, 1089 (discussing the holding of the court).

96. See, e.g., Pando, *supra* note 22 (discussing the explosion of private sector investment in space); see also OFF. OF TECH. ASSESSMENT, *supra* note 71, at 6 (“Whether a firm chooses to conduct space research or to market a space product will depend in part on . . . the ability to protect—either through patent or trade secret laws—the result of the firm’s investment, and the administrative complexity and cost of getting the product to market.”).

97. See Burk, *supra* note 10, at 296–97 (discussing that legal questions surrounding patents in outer space are part of a recent movement towards private commercial activity in outer space); Malagar & Magdoza-Malagar, *supra* note 21, at 313 (discussing that the expansion of operations in space in the 1950s prompted the international community to begin promulgating regulations and guidance on operations in space).

98. See Burk, *supra* note 10, at 316–22 (discussing how the international community has addressed jurisdictional issues in international waters).

C. Jurisdiction and Patent Law on Earth from an International Perspective

Laws governing patent rights vary depending on which jurisdiction applies.⁹⁹ Outer space and certain areas of Earth, such as Antarctica and international waters, share similar difficulties with defining jurisdictional boundaries.¹⁰⁰ However, the international community has wrestled with jurisdictional and patent issues in the multinational context on Earth for much longer than in outer space.¹⁰¹

One major difference between jurisdiction on Earth and in outer space involves defining boundaries.¹⁰² International leaders cannot agree on how to define a demarcation line where outer space begins and airspace on Earth ends.¹⁰³ Therefore, there is no internationally accepted definition of the boundary between Earth and outer space.¹⁰⁴

99. See MOY, *supra* note 19, at § 12.1 (discussing that patents are only effective within the country they are designated to).

100. See Winston, *supra* note 20, at 519–23, 543–44 (discussing jurisdictional issues in international waters and Antarctica).

101. See, e.g., WILLIAM F. PATRY, PATRY ON COPYRIGHT § 23.16 (2019) (discussing that the roots for the Berne Convention for the Protection of Literary and Artistic Works can be traced back to 1878); see also Hans Peter Kunz-Hallstein, *The United States Proposal for a Gatt Agreement on Intellectual Property and the Paris Convention for the Protection of Industrial Property*, 22 VAND. J. TRANSNAT'L L. 265, 268 (1989) (providing that the Paris Agreement for the Protection of Industrial Property was signed in 1883). The international community did not take serious action in developing space law until 1957 when *Sputnik* was launched. See Malagar & Magdoza-Malagar, *supra* note 21, at 320.

102. See Winston, *supra* note 20, at 526–27 (discussing how there is currently no international agreement that defines or delimits the boundaries of airspace from that of outer space). However, there are distinct zones and boundaries defined that govern jurisdiction in international waters and Antarctica. See *id.* at 505–07, 540–44.

103. See Malagar & Magdoza-Malagar, *supra* note 21, at 312–16 (discussing that it is ambiguous as to where outer space begins and Earth's atmosphere ends); Winston, *supra* note 20, at 529–30 (“[One] approach asks what is the function of the vessel in question. If it is an aircraft, then the law of the air should govern it. If it is a spacecraft, then the law of outer space should govern it It is more formally recognized in Australia's use of the 100 kilometers demarcation, which is based on the ‘von Karman line.’ The ‘von Karman line’ is the altitude, approximately 100 kilometers, where the atmosphere is too thin for an airplane's wings to generate the aerodynamic lift necessary to sustain flight.”).

104. See Malagar & Magdoza-Malagar, *supra* note 21, at 317–18 (discussing attempts by the international community to come to a consensus on defining the boundary between outer space and Earth's atmosphere).

One approach to draw a demarcation line between Earth and outer space uses the von Karman line.¹⁰⁵ This method provides that space begins, and airspace ends, at approximately 100 kilometers above Earth's surface.¹⁰⁶ The significance of this altitude is that the air is generally too thin for aircraft to fly at 100 kilometers, and therefore spacecraft are necessary for travel at this altitude.¹⁰⁷ Many countries address this issue differently, while others do not address it at all.¹⁰⁸

On Earth, boundaries determine a country's authority and control in areas that are not part of any sovereignty.¹⁰⁹ Through the territorial principle, a country may exercise exclusive jurisdiction within that country's borders.¹¹⁰ However, navigable seas and bodies of water often fall between the borders of multiple nations.¹¹¹

Three distinct zones determine a country's authority and control in navigable seas.¹¹² The first zone is often referred to as internal waters.¹¹³ Internal waters are the navigable waters within a country's borders.¹¹⁴ Internal waters are under absolute sovereignty of the

105. See, e.g., Winston, *supra* note 20, at 529–30 (describing the von Karman line approach to delineating between space and airspace); see also Malagar & Magdoza-Malagar, *supra* note 21, at 313–16 (discussing other approaches to define a boundary between space and airspace).

106. See *Where is Space?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN. (Feb. 22, 2016), <https://www.nesdis.noaa.gov/content/where-space> [<https://perma.cc/K6ND-2XUL>] (“A common definition of space is known as the [von] Kármán Line, an imaginary boundary 100 kilometers (62 miles) above mean sea level.”).

107. See Winston, *supra* note 20, at 529–30 (stating that aircraft generally cannot fly at the von Karman line and that spacecraft are necessary for travel at this altitude).

108. See *id.* at 529–30. Australia uses the von Karman line to delineate between space and airspace. See *id.* The United Kingdom does not have a working definition of this altitude. See *id.* at 530. German law does not differentiate between spacecraft and aircraft. See *id.*

109. See Laura L. Roos, *Stateless Vessels and the High Seas Narcotics Trade: United States Courts Deviate from International Principles of Jurisdiction*, 9 MAR. LAW. 273, 273 (1984) (discussing national and international boundaries in international waters).

110. See Winston, *supra* note 20, at 516 (discussing that a country has exclusive control over bodies of water within its territory).

111. See *id.* (explaining that bodies of water often transcend national borders).

112. See Roos, *supra* note 109, at 273–74 (discussing the three different zones that navigable sea is divided into and the jurisdictional control that can be exercised within each zone).

113. See *id.* at 273.

114. *Id.* (“The first zone, referred to as ‘inland’ or ‘internal’ waters, is that which is nearest to a nation’s shores. A coastal nation enjoys absolute sovereignty with respect to this zone, as if it were an extension of land, and therefore has the authority to exclude foreign vessels altogether.”).

country whose borders they lie within.¹¹⁵ The second zone is known as the territorial waters zone.¹¹⁶ Within this zone, a nation maintains substantial control.¹¹⁷ The third zone is commonly referred to as the high seas.¹¹⁸ The high seas are international waters not under the sovereignty or jurisdiction of any nation.¹¹⁹ However, a nation may exercise extraterritorial jurisdiction, or jurisdiction outside the territorial borders of a country, if it is predicated on principles accepted through international custom.¹²⁰

One international-accepted basis for exercising jurisdiction in the international sphere is known as the floating island principle, or the Law of the Flag principle.¹²¹ Through this principle, the flagship state, or country whose flag is flown on the vessel, has exclusive jurisdiction over the vessel and activities that take place on the vessel while it is in the high seas zone.¹²² However, once the ship enters a

115. *Id.* (“Beyond the inland waters lies the second zone, known as the ‘territorial waters’ or ‘territorial sea.’ The breadth of the territorial sea depends on the claims of the coastal state. Within this zone a coastal nation may exercise substantial control, but may not deny foreign vessels the right of innocent passage.”).

116. *Id.* (“Outside the belt of territorial waters is the third zone, commonly known as the ‘high seas.’ Since time immemorial the high seas have been free and open, i.e., they are ‘international waters not subject to the dominion of any one nation.’”).

117. *See id.* (providing that a country cannot deny foreign vessels innocent passage through the territorial waters zone). Furthermore, the size of the territorial waters zone depends on the claim of the nation whose coast it is on. *See id.* The United States, for example, claims that this zone generally extends twenty-four nautical miles from its coast. *See Winston, supra* note 20, at 507.

118. *United States v. Louisiana*, 394 U.S. 11, 23 (1969) (“Outside the territorial sea are the high seas, which are international waters not subject to the dominion of any single nation.”).

119. *See id.* (discussing the high seas).

120. *Roos, supra* note 109, at 275 (“[J]urisdiction in the international sphere must be predicated on one of the six bases which have become accepted through international custom: the territorial principle; the nationality principle; the protective principle (or injured forum theory); the passive personality principle; the universal theory; or the floating territorial principle.”).

121. *Patterson v. Bark Eudora*, 190 U.S. 169, 176 (1903) (“A ship which bears a nation’s flag is to be treated as a part of the territory of that nation. A ship is a kind of floating island.’ Yet when a foreign merchant vessel comes into our ports, like a foreign citizen coming into our territory, it subjects itself to the jurisdiction of this country.”).

122. *See Roos, supra* note 109, at 277–78 (discussing the jurisdiction of a ship at sea under the floating island principle).

foreign port, the jurisdiction of the vessel becomes concurrent with the country whose port the vessel has entered.¹²³

Another basis for exercising jurisdiction in the international sphere is the nationality principle.¹²⁴ The nationality principle permits a country to exercise jurisdiction over individuals or entities that are nationals of that country, regardless of whether the individual is outside of the country.¹²⁵ The international community has drawn on these theories when forming international treaties and agreements that govern control and authority over areas of Earth that are not under the sovereignty of any country.¹²⁶

For example, the international community sought to resolve complex multinational issues in Antarctica through the Antarctic Treaty.¹²⁷ Multiple nations have made territorial claims, often overlapping with territorial claims by other nations, to parts of Antarctica.¹²⁸ However, the Antarctic Treaty does not take a stand on national sovereignty issues or territorial claims in Antarctica.¹²⁹ Rather, the Antarctic Treaty preserves the status quo of all claimed territories but denies new claims to territory or the enlargement of claims already existing.¹³⁰ Unlike in international waters where the

123. *Id.* at 278 (“The jurisdiction of the flagship state loses its exclusive character and becomes concurrent when the vessel enters a foreign port. The port state will only enforce its laws, however, when the peace and tranquility of the port are threatened.”).

124. WAYNE R. LAFAVE, *SUBSTANTIVE CRIMINAL LAW* § 4.3(b) (3d ed. 2018) (“As a matter of international law, a nation has the power to prescribe rules of conduct . . . for its own nationals while they are outside its territorial limits.”).

125. *See id.* (“This nationality jurisdiction is normally justified by the theory that the national owes allegiance to the home state both while at home and while abroad.”).

