LEGAL ISSUES FOR LUNAR ORBITING SATELLITES AND SUGGESTED SOLUTIONS

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ABSTRACT

A new space race has started, once again with focus on the Moon. More than one country is interested in the Moon, principally because of its resources. The private sector is also involved in this new "Moon race" at an unprecedented level... Lunar activities will depend heavily on lunar satellites. Unfortunately, the current international and domestic legal frameworks are inadequate in respect of the management of non-Earth orbiting satellites, and this lack of clarity could create or worsen potential conflicts on the Moon. The lack of clear guidelines and regulations and doubts about the meaning of fundamental concepts like "appropriation," exacerbate uncertainty. This article discusses some legal issues and uses the Building Blocks for the Development of an International Framework on Space Resource Activities and the Artemis Accords to develop a model for "Guidelines for Lunar Satellites," with which is recommended that stakeholders voluntarily comply as best practices and which can be adopted in national legislation.

I. INTRODUCTION

A new space race has started, once again with focus on the Moon. More than one country is interested in the Moon, principally because of its resources. Both the US Artemis Program and China's Lunar Exploration Program, C*hang'e,* envision sending people to

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the Moon, promoting lunar resource utilization and building a space station in lunar orbit. Private actors are actively involved in projects for lunar exploration. The governmental programs and the commercial activities on the Moon, such as scientific activities and resource utilization, will be heavily dependent on lunar satellites. However, lunar satellites currently operate with little guidance, regulation or restrictions.

Lunar resource extraction has been the focus of attention,[1] while lunar satellites, which are a prerequisite to mining endeavors, have largely been ignored.[2] Conditions for use and regulation of lunar satellites, both domestic and international, are the subject of this article. The broad thesis is that all or almost all current regulation, both domestic and international, either does not apply or applies only minimally to lunar satellites. As a result, lunar satellites currently operate with little guidance, regulation, or restriction. This article proposes several solutions to this vacuum of regulation. Part II provides background information regarding lunar programs and lunar satellites and suggests that conflicts between the lunar stakeholders can be worsened by the insufficiency of regulation. Part III demonstrates the inadequacy of international regulation and proposes modifications and solutions. Part IV turns to domestic regulation,[3] and presents an analysis demonstrating

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[1] *See e.g.*, The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids, https://www.nasa.gov/wp-content/uploads/2022/11/Artemis-Accords-signed-13Oct2020.pdf [hereinafter Artemis Accords] (dedicating the entire § 10 to space resources); BUILDING BLOCKS FOR THE DEVELOPMENT OF AN INTERNATIONAL FRAMEWORK FOR THE GOVERNANCE OF SPACE RESOURCE ACTIVITIES, https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht--en-ruimterecht/space-resources/revised-building-blocks-following-the-meeting-of-april-2019.pdf [hereinafter BUILDING BLOCKS] (specifically dedicated to space resources). Four countries issued specific laws on space resource utilization (the United Sates, Luxembourg, the United Arab Emirates and Japan). *See also* Francesca Giannoni-Crystal, *Jurisdictional Choice for Space Resource Utilization Projects; Current Space Resource Utilization Laws,* Santa Clara J. Int'l L., forthcoming (Spring 2024) [hereinafter *Jurisdictional Choice for Space Resource Utilization Projects*].

[2] The Artemis Accords – while applicable to lunar orbits – do not contain specific provisions regarding lunar satellites. The Building Blocks mention satellites only to exclude that satellites orbits are resources. Artemis Accords, *supra* note 1; BUILDING BLOCKS, *supra* note 1.

[3] The focus is on domestic regulation in the United States. The US is one of the primary spacefaring States, and often partners with and influences the domestic activities of other countries.

the inadequacy of regulation and again offers proposed solutions and modifications. While a multilateral treaty is likely not be feasible in the current geopolitical situation,[4] "soft law" remains a viable option and Part V provides a comprehensive proposal of Lunar Satellites Guidelines drawn from a number of sources, including the Building Blocks for the Development of an International Framework on Space Resource Activities, together with the Artemis Accords[5] and some other international documents.[6] While this article develops the Guidelines specifically for lunar satellites, this solution can also apply to other non-Earth orbiting satellites (e.g., around Mars) and help resolve surface conflicts. Lunar stakeholders should follow the Guidelines as best practices and as many countries as possible should adopt similar principles in national legislation, either directly in statute or by requiring compliance as part of their authorization procedure.

II. THE BACKGROUND: LUNAR PROGRAMS AND LUNAR SATELLITES

A. The Lunar Programs

More than one country is interested in the Moon, both because of its resources and its value as a low-gravity, intermediary launch point.[7] The exploration and development of the Moon could create

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[4] Melissa J. Durkee, *Interstitial Space Law*, 97 WASH. U. L. REV. 423, 434 (2019) (stating that "the era of multilateral treaty-making may now be coming to a close as major geopolitical rifts divide former allies and seem to diminish the possibilities for meaningful multilateral agreements"). *See also*, Ram Jakhu & Steven Freeland, *The Relationship Between the Outer Space Treaty and Customary International Law*, *in* PROC. 59TH COLLOQUIUM L. OUTER SPACE 183, 187 (2016).

[5] Artemis Accords, *supra* note 1.

[6] *See*, *e.g.*, UNITED NATIONS OFF. FOR OUTER SPACE AFFS., SPACE DEBRIS MITIGATION GUIDELINES OF THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE (2010), https://www.unoosa.org/pdf/publications/st_space_49E.pdf [hereinafter SPACE DEBRIS MITIGATION GUIDELINES].

[7] The global energy crisis and the need to move away from fossil fuels is a push towards alternative energy sources. Nuclear fusion (i.e., transforming hydrogen into helium) can be a solution. It can be achieved in various ways but one of the most effective is to combine deuterium with helium-3, the result of which is helium-4 (the most common type of helium), protons and energy. While deuterium can be extracted from seawater on Earth, helium-3 is very rare on Earth; the current price is $ 1.4 million/kg. In some parts of the Moon (the Sea of Tranquility and the Ocean of Storms), helium-3 is abundant. In fact, because of the absence of a magnetic field or a protective atmosphere, the

conflicts among the spacefaring countries, especially considering that the rules related to the use of lunar resources are unclear.

China and the US's lunar aspirations are similar but uncoordinated. China launched its first satellite in 1970,[8] but rapidly made up for the late start,[9] beginning its Moon program, *Chang'e*,[10] in October 2007. Whatever China's motivations for the Moon exploration, it has committed significant resources to the space program and has reaped significant success.[11]

Notwithstanding the mythological name of the program,[12] China's discourse about space (and the Moon in particular) is very much about economic development.[13] As part of its program, China plans to send people to the Moon, to mine the Moon's resources and to place a space station in lunar orbit.[14] According to one estimate, China could successfully land taikonauts,[15] Chinese astronauts, on

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bombardment of solar wind deposits helium-3 on the lunar surface. At current price, there is an estimated $ 1.5 quadrillion of helium-3 on the Moon. Colin Stuart, *A Race Is Afoot to Make Billions from the Moon's Resources*, BBC (July 17, 2022), https://www.sciencefocus.com/space/new-space-race-Moon.

[8] Michelle L. D. Hanlon, *The Middle Kingdom's Shrewd Strategy to Become the Centre of the Universe*, 41 ANNALS AIR & SPACE L. 287, 294-95 (2016). "It would not be an exaggeration to suggest that the genesis of the PRC's space programme was infused with bitter rejection and a massive national inferiority complex."

[9] *Id*. at 295-296.

[10] Adam Mann, *China's Chang'e Program: Missions to the Moon*, SPACE.COM (Feb. 1, 2019), https://www.space.com/43199-chang-e-program.html; *ESA Tracks Chang'e-5 Moon Mission*, EUR. SPACE AGENCY (Nov. 18, 2020), https://www.esa.int/ESA_Multimedia/Images/2020/11/ESA_tracks_Chang_e-5_Moon_mission.

[11] The China program has already successfully accomplished the collection of Moon samples. *See, e.g.,* Mike Wall, *China's Chang'e 5 Capsule Lands on Earth with the 1st New Moon Samples in 44 Years*, SPACE.COM (Dec. 16, 2020), https://www.space.com/china-chang-e-5-Moon-samples-capsule-landing.

[12] *Chang'e* is named after the Chinese goddess of the Moon. *See* Mike Greenberg, *The Chinese Goddess of the Moon*, MYTHOLOGY SOURCE (Jan. 21, 2021), https://mythologysource.com/change-chinese-goddess/.

[13] Cao Siqi, *China Mulls $10 Trillion Earth-Moon Economic Zone*, GLOBAL TIMES (Nov. 1, 2019), https://www.globaltimes.cn/content/1168698.shtml.

[14] Andrew Jones, *China Lays Out Big Plans for Its New Tiangong Space Station*, SPACE.COM (May 3, 2022), https://www.space.com/china-big-plans-tiangong-space-station.