126. *See* Antarctic Treaty, Dec. 1, 1959, 12 U.S.T. 794; Winston, *supra* note 20, at 519–23, 543–44 (discussing how the international community addresses jurisdiction in a variety of contexts).

127. *See* Antarctic Treaty, *supra* note 126; *see also* Leslie Hook & Benedict Mander, *The Fight to Own Antarctica*, *FIN. TIMES* (May 24, 2018), <https://www.ft.com/content/2fab8e58-59b4-11e8-b8b2-d6ceb45fa9d0> (discussing the international effort to address complex issues in Antarctica).

128. *See Who Owns Antarctica?*, AUSTRALIAN ANTARCTIC DIV. (Sept. 8, 2017), <http://www.antarctica.gov.au/about-antarctica/people-in-antarctica/who-owns-antarctica> [<https://perma.cc/ZZ95-WZ48>] (discussing that various countries have claimed part of Antarctica as part of its territory).

129. *See* Antarctic Treaty, *supra* note 126, at art. IV (discussing claims to territory in Antarctica).

130. *Id.* (“No acts or activities taking place while the present Treaty is in force shall constitute a basis for asserting, supporting or denying a claim to territorial sovereignty in Antarctica or create any rights of sovereignty in Antarctica. No new

floating island principle determines jurisdiction, the Antarctic Treaty adopted the nationality principle to govern jurisdiction in Antarctica.¹³¹ The Antarctic Treaty states that individuals in Antarctica will be subject to the jurisdiction of the country in which they are nationals, regardless of the national origin of the base or structure that they are in.¹³²

Another point of comparison between outer space law and international agreements over activities on the high seas and in Antarctica is how they address patent law.¹³³ International agreements on Earth treat patent law in largely the same way that outer space law does.¹³⁴ While the regime of patent law that applies usually depends on which jurisdiction applies, in Antarctica the jurisdiction that applies depends on the individual's nationality.¹³⁵ Therefore, scientists of different nationalities could be working on the same project but would be operating under different systems of patent law.¹³⁶ This system can lead to jurisdictional confusion and infringement issues.¹³⁷

claim, or enlargement of an existing claim, to territorial sovereignty in Antarctica shall be asserted while the present Treaty is in force.”).

131. See Darrel C. Menche, *Jurisdiction in Cyberspace: A Theory of International Spaces*, 4 MICH. TELECOMM. & TECH. L. REV. 69, 89 (1998) (providing that the Antarctic Treaty uses the nationality principle to govern jurisdiction in Antarctica).

132. Antarctic Treaty, *supra* note 126, at art. VIII (“In order to facilitate the exercise of their functions under the [Antarctic] Treaty . . . observers designated under paragraph 1 of Article VII and scientific personnel exchanged under subparagraph 1(b) of Article III of the Treaty, and members of the staffs accompanying any such persons, shall be subject only to the jurisdiction of the Contracting Party of which they are nationals in respect of all acts or omissions occurring while they are in Antarctica for the purpose of exercising their functions.”).

133. See Winston, *supra* note 20, at 537–44 (discussing jurisdictional issues in Antarctica and the high seas).

134. See *id.* at 519–23, 544 (discussing how patent law is applied on the high seas and in Antarctica).

135. *Smith v. United States*, 507 U.S. 197, 212–13 (1993) (Stevens, J., dissenting) (“As was well settled at English common law before our Republic was founded, a nation’s personal sovereignty over its own citizens may support the exercise of civil jurisdiction in transitory actions arising in places not subject to any sovereign.”); see Winston, *supra* note 20, at 544 (providing that, “as in outer space, the patent boundaries of the Antarctic region are personnel-based and not territorial-based”).

136. See Winston, *supra* note 20, at 543–44.

137. *Id.* at 544 (“Like in outer space, two scientists of different nationalities can work together at the same lab bench, sharing data and research, and one can be found to infringe a United States patent while the other, doing exactly the same thing, is not infringing.”); see also OFF. OF TECH. ASSESSMENT, *supra* note 71, at 6 (“To encourage private, commercial space activities, the U.S. Government may wish to

On the high seas, the system of patent law applied on a vessel is typically under the jurisdiction of a vessel found through the floating island principle.¹³⁸ Companies often exploit this principle by registering vessels in countries other than the one in which they are actually based.¹³⁹ This practice is commonly referred to as the “flags of convenience” principle, and it allows companies to operate under patent law jurisdictions that are most convenient for them.¹⁴⁰ Business entities gaming the system of different national-level patent law regimes in this manner may have a negative impact on business innovation and commercial investment in research and development.¹⁴¹ In fact, the Commission on the Patent System, created by President Johnson in 1966 to study the United States patent system, found that uncertain patent rights present serious challenges to businesses and undermine the value of patent disclosures.¹⁴² The international community, including the United States, seems to believe that increasing cooperation and harmonization between

help firms determine which Federal and State laws will govern their activities Determining jurisdiction is the most important issue to resolve during the planning stage for the [International] space station.”)

138. Winston, *supra* note 20, at 519 (“[A] ship is governed by the laws of the nation whose flag the ship bears, even in the territorial waters of another country. In other words, patent infringement may not occur, even within the territorial waters of the United States, if the infringement occurs on a foreign-flagged ship temporarily present in the United States.”).

139. Pannell, *supra* note 68, at 749–52 (“Current patent law requires a company to apply for a patent in every country where its space object may potentially be infringed upon. This can be a long, tedious, and expensive process in many cases. Any country in which the company fails to obtain patent protection could become a loophole exploited by competitors through flags of convenience.”).

140. Winston, *supra* note 20, at 519 (“These ‘flags of convenience’ may shelter a vessel from the laws of the country where the vessel is located. Ships that sail under a nation’s flag ‘shall be subject to its exclusive jurisdiction on the high seas.’”).

141. Emily Michiko Morris, *Res or Rules—Patents and the (Uncertain) Rules of the Game*, 18 MICH. TELECOMM. & TECH. L. REV. 481, 488 (2012) (“Certainty in patent boundaries is desirable because it would provide patent holders some reassurances in investing in their rights of exclusion and allow for easy resolution of any conflicts over those rights, leading to greater efficiency overall.”).

142. See FTC, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 17 (Oct. 2003). In 1966, the Commission on the Patent System, created by President Johnson, found that it was important to not only increase the value of patent disclosures but to also “decrease the possibility [that] the system could be gamed so as to undermine the value of those disclosures.” *Id.* The Commission also stated that “[u]ncertain patent rights pose severe difficulties for business planning: they undermine competitors’ decisions about where to channel R&D and what products to market.” *Id.* at 3.

national-level patent law regimes would benefit the international business community.¹⁴³ However, national systems of patent law remain distinct from one another, even though many underlying principles are similar.¹⁴⁴

For example, new patent law systems in China, Russia, and Eastern European countries adopted many of the same procedures and concepts found in the patent law systems of Japan, Germany, and the United States.¹⁴⁵ Furthermore, most patent activity takes place within countries that have similar principles of patent law.¹⁴⁶ The United States, China, and Japan accounted for approximately 73% of the total patent applications filed worldwide in 2018.¹⁴⁷ Other patent offices in the top ten for most patents filed are Germany, Russia, and the European Patent Office.¹⁴⁸ Although most patents filed throughout the world are filed in systems with similar characteristics, these systems

143. See *What is WIPO?*, WORLD INTELLECTUAL PROP. ORG., <https://www.wipo.int/about-wipo/en/> [<https://perma.cc/6SRV-HXBR>] (last visited Nov. 11, 2019). The World Intellectual Property Organization (WIPO) was established by the United Nations in 1967. *Id.* The mission of the World Intellectual Property Organization is to “lead the development of a balanced and effective international [intellectual property (IP)] system that enables innovation and creativity for the benefit of all.” *Id.* The United States Patent and Trademark Office (USPTO) established the Office of International Patent Cooperation (OIPC) in 2014. *International Patent Cooperation*, U.S. PAT. & TRADEMARK OFF., <https://www.uspto.gov/patents-getting-started/international-patent-cooperation> [<https://perma.cc/RQ6B-GFCM>] (last visited Nov. 11, 2019). “The [OIPC] leads efforts to assist U.S. inventors and businesses in protecting their patent rights worldwide and supports the global innovation community. [The OIPC] strive[s] to improve the international patent system in two critical areas: increasing certainty of intellectual property (IP) rights and reducing costs for international stakeholders.” *Id.*

144. Ben McEnery, *The Time is Nigh: A Proposal for an International Patent System*, 16 CHI.-KENT J. INTEL. PROP. 167, 169 (2016) (“[H]armonization efforts that have taken place in the last 150 years have ensured that the concepts of patentability are largely similar around the world”); Michael N. Meller, *Planning for a Global Patent System*, 80 J. PAT. & TRADEMARK OFF. SOC’Y 379, 379 (1998) (“[W]ith the adjustment of norms for patent application rules and even patent law principles around the world, patent law is becoming more and more uniform”).

145. Meller, *supra* note 144, at 380 (“Most new patent systems of countries like China, Russia and other Eastern European countries have mirrored a modern Japanese/German or U.S. standard, closely akin to the European Patent Convention.”).

146. See *Facts and Figures*, WORLD INTELLECTUAL PROP. ORG., <https://www.wipo.int/edocs/infogdocs/en/ipfactsandfigures2018/> [<https://perma.cc/JLZ6-ZVYX>] (last visited Nov. 11, 2019) (providing data on intellectual property activity around the world).

147. *Id.*

148. See *id.*

are still distinct from one another, and separate patents must still be filed in each country in which patent protection is sought.¹⁴⁹ The European Union, however, recently took major steps to harmonize and unify patent law at the international level.¹⁵⁰

Beginning in 2020, a “unitary” patent may be filed in Europe that grants patent protection in twenty-six of the European Union Member States.¹⁵¹ The European Union created the Unified Patent Court (UPC) to enforce this new unified system of patent law across the Member States of the European Union.¹⁵² The judges of the UPC must meet high standards of achievement, including having proven experience within the field of patent litigation.¹⁵³ The UPC has exclusive jurisdiction over any litigation relating to unitary patents, but Member States of the European Union maintain jurisdiction over any litigation relating to national patents.¹⁵⁴ However, the UPC only

149. See Kleiman, *supra* note 3, at 4 (explaining that under the current system of outer space patent law, inventors must file for patent protection in every jurisdiction in which they desire patent protection).

150. See *Main Features*, EUROPEAN PAT. OFF., <https://www.epo.org/law-practice/unitary/unitary-patent/features.html> [<https://perma.cc/47A8-Z2DD>] (last visited Nov. 11, 2019) (discussing the recently created unitary patent and the Unified Patent Court in the European Union).