[15] Taikong is the "name used in the west for a Chinese astronaut. It comes from the Chinese word 'taikong' meaning space or cosmos." However, the "official Chinese name is *yuhangyuan* …" Definition of *Taikonaut,* OXFORD REFERENCE, https://www.oxfordreference.com/view/10.1093/oi/authority.20110803101916587 (last accessed Nov. 20, 2023).

the Moon in 2024/2026.[16] As for lunar mining, China believes, like the US, in the "first come, first served" principle,[17] but it does not yet have a law on lunar resources.[18]

Perhaps as a partial consequence of China's project, the US placed new emphasis on space and on the goal of landing astronauts again on the Moon during the Trump Administration.[19] The Artemis Program—announced in 2020—is the US and its partners' program of exploration and use of the Moon.[20] It envisions the construction of a space station in lunar orbit and mining on the Moon. "Artemis aims to establish a long-term, sustainable human presence on and around the [M]oon by the end of the 2020s."[21] In order "to establish a common vision of space authorities regarding the use of the Moon and other celestial bodies,"[22] the National Aeronautics and Space Administration (NASA) and the space agencies of several partners entered into non-legally binding bilateral arrangements, known as the Artemis Accords.[23] Importantly, the Artemis Accords take the position that they are implementing the Treaty on Principles Governing the Activities of States in the Exploration and Use

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[16] *China Releases White Paper on Space Program*, CHINA NAT'L SPACE ADMIN. (Jan. 28, 2022), http://www.cnsa.gov.cn/english/n6465652/n6465653/c6813100/content.html. An integral part of China's space program is the establishment of space-based solar panels. Andrew Jones, *China Aims for Space-Based Solar Power Test in LEO in 2028, GEO in 2030*, SPACENEWS (June 8, 2022) https://spacenews.com/china-aims-for-space-based-solar-power-test-in-leo-in-2028-geo-in-2030/.

[17] Namrata Goswami, *Moon Mining and Lunar Bases: Legal Implications?*, NAMRATA GOSWAMI (May 11, 2020), https://www.linkedin.com/pulse/Moon-mining-lunar-bases-legal-implications-namrata-goswami/ (stating that "[t]here are indications that China's national space law will prioritize 'first come, first serve[d]'"). As for the US, the "first come, first served" is "inherent in the Artemis Accords." Roger J. Cochetti, *Who Can Own the Moon?*, THE HILL (June 24, 2020), https://thehill.com/opinion/technology/504289-who-can-own-the-Moon/.

[18] Unlike China, other countries have passed laws on the mining of celestial bodies, e.g., Japan, the UAE, the US and Luxembourg. For a discussion of these four laws, see e.g., *Jurisdictional choice for space resource utilization projects.*

[19] Bryant A. Mishima-Bake, *Moon Wars: Legal Trouble in Space and Moon Law*, JAG REPORTER (Mar. 4, 2021), https://www.jagreporter.af.mil/Post/Article-View-Post/Article/2544589/Moon-wars/.

[20] *See, e.g.,* Paul B. Larsen, *Is There a Legal Path to Commercial Mining on the Moon?*, 83 U. PITT. L. REV. 1, 35-36 (2021).

[21] Jeff Spry, *Artemis Moon Program Will Boost Science and Private Spaceflight, NASA Says*, SPACE.COM (Apr. 12, 2022), https://www.space.com/artemis-Moon-program-science-private-spaceflight.

[22] Larsen, *supra* note 20, at 37.

[23] Artemis Accords *supra* note 1; Larsen, *supra* note 20, at 36-37.

of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty, or OST)[24] and not modifying it.[25] The Artemis Accords are based on principles of peaceful use, transparency, emergency assistance, safety/sustainability and "deconfliction."[26] The establishment of reasonable safety zones and a commitment to debris mitigation is critical to the Artemis Accords.[27]

The Chinese and American lunar projects are not coordinated.[28] This lack of coordination coupled with the uncertainties of the legal framework—especially for the commercial exploitation of lunar resources[29]—may produce conflicts.[30] However, the coordination between China and the US for lunar activities is complicated by the so-called Wolf Amendment, which limits US-China dialogue and the US ability to work with China or a Chinese-owned company in space activities by barring funding of such collaborations to NASA or the Office of Science and Technology Policy (OSTP).[31]

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[24] 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 or OST].

[25] Artemis Accords *supra* note 1, Preamble ("AFFIRMING the importance of compliance with the [Outer Space Treaty]" and "DESIRING to implement the provisions of the Outer Space Treaty") and Section 1-Purpose and Scope ("The Accords represent a political commitment to the principles described herein, many of which provide for operational implementation of important obligations contained in the Outer Space Treaty and other instruments."). Larsen, *supra* note 20, at 37.

[26] Artemis Accords *supra* note 1, §§ 1, 3, 6, 10 & 11; Larsen, *supra* note 20, at 38-39.

[27] Artemis Accords, supra note 1, § 11(7); Larsen, *supra* note 20 at 40.

[28] *Id*. at 6.

[29] Larsen gives the following scenario as an example:

> As a hypothetical scenario, suppose that, one day, a Chinese company challenges a lunar mining site selected by a US mining company. Suppose then that the US company asks the Department of Defense (DOD) for protection. In response, the Chinese company may seek protection for itself from the Chinese government. The conflict described in this scenario would make it difficult to do business. Commercial confrontations could begin a war in outer space.

Id. at 23.

[30] *Id*. at 26.

[31] Pub. L. 112–10, Sec. 1340 (2011). The Wolf Amendment provides that:

> (a) None of the funds made available by this Act may be used for the National Aeronautics and Space Administration (NASA) or the Office of Science and Technology Policy (OSTP) to develop, design, plan, promulgate, implement, or execute a bilateral policy, program, order, or contract of any kind to participate, collaborate, or

Possible conflicts are also likely because the involvement of the private sector will increase the lunar stakeholders.[32] Of course, the involvement of private actors in space is not new;[33] however, in the current phase, the role of the private sector will be very different, from the historic model, both in quantity and quality.[34] NASA has used private companies as contractors for decades; the private sector has ventured to outer space on NASA's projects.[35] But in the new space era, NASA plans to be and "enabler"[36] and/or "customer," not employer.[37] Commercial entities will mine the Moon and perform other activities there. For example, ispace, inc.[38] plans to robotically mine lunar resources.[39] Launching companies like Space

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> coordinate bilaterally in any way with China or any Chinese-owned company unless such activities are specifically authorized by a law enacted after the date of enactment of this Act.

[32] *See e.g.*, Leonard David, *Our Moon: Risks of Crowding and Interference*, (Feb. 28, 2023), https://www.leonarddavid.com/our-Moon-risks-of-crowding-and-interference/; Caleb White, *Earth, Moon's Cislunar Space Is Becoming Overcrowded, May Result in War,* SCIENCE TIMES (Jan. 24, 2023), https://www.sciencetimes.com/articles/42009/20230124/earth-Moons-cislunar-space-becoming-overcrowded-result-war-report.htm.

[33] Mark J. Sundahl, *Transcript: Returning to the Moon: Legal Challenges as Humanity Begins to Settle the Solar System - Full Transcript,* 9 GLOBAL BUS. L. REV. 1, 26 (2021).

[34] While NASA has used the private sector for decades, "the relationship between NASA and the commercial world is also undergoing a change." *Id*. at 32-33. NASA will be the "enabler." *Id*. at 33.

[35] *Id*. at 32-33.

[36] *Id*. at 33.

[37] *Id*. at 32-33.

[38] Ispace is a "a global lunar exploration company with its headquarters in Japan and regional offices in the United States and Europe." Doug Messier, *Japanese Govt Grants License to ispace to Conduct Business Activity on Moon*, PARABOLIC ARC (Nov. 9, 2020), https://parabolicarc.com/2022/11/09/japanese-govt-grants-license-to-ispace-to-conduct-business-activity-on-Moon/.

[39]In preparation for that, ispace launched its *HAKUTO-R* Mission 1 in April 2023 but the spacecraft failed its lunar landing. Mariella Moon, *Japan's ispace confirms that Hakuto-R failed its lunar landing,* available at https://www.engadget.com/japans-ispace-confirms-that-hakuto-r-failed-its-lunar-landing-110531710.html.

X,[40] Blue Origin,[41] and RocketLab[42] will also be involved in lunar activities[43] and other companies will offer supporting services like lunar data, payload, tracking and collision warning.[44] The involvement of the private sector is not limited to the US. The Chinese government[45] has encouraged the development of the private space sector[46] with companies like Galactic Energy,[47] LinkSpace,[48] and Landspace.[49]

While the US and China are currently the most active in pursuing Moon development programs, other countries have also

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[40] *See* SpaceX, https://www.spacex.com (last visited on Nov. 20, 2023). "SpaceX's Starship spacecraft and Super Heavy rocket … [will carry] …both crew and cargo to … the Moon … Starship will be the world's most powerful launch vehicle ever developed, with the ability to carry in excess of 100 metric tonnes to Earth orbit." SpaceX explains on its website that "[l]unar missions … would typically last 6-7 days." In November 2022, Starship was "selected by NASA to support sustained lunar exploration."

[41] *See* Blue Origin, https://www.blueorigin.com/about-blue/ (last visited Nov. 20, 2023).

[42] *See* Rocket Lab, https://www.rocketlabusa.com (last visited Nov. 20, 2023).

[43] *See* Jordan McDonald, *NASA Shoots for the Moon as Private Companies Reach for the Stars*, TECH BREW (Aug. 24, 2022), https://www.emergingtechbrew.com/stories/2022/08/24/nasa-shoots-for-the-Moon-as-private-companies-reach-for-the-stars.

[44] *See, e.g., Intuitive Machines,* https://www.intuitivemachines.com/; Astrobotic "the latest company in a growing sector of the space industry focused on tracking and characterizing objects in orbit and providing services, such as collision warnings, to satellite operators") (last visited Nov. 20, 2023); Jeff Foust, *Privateer Unveils Technology for Improved Tracking of Space Objects*, SPACENEWS (Mar. 4, 2022), https://spacenews.com/unveils-technology-for-improved-tracking-of-space-objects/.

[45] Hanlon, *supra* note 8*,* at 296.

[46] *See* Zhao Chenchen, *China's Private Space Companies: A Race for the Universe*, CGTN (Jan. 19, 2022), https://news.cgtn.com/news/2021-12-24/China-s-private-space-companies-A-race-for-the-universe-16fCBj4ss9y/index.html.

[47] *Id*.

[48] *Id*.

[49] Andrew Jones, *China's Landspace Appears to be Preparing to Launch its New Methane-Fueled Rocket*, SPACENEWS (Jan. 18, 2022), https://spacenews.com/chinas-landspace-appears-to-be-preparing-to-launch-its-new-methane-fueled-rocket/. Some would argue that Chinese private companies, especially in certain sectors, are not really private in China. To be sure, China has a different concept of private sector: the latter is required to be "united around the [Chinese Communist] party." *See* Stephen Olson, *Are Private Chinese Companies Really Private?*, DIPLOMAT (Sept. 30, 2020), https://thediplomat.com/2020/09/are-private-chinese-companies-really-private/.

expressed interest in space exploration, including the United Arab Emirates (UAE), Luxembourg,[50] India[51] and South Korea.[52]

B. Lunar and Generally Non-Earth Orbiting Satellites

This article deals generally with non-Earth orbiting satellites, meaning those space objects that permanently orbit celestial bodies other than Earth,[53] but more particularly with lunar satellites, which are those satellites in a stable orbit of the Moon, at a speed that is enough to "defeat the downward pull of gravity."[54] Both the US[55] and China,[56] already have space objects orbiting the Moon. However, with the coming era of exploitation of lunar resources, the quantity of lunar satellites will rise to another level because companies will require them for communication, reconnaissance and other activities. As an example: lunar mining will be primarily conducted by "automated/robotic technologies that require the support of radio communications."[57] The Artemis and *Chang'e* programs will "require reliable navigation and telecommunication capabilities."[58] Artemis will have a unified communication system for all the missions, consisting of an entire constellation of satellites

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[50] *See* Mahulena Hofmann & Federico Bergamasco, *Space Resources Activities from the Perspective of Sustainability*, 3 GLOB. SUSTAINABILITY 1, 2 (2020) (citing both UAE and Luxembourg programs).

[51] *See generally* Venkatesan Sundararajan, *Overview and Technical Architecture of India's Chandrayaan-2 Mission to the Moon*, AM. INST. AERONAUTICS & ASTRONAUTICS (2020), https://scholar.harvard.edu/files/vps/files/chandrayaan-2_mission_paper-aiaa_scitech_forum_2018-2178vs.pdf

[52] *See KPLO Mission*, SPACEX (Aug. 4, 2022), https://www.spacex.com/launches/kplo/.

[53] *See, e.g.,* Danny Lewis, *Here's How NASA is Keeping The Satellites Around Mars From Running Into Each Other*, SMITHSONIAN (May 6, 2015), https://www.smithsonianmag.com/smart-news/mars-drawing-crowd-satellites-180955183/.

[54] *Why Don't Satellites Fall Out of the Sky?,* NAT'L OCEANIC & ATMOSPHERIC ADMIN. (Sept. 27, 2017), https://www.nesdis.noaa.gov/news/why-don't-satellites-fall-out-of-the-sky.

[55] *Lunar Reconnaissance Orbiter*, NAT'L AERONAUTICS & SPACE ADMIN., https://lunar.gsfc.nasa.gov/about.html (last visited Nov. 20, 2023).

[56] *See* Andrew Jones, *A Chinese Spacecraft is Testing Out a New Orbit Around the Moon*, SPACENEWS (Feb. 15, 2022), https://spacenews.com/a-chinese-spacecraft-is-testing-out-a-new-orbit-around-the-Moon/.

[57] Anne-Sophie Martin, *The Relevance of ITU Rules For Regulating the Use of Radio Frequency and Associated Orbits in the Context of Space Mining Activities,* 43 J. SPACE L. 85, 104 (2019).

[58] *Lunar Economy Applications,* EUR. SPACE AGENCY, https://business.esa.int/funding/intended-tender/lunar-economy-applications (last visited Nov. 20, 2023).

provided by the European Space Agency (ESA), which in turn will outsource it to a consortium (Moonlight initiative).[59] The Chinese program will also require several satellites. China already has a relay satellite - a satellite that relays information from the lunar surface to Earth's surface -[60] in halo lunar orbit,[61] which was pivotal to the *Chang'e* 4 mission to the far side of the Moon.[62]

The US Biden Administration's National Cislunar Science & Technology Strategy,[63] provides the "first interagency strategy to guide the actions of the US government in advancing scientific, exploration, and economic development activities in Cislunar space."[64] It was issued in November 2022 by the National Science & Technology Council and highlights four objectives of the US "Cislunar S&T Strategy."[65]

> Objective 1. Support research and development (R&D) to enable long-term growth in Cislunar space;[66]
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> Objective 2. Expand international S&T cooperation in Cislunar space;[67]

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[59] *Lunar Satellites*, EUR. SPACE AGENCY, https://www.esa.int/Applications/Connectivity_and_Secure_Communications/Lunar_satellites (last visited Nov. 20, 2023). The satellites would provide "adequate positioning services and constant connectivity for ground control and for scientists on Earth," including controlling of activities on the far side of the Moon. Having a constellation of satellites responsible for communication of several missions is more efficient than having a communication system for every mission and can "[free] space for more scientific instruments or other cargo."

[60] Kul B. Bhasim et al., *Lunar Relay Satellite Network for Space Exploration*, presented at 24th Int'l Commc'n Satellite Sys. Conf., at 2 (2006).

[61] Andrew Jones, *Chang'e-4 Relay Satellite Enters Halo Orbit Around Earth-Moon L2*, SPACE.COM (June 15, 2018), https://www.space.com/40897-china-Moon-relay-satellite-arrives-orbit.html. China will launch soon a second relay satellite. Andrew Jones, *China to launch Queqiao-2 Moon relay satellite in early 2024,* SPACE.COM (October 17, 2023).

[62] *See China's Space Program: A 2021 Perspective*, STATE COUNCIL INFO. OFF. (CHINA), http://english.www.gov.cn/archive/whitepaper/202201/28/content_WS61f35b3dc6d09c94e48a467a.html (last updated Jan. 29, 2022).

[63] NAT'L SCI. & TECH. COUNCIL, *National Cislunar Science & Technology Strategy*, WHITE HOUSE (Nov. 2023) https://www.whitehouse.gov/wp-content/uploads/2022/11/11-2022-NSTC-National-Cislunar-ST-Strategy.pdf.

[64] *Id*. at ii.

[65] *Id*. at 5.

[66] *Id*. at 7.

[67] *Id*. at 10.

> Objective 3. Extend U.S. space situational awareness capabilities into Cislunar space;[68]
>
> Objective 4. Implement Cislunar communications and PNT capabilities with scalable and interoperable approaches.[69]

The document deals with lunar satellites under the third objective (the extension of "space situational awareness [SSA] capabilities into Cislunar space")[70] where it points out how SSA is "essential to safe and successful spacecraft operations in all orbits, including in Cislunar space"[71] and how this data "help satellite operators avoid collisions with other satellites or debris."[72] The US plans to develop an "integrated catalog of Cislunar objects, both natural and human-made, utilizing data from all available sources and in collaboration with private entities."[73] The document envisions "satellites operators … [will] periodically provide their planned maneuvers and trajectories to the catalog."[74]

Notwithstanding the burgeoning of the lunar satellite industry, the regulation of lunar satellites remains both unclear and incomplete.

III. ISSUES IN THE INTERNATIONAL FRAMEWORK OF NON-EARTH ORBITING SATELLITES AND SUGGESTED SOLUTIONS

A. Current Framework

1. The Outer Space Treaty

When considering which law applies to lunar satellites, the discussion must necessarily start with the OST—which is binding

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[68] *Id*. at 11.

[69] *Id*. at 12.

[70] *Id*. at 11.

[71] *Id*.

[72] *Id*. The US aims to expand "SSA capabilities" because of many benefits, including detection and warning of "incoming potentially hazardous asteroids," understanding "the long-term effects of growing human activities on the Cislunar environment," and preserving "a safe and sustainable environment in Cislunar space—such as limiting debris in Lunar orbit."

[73] *Id*. at 11-12.

[74] *Id*. at 12.

on nearly all spacefaring countries[75]— and other relevant space treaties, for the countries that are bound by them.[76] Conversely, the specific treaty that was drafted to regulate the Moon and the other celestial bodies, the Moon Treaty,[77] has not been ratified by most spacefaring countries and, notwithstanding some opinions to the contrary,[78] ought not be relied upon.

As Brian J. Egan, former legal advisor to the Department of State, stated regarding the OST:

> [This] Treaty serves a constitutional role in the international legal framework for outer space. It does not attempt to answer every legal question directly, or speak to any activity specifically. Instead it has served, for half a century, as the framework within which States have cooperated to address new capabilities and activities in outer space, and the legal questions such activities inevitably generate.[79]

The application of the OST to Moon orbits has received less attention than the prospective lunar mining activities.[80]

Notwithstanding some who argue otherwise,[81] according to the opinion of some eminent scholars[82] and the position of spacefaring

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[75] *See* Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcommittee on its Sixty-First Session, *Status of International Agreements Relating to Activities in Outer Space as at 1 January 2022*, U.N. Doc. A/AC.105/C.2/2022/CRP.10 (2022) [hereinafter Status of International Space Agreements].

[76] *See e.g.,* 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].

[77] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1362 U.N.T.S. 3 [hereinafter Moon Treaty].

[78] *See, e.g.*, Michael Listner, *The Moon Treaty: Failed International Law or Waiting in the Shadows?*, SPACE REV. (Oct. 24, 2011), https://www.thespacereview.com/article/1954/1.