151. *Id.* (“Instead of validating a European patent in several countries, patent proprietors can choose to file a request for unitary effect and obtain—in a single and straightforward procedure carried out centrally by the EPO—a Unitary Patent providing uniform protection in up to 26 participating Member States.”). This system is to take effect in the first half of 2020. See *When Will the Unitary Patent System Start?*, EUROPEAN PAT. OFF., <https://www.epo.org/law-practice/unitary/unitary-patent/start.html> [<https://perma.cc/NMS7-KU52>] (last visited Nov. 11, 2019).

152. *About the UPC*, UNIFIED PAT. CT., <https://www.unified-patent-court.org/> [<https://perma.cc/GU5Z-884E>] (last visited Nov. 11, 2019) (“The Unified Patent Court (UPC) will be a court common to the Contracting Member States and thus part of their judicial system. It will have exclusive competence in respect of European patents and European patents with unitary effect.”); *Main Features*, *supra* note 150 (“The Unified Patent Court (UPC) is an international court set up by 25 of the participating Member States to deal with the infringement and validity of both Unitary Patents and European patents. Its rulings will apply in all Member States that have ratified the Agreement on a Unified Patent Court . . .”).

153. See *The UPC and its Judges*, UNIFIED PAT. CT., <https://www.unified-patent-court.org/faq/upc-and-its-judges> [<https://perma.cc/GFS2-XFHU>] (last visited Nov. 11, 2019) (discussing the high standards that potential UPC judges must meet).

154. See *Main Features*, *supra* note 150 (providing that the Unified Patent Court has “exclusive jurisdiction for litigation relating to Unitary Patents and European patents and harmonising the scope and limitations of the rights conferred by a patent, and remedies available beyond EU Directive 2004/48/EC (Enforcement Directive)”).

decides on cases occurring within the European Union.¹⁵⁵ There is currently no global court to handle patent issues arising in a multinational context.¹⁵⁶

The World Intellectual Property Organization and other international bodies offer alternative dispute resolution (ADR) services that parties from different countries may use to resolve international patent disputes.¹⁵⁷ However, both parties must agree to use the ADR process.¹⁵⁸ If one party refuses or simply does not consent to the ADR process, then the ADR proceedings will not take place.¹⁵⁹ Furthermore, there can be significant challenges to enforcing arbitration decisions.¹⁶⁰ Although there is no global court to decide

155. See *id.* (discussing that the jurisdiction of the Unified Patent Court extends to Member States of the European Union that have ratified the Agreement on a Unified Patent Court).

156. See Michael N. Meller, *Principles of Patentability and Some Other Basics for a Global Patent System*, 83 J. PAT. & TRADEMARK OFF. SOC'Y 359, 371–72 (2001) (discussing a possible structure under which a future unified global patent court could operate).

157. See *WIPO Alternative Dispute Resolution—Saving Time and Money for IP Disputes*, WIPO MAGAZINE (Nov. 2016), https://www.wipo.int/wipo_magazine/en/2016/si/article_0010.html [<https://perma.cc/FW62-JR6Z>] (discussing WIPO's ADR options, which include mediation, arbitration, expedited arbitration, and expert determination). “With the globalization of trade and the increasingly international creation and exploitation of IP, these disputes often span multiple jurisdictions and involve highly technical matters, complex laws and sensitive information.” *Id.*; see also *ICC International Centre for ADR*, INT'L CHAMBER OF COMMERCE, <https://iccwbo.org/dispute-resolution-services/mediation/icc-international-centre-for-adr/> [<https://perma.cc/BEQ2-LBCU>] (last visited Nov. 11, 2019) (discussing ADR services offered by the International Chamber of Commerce).

158. See *WIPO ADR Procedures*, WORLD INTELLECTUAL PROP. ORG., <https://www.wipo.int/amc/en/center/wipo-adr.html> [<https://perma.cc/57AP-RST5>] (last visited Nov. 11, 2019) (providing that the various ADR procedures offered through WIPO require consent); Norman Zhang, *Solving Patent Disputes via International Arbitration: A Better Alternative?*, AM. REV. OF INT'L ARBITRATION (Dec. 5, 2017), http://aria.law.columbia.edu/solving-patent-disputes-via-international-arbitration-a-better-alternative/#_ftn7 [<https://perma.cc/FCY6-7VVT>] (providing that arbitration occurs when “both parties agreed to arbitrate”); *Guide to Drafting International Dispute Resolution Clauses*, INT'L CTR. FOR DISPUTE RESOLUTION (discussing how ADR measures between parties are drafted in contracts).

159. Marc Jonas Block, *The Benefits of Alternate Dispute Resolution for International Commercial and Intellectual Property Disputes*, 44 RUTGERS L. REC. 1, 13 (2016) (“ADR’s voluntary nature makes it less appropriate if one of [the] parties is extremely uncooperative, which may occur in the context of an extra-contractual infringement dispute.”).

160. Zhang, *supra* note 158 (“[M]ost countries do not allow the arbitration of patent validity claims Therein lies a principal barrier of embracing arbitration as

patent disputes, other disputes, such as those arising from treaty obligations, often fall under the jurisdiction of the International Court of Justice (ICJ).¹⁶¹ Leaders from over fifty countries agreed to establish the ICJ in 1945 as the principal judicial organ of the United Nations.¹⁶² The ICJ is made up of a panel of fifteen judges who are elected to nine-year terms by the United Nations General Assembly and the Security Council.¹⁶³ Individuals, private enterprises, and organizations cannot bring cases before the ICJ.¹⁶⁴ The ICJ may only hear cases between states.¹⁶⁵ For a non-state entity's case to be heard, the country of the non-state entity bringing the claim must agree to bring the suit on the non-state entity's behalf.¹⁶⁶ Additionally, both states involved in the suit must agree to submit to the ICJ's jurisdiction and accept the ruling of the court as binding.¹⁶⁷

The ICJ has been subject to various criticisms.¹⁶⁸ One criticism is that no nation can be forced to accept the ruling of the ICJ, and

an alternative to multi-jurisdiction patent litigation, at least on disputes involving patent validity. An award validly rendered in the United States remains at risk of not being recognized or enforced in foreign jurisdictions where patent validity is non-arbitrable.”).

161. See Blake Gilson, *Defending Your Client's Property Rights in Space: A Practical Guide for the Lunar Litigator*, 80 *FORDHAM L. REV.* 1367, 1381 (2011) (discussing the jurisdiction of the International Court of Justice).

162. See *The Court*, INT'L COURT OF JUSTICE, <https://www.icj-cij.org/en/court> [<https://perma.cc/3LSB-LWW9>] (last visited Nov. 11, 2019) (providing background on how the ICJ was established).

163. *Members of the Court*, INT'L COURT OF JUSTICE, <https://www.icj-cij.org/en/members> [<https://perma.cc/Q9GB-RCBW>] (last visited Nov. 11, 2019) (“The International Court of Justice is composed of 15 judges elected to nine-year terms of office by the United Nations General Assembly and the Security Council.”).

164. See *How the Court Works*, INT'L COURT OF JUSTICE, <https://www.icj-cij.org/en/how-the-court-works> [<https://perma.cc/35KQ-GKWU>] (last visited Nov. 11, 2019) (discussing how the ICJ functions).

165. See Gilson, *supra* note 161, at 1381 (providing details on the jurisdiction of the ICJ).

166. See *id.* at 1381–82 (providing that “a plaintiff can only bring suit in the ICJ by convincing his country to bring the suit on his behalf against the country of the defendant”).

167. *Id.* at 1382 (“The ICJ only has the power to adjudicate when both countries submit to jurisdiction.”); see also U.N., Statute of the International Court of Justice (providing details regarding the organization and structure of the International Court of Justice).

168. See Eric A. Posner & Miguel de Figueiredo, *Is the International Court of Justice Politically Biased?* 2, 4 (Univ. of Chi. Law Sch., Working Paper No. 234, 2004) (“[J]udges are significantly biased in favor of their home state when that state appears as a party. Whereas judges vote in favor of a party about 50 percent of the time when they have no relationship with it, that figure rises to 85-90 percent when

therefore its rulings are essentially non-binding.¹⁶⁹ Additionally, the U.N. Security Council can veto the rulings of the ICJ.¹⁷⁰ Scholars, and even a former ICJ judge, have also argued that the election process for judges of the ICJ, which only mandates that all fifteen judges be from different countries, is highly politicized.¹⁷¹ Scholars have also argued that the judges themselves are often biased against any ruling that would not be in the best interests of their home countries.¹⁷² Due in part to these characteristics, the ICJ has not heard any cases arising out of patent disputes stemming from treaties.¹⁷³

The trend of increasing activity of private entities in outer space is not poised to stop anytime soon.¹⁷⁴ In fact, both governmental and private entities have plans to put humans on Mars in the coming decades and even begin the process of building permanent structures on the planet's surface.¹⁷⁵ It is not outside the realm of possibility that

the party is the judge's home state."); *see also* Davis R. Robinson, *The Role of Politics in the Election and the Work of Judges of the International Court of Justice*, 97 AM. SOC'Y INT'L L. 277, 278–79 (2003) (discussing issues with the elections process of ICJ judges).

169. *See* *Medellin v. Texas*, 552 U.S. 491, 509 (2008) (discussing that the decisions of the ICJ are not automatically enforceable on national courts). The sole remedy for noncompliance with a decision of the ICJ is to refer the matter to the United Nations Security Council. *See id.*; Jana Maftai, *Sovereignty in International Law*, 11 ACTA UNIVERSITATIS DANUBIUS JURIDICA 54, 55 (2015) ("State Sovereignty is the quality of state power 'to be supreme in relation to any other existing social power within its territorial limits and independence compared to the power of any state or international body").

170. *See* *Medellin*, 552 U.S. at 509 (discussing that the United Nations Security Council has authority to veto a decision by the ICJ).

171. *See* Posner & de Figueiredo, *supra* note 168, at 11–12; Robinson, *supra* note 168, at 278–79 (discussing how the election process for judges on the International Court of Justice is highly political and undesirable).

172. Posner & de Figueiredo, *supra* note 168, at 4 ("We hypothesize that even when a judge's home state is not a party, his home state may have an interest in one party prevailing, and that the judge's vote will reflect his state's interest.")

173. *See List of All Cases*, INT'L CT. JUST., <https://www.icj-cij.org/en/list-of-all-cases> [<https://perma.cc/BZ6N-RYBU>] (last visited Nov. 11, 2019) (providing a list and description of every case that the ICJ has ruled on). The ICJ has not heard a case involving patent rights. *See id.*

174. *See* WORLD INTELL. PROP. ORG., *supra* note 7, at 4 (discussing the increasing shift from government activities in space to private and commercial activities).