[79] DEPT. OF STATE, *Galloway Symposium on Critical Issues in Space Law* (2016), https://2009-2017.state.gov/s/l/releases/remarks/264963.htm [hereinafter *Galloway Symposium*].

[80] *See* Artemis Accords, *supra* note 1; BUILDING BLOCKS, *supra* note 1.

[81] Some scholars argue that private companies, much like sovereign nations, do not possess the right to appropriate resources in outer space. *See*, *e.g.*, Fabio Tronchetti, *The Non-Appropriation Principle as a Structural Norm of International Law*, 33 AIR & SPACE L. 277, 281-284 (2008).

[82] Frans von der Dunk, *Private Property Rights and the Public Interest in Exploration of Outer Space*, 13 BIOLOGICAL THEORY 142, 144 (2018); Han Taek Kim, *Fundamental Principles of Space Resources Exploitation: A Recent Development of International and Municipal Law*, 11 J. E. ASIA & INT'L L. 35 (2018); Frans von der Dunk, *The US*

countries,[83] the OST can be interpreted to allow the use of the Moon's resources,[84] which the author argues includes the use of the lunar orbits. This comes from a logical and combined interpretation of Articles I and II of the OST. Article I, states that "[o]uter space, including the [M]oon and other celestial bodies, shall be *free for exploration and use* by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies."[85] Article II provides: "[o]uter space, including the [M]oon 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."[86]

Thus, although Article II clearly prohibits a claim of sovereignty, the OST does not preclude activities on the Moon, including the launching of satellites into the Moon's orbit. But, of course, uncertainties for operators remain for the reasons that Larsen explains with reference to lunar resource activities, not lunar satellites.[87]

Space Launch Competitiveness Act of 2015, https://www.jurist.org/commentary/2015/11/frans-vonderdunk-space-launch/.

[83] *See Galloway Symposium*, *supra* note 79. Four countries issues space resource utilization laws: US Commercial Space Launch Competitiveness Act of 2015, H.R.2262, 114th Cong. (2015) [hereinafter SPACE Act]; *Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace*, Journal Officiel du Grand Luxembourg, July 20, 2017 (entered into force July 20, 2017), https://data.legilux.public.lu/ file/eli-etat-leg-loi-2017-07-20-a674-jo-fr-pdf.pdf [hereinafter Luxembourg Space Resources Act]; UAE Federal Law No. 12 of 2019 on the Regulation of the Space Sector (Dec. 19, 2019), https://www.moj.gov.ae/assets/2020/Federal%20Law%20No%2012%20of%202019%20on%20THE%20REGULATION%20OF%20THE%20SPACE%20SECTOR.pdf.aspx; Japan Act no. 83 of 2021 on Promotion of Business Activities Related to the Exploration and Development of Space Resources, https://kanpou.npb.go.jp/old/20210623/20210623g00141/20210623g001410004f.html.

[84] Larsen, *supra* note 20, at 25-26. *But see, e.g.,* Stephen Gorove, *Interpreting Article II of the Outer Space Treaty,* 37 FORDHAM L. REV. 349, 350 (1969) (distinguishing between inexhaustible resources, which could be appropriated, and "exhaustible spatial resources" for whose national appropriation "the Treaty as it stands seems to make little allowance").

[85] OST, *supra* note 24, art. I (emphasis added).

[86] *See* OST, *supra* note 24, art. II.

[87] For example, Larsen points out that the "safety zones" provided by the Artemis Accords could be seen as impermissible appropriation under OST Art. II ("by means of use or occupation"), which could be challenged by countries that are not parties of the Artemis Accords, such as China. Larsen, *supra* note 20, at 42. The possible challenges create uncertainty for the commercial operators of lunar mines. *Id.* at 42-43. While Larsen's article focuses on lunar mining, his reasoning could be extended to lunar satellites.

In later Parts, this article will discuss other provisions of the OST, in particular Article VIII with reference to intellectual property[88] and Article VI regarding domestic legislation.[89]

2. Intellectual Property Issues

The law governing intellectual property (IP) in space—and hence for lunar satellites—is also lacking. In particular, IP treaties offer insufficient protection of intellectual property rights in space in general.[90] The IP Treaties

> focus on terrestrial matters, leaving ambiguity regarding the jurisdiction and enforcement of intellectual property rights in space. The lack of clarity on which laws apply to space-based activities hampers effective protection.[91] This is a problem in the coming era of increasing commercialization of space because launching and placing a satellite into lunar orbit will

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[88] *Infra* Part III(A)(3).

[89] *Infra* Part IV(A). There are three other important international treaties entered into between 1968 and 1972, which also apply to Moon activities and Moon satellites, namely the Rescue Agreement (Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue Agreement]*;* the Liability Convention (Convention on the International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S 187 [hereinafter Liability Convention]) and the Registration Convention (*Convention on Registration of Objects Launched into Outer Space*, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15).These treaties (hereinafter referred to together as Space Treaties, along with the OST) remain applicable to lunar satellites; for example, under Article III of the Liability Convention, if lunar satellite A collides with lunar satellite B, resulting in damage to lunar satellite B (or property aboard it), the launching State of lunar satellite A shall be held liable if the damage is attributed to its fault or the fault of individuals under its responsibility. As this article is centered around discussing instances of uncertain application and regulatory gaps, I will refrain from delving into treaties that are unquestionably in effect.

[90] Paris Convention for the Protection of Industrial Property, Mar. 20, 1883, 21 U.S.T. 1583, 828 U.N.T.S. 305 (hereinafter Paris Convention); Berne Convention for the Protection of Literary and Artistic Works, September 9, 1886, revised at Paris July 24, 1971, 1161 U.N.T.S. 3 (hereinafter Berne Convention); WIPO Copyright Treaty, Dec. 20, 1996, S. Treaty Doc. No. 105-17, 2186 U.N.T.S. 121 (hereinafter Copyright Treaty); Agreement on Trade-Related Aspects of Intellectual Property Rights, Marrakesh Agreement Establishing the World Trade Organization, Apr. 15, 1994; Annex 1C, 1869 U.N.T.S. 3, 33 I.L.M. 1197 [hereinafter TRIPS]. Together, these treaties are referred to in this article as "IP Treaties."

[91] *See generally*, *Issue Paper Prepared by the International Bureau of WIPO, Intellectual Property and Space Activities*, WIPO (Apr. 2004), https://www.wipo.int/export/sites/www/patent-law/en/developments/pdf/ip_space.pdf (hereinafter WIPO 2004).

> require considerable investment by a private company, which will obviously want to protect its IP but might be unable to.[92] Without a robust IP protection, obtaining financing is difficult; in fact, creditors or investors expect a company to have legal and enforceable rights in its IP.[93] Also, because of insufficient protection of IP, conflicts between the lunar stakeholders can ensue at the international level.

Currently, no space treaty mentions IP. The International Space Station Intergovernmental Agreement (ISS IGA of 1998)[94]—a multilateral instrument signed by fifteen governments, which serves as the legal framework for the operation, management and utilization of the International Space Station (ISS)[95]—mentions IP.[96] The United Nations resolution, Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries, mentions IP but only in passing.[97] The Artemis Accords mention IP, but they are not adopted by all the spacefaring countries.[98]

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[92] *Id.* ¶ 18 (arguing that "in general, those non-governmental entities are more conscious of their "property", both in tangible and intangible forms. Further, due to financial and technical resources which are required to realize space projects, collaboration with the private sector is not alien to many of the state-owned space agencies today.")

[93] *IP and Investors: What Startups Need to Know*, COGNITION IP (May 1, 2022), https://www.cognitionip.com/ip-and-investors-what-startups-need-to-know/.

[94] *See* International Space Station Intergovernmental Agreement, Jan. 29, 1998, T.I.A.S. 12927 [hereinafter ISS IGA]; Clark W. Lackert, *Trademarks in Outer Space*, WIPO MAG. (Dec. 2021), https://www.wipo.int/wipo_magazine/en/2021/04/article_0005.html.

[95] The European Space Agency, *International Space Station Legal Framework*, https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/International_Space_Station/International_Space_Station_legal_framework

[96] ISS IGA, *supra* note 94, art. 21 (the main principle being that activities on a Space Station flight element are considered to occur within the territory of the Partner State of that element's registry). For a discussion about this, *see, e.g.,* Lackert, *supra* note 94.

[97] G.A. Res. 51/122, ¶ 2 (Feb. 4, 1997) (mentioning that "[s]tates are free to determine all aspects of their participation in international cooperation in the exploration and use of outer space on an equitable and mutually acceptable basis" and that "[c]ontractual terms … should be fair and reasonable and they should be in full compliance with the legitimate rights and interests of the parties concerned, as, for example, with intellectual property rights.")

[98] Artemis Accords, *supra* note 1, § 2(b) ("The Signatories' bilateral instruments referred to above are expected to contain other provisions necessary to conduct such cooperation, including those related to liability, *intellectual property*, and the transfer of goods and technical data.") (emphasis added).

The main problem is that IP protection is territorial. Article VIII OST could be interpreted as expressing a general principle of quasi-territoriality:

> 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. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth...[99]

The International Bureau of the World Intellectual Property Organization (WIPO)[100] noticed that the shift from essentially government-based space activities to privately-owned space ventures has shown how IP in space is a significant problem.[101] The main function of every type of intellectual property is to grant exclusivity to its owner. Whether it be patents, trademarks, industrial designs, or copyrights, for each category of IP, domestic laws grant the owner with the sole right to use and benefit from their creation.[102] However, "national law, in principle, only applies to the territory (including air space) of a country and not to outer space."[103] In fact, space is not the territory of any country.[104] While the WIPO paper is already almost two decades old, the situation has not changed at the international level.[105] The WIPO discusses a number of possible approaches to dealing with the issue of intellectual property in space. For example, considering that under the OST, the State of registry of a space object retains jurisdiction and control over the object and its personnel,[106] the WIPO suggests to use the State of

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[99] OST, *supra* note 24, art. VIII.