175. *See* SPACEX, *Making Life Multiplanetary*, <https://www.spacex.com/mars> [<https://perma.cc/PA3X-6ZAW>] (last visited Nov. 11, 2019); NASA, *NASA's Journey to Mars*, <https://www.nasa.gov/content/nasas-journey-to-mars> [<https://perma.cc/94E5-MBKH>] (last updated Aug. 7, 2017). SpaceX hopes to send a first cargo mission to Mars in 2022. *See* SPACEX, *supra*. SpaceX plans to send more cargo and humans to Mars in 2024. *See id.* SpaceX believes these missions will serve as the beginnings of

soon humans will not only walk on another celestial body, as they walked on the moon, but will actually permanently live on another planet.¹⁷⁶ Therefore, a serious examination of how the current system of outer space patent law impacts investment in outer space by commercial entities is necessary now more than ever.¹⁷⁷

II. HOW THE CURRENT SYSTEM OF OUTER SPACE PATENT LAW HINDERS PRIVATE SECTOR INVESTMENT IN OUTER SPACE

The current state of outer space patent law does not clearly address issues central to an effective system of patent law.¹⁷⁸ This is due in part to a patchwork of national-level laws governing multinational endeavors in outer space.¹⁷⁹ One problem this patchwork creates is a lack of robust patent protection in outer space.¹⁸⁰ Furthermore, applying national-level patent law to the outer space setting through extraterritorial jurisdiction creates jurisdictional ambiguity and even conflicting jurisdictions.¹⁸¹ Weak patent protection and confusion as to which jurisdiction applies in multinational outer space endeavors discourages private investment in outer space.¹⁸²

a Mars base, from which a self-sustaining civilization on Mars can be built. *See id.* NASA also hopes to send humans to Mars in the 2030s. *See* NASA, *supra*.

176. *See* NASA, *supra* note 175; SPACEX, *supra* note 175.

177. *See* WORLD INTELL. PROP. ORG., *supra* note 7, at 5 (discussing that patent law in outer space is especially important currently, in part because new business opportunities are emerging in outer space due to the advancement of space technology). Furthermore,

[t]he importance of establishing a legal regime that effectively protects intellectual property in space cannot be overemphasized. Lack of legal certainty will influence the advancement of space research and international cooperation. Because of the large investments involved in space activities, a legal framework that assures a fair and competitive environment is necessary to encourage the private sector's participation in this field.

Id.

178. *See* Winston, *supra* note 20, at 531–37 (discussing jurisdictional ambiguity in outer space); *see also* Pannell, *supra* note 68, at 749–53 (discussing inadequate patent protection in outer space).

179. *See* Burk, *supra* note 10, at 331–35 (discussing the interplay between national and international law in outer space).

180. *See* Pannell, *supra* note 68, at 749–53 (discussing ways that patent infringement can be evaded in outer space).

181. *See* Malagar & Magdoza-Malagar, *supra* note 21, at 360 (discussing the difficulty in applying national law regimes in outer space).

182. *See* FTC, *supra* note 142, at 17 (discussing the relationship between private investment in space and certainty in rights).

A. Lack of Adequate Patent Protection in Outer Space

Patent laws are intended to provide a business with increased confidence to invest its resources in new, innovative technologies without fear of a competitor taking advantage of its investment by copying and selling the newly developed technology.¹⁸³ The unique characteristics of human activity in outer space, however, present new challenges to traditional systems of patent law developed for human activity on Earth.¹⁸⁴ Outer space, by its very nature, transcends national territorial boundaries and frequently involves multinational endeavors.¹⁸⁵ As a consequence, patent infringement can be evaded relatively easily in outer space as compared to on Earth.¹⁸⁶

For example, to evade actions that would constitute infringement of a United States' patent on a multinational space station, one may walk a few feet from a United States' module and into a Japanese module.¹⁸⁷ Once in the Japanese module, one would be under Japanese jurisdiction.¹⁸⁸ At this point, the patented invention could be reproduced without infringing on the United States patent.¹⁸⁹ The difficulty and expense of evading infringement of a United States patent on Earth are much greater as one must physically leave the territorial boundaries of the United States.¹⁹⁰

183. Morris, *supra* note 141, at 488 (“Certainty in patent boundaries is desirable because it would provide patent holders some reassurances in investing in their rights of exclusion.”); *see also* FTC, *supra* note 142 (providing that “[u]ncertain patent rights pose severe difficulties for business planning: they undermine competitors’ decisions about where to channel R&D and what products to market”).

184. *See* Malagar & Magdoza-Malagar, *supra* note 21, at 328 (explaining that outer space transcends national boundaries).

185. *See id.* (explaining how outer space transcends national boundaries).

186. Winston, *supra* note 20, at 533 (“[I]f a space object is registered to Azerbaijan, [the] use of a microchip that could potentially infringe a United States patent would be sheltered from infringement on the Azerbaijan space object, presuming no patent issued in Azerbaijan. This is true even if a United States company is the one that launched the space object and registered it in Azerbaijan.”).

187. *See* Pannell, *supra* note 68, at 749; Winston, *supra* note 20, at 531–37 (discussing jurisdictional boundaries with regards to space objects in outer space).

188. *See* Intergovernmental Agreement, *supra* note 49, at art. 21 (discussing the international agreement governing activities on the International Space Station).

189. Timothy R. Holbrook, *Extraterritoriality in U.S. Patent Law*, 49 WM. & MARY L. REV. 2119, 2123 (2008) (“[A] patent, copyright, or trademark only affords the owner the right to exclude within a given country’s borders.”); *see* MOY, *supra* note 19, at § 12.1 (providing that patents are only enforceable within the territory of the country that they are designated to).

190. *See* Holbrook, *supra* note 189, at 2123 (discussing the territorial nature of patents).

Businesses operating in outer space may also use similar methods as businesses operating in international waters to evade infringement.¹⁹¹ On the high seas, businesses use the flags of convenience principle to register a vessel to, and operate under, the most convenient jurisdiction rather than the jurisdiction of the country in which they are actually based.¹⁹² Businesses can use this method to evade infringement in outer space by registering a space object to a country where a patent is not enforced, even if the company only has a tenuous connection to that country.¹⁹³

Other hypotheticals also illustrate ways in which infringement can be evaded relatively easily in space as compared to on Earth.¹⁹⁴ For example, infringement of a patented method that includes a series of steps for performing a process could be evaded by undertaking one or more of the steps in a module registered to a country other than one in which patent is designated to.¹⁹⁵ Moreover, one of these steps could be taken outside of a manmade structure in the emptiness of space where it is not clear if and how any country has jurisdiction.¹⁹⁶

Finally, there is no judicial body to adjudicate disputes and enforce binding decisions at an international level regarding

191. See *id.* at 2175; Pannell, *supra* note 68, at 749–53 (discussing how companies may register space objects to certain countries to evade patent infringement).

192. See Winston, *supra* note 20, at 519 (discussing how companies may choose to register their ship in countries in which they only have a tenuous nexus); see also Pannell, *supra* note 68, at 749–53 (providing examples of how companies can evade patent infringement in outer space through the flags of convenience principle).

193. See, e.g., Winston, *supra* note 20, at 519 (discussing how companies may use the flags of convenience principle to evade patent infringement); see also Pannell, *supra* note 68, at 749–53 (providing examples of how companies may evade patent infringement in outer space through the flags of convenience principle).

194. See Ro, Kleiman & Hammerle, *supra* note 5, at 217–22; Winston, *supra* note 20, at 531–37; see also Pannell, *supra* note 68, at 749–53 (discussing various ways in which patent infringement in outer space may be evaded).

195. See Holbrook, *supra* note 189, at 2123 (discussing the territorial nature of patents); Winston, *supra* note 20, at 537 (“The territoriality of the patent rights relies on the module in which the patent is used on the International Space Station. Patent infringement can occur in one module, and not another. Infringement of a method patent may, therefore, be evaded by simply making sure that at least one element of the claim occurs in a different module from the remaining elements and by a citizen of another country.”).

196. See Sarah Fecht, *Do Earth Laws Apply to Mars Colonists?*, POPULAR SCI. (Sept. 27, 2016), <https://www.popsci.com/who-would-rule-colony-on-mars> [<https://perma.cc/PA7Y-M3ZC>] (discussing the difficulty with trying to apply national laws on Mars).

infringement actions.¹⁹⁷ If an international ADR process is not possible, parties involved in disputes of this nature must undergo litigation in each national court system of the countries in which the infringing activity took place.¹⁹⁸ This process is costly, time consuming, and complex.¹⁹⁹ A business entity seeking to invest in outer space activities may likely consider this process a hassle and be less likely to pursue its interests in outer space.²⁰⁰

B. Conflicting and Ambiguous Jurisdictional Issues

Currently, the United States and Germany are the only countries that have officially extended their patent laws to the outer space setting.²⁰¹ One reason other countries have been reluctant to pass similar laws is because of the possible conflict these laws create between other systems of national and international law.²⁰² Statutory laws, such as the Patents in Space Act, as well as case law, such as the *Decca Ltd. v. United States* decision, apply principles of extraterritorial jurisdiction to extend the reach of United States' jurisdiction.²⁰³ While in some sense these laws provide more certainty to businesses looking to invest in outer space endeavors, they likewise

197. See Meller, *supra* note 156, at 366 (discussing how there is currently no worldwide court system charged with the responsibility to adjudicate global patent issues).

198. McEniery, *supra* note 144, at 169 (“[A] patent holder must enforce each distinct national patent country by country, which is complex, incredibly costly and time-consuming.”); see Pannell, *supra* note 68, at 737 (discussing that inventors only obtain legal protection of an invention in the country that the patent is designated to).

199. See generally *IP Litigation Costs: Special Edition*, WIPO MAG. (2010) (discussing the costs of patent litigation in different countries around the world). The average cost of litigation in patent infringement cases in the United States in 2009 was over \$3,000,000. *Id.* at 3. The average cost of litigation in patent infringement cases in the United Kingdom was over \$500,000 in 2009. *Id.* at 6.

200. See FTC, *supra* note 142, at 17; Morris, *supra* note 141, at 488 (discussing the relationship between private investment and patent law).

201. See *Patents and Space-Related Inventions*, *supra* note 73 (providing that the United States and Germany are the only countries to have officially extended their patent laws to an outer space setting).

202. See Dan L. Burk, *Patents in Cyberspace: Territoriality and Infringement on Global Computer Networks*, 68 TUL. L. REV. 1, 49 (1993) (discussing possible conflicts of national law in the context of outer space).