[100] WIPO is an "intergovernmental organization" (specialized agency of the United Nations) based in Switzerland, which is "responsible for the promotion of the protection of intellectual property throughout the world." WIPO 2004, *supra* note 91, ¶ 4.

[101] *See id.* ¶ 18.

[102] *Id.* ¶¶ 6-17.

[103] *Id.* ¶ 1.

[104] OST, *supra* note 24, art. II.

[105] *See* Clark W. Lackert & Jonathan Goodwill, *Outer Space: Time to Address the Real-World IP Issues*, AM. BAR ASS'N (June 30, 2021), https://www.americanbar.org/groups/intellectual_property_law/publications/landslide-extra/outer-space/; *see also* Lackert, *supra* note 94.

[106] OST, *supra* note 25, art. VIII.

registration as the State having jurisdiction over intellectual property (and if more than one State is a registrant, the States could agree on the State having jurisdiction).[107] The WIPO distinguishes between creations made in outer space but used on Earth, which are generally governed by the IP law of the relevant country or countries, and activities conducted in outer space (irrespective of where the invention originated), which constitute the real issue.[108] The WIPO seems to favor quasi-territoriality, but recognizes that this depends on registration of all space objects.[109] Also, quasi-territoriality may be difficult in practice since components of a space object may come from different countries with different intellectual property regimes.[110] The WIPO also discusses the difficulties of enforcement of IP in space objects.[111]

3. ITU Rules

Radio frequencies are vital for the operation of satellites: in fact, each satellite must have a frequency to operate.[112] The international organization that deals with the assignment of frequencies and manages spectrum is the International Telecommunication Union (ITU),[113] a specialized agency of the UN with 193 State- and non-State members.[114] Most space objects, aside from a few passive satellites, need radio components for transmitting and receiving signals crucial for space operations. These components enable satellite control and facilitate communication or other space services. Each object is allocated specific radio frequencies, managed by the ITU Radio Regulations to prevent signal interference.[115]

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[107] WIPO 2004, *supra* note 91, ¶ 41.

[108] *Id.* ¶ 42.

[109] *Id.* ¶ 49.

[110] See *id.* ¶¶ 19 and 33.

[111] *Id*. ¶51-63.

[112] ITU News, *Managing Radio Frequency Spectrum Amid a New Space Race*, (Nov. 12, 2021), https://www.itu.int/hub/2021/11/managing-radio-frequency-spectrum-amid-a-new-space-race/ (hereinafter, *Managing Radio Frequency Spectrum*).

[113] The ITU is an international agency established in 1865 as the International Telegraph Union to interconnect telegraph systems. Its mandate is to facilitate equitable access to radio frequencies and to promote the advancement of frequency technology.

[114] For a detailed explanation of allocation of radio spectrum, *see generally*, Sara Anne Hook, *Allocation of the Radio Spectrum: Is the Sky the Limit?*, 3 IND. INT'L & COMP. L. REV. 319 (1993).

[115] Managing Radio Frequency Spectrum, *supra* note 112.

The ITU rules consist of several documents: 1) the Constitution of the ITU, containing the substantive rights of member States;[116] 2) the Convention of the ITU, containing rules on internal bodies;[117] and 3) the Radio Regulations adopted by the World Radiocommunication Conference.[118]

Radio frequencies and orbits are assigned mainly on a "first come, first served" basis.[119] In other words, they are assigned to States according to their request.

The ITU's coordination is important most of all to avoid "harmful interference." As indicated in Article 45.1 of the ITU Constitution:

> All stations, whatever their purpose, must be established and operated in such a manner as not to cause harmful interference to the radio services or communications of other Member States or of recognized operating agencies, or of other duly authorized operating agencies which carry on a radio service, and which operate in accordance with the provisions of the Radio Regulations.[120]

Member States must take measures to avoid "harmful interference."[121] This is emphasized again in the ITU Radio Regulations whose "main objective . . . is also to prevent harmful interference between stations."[122]

The provisions of the Radio Regulations require the rational, efficient and economic use of radio frequencies and any associated orbits.[123] Article 44.2 of the ITU Constitution also contains reference to the principle of "equitable access" to radio frequencies and any associated orbits of "countries or groups of countries … taking

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[116] Constitution and Convention of the International Telecommunication Union, Dec. 22, 1992, T.I.A.S. No. 97-1026, 1825 U.N.T.S. 330 [hereinafter ITU Constitution and Convention].

[117] *Id*.

[118] INT'L TELECOMM. UNION, RADIO REGULATIONS (2020) [hereinafter Radio Regulations], https://www.itu.int/en/publications/ITU-R/pages/publications.aspx?parent=R-REG-RR-2020&media=electronic.

[119] Setsuko Aoki, *Efficient and Equitable Use of Orbit by Satellite Systems: Paper Satellite Issues Revisited*, 56 PROC. INT'L INST. SPACE L. 229, 232 (2013).

[120] ITU Constitution and Convention, *supra* note 116, art. 45.

[121] *Id*. art. 45(2), 45(3).

[122] Martin, *supra* note 57, at 94.

[123] ITU Constitution and Convention, *supra* note 116, art. 44.2.

into account the special needs of the developing countries and the geographical situation of particular countries." The "equitable access" principle was introduced in the eighties,[124] under pressure from developing countries.[125] The result was a change in Article 44, which tries to balance the principle of efficiency and "equitable access" by supplementing the "first come, first served" basis method of allocation with another system for a portion of the frequencies, the "a priori" method, which sets aside frequencies for future needs of the non-spacefaring countries.[126]

In the past, much of the focus of the ITU has been on geostationary orbits (GSO), but more recently, the ITU has focused more on low-Earth orbits.[127] Now the focus should shift again.

In recent years, frequency requirements have increased very quickly due to the development of new technologies. Given the increased diversity of actors and activities in space, it is time to consider developing a more detailed system for regulating spectrum beyond Earth orbit. The consideration and possible evolution of the current role of the ITU in this field should certainly be a high priority for the interested States.[128]

The ITU does not specifically coordinate radio frequencies for the Moon.[129] In fact, no international entity deals with the issue of

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[124] *See* Aoki, *supra* note 119, at 233 (explaining how the ITU made concessions to the developing countries in the World Administrative Radiocommunication Conferences (WARC) of 1985 and 1988 "including through an allotment plan to guarantee some spectrum and GSO spots").

[125] *See, e.g.*, Iulia-Diana Galeriu, *"Paper Satellites" and the Free Use of Outer Space*, GLOBALEX (Apr. 2018), https://www.nyulawglobal.org/globalex/Paper_satellites_free_use_outer_space1.html (arguing that arguing that the 1976 Bogota Declaration, claiming jurisdiction over specific portions of the Geostationary Orbit of developing States' respective territories, served as a means to exert political pression and slot concession from the ITU).

[126] *ITU Radio Regulatory Framework for Space Services*, ITU, https://www.itu.int/en/ITU-R/space/snl/Documents/ITU-Space_reg.pdf.

[127] *Managing Radio Frequency Spectrum*, *supra* note 112. "Alongside human spaceflight, falling technology and launch costs are reflected in the burgeoning deployment of non-geostationary mega-constellations and small satellites that can be used for low-latency broadband communication, Earth observation, and Internet of Things applications."

[128] Martin, *supra* note 57, at 87.

[129] *Id*. at 100.

potential radio frequency interference there.[130] While the general prohibition against harmful interference applies also to the Moon's frequencies, there is no advance notification procedure like there is for Earth's orbits.[131] Like Earth's geostationary orbits, the Moon's orbits could become overcrowded.[132] It is imperative to regulate them.

The ITU foresees a surge in lunar activities soon,[133] but this acknowledgment has not translated into a change in the rules yet. This will be a problem. In the coming era of Moon activities, many satellites will need to be placed in lunar orbit. Currently, there are uncertainties on whether commercial actors can be assigned the radio frequencies that they need for their new space ventures and whether they will be able to operate without harmful interference.[134]

First, absent a change in the ITU regulations, member States can only assign lunar frequencies for radio stations around the Moon; these frequency bands must be allocated either for "research" or for "operational purposes of spacecraft."[135] Hence, commercial

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[130] ITU, *Reducing Harmful Interference to Satellites Near Earth, the Moon and Beyond*, available at https://www.itu.int/hub/2020/09/reducing-harmful-interference-satellites-earth-Moon-beyond/. (hereinafter ITU, *Reducing Harmful Interference*).

[131] Radio Regulations, *supra* note 118, art. 9.6 ("Before an administration notifies to the Bureau or brings into use a frequency assignment in any of the cases listed below, it shall effect coordination, as required, with other administrations identified under No. 9.27."); Radio Regulations' Article 9.7 lists the cases in which coordination must be performed and satellites in lunar orbit are not in the list. The only provision for preventing harmful interference on the Moon is in Section V, where Article 22 prohibits emissions in the shielded zone to protect radio astronomy and other passive services from disruption.

[132] GSOs are the most coveted satellite positions in Earth's orbit because in their orbit above the equator, a single satellite is capable of covering approximately a third of the Earth's surface. Kenneth M. Peterson, *Satellite Communications*, *in* 3 ENCYCLOPEDIA OF PHYSICAL SCIENCE AND TECHNOLOGY 413 (2003), https://www.sciencedirect.com/topics/engineering/geostationary-orbit; *see* ITU, *Reducing Harmful Interference, supra* note 130 (contending that coordination is key on the Moon, which "[w]hile it is now quiet, the Moon is about to get busy").