203. See 35 U.S.C. § 105 (2018) (extending United States patent law to activities occurring in outer space); *Decca Ltd. v. United States*, 544 F.2d 1070, 1083 (Ct. Cl. 1976) (creating a three-part test for determining if United States patent law may apply to technological systems through extraterritorial jurisdiction).

provide instances of conflicting claims of jurisdiction between different countries.²⁰⁴

Space-based technologies that transcend national borders allow the possibility of conflicting jurisdictions to arise.²⁰⁵ One of the seminal cases in United States extraterritorial patent law is *Decca*.²⁰⁶ In this case, the United States Court of Claims developed a three-prong test to address the scope of the extraterritorial jurisdiction of the United States.²⁰⁷ The test asks if (1) the control of a system occurs within United States territory; (2) the system is owned by a United States entity; and (3) if there is a beneficial use for the system in the United States.²⁰⁸

On the other hand, the Registration Convention provides that the country a space object is registered to maintains jurisdiction and control of that space object.²⁰⁹ However, the United States could exercise control over the same object through ground-based communication systems located within the territorial borders of the United States.²¹⁰ A United States-based company may also own and control a space object registered to a foreign country.²¹¹ Therefore, a Japanese-registered space object can be under the jurisdiction and

204. See, e.g., Shoemaker, *supra* note 45, at 420–23 (discussing how the Patents in Space Act may conflict with international law); see also Burk, *supra* note 10, at 346–47 (discussing how the *Decca* ruling can create situations in which the United States may exercise factual control over a space object registered to a foreign nation, which may create the situation where United States patent law is applied to space objects registered to foreign nations); Ro, Kleiman, & Hammerle, *supra* note 5, at 218–20 (discussing other situations in which jurisdictional confusion occurs in the outer space setting).

205. See *Decca*, 544 F.2d at 1098 (discussing the multinational nature of a global navigation system); Pannell, *supra* note 68, at 738 (“Although patent jurisdiction is territorial, this does not limit patent infringement liability to acts that physically occur on United States soil. For example, United States courts have interpreted the definition of ‘use’ of an infringing system or apparatus in a manner that allows certain extraterritorial acts to trigger infringement under United States jurisdiction.”).

206. See *Decca*, 544 F.2d at 1081–82 (discussing the extraterritorial reach of United States’ jurisdiction).

207. See *id.* at 1083 (discussing the three factors to determine the scope of United States extraterritorial jurisdiction).

208. See *id.*

209. See Registration Convention, *supra* note 39, at art. II.

210. See Burk, *supra* note 10, at 346–47 (explaining that conflict between jurisdiction and control of a space object “might arise if communications or ground control services were provided to a foreign space object by U.S. facilities”).

211. *Id.* at 347 (“[O]wnership or management by United States corporations might constitute ‘control’ over a space object on a foreign registry.”).

control of Japan, while at the same time *Decca* could indicate that the space object, while registered to Japan, is subject to United States' jurisdiction and control.²¹² The system of patent law that should apply under these circumstances is not clear.²¹³

Furthermore, each prong of the *Decca* test, in the context of multinational space endeavors, is subject to a large number of judicial interpretations.²¹⁴ Consider the hypothetical scenario in which a global communication system is used to guide and control a space object.²¹⁵ Examining the first prong of the *Decca* test, a system can be owned by the United States, but part of the same system can be owned by another country or multiple other countries.²¹⁶ Using the second prong of the *Decca* test, the control of a system can be distributed between multiple modules that are registered to different countries as part of a multinational space station.²¹⁷ Finally, using the third prong of the *Decca* test, a system that has a beneficial use in many countries, in addition to the United States, is easy to conceive.²¹⁸

While extending the reach of the extraterritorial jurisdiction of the United States through *Decca* and the Patents in Space Act can be problematic, the alternative—not specifically extending the extraterritorial reach of a country to outer space—has its own set of problems.²¹⁹ The hypothetical scenario of someone stepping out of a United States module and into a Japanese module to evade infringement provides a good example of one of these problems.²²⁰

212. See *Decca*, 544 F.2d at 1083 (describing the *Decca* test); Burk, *supra* note 10, at 346–47 (discussing how the *Decca* ruling can create situations in which the United States may exercise factual control over a space object registered to a foreign nation, which may create the situation where United States patent law is applied to space objects registered to foreign nations).

213. See Burk, *supra* note 10, at 346–47 (discussing the jurisdictional ambiguity created between national extraterritorial jurisdiction and international law in the context of outer space).

214. See *id.*

215. See *Decca*, 544 F.2d at 1097–98 (illustrating a good example of a global system that transcends national borders).

216. See Burk, *supra* note 10, at 346–47 (discussing how the *Decca* test can lead to uncertainty in knowing which system of patent law applies to a space object).

217. See *id.* at 346; see also Shoemaker, *supra* note 45, at 398–99 (discussing the problematic nature of understanding which laws apply in the context of multinational space endeavors).

218. See Burk, *supra* note 10, at 346–47.

219. See *id.* at 327 (discussing that it is beneficial for private firms looking to invest in outer space endeavors to have clear laws that explicitly apply patent law to space objects).

220. See Ro, Kleiman, & Hammerle, *supra* note 5, 217–22; Winston, *supra* note 20, 531–37; see also Pannell, *supra* note 68, at 749–53 (discussing the difficulties

Presumably, this person would now be subject to Japanese patent laws.²²¹ However, Japan, like most countries, has not specifically extended its patent laws to the outer space setting.²²²

Uncertainty created by not explicitly extending federal patent laws into outer space, especially in the context of multinational space endeavors, could have a negative impact on commercial investment in space.²²³ This was one of the chief reasons why the United States enacted the Patents in Space Act, which clarified that United States patent law applies to objects in space under the jurisdiction of the United States.²²⁴ Ultimately, a business planning to invest in space-based systems that have components in multiple countries or in outer space objects that are registered to different countries will have to rely on multiple sources of law.²²⁵ These sources of law include (1) judicial discretion applied through the *Decca* test; (2) statutory law, such as the Patents in Space Act; and (3) international law, such as the Registration Convention.²²⁶ These sources of law may conflict with

in providing robust patent protection in outer space due to the territorial nature of patent law).

221. See Registration Convention, *supra* note 39, at art. II (providing that jurisdiction of a space object will be subject to which country the space object is registered to); see also Intergovernmental Agreement, *supra* note 49, at art. 21 (providing that activity that occurs in a registered module will be deemed to have occurred in the nation the module is registered to); Winston, *supra* note 20, at 502 (discussing the territorial nature of patents).

222. See *Patents and Space-Related Inventions*, *supra* note 73 (providing that the United States and Germany are the only countries to have officially extended their patent laws to an outer space setting).

223. See 35 U.S.C. § 105 (2018) (providing further clarification on the extension of United States patent law to activities occurring in outer space); OFF. OF TECH. ASSESSMENT, *supra* note 71 (discussing whether the patent laws of the United States already apply in space or whether additional legislation was needed); Shoemaker, *supra* note 45, at 398 (explaining that the Patents in Space Act was meant to provide increased certainty in United States patent law in order to promote commercial investment in space); see also FTC, *supra* note 142, at 3 (providing that “[u]ncertain patent rights pose severe difficulties for business planning”).

224. See Shoemaker, *supra* note 45, at 398 (explaining that “Congress’ stated purpose in passing the Patents in Space Act was to provide a ‘clear, indefinite and understandable set of rules for determining when and how United States patent law applies in outer space’”).

225. See § 105; Registration Convention, *supra* note 39, at art. II; *Decca Ltd. v. United States*, 544 F.2d 1070, 1070 (Ct. Cl. 1976). A business interested in pursuing activities in outer space will must be aware of the relationship between statutory law, case law, and international law in outer space. See § 105; Registration Convention, *supra* note 39, at art. II; *Decca*, 544 F.2d at 1070.

226. See Ro, Kleiman, & Hammerle, *supra* note 5, at 231 (describing outer space patent law as an “adventurous voyage exploring the mishmash of statutory law,

each other, thereby disincentivizing business investment in outer space endeavors.²²⁷

It is also important to consider the application of outer space patent law outside of space objects.²²⁸ The appropriate jurisdiction to apply to someone wearing a space suit outside of any manmade structure, whether it be a space station or a colony on a celestial body, is unclear.²²⁹ Although this scenario rarely occurs at the present time, it is likely to occur much more frequently in the near future.²³⁰ Governmental and private entities have plans to put humans on Mars in the coming decades and even begin building permanent structures on the planet's surface.²³¹

The Outer Space Treaty makes clear that no nation shall exercise sovereignty over celestial bodies.²³² Therefore, unless the treaty is disregarded or amended, no country may extend its sovereignty to Mars.²³³ Consequently, a colony on Mars would have to rely on the same troublesome patent law framework that a multinational space station operates under.²³⁴

It is unclear how infringement would be analyzed if someone in a colony were to exit a structure and engage in the unauthorized use

case law, and international treaties that make up a legal 'Wonderland' known as the extraterritorial reach of U.S. patent law on space-related activities, complete with sensical and nonsensical twists and turns").

227. Morris, *supra* note 141, at 488 ("Certainty in patent boundaries is desirable because it would provide patent holders some reassurances in investing in their rights of exclusion and allow for easy resolution of any conflicts over those rights, leading to greater efficiency overall.").

228. See Fecht, *supra* note 196 (discussing the difficulty in applying national laws on Mars).

229. See Taylor Stanton Hardenstein, *In Space, No One Can Hear You Contest Jurisdiction: Establishing Criminal Jurisdiction on the Outer Space Colonies of Tomorrow*, 81 J. AIR L. & COM. 251, 285 (2016) (discussing how law may be applied on space colonies).

230. See SPACEX, *supra* note 175; NASA, *supra* note 175 (discussing plans to send humans to mars in the coming decades).

231. See SPACEX, *supra* note 175; NASA, *supra* note 175.

232. Outer Space Treaty, *supra* note 36, at art. II ("Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."); Hardenstein, *supra* note 229, at 285 ("If territorial jurisdiction were to govern colonial bases in outer space, the territory would be only the physical installation. Therefore, if an incident were to occur outside the installation, then the law of the installation's registering state would not apply because the registering or controlling state's law cannot extend outside the registered object; if it did, then that would be a clear violation of the non-appropriation article in the Outer Space Treaty.").