[133] *See Managing Radio Frequency Spectrum*, *supra* note 112.

[134] Martin, *supra* note 57, at 104.

[135] *Id.* at 88-89 (Explaining how member States are limited to assigning lunar frequencies to radio stations around the Moon, typically for either "research" (space research services) or the "operational purposes of spacecraft" (space operation services). While in an initial phase commercial entities can be satisfied with receiving frequencies for research, as their activities increase, the frequency allocation's norms need updating to effectively allocate frequencies to commercial actors.)

entities must also be assigned these types of frequencies.[136] It is necessary for the ITU regulations to evolve and introduce a commercial category for activities beyond Earth's orbit.[137] While for the moment the provisional solution of assigning "research" frequencies to commercial ventures is still viable, this will not be the case for long.[138]

Second, although this is not the focus of this article, the situation is even more complicated for mining ventures: the ITU has not allocated specific frequency bands for space resource activities; however, they could potentially use bands designated for long-distance space flights.[139] Third, companies engaged in "new space" will need access to different types of frequencies depending on the activities,[140] including X Band frequency traditionally used by the NASA Deep Space Network.[141] Fourth, the implementation of new technologies (including quantum communication systems) will require a new frequency assignment framework.[142]

Significantly, the Building Blocks,[143] which mention frequency assignment for space resource activities in Section 14,[144] provide some guidance as to the registration of the frequency allocations.

4. International Non-Binding Instruments

*S*ome important nonbinding international guidelines and resolutions also govern special aspects of outer space activities. Unfortunately, most of them do not apply, or only arguably appl-y, to lunar satellites.

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[136] *Id*. at 89 ("States have developed a practice of assigning lunar frequencies for 'research purposes' to commercial entities.").

[137] In fact, "the practice of using the "research" category is primarily because of the absence of a commercial category." *Id*.

[138] *See id*.

[139] *Id*. at 99.

[140] *See id.* at 99-100, (contending that space companies embarking on lunar and deep space missions require access to three frequency types: S Band for robust wireless connections between landers and rovers, K Band for navigation and X Band for deep space communications).

[141] *Id*. at 100.

[142] *Id*.

[143] Building Blocks, *supra* note 1.

[144] *Id*. § 14(d) ("The international framework should provide that States and international organizations shall … (d) Notify frequency assignments for recording in the Master International Frequency Register in accordance with the Radio Regulations of the International Telecommunication Union.).

a. Remote Sensing Principles

The United Nations General Assembly adopted the Remote Sensing Principles as a non-binding resolution on January 22, 1987.[145] The Remote Sensing Principles do not apply to lunar satellites since Principle I(a)[146] clarifies that the "term 'remote sensing' means the sensing *of the Earth's* surface from space."[147]

The Remote Sensing Principles' main purpose is to regulate three main issues, which had been debated within the Committee on the Peaceful Uses of Outer Space *(*COPUOS):[148] "the right (of the sensing States) to launch satellites and the right to sense; the right of the sensing States to distribute the data and images; and the right of the sensed States to obtain images."[149] The conflict, which was centered on sovereignty between sensing States and sensed States, was solved with a compromise: sensing States would not need prior consent to sense, but sensed States could obtain access "[on a non-discriminatory basis and at reasonable costs] to the primary and processed data concerning their territory."[150] Sensing States obtained the right of distribution,[151] and sensed States obtained a right to the data and images in certain circumstances.[152] While the Remote Sensing Principles are not applicable to lunar satellites or other non-Earth orbiting satellites,[153] we do not have these sovereignty issues on the Moon, which under the OST cannot be subject to sovereignty.[154] However, lunar satellites will have

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145 G.A. Res. 41/65 (Dec. 3, 1986) [hereinafter Remote Sensing Principles].

146 *Id*. at Principle I(a).

147 *Id*. (emphasis added).

148 Formed by the General Assembly in 1959 and instrumental in the creation of the five treaties and five principles of outer space, COPUOS's mandate is to foster international cooperation in peaceful uses of outer space, encourage space research programs, and study legal problems arising from the exploration of outer space. *Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFF. OF OUTER SPACE AFFS., https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (last visited Nov. 20, 2023).

149 Eng Teong See, *Commercialization of Space Activities—The Laws and Implications,* 82 J. AIR L. & COMM. 145, 153 (2017).

150 *Id*. at 154.

151 *Id*.

152 *Id*.

153 Remote Sensing Principles, *supra* note 145, at Principle I(a) (referring to the "sensing *of the Earth's* surface from space") (emphasis added).

154 Outer Space Treaty, *supra* note 24, art. II.

remote sensing capability.[155] How, if at all, should such activity be regulated? For example, should a US lunar satellite be able to obtain images of a Chinese base on the Moon? If yes, must it share this data with China? Also, can it distribute the data to other countries? All of these open questions could create tensions.

b. Resolution on International Cooperation

General Assembly Resolution 1721, International co-operation in the peaceful uses of outer space (Resolution 1721),[156] which [aims at promoting collaboration among nations for the peaceful exploration and utilization of space, would not seem to apply to the Moon. Point D focuses on communication via satellites, which the UN desires should be available "to the nations of the world as soon as practicable on a global and non-discriminatory basis."[157] Based on its recommendation that the ITU consider aspects of space communication in which international cooperation will be required,[158] it seems clear that Resolution 1721 Point D refers to the communications with Earth and not with the Moon. This does not seem to be a problem because it would seem unlikely that all the "nations of the world" would need "as soon as practicable" communication with the Moon. Therefore, an extension to the Moon would not seem urgent.

c. Debris Mitigation Guidelines

The Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (Space Debris Mitigation Guidelines),[159] which the UN General Assembly approved in 2008, do not directly apply to the Moon because they define "space debris" as "all

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[155] Greg Autry, *Lunar Orbital Congestion is Gonna be a Thing,* FORBES (May 20, 2023), https://www.forbes.com/sites/gregautry/2023/05/20/lunar-orbital-congestion-is-gonna-be-a-thing/?sh=6f7d37f298c6 (contending that to meet the needs of lunar activities, lunar satellites will eventually have the same capabilities as Earth's satellites do today, including remote sensing capabilities).

[156] G.A. Res. 1721 (XVI), International Co-operation in the Peaceful Uses of Outer Space (Dec. 20, 1961).

[157] *Id.* at D.

[158] *Id.*

[159] SPACE DEBRIS MITIGATION GUIDELINES, *supra* note 6 (emphasis added).

man-made objects … *in Earth orbit or re-entering the atmosphere*, that are non-functional."[160]

Nonetheless, debris is expected to be a problem on the Moon,[161] perhaps even more than it is on Earth.[162] Besides the Space Debris Mitigation Guidelines, several nonbinding documents have been developed. These include the European Code of Conduct of Space Debris Mitigation, which was signed by the Agenzia Spaziale Italiana, the British National Space Centre, the National Centre for Space Studies, the German Aerospace Center and the European Space Agency.[163] Though the way these documents define "debris" is inapplicable to the Moon, they may be useful in developing principles regarding debris mitigation for the Moon.

d. LTS Guidelines

Adopted in 2019, the Guidelines for the Long-Term Sustainability of Outer Space Activities (LTS Guidelines)[164] apply only partially to Moon satellites. The very useful Guideline A.4, which discusses the "equitable, rational, and efficient" use of the radio frequency spectrum and the various orbital regions used by satellites,

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[160] *Id.* at Background (emphasis added).

[161] Adam Mann, *The Moon Could Soon Have a Space Junk Problem*, SCIENCE (Feb. 22, 2022), https://www.science.org/content/article/Moon-could-soon-have-space-junk-problem (stating that though there are probably fewer than 200 large pieces of space junk around the Moon, that number could increase significantly in the next five years thanks to roughly 50 planned missions from various actors). *See also* Leila Fadel, *3 Tons of Space Junk Are Expected to Hit the Moon and Carve Out a Crater*, NPR (Mar. 3, 2022), https://www.npr.org/2022/03/03/1084113756/3-tons-of-space-junk-are-expected-to-hit-the-Moon-and-carve-out-a-crater.

[162] *See*, *e.g.*, Jinyuan Su, *Active Debris Removal: Potential Legal Barriers and Possible Ways Forward*, 9 J. E. ASIA & INT'L L. 403, 405 (2016) (explaining how space debris became "a matter of major concern" in the 1970s).

[163] UNITED NATIONS OFF. FOR OUTER SPACE AFFS., EUROPEAN CODE OF CONDUCT OF SPACE DEBRIS MITIGATION (2004), https://www.unoosa.org/documents/pdf/space-law/sd/2004-B5-10.pdf.

[164] G.A. Res. A/AC.105.2018, Guidelines for the Long-Term Sustainability of Outer Space Activities (June 27, 2018). [hereinafter LTS Guidelines]. The US Department of State has sought input from the private sector on the implementation of the LTS Guidelines. *See also,* Notice 11630: Seeking Private Sector Written Input on Implementation of the 21 Guidelines for the Long-Term Sustainability of Outer Space Activities*,* US DEP'T OF STATE (July 8, 2022), https://www.state.gov/remarks-and-releases-bureau-of-oceans-and-international-environmental-and-scientific-affairs/notice-11630-seeking-private-sector-written-input-on-implementation-of-the-21-guidelines-for-the-long-term-sustainability-of-outer-space-activities/.

would not apply to lunar satellites.[165] In January 2023, during the Committee on the Peaceful Uses of Outer Space (COPUOS) meeting, Canada, along with other nations, advocated for the consideration of regulating deep space activities, such as lunar endeavors, as an extension of the LTS Guidelines.[166]

e. COSPAR

Article IX OST imposes the obligation to avoid harmful contamination on member States, including on the Moon:

> … States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.[167]

The Committee on Space Research Policy on Planetary Protection (COSPAR Policy)[168] facilitates international collaboration and coordination to align with Article IX OST. While not legally enforceable on a global scale, the standard presented by the COSPAR Policy, along with its associated requirements, receives international endorsement. Implementation guidelines are also provided as a reference to assist States in adhering to the principles outlined in Article IX.[169]

COSPAR is an NGO and was established in 1958 when planetary contamination started to be a concern.[170] COSPAR meets

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[165] LTS Guidelines, *supra* note 164, at Guideline A.4.