233. See Outer Space Treaty, *supra* note 36, at art. II.

234. See Hardenstein, *supra* note 229, at 285.

of a patented invention.²³⁵ One possibility is that the nationality principle could apply to subject the alleged infringer to the jurisdiction of his nationality.²³⁶ In this case, the outcome of the unauthorized use of a patented invention designated to the United States carried out by a citizen of the United States and a citizen of Russia, both standing on the surface of Mars, would be uncertain.²³⁷ One possibility may be that only the United States citizen would be infringing the patent.²³⁸ These ambiguities further contribute to uncertainty in outer space patent law.²³⁹

The current system of patent law in outer space is not conducive to the transcendental and increasingly multinational nature of outer space.²⁴⁰ As it is, outer space patent law does not provide a level of patent protection that is robust enough to inspire confidence that promotes investment in outer space endeavors.²⁴¹ Jurisdictional ambiguities likewise degrade the confidence and certainty in which a country's patent law applies.²⁴² Solutions, both in the short-term and long-term, are necessary to overcome these negative traits that disincentivize private investment in outer space.²⁴³

235. *See id.*

236. *See id.* (explaining that the nationality principle could be “applied to outer space colonies . . . [where] any incident involving a national occurring outside the physical installation would fall under the jurisdiction of at least one state because the nationality principle . . . attaches a Partner State’s jurisdiction to any of its nationals, irrespective of where the incident occurred.”).

237. *See* Winston, *supra* note 20, at 544 (discussing different approaches to applying patent law).

238. *Id.* (“[I]n outer space, the patent boundaries . . . are personnel-based and not territorial-based.”).

239. *See* Hardenstein, *supra* note 229, at 285.

240. *See* Shoemaker, *supra* note 45, at 399 (explaining that research and exploration in outer space is becoming an increasingly multinational effort).

241. *See* Pannell, *supra* note 68, at 749–53; Ro, Kleiman, & Hammerle, *supra* note 5, at 217–22; Winston, *supra* note 20, at 531–37 (discussing various ways in which the current system of patent law in outer space lacks certainty and adequate patent protection).

242. *See* Malagar & Magdoza-Malagar, *supra* note 21, at 363 (explaining that multinational space endeavors, such as the International Space Station, are raising new issues regarding the protection of industrial property).

243. *See, e.g.,* FTC, *supra* note 142, at 17; *see also* Morris, *supra* note 141, at 488 (discussing how businesses desire certainty).

III. PROPOSED SOLUTIONS TO PROMOTE PRIVATE SECTOR INVESTMENT IN OUTER SPACE

An effective system of outer space patent law will promote commercial investment in outer space.²⁴⁴ Accordingly, one of the main goals of outer space patent law should be to increase the confidence of commercial enterprises seeking to invest their resources in endeavors beyond planet Earth.²⁴⁵ A desirable system of outer space patent law will inspire confidence in commercial enterprises by being cost effective and providing inventors with robust patent protection and jurisdictional certainty in the context of complex multinational endeavors.²⁴⁶

The goal of having a system of outer space patent law that provides robust patent protection, jurisdictional certainty, and cost effectiveness can be achieved by implementing changes to the current structure of outer space patent law.²⁴⁷ Some changes, such as creating laws to make evading patent infringement more difficult, are relatively minor and easy to implement.²⁴⁸ Other changes, such as taking measures to unify and harmonize different national systems of patent law in outer space, are relatively drastic and may be difficult to implement in the short-term.²⁴⁹ The international community should implement minor changes in the short-term to provide an immediate boost of confidence to businesses seeking to invest in outer space

244. See, e.g., Morris, *supra* note 141, at 488; see also FTC, *supra* note 142, at 17; Morris, *supra* note 141, at 488 (discussing that certainty in patent boundaries increase confidence of users of the patent system).

245. FTC, *supra* note 142, at 3 (“Uncertain patent rights pose severe difficulties for business planning: they undermine competitors’ decisions about where to channel R&D and what products to market.”); Morris, *supra* note 141, at 488 (“Certainty in patent boundaries is desirable because it would provide patent holders some reassurances in investing in their rights of exclusion . . .”).

246. See Morris, *supra* note 141, at 488 (providing that having certainty in patent boundaries reassures businesses seeking to invest in outer space endeavors); Pannell, *supra* note 68, at 751–53 (discussing how the inadequate patent protection may cause “detrimental damage” to businesses interests in outer space).

247. See Pannell, *supra* note 68, at 753–59 (discussing potential solutions to improve outer space patent law).

248. See *id.* (discussing possible solutions to limit the ability of companies from exploiting the flags of convenience principle to evade patent infringement in outer space).

249. See Meller, *supra* note 156, at 359 (discussing profound differences between national systems of patent law on Earth).

endeavors.²⁵⁰ The more drastic changes will likely take many years to implement and will be a long-term solution.²⁵¹

A. Short-Term: Make Evading Patent Infringement in Outer Space More Difficult

The international community can take certain measures in the short-term that will provide businesses seeking to invest in outer space endeavors with more confidence that their patent rights will not be infringed.²⁵² These measures, such as passing laws that make it more difficult for businesses to evade patent infringement by taking advantage of the flags of convenience principle, would be relatively easy to implement.²⁵³ Implementing these measures will provide commercial enterprises with a higher degree of patent protection.²⁵⁴

Businesses take advantage of the flags of convenience principle to evade patent infringement by registering ships in international waters to countries the business has only a tenuous connection to.²⁵⁵ This practice allows the ship to evade patent infringement by operating under the patent laws of a country that a specific patent is not designated to.²⁵⁶ As commercial activity in outer space increases, it is likely that businesses will also use the flags of convenience principle to strategically register space objects to nations, pursuant to the Registration Convention, in which a specific patent is not designated.²⁵⁷ Patented technology, developed by another commercial entity, can then be freely used in outer space while still evading patent infringement.²⁵⁸ This practice reduces the patent protection that a

250. See FTC, *supra* note 142, at 37 (providing that businesses desire certainty in their patent rights before making businesses decisions); Morris, *supra* note 141, at 488 (discussing how patent holders desire certainty in their patent rights).

251. See Meller, *supra* note 144, at 379–80 (discussing that the concept of a global patent system has been around for about 115 years and that it will take at least twenty to twenty-five years to create such a system).

252. See Pannell, *supra* note 68, at 753–59 (discussing potential solutions to improve outer space patent law in the short-term).

253. See *id.*

254. See FTC, *supra* note 142, at 17; Morris, *supra* note 141, at 488 (discussing how businesses desire certainty before making decisions).

255. See Winston, *supra* note 20, at 512–23 (explaining how businesses take advantage of the flags of convenience principle to evade patent infringement in international waters).

256. See *id.* (describing the flags of convenience principle).

257. See Pannell, *supra* note 68, at 751 (explaining how the flags of convenience principle is likely to be exploited by businesses operating in outer space).

258. See *id.*

business has in outer space and thereby reduces the confidence that a business will have to invest its resources in outer space endeavors.²⁵⁹ The international community can pass laws in the short-term that would limit the ability of businesses to use the flags of convenience principle to evade patent infringement.²⁶⁰

These laws could take on qualities similar to that of the *Decca* test.²⁶¹ The *Decca* test asks if (1) the control of a system occurs within United States territory; (2) the system is owned by a United States entity; and (3) if there is a beneficial use for the system in the United States.²⁶² If the answers to the prongs of the *Decca* test are “yes” for any given space object, then a business should not be able to register that space object outside of the United States.²⁶³ However, businesses may find ways around the first two prongs of the test by taking relatively inexpensive actions.²⁶⁴

A business could build a long-term control center in Azerbaijan, thereby dodging the first prong of the test.²⁶⁵ A business may find ways to dodge the second prong of the test by legally registering or classifying itself as an entity outside of the United States or by registering the space object to another business outside of the United States.²⁶⁶ Although the first two prongs can be dodged with relative ease, these prongs should still remain a part of the test as a minimum bar that an entity must satisfy to legally register a space object outside of the United States.²⁶⁷ However, the third prong of the test also presents a problematic scenario.²⁶⁸

259. Kleiman, *supra* note 3, at 4 (“Permitting space companies to evade patents using flags of convenience will lessen the value of . . . patents. Space companies may find it more difficult to secure private financing for research and development activities . . .”).

260. See Pannell, *supra* note 68, at 753–59 (providing potential solutions to limit the use of the flags of convenience principle in outer space).

261. See *Decca Ltd. v. United States*, 544 F.2d 1070, 1083 (Ct. Cl. 1976) (providing the *Decca* test to determine if a multinational technological system can be subject to the patent laws of the United States).

262. See *id.* (explaining the *Decca* test as it is used to determine the extraterritorial reach of United States’ jurisdiction).

263. See *id.*

264. See Pannell, *supra* note 68, at 749–53 (providing examples of how businesses may evade patent infringement in outer space).

265. See *id.*

266. See Winston, *supra* note 20, at 535 (describing how business can register space objects to countries outside of the United States).

267. See *Decca*, 544 F.2d at 1083 (discussing the first two prongs of the *Decca* test).

268. See *id.* (discussing the beneficial use portion of the *Decca* test).

A space object may provide a beneficial use in many countries around the world in addition to the United States.²⁶⁹ Therefore, a company would always be required to register a space object to the United States if it finds a beneficial use there, even though the beneficial use in the United States may be minor in comparison to other countries.²⁷⁰ The test could be strengthened by modifying the third prong of the test.²⁷¹

The language of the third prong should ask whether the majority of income derived from a space object is from the United States' consumer base.²⁷² If the answer to this question is "yes," then it would be impossible for the space object to have derived more income from any other country's consumer base.²⁷³ Therefore, the undesirable scenario of a space object having a beneficial use in many different countries would be eliminated.²⁷⁴ This modification also limits a company from unfairly registering a space object to a foreign country, where little to no income is derived, rather than to the United States where more than half of the income is derived.²⁷⁵ The United States, or any country enforcing this test, could do so through a combination of excluding a business from access to its consumer base and through penalties and fines.²⁷⁶

There is still room for businesses to take advantage of the flags of convenience principle to evade patent infringement through this test.²⁷⁷ However, this test can be implemented relatively quickly and

269. See Ro, Kleiman, & Hammerle, *supra* note 5, at 214–15 (explaining how a space object can have beneficial uses in more than one country).

270. See *Decca*, 544 F.2d at 1083 (discussing the beneficial use portion of the *Decca* test); see also Winston, *supra* note 20, at 534 (discussing the multinational nature of space objects).