[166] *Canada's Submission to the Working Group on Legal Aspects of Space Resources Activities of the Legal Subcommittee of UN COPUOS* (January 2023) https://www.unoosa.org/documents/pdf/copuos/lsc/spacere-sources/LSC2023/StatesResponses/Canadas_Submission_to_the_SRU_WG_at_LSC62_Jan2023.pdf.

[167] Outer Space Treaty, *supra* note 24, art. IX.

[168] COMM. ON SPACE RSCH. (COSPAR), POLICY ON PLANETARY PROTECTION (2021), https://cosparhq.cnes.fr/cospar-policy-on-planetary-protection/ (hereinafter *COSPAR Policy*).

[169] *See generally*, Athena Coustenis et al., *Planetary Protection: An International Concern and Responsibility*, 10 Front. Astron. Space Sci. (2023).

[170] COSPAR, *About,* https://cosparhq.cnes.fr/about/; *See also*, Leslie I. Tennen, *The Role of COSPAR for Space Security and Planetary Protection, in* HANDBOOK OF SPACE SECURITY 1559-1580 (2020).

periodically and reviews its planetary policy.[171] The COSPAR Policy—which applies to the Moon—[172] divides space missions into five categories, depending on the target of the mission and its need of protection.[173] The consequence of being in one category or the other is the different requirements for the mission.[174] Recently COSPAR added two sub-categories for lunar surface missions: Category IIa, which covers all missions to the surface of the Moon except certain areas that are in Category IIb, and Category IIb, for missions to "Permanently Shadowed Regions (PSRs) and the lunar poles," and which requires more documentation (organic inventory).[175] With the increasing commercialization of the Moon, this Policy should be imposed on commercial actors as part of the national authorization procedure.

f. Disaster Charter

The discussion of international nonbinding documents would be incomplete without mentioning the International Charter on Space and Major Disasters (Disaster Charter),[176] which has had remarkable results for recent crises on Earth.[177] The Disaster Charter is:

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[171] COSPAR, *By-Laws* (July 2022), https://cosparhq.cnes.fr/about/by-laws/ (COSPAR convenes to review and revise its policies biennially, typically during the COSPAR Scientific Assemblies.).

[172] *COSPAR Policy*, *supra* note 168, art. 8 (*Category II requirements for missions to the Moon*), art. 8.1 (Orbiter and fly-by missions to the Moon), art. 8.2 (*Lander missions to the Moon*).

[173] *Id*. at 1 ("The five categories for target body/mission type combinations and their respective suggested ranges of requirements are described as follows, and in Table 1.")

[174] No requirement is provided for Category I missions. Documentation is required for Category II missions and above; Category III requires more documentation and that missions have a procedure in place. *Id.*

[175] COSPAR, PRESS RELEASE (2021), https://cosparhq.cnes.fr/assets/uploads/2021/07/Press-Release_PPP_15July2021_FINAL.pdf.

[176] UNITED NATIONS OFF. FOR OUTER SPACE AFFS., INTERNATIONAL CHARTER ON SPACE AND MAJOR DISASTERS, (2000), https://disasterscharter.org/web/guest/text-of-the-charter [hereinafter Disaster Charter]. The Disaster Charter is an agreement between space agencies and space system operators.

[177] The Charter is most commonly activated for floods and storms. Since its inception, it has been activated 750 times in response to disasters occurred in 130 countries. *International Charter Space and Major Disasters, Overview,* EUR. SPACE AGENCY, https://earth.esa.int/eogateway/activities/international-charter-space-and-major-disasters (last visited Nov. 11, 2023).

> an inter-agency agreement among outer space-related agencies in several countries including the United States, Russia, China, ESA, and Canada. … Each participant contributes its own resources (remote sensing, meteorological information, geological information) … All countries, whether members of the Charter or not, have the right to obtain assistance from Charter members.[178]

The Charter recognizes the potential uses of space technologies in handling disasters resulting from natural events or technological mishaps, particularly in Earth observation, telecommunications, meteorology and positioning technologies the significance of fostering initiatives related to utilizing space facilities for the management of both natural and technological disasters.[179] The Disaster Charter does not mention lunar facilities, but its extension to space facilities on and around the Moon would be appropriate. As the lunar economy expands,[180] the potential for disasters on the Moon also increases. For example, the Moon is certainly less seismically active than Earth, with its quakes are primarily driven by tidal forces. Nevertheless, the Moon experiences significant seismic activity, with moonquakes causing it to resonate, akin to a vibrating bell. These quakes, mostly minor and registering under 3 on the Richter scale, often coincide with lunar tidal phases. Also, during Apollo missions, 11 meteorite impacts were detected.[181]

5. A Non-Governmental International Document: the Building Blocks

The Building Blocks for the Development of an International Framework on Space Resource Activities (Building Blocks)[182] is the product of the Hague International Space Resources Governance Working Group, an international, interagency and

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[178] Paul B. Larsen, *The Oso Landslide: Disaster Management Law in the Space Age*, 40 WM. & MARY ENVTL. L. & POL'Y REV. 335, 360-361 (2016).

[179] *Disaster Charter*, *supra* note 176, at Preamble.

[180] PWC, L*unar Market Assessment: Market Trends and Challenges in the Development of a Lunar Economy*, https://www.pwc.fr/en/industrie/secteur-spatial/pwc-space-team-public-reports-and-articles/lunar-market-assessment.html (last visited Nov. 23, 2023).

[181] Stuart Ross Taylor, *The Moon*, *in* ENCYCLOPEDIA OF THE SOLAR SYSTEM 227 (2d ed. 2007).

[182] BUILDING BLOCKS, *supra* note 1.

interdisciplinary group established in 2016.[183] While not a governmental document or adopted by the United Nations, the proposal provides some "agreed-upon rules for space resource activities," including commercial lunar mining, and is intended "to become the basis for future negotiations."[184] Because the Building Blocks focus on lunar mining and other on-the-surface lunar activities, they do not deal with lunar satellites, if not in passing.[185] However, they provide an excellent basis for drafting lunar satellites guidelines. Together with the Artemis Accords,[186] and some other international documents, the suggested Guidelines in Part V of this paper are heavily based on the Building Blocks.[187]

B. Proposed Solutions at the International Level

1. Why the Current International Framework is Deficient

The current international framework of reference is deficient.[188] This problem is significant especially because of the prospective involvement of the private sector in this Moon race will expand the number of stakeholders.[189]

When private entities carry out their activities on the Earth, they are governed by the laws of the jurisdiction in which they carry out the activities.[190] In outer space, what laws are to govern their activities? Since the activities are international in nature, international law prima facie applies.[191] In fact, as discussed, there is very little doubt that all the provisions of OST apply to lunar satellites,

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[183] Universiteit Leiden, International Institute of Air and Space Law, *The Hague International Space Resources Governance Working Group*, https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group (last visited Nov. 23, 2023).

[184] Larsen, *supra* note 20, at 28-30.

[185] BUILDING BLOCKS, *supra* note 1, § 14(d).

[186] Artemis Accords, *supra* note 1.

[187] *See infra*, Part V

[188] *See supra,* Part III.

[189] *See supra*, Part II(A).

[190] Teong See, *supra* note 149, at 147.

[191] *Id.*

encompassing both governmental and private activities.[192] The other Space Treaties could also apply.[193]

But is this enough? The Space Treaties in place were drafted when space activities were only performed by States.[194] They "were not intended for private commercial activities in space"[195] and "are insufficient for current and future space utilization needs."[196] Certainly, we need to look at the nature of the activity to see "whether the international legal framework is sufficient to deal with commercialization of space activities."[197] Lunar satellites regulation require changes, both at the domestic and the international level. Following are some proposals.

2. Proposed Changes to the ITU Rules

It is time for the ITU to act on frequencies for the Moon. The ITU regulations should be amended to include: 1) a commercial category for space activities which are not in Earth orbit; 2) different types of frequencies depending on the activities, including X Band

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[192] John S. Goehring, *Properly Speaking, The United States Does Have an International Obligation to Authorize and Supervise Commercial Space Activity*, 78 AIR FORCE L. REV. 101, 119-122 (2018), *contra*, Laura Montgomery, adjunct professor of space law at Catholic University's Columbus School of Law, former manager of the Space Law Branch in the FAA's Office of the Chief Counsel, and who in private practice specializes in regulatory space law with an emphasis on commercial space transportation and the Outer Space Treaties, expressed the view that the "bulk of provisions" of the OST (e.g., Article IV's ban of nuclear weapons and weapons of mass destruction, and Article IX's avoidance of harmful contamination) would not apply to private actors. *See* Laura Montgomery, *Testimony of Laura Montgomery: Ground Based Space Matters Before the Senate Committee on Commerce, Science, and Transportation* 12 (May 23, 2017) [hereinafter Testimony of Laura Montgomery]. Goehring, assistant general counsel with the Department of Defense and a lieutenant colonel in the US Air Force Reserve, criticizes this position, arguing that Montgomery's argument faces skepticism due to its potential harm to US national security. The OST's drafters intended its rules to apply to commercial entities, as clearly stated. Interpreting provisions narrowly, ignores Article VI's language and negotiation context. While Montgomery's stance may help commercial space industries briefly, it poses lasting risks to national security. The possibility of other States adopting similar interpretations is worrying, highlighting the US's lack of readiness for such outcomes. Goehring, *supra* note 192, at 119.