271. See *Decca*, 544 F.2d at 1083 (discussing the third prong of the *Decca* test).

272. See *Majority*, BLACK'S LAW DICTIONARY (11th ed. 2019) (defining majority as "a group of more than 50 percent").

273. See *id.* (providing that majority means more than 50%, or half, of a quantity).

274. See *id.* If the majority, or more than 50%, of income is derived from a single country, then it is mathematically impossible for any other source of income to be larger. *Id.*

275. See Registration Convention, *supra* note 39, at art. II (providing details about how space objects must be registered with the United Nations).

276. See Pannell, *supra* note 68, at 757–59 (discussing how a country may exclude a company from accessing its consumer base if the company uses the flags of convenience principle to evade patent infringement in outer space).

277. See Winston, *supra* note 20, at 533–34 (discussing how a business may evade patent infringement in outer space).

presents a serious obstacle to deter potential patent infringers in a fair and reasonable way.²⁷⁸ This test would provide an immediate boost of confidence to a business seeking to invest in outer space endeavors by strengthening its patent rights.²⁷⁹

B. Long-Term: Implement a Unified System of Outer Space Patent Law

The overarching problem with outer space patent law is that a network of different national patent law systems must attempt to provide adequate patent protection in an increasingly multinational environment where natural borders do not exist.²⁸⁰ Inventors must navigate a complex web of numerous jurisdictions, each with its own set of patent laws and each providing a potential safe-haven for would-be patent infringers.²⁸¹ Adding to an inventor's troubles is the cost associated with filing a patent in each country where patent rights are desired and litigating patent infringement proceedings in each country where a patent has been infringed.²⁸² An effective system of outer space patent law will provide inventors with a clear and cost-efficient path that grants them robust patent rights in all of outer space, regardless of which jurisdiction they may be subject to at any given time.²⁸³ A unified system of outer space patent law is necessary to achieve this goal.²⁸⁴

278. See Ro, Kleiman, & Hammerle, *supra* note 5, at 217–20, 230–31 (providing that harmonization of international patent law in outer space may be the best way to mitigate patent infringement in outer space, but in the meantime, preventing the use of the flags of convenience principle to get around patent infringement in outer space is an important step to take in the process of improving outer space patent law); Winston, *supra* note 20, at 533–35 (discussing different ways that a business may evade patent infringement in outer space).

279. See Pannell, *supra* note 68, at 750–51 (discussing how a business may not invest in outer space endeavors due to the ability of other entities to evade patent infringement relatively easily).

280. See Kleiman, *supra* note 3, at 4 (explaining that under the current system of outer space patent law, inventors must file for patent protection in every jurisdiction in which they desire patent protection).

281. See *id.* at 5 (discussing how inventors must rely on courts across various jurisdictions to enforce their patents against outer space patent infringers).

282. See *id.*

283. See Meller, *supra* note 156, at 372 (discussing the need for an effective patent system that serves the needs of inventors worldwide).

284. See FRANCIS LYALL & PAUL B. LARSEN, *SPACE LAW: A TREATISE* 127 (2009) (“[G]eneral and uniform patent protection for inventions made in outer space would give investors confidence in outer space research and encourage such activities.”).

Implementing a unified system of outer space patent law would be a drastic undertaking.²⁸⁵ Guidance on the implementation of such a system can be found by examining the European Union's unitary patent system.²⁸⁶ The unitary patent system in the European Union allows inventors to file a single patent that grants them patent rights in almost every Member State of the European Union.²⁸⁷ Three key issues must still be addressed before implementing a unified system of outer space patent law: (1) defining an internationally accepted boundary between outer space and Earth; (2) creating an international court with jurisdiction over the unified system of outer space patent law; and (3) defining a uniform set of rules to govern the unified system of outer space patent law.²⁸⁸

1. *Define the Boundary Between Outer Space and Earth*

An important step in creating a unified system of outer space patent law is to define where the system applies.²⁸⁹ The unified system of outer space patent law should only apply in outer space.²⁹⁰ However, there is currently no internationally accepted demarcation line between Earth and outer space.²⁹¹

285. See Ro, Kleiman, & Hammerle, *supra* note 5, at 230–31 (discussing how efforts to harmonize international patent laws will be difficult due to the reluctance of nations to surrender part of their sovereignty to an international organization).

286. See *Main Features*, *supra* note 150 (discussing the unitary patent system in the European Union).

287. *Id.* (“Instead of validating a European patent in several countries, patent proprietors can choose to file a request for unitary effect and obtain—in a single and straightforward procedure carried out centrally by the EPO—a Unitary Patent providing uniform protection in up to 26 participating Member States.”).

288. See Winston, *supra* note 20, at 529–30 (providing that there is not internationally accepted definition of where outer space begins). Additionally, there is no world-wide court system charged with the responsibility to adjudicate global patent issues. See Meller, *supra* note 156, at 366. Finally, there is no harmonized system of rules to govern international patent law. See *id.* at 359.

289. See Winston, *supra* note 20, at 529–30 (providing that there is not internationally accepted definition of where outer space begins).

290. Implementing a unified system of patent law in outer space may be easier to do than implementing a unified system of patent law on Earth. See McEniery, *supra* note 144, at 169. On Earth, countries are reluctant to give up or diminish their rights due to the high value countries place on their national sovereignty. See *id.* However, a unified system of outer space patent law that only applies in outer space would not affect national sovereignty on Earth. See *id.*

291. See Winston, *supra* note 20, at 529–30.

The von Karman line should be used as the boundary that legally separates outer space from Earth's atmosphere.²⁹² The von Karman line provides that outer space begins, and airspace ends, at approximately 100 kilometers above Earth's surface, where spacecraft are necessary for travel due to the thin air.²⁹³ The von Karman line method is desirable because it is based on the practical consideration that spacecraft are almost always necessary at altitudes of 100 kilometers and higher.²⁹⁴ Consequently, almost all human activities at this altitude will be using space-based technology.²⁹⁵ Therefore, it would be sensible for a unified system of outer space patent law to govern the predominately space-based activities that take place at this altitude and higher.²⁹⁶ After defining the jurisdictional boundary of the unified system of outer space patent law, an international patent court must be created to enforce the rules that govern of this new system of patent law.²⁹⁷

2. *Create a Court with Jurisdiction over the Unified System of Outer Space Patent Law*

A system of patent law that transcends jurisdictional lines will require the creation of a new court with the jurisdiction to properly enforce the rules of this system.²⁹⁸ The outer space patent law court

292. See *id.* (describing the von Karman line approach to delineating between space and airspace); see also Malagar & Magdoza-Malagar, *supra* note 21, at 313–16 (further discussing issues surrounding the boundary between space and the Earth's atmosphere).

293. See *Where is Space?*, *supra* note 106 (stating that the altitude of the von Karman line is approximately 100 kilometers); Winston, *supra* note 20, at 529–30 (stating that aircraft generally cannot fly at the von Karman line and that spacecraft are necessary for travel at this altitude).

294. *Where is Space?*, *supra* note 106 (“In theory, once this 100 km line is crossed, the atmosphere becomes too thin to provide enough lift for conventional aircraft to maintain flight. At this altitude, a conventional plane would need to reach orbital velocity or risk falling back to Earth.”).

295. See *How High is Space?*, SPACE TODAY ONLINE, <http://www.spacetoday.org/SolSys/Earth/AltitudesChart.html> [https://perma.cc/7VBM-P843] (last visited Nov. 11, 2019) (providing the altitude of the von Karman line and various other objects in relation to the Earth's surface).

296. See *id.* (providing that activities above the von Karman line are predominantly space-based activities).

297. See Meller, *supra* note 156, at 366 (discussing how there is currently no international court to adjudicate global patent issues).

298. See *Main Features*, *supra* note 150 (discussing the Unified Patent Court of the European Union). There must be a means to enforce patent rights in various countries in a system of patent law that transcends national borders. See *id.*; see also

must be made up of unbiased judges and have clearly defined jurisdiction.²⁹⁹ The models of the Unified Patent Court (UPC) of the European Union and the International Court of Justice (ICJ) can be used to guide the creation of the outer space patent law court.³⁰⁰

To prevent bias with respect to an inventor's nationality, the outer space patent law court should consist of judges of different nationalities at all times.³⁰¹ Unlike the ICJ where judges are voted in through a process that only mandates that all judges be of a different nationality, judges to the outer space patent law court should be selected on a pre-determined rotational basis that is based on the judge's nationality.³⁰² A mandated and predictable rotation of judges based on nationality limits the ability of countries to engage in unwanted political maneuvering in an effort to block judges from other countries.³⁰³ This process also ensures that the panel of judges is not monopolized by any single country or allied group of countries.³⁰⁴ Like the ICJ, the panel of judges could consist of fifteen judges elected to nine-year terms.³⁰⁵ Finally, similar to the required credentials of UPC judges, the judges of the outer space patent law court should meet high standards of competence and have proven experience in patent litigation.³⁰⁶ This basic framework for selecting judges to the outer space patent law court would limit judicial bias based on nationality while also maintaining a high degree of competence within the panel of judges.³⁰⁷

Meller, *supra* note 156, at 366 (discussing the need for an international court to enforce patents on a global scale).

299. See Meller, *supra* note 156, at 371–72 (discussing how a future international patent court may be structured).

300. See *Main Features*, *supra* note 150 (discussing details regarding the Unified Patent Court); *The Court*, *supra* note 162 (discussing details regarding the International Court of Justice).

301. See Posner & de Figueiredo, *supra* note 168, at 4 (discussing the issues associated with impartiality of judges on the International Court of Justice).

302. U.N., *supra* note 167 (“The Court shall be composed of a body of independent judges, elected regardless of their nationality . . .”).

303. See Robinson, *supra* note 168, at 278–79 (discussing how the election process for judges on the International Court of Justice is highly political and undesirable).

304. See *id.*

305. *Members of the Court*, *supra* note 163 (“The International Court of Justice is composed of 15 judges elected to nine-year terms of office by the United Nations General Assembly and the Security Council.”).

306. See *The UPC and its Judges*, *supra* note 153 (discussing the high standards that potential UPC judges must meet).

307. See Robinson, *supra* note 168, at 278–79 (discussing international political issues associated with appointing judges without regard to their nationality).

The jurisdiction of the outer space patent law court must also be clearly defined.³⁰⁸ Based on the von Karman line, the jurisdiction of the outer space patent law court will only apply at altitudes of 100 kilometers and higher.³⁰⁹ However, nations will still likely be reluctant to give up any sovereignty, which national systems of patent law, even in outer space, are a part of.³¹⁰

To ease concerns over national sovereignty, the outer space patent law court would not have jurisdiction over national patents.³¹¹ However, the outer space patent law court will have exclusive jurisdiction over patents designated within the unified system of outer space patent law.³¹² To accommodate future colonization beyond Earth, the system of outer space patent law will also extend to celestial bodies, such as Mars.³¹³ This jurisdictional model for the outer space patent law court allows for the enforcement of patent rights within the unified system of outer space patent law in outer space and on celestial bodies.³¹⁴ This model also allows countries to maintain complete jurisdiction over their own system of patent law.³¹⁵

The required credentials of judges to be appointed to the outer space patent law court could be similar to the required credentials for UPC judges. *See The UPC and its Judges*, *supra* note 153 (discussing the credentials required to be a UPC judge).

308. Like the jurisdiction of the UPC, the jurisdiction of the outer space patent law court should be clear. *See About the UPC*, *supra* note 152 (providing a brief and clear description of the jurisdiction of the UPC).

309. *See Winston*, *supra* note 20, at 529–30 (stating that the altitude of the von Karman line is approximately 100 kilometers).

310. Randy Campbell, *Global Patent Law Harmonization: Benefits and Implementation*, 13 No. 2 *IND. INT'L & COMP. L. REV.* 353, 616–17 (2003) (“Both patent protection and the patent grant itself derive from the sovereign as incidents of national law. The national government seeks to control its patent system because it gives the government control over technological and economic developments for its own country. Also, nationalistic and protectionist tendencies resist pressures for change from outside the national borders.”).

311. Like the UPC, the outer space patent law court will not have jurisdiction over national patent law. *About the UPC*, *supra* note 152 (“The UPC will not have any competence with regard to national patents.”).

312. The outer space patent law court, like the UPC, will have some form of exclusive jurisdiction. *Id.* (“[The UPC] will have exclusive competence in respect of European patents and European patents with unitary effect.”).

313. In addition to outer space, the system of outer space patent law should extend to celestial bodies because it is likely that humans will soon settle on celestial bodies such as Mars. *See NASA*, *supra* note 175; *SPACE X*, *supra* note 175 (discussing future plans to send humans to Mars).

314. The jurisdictional model of the outer space patent law court should be based off the UPCs jurisdictional model. *See About the UPC*, *supra* note 152.

315. There is a better chance for international agreement concerning the adoption of a unified system of outer space patent law if countries are able to maintain

3. *Define a Uniform Set of Rules to Govern the Unified System of Outer Space Patent Law*

The international community must also determine which specific patent laws will be applied in outer space.³¹⁶ Obtaining international consensus on the specific patent laws to be applied in outer space will likely be the most difficult step in implementing a unified system of outer space patent law.³¹⁷ Nations maintain distinct and independent systems of patent law on Earth.³¹⁸ Each country will likely push for the laws of the unified system of outer space patent law to be as similar to its own national patent laws as possible.³¹⁹ Consequently, some scholars believe that harmonization of patent law on an international level is not possible.³²⁰

Even with this difficulty, the possibility of creating a uniform set of patent laws to apply in outer space is not insurmountable.³²¹ Although national systems of patent law on Earth are distinct from one another, many of the underlying principles are similar.³²² New patent law systems in China, Russia, and Eastern European countries have adopted many of the same procedures and concepts found in the patent law systems of Japan, Germany, and the United States.³²³ Additionally,

complete control over national patent law systems. *See* McEniery, *supra* note 144, at 169 (discussing how countries are hesitant to harmonize patent law at an international level due to the possibility of giving up national sovereignty).

316. Meller, *supra* note 156, at 359 (“Uniform principles of patentability involving novelty, utility and unobviousness are the three-legged stool on which any international or global patent law must be set.”).

317. *See* McEniery, *supra* note 144, at 201 (providing that there are both economic and political obstacles to implementing a global system of patent law).

318. *Id.* at 169 (“[Patent law] fragmentation is the natural consequence of a global political and economic system that values national sovereignty most highly.”).

319. *See id.*

320. *See* Anthony D. Sabatelli & J.C. Rasser, *Impediments to Global Patent Law Harmonization*, 22 N. KY. L. REV. 579, 580 (1995) (“Despite . . . multilateral attempts, true harmonization is a lofty goal. The dream of a single, globally valid and enforceable patent is probably not attainable in the future.”).

321. *See* Meller, *supra* note 156, at 359 (providing that the goal of a concept of a global patent “is no longer a dream that might be realized in another millennium” but a goal that could be realized by this generation).

322. *See* McEniery, *supra* note 144, at 169 (“[H]armonization efforts that have taken place in the last 150 years have ensured that the concepts of patentability are largely similar around the world”); Meller, *supra* note 144, at 379 (“[W]ith the adjustment of norms for patent application rules and even patent law principles around the world, patent law is becoming more and more uniform”).

323. *See* Meller, *supra* note 144, at 380 (“Most new patent systems of countries like China, Russia and other Eastern European countries have mirrored a

the United States, China, and Japan accounted for approximately 73% of the total patent applications filed in the world in 2018.³²⁴ Because the large majority of patent activity in the world today stems from patent law systems that are relatively similar to one another, the goal of creating a unified system of outer space patent law based on these systems of patent law should be achievable in the long term.³²⁵

A unified system of outer space patent law would promote commercial investment in outer space endeavors.³²⁶ A business could receive patent protection in outer space at a low cost by filing a single patent application rather than filing patent applications in every country in which patent protection is desired.³²⁷ A business would no longer need to worry about complicated jurisdictional boundaries that arise in the context of multinational outer space endeavors.³²⁸ The unified system of outer space patent law would transcend jurisdictional boundaries to provide seamless patent protection in outer space.³²⁹

The current system of outer space patent law leaves businesses unacceptably vulnerable to patent infringement and struggling to determine which national system of patent law applies in complex multinational space endeavors.³³⁰ Measures can be taken in the short

modern Japanese/German or U.S. standard, closely akin to the European Patent Convention.”).

324. *Facts and Figures*, *supra* note 146 (providing data on intellectual property activity around the world).

325. *See* Meller, *supra* note 144, at 380 (discussing how most new systems of patent law, including the Chinese and Russian systems, have adopted many of the same basic principles of patent law found in the United States, Japan, and Germany); *Facts and Figures*, *supra* note 146 (providing that the large majority of patent activity in the world takes place in China, the United States, and Japan).

326. *See* WORLD INTELLECTUAL PROP. ORG., *supra* note 7, at 22 (providing that a unified system of outer space patent law would be the best solution to solve the current issues with outer space patent law).

327. Pannell, *supra* note 68, at 749 (“Current patent law requires a company to apply for a patent in every country where its space object may potentially be infringed upon. This can be a long, tedious, and expensive process in many cases.”).

328. *See id.* (discussing that any country in which a business fails to obtain patent protection in can be exploited by competitors to use the patented technology without committing patent infringement).

329. *See* Kleiman, *supra* note 3, at 6 (explaining that the best way to increase patent protection in outer space is to implement a unified system of outer space patent law).

330. *See* WORLD INTELLECTUAL PROP. ORG., *supra* note 7, at 22 (discussing how the current system of outer space patent law does not provide businesses with legal certainty); Pannell, *supra* note 68, at 751–52 (explaining how the current system of outer space patent law leaves businesses highly vulnerable to patent infringement).

term, such as implementing a modified version of the *Decca* test to limit the ability of businesses to evade patent infringement through the flags of convenience principle.³³¹ However, the long-term solution that could solve many issues with the current system of outer space patent law would be to implement a unified system of outer space patent law.³³²

CONCLUSION

Outer space presents both challenges and opportunities for human civilization.³³³ The private sector has increasingly begun to take advantage of the many opportunities that outer space has to offer.³³⁴ One significant and positive consequence of this is that the vast resources and constant innovation of the private sector in outer space will likely lead to important technological breakthroughs that will push society toward a brighter future.³³⁵

The current system of outer space patent law, however, creates obstacles and disincentivizes private sector investment in outer space.³³⁶ In the short term, the international community should pass

331. See Pannell, *supra* note 68, at 753–59 (discussing potential short-term solutions to limit the ease of which patent infringement in outer space can be evaded).

332. Kleiman, *supra* note 3, at 6 (“The ideal solution to the flag-of-convenience problem, at least as it relates to effective patent protection, is to create a new multinational patent jurisdiction for filing and enforcing patents in outer space.”).

333. Jeff Foust, *A Trillion-Dollar Space Industry Will Require New Markets*, SPACENEWS (July 5, 2018), <https://spacenews.com/a-trillion-dollar-space-industry-will-require-new-markets/> [<https://perma.cc/X36Q-KCAE>] (“[S]everal reports in the last year by investment banks predicted that the global space economy, currently valued at about \$350 billion, could grow to \$1 trillion or more in the 2040s.”).

334. WORLD INTELLECTUAL PROP. ORG., *supra* note 7, at 21 (“It can be expected that technical inputs as well as financial contributions from the private sector will become more and more important in the context of future development of outer space activities.”).

335. See Burk, *supra* note 10, at 300–01 (discussing how society has already benefitted from private-sector investment in outer space and how outer space holds the promise of many more significant benefits); Foust, *supra* note 333 (providing that the space economy is currently valued at about \$350 billion and is expected to grow rapidly).

336. See Pannell, *supra* note 68, at 749–53 (explaining how inventors in space have inadequate patent protection due to the ease with which entities can evade patent infringement in outer space); Winston, *supra* note 20, at 533 (providing further examples of how businesses may evade patent infringement in space with relative ease); McEniery, *supra* note 144, at 169 (discussing how the structure of various national systems of patent law impose high costs and are time consuming for inventors seeking patent protection in multiple countries).

laws to limit the ease by which patent infringement in space can be evaded to provide an immediate boost to the private sector's confidence to invest in outer space endeavors.³³⁷ However, a unified system of outer space patent law that transcends national jurisdictional boundaries is the best solution for boosting the private sector's confidence to invest in outer space endeavors.³³⁸ American astrophysicist Neil deGrasse Tyson said, "The universe is under no obligation to make sense to you"; however, society's system of outer space patent law should be.³³⁹

337. See Pannell, *supra* note 68, at 753–57 (describing solutions that could be implemented to limit the use of the flags of convenience principle to evade patent infringement in outer space).

338. See WORLD INTELLECTUAL PROP. ORG., *supra* note 7, at 22 ("From the business perspective, . . . legal certainty is an essential factor for the space industry [T]he best solution [is to] declare space and its accessories . . . as a single territory with a single and uniform law and with a single and universal enforcement body. Indeed, it appears that many of the practical difficulties that arise from the commercial application of space technologies stem from the very principle of territoriality and differences among national intellectual property law.").

339. NEIL DEGRASSE TYSON, *ASTROPHYSICS FOR PEOPLE IN A HURRY* 13 (2017).