[193] *See* Teong See, *supra* note 149, at 147-148.

[194] *Id.*

[195] *Id.* at 148.

[196] Ram S. Jakhu & Yaw Otu M. Nyampong, *International Regulation of Emerging Modes of Space Transportation, in* SPACE SAFETY REGULATIONS AND STANDARDS 215, 223 (Joseph N. Pelton & Ram S. Jakhu eds., 2010).

[197] Teong See, *supra* note 149, at 148.

frequency and some specific frequencies for lunar mining; and 3) a new frequency assignment framework in relation to new technologies that will emerge over time. Also, the ITU rules should change in order for the ITU to be able to manage lunar frequency spectrum.

Because lunar frequencies and orbits are particularly scarce and because developing countries are not expected to access the Moon in the near future, the efficiency principle must be favored, and the equitable principle should not apply to lunar orbits. The only allocation method should be the "a posteriori" method.

The proper place for dealing with changes is the ITU Plenipotentiary and World Telecommunications Development Conferences. Because the conference agenda is finalized four years in advance, and it is likely difficult to change the agenda once finalized: thus, this item should be included in the agenda as soon as practicable.[198]

3. Proposed Extension of Certain Non-Binding International Documents

This paper has above discussed some international nonbinding documents that do not apply to lunar satellites or apply only in part.[199] In particular, the Space Debris Mitigation Guidelines do not apply to the Moon though debris is expected to be an even bigger problem around the Moon than around Earth.[200] The Space Debris Mitigation Guidelines should be expanded to specifically deal with debris around the Moon. A change in the definition of debris is necessary. For example, we could define "debris" as "all man-made objects … in Earth orbit or re-entering the atmosphere, *in lunar orbit or in the orbit of any other celestial body,* that are non-functional" (additions underlined).[201]

This paper has also discussed how the LTS Guidelines apply only partially to lunar satellites. The LTS Guidelines should be expanded and specifically mention the Moon, particularly Guideline A.4. This paper has also discussed the Remote Sensing Principles

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[198] ITU Constitution and Convention, *supra* note 118, at art. 7. Once established, the agenda can be changed only if at least one-quarter of Member States requests this change (or on proposal of the Council), if the council approves it, and the change is also approved by the majority of the Member States. Article 7.3(1) and (2) ITU Convention.

[199] *See supra*, Part III(A)(5).

[200] Id.

[201] Space Debris Mitigation Guidelines, *supra* note 6, at Background.

and established that they do not apply to lunar satellites.[202] Because the sensing of other countries' facilities on the Moon could create tensions,[203] COPUOS should discuss whether the Remote Sensing Principles should be amended to include specific principles for lunar sensing. Those principles could be similar to the sensing principles on Earth in the case of sensing of a country's permanent base on the Moon.

Finally, with reference to the Disaster Charter,[204] this paper - considering the possibilities of natural lunar disasters -[205] advocates to expressly extend it to space facilities on and around the Moon.

4. Proposed Solutions for Intellectual Property Issues

As discussed, IP protection is a problem in space, including the Moon.[206] Considering the uncertainties of IP in space, this article offers some suggestions of protection for lunar satellites' operators. Only by a more robust protection of IP may the lunar satellite industry burgeon and develop easily.

Building on its work of 2004,[207] the WIPO should issue guidelines specifically targeting the Moon (as the next frontier), which could be transposed into domestic legislation. The WIPO in fact is well-suited to do a comprehensive study of the IP issues related to the Moon with a view to making recommendations for how the issue could be dealt with. A modification of the IP Treaties[208] to specifically deal with space IP or a new specific treaty on space IP would certainly be a solution; since the WIPO already administers the Madrid protocol,[209] a new "space protocol" would be a natural

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[202] *See supra*, Part III(A)(5).

[203] *Id.*

[204] *Id.*

[205] Id.

[206] *See supra*, Part III(A)(3).

[207] WIPO 2004, *supra* note 91.

[208] IP Treaties, *supra* note 90.

[209] Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks, adopted at Madrid, June 27, 1989, WIPO Doc. MM/DC/27 Rev. (1989) [hereinafter Madrid Protocol], https://www.uspto.gov/trademarks/laws/madrid-protocol. The Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks -- the Madrid Protocol -- is one of two treaties comprising the Madrid System for international registration of trademarks. The protocol is a filing treaty and not a substantive harmonization treaty."

extension. However, considering the difficulties of passing new treaties,[210] soft law is probably the most feasible solution. This paper suggests some ideas for protection for lunar satellites' operators in the *Guidelines for Lunar Satellites*.[211]

IV. DOMESTIC FRAMEWORK OF REGULATION OF NON-EARTH ORBITING SATELLITES AND SUGGESTED SOLUTIONS

A. Current Framework

This paper will focus on the US regulations as they are the most robust.[212] In fact, many countries do not have domestic regulation on space at all.

Article VI OST provides:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the [M]oon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty.[213]

Article VI was the result of a compromise at the time the OST was negotiated; [214] assimilates private activities to governmental ones and imposes an obligation on States to implement an authorization proceeding and to perform continuing supervision.

Pursuant to Article VI, the US has implemented authorization procedures in the form of licenses. Generally speaking, to launch a

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[210] Durkee, *supra* note 4.

[211] *Infra*, Part V.

[212] *See* Milton "Skip" Smith, *United States*, *in* THE SPACE LAW REVIEW 100, 100 (2019) (arguing that The United States has the most extensive space laws in the world, which also serve as a model for many other nations).

[213] OST *supra* note 24, art. VI.

[214] Goehring, *supra* note 192, at 104 (arguing that Article VI was the result of compromise between the then-Soviet Union, which advocated for space activities to be reserved to governmental agencies, and the United States, which advocated for the private sector to be able to perform space activities. The result was Article VI, which makes State Parties directly responsible for the activities of private entities.)

satellite into orbit, three or four authorizations are necessary: (i) a launch license from the Federal Aviation Administration (FAA) under the Commercial Space Launch Act of 1984;[215] (ii) a Payload review (also from the FAA);[216] (iii) a frequency license from the Federal Communication Commission (FCC);[217] and (if the satellite engages in Earth observation) iv) a Remote Sensing license from the National Oceanic and Atmospheric Administration (NOAA).[218]

It is important to understand whether these authorizations also apply to lunar satellites.

1. Launch License

A launch license must be obtained by a launch service provider to launch to the Moon.[219] The Commercial Space Launch Act of 1984:

> prohibits persons from launching a launch vehicle or operating a launch site within the United States (or, in the case of U.S. citizens, from outside the United States and outside the territory of a foreign nation) unless they are properly licensed; and (2) in the case of a license holder, launching a payload (an object placed in space) unless such payload complies with all requirements of Federal law.[220]

The Secretary of the Department of Transportation is the competent authority for oversight, including the issuance of licenses and permits. In 1984, the Office of Commercial Space Transportation (AST) was established as "part of the Office of the Secretary of Transportation within the Department of Transportation (DOT)" but in 1995, it was transferred to the Federal Aviation Administration (FAA).[221] 51 U.S.C. § 50901 et seq. certainly apply to a launch to the Moon, since it defines a "launch" as:

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[215] Commercial Space Launch Activities, 51 U.S.C. § 50901.

[216] 14 C.F.R. § 450.93.

[217] 47 U.S.C. § 301.

[218] 15 C.F.R. Part 960.

[219] 51 U.S.C. §50901 *et seq*.

[220] Commercial Space Launch Act, H.R. 3942, 98th Cong. (1983).

[221] Federal Aviation Administration, *About the Office of Commercial Space Transportation,* https://www.faa.gov/about/office_org/headquarters_offices/ast (last visited Nov. 23, 2023).

> to place or try to place a launch vehicle or reentry vehicle and any payload or human being from Earth—(A) in a sub-orbital trajectory; (B) in Earth orbit in outer space; or (C) otherwise in outer space.[222]

"Every artificial satellite is launched into orbit atop a rocket or, as it is known in the aerospace industry, a launch vehicle."[223] Based on this definition, there is no doubt that the launch provider launching to the Moon are required to obtain a launch license.[224]

2. Payload Review

Every payload that goes off-world and hence to the Moon is required obtain a payload review.[225] The process certainly applies to lunar satellites because every satellite includes a payload that needs to be reviewed.[226] The payload, essential for its function, performs the satellite's intended tasks. .[227]

A payload review is normally performed as part of a launch or reentry authorization. However, an applicant may request a payload review and determination in advance of and separately from a launch or reentry authorization.[228]

As per 14 CFR§ 450.43, the FAA assesses a proposed payload for launch or reentry to confirm whether the license applicant or

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[222] 51 U.S.C. § 50902(7). *See* Eric J. Novotny, *Satellite Launch Vehicles,* *ACCESSSCIENCE*, https://www.accessscience.com/content/article/aYB040600. (last reviewed Jan. 2004). While somewhat dated, *see*, *e.g.*, FED. AVIATION ADMIN., SELECTING A LAUNCH VEHICLE: WHAT FACTORS DO COMMERCIAL SATELLITE CUSTOMERS CONSIDER? (2001), on launching vehicles for satellites.

[224] PWC, *supra* note 180, at 4 (contending that some commercial actors with Moon projects are opting to develop to construct their lunar vehicles, whereas others prioritize payload development and delegate transportation requirements to external providers).

[225] *See* 14 C.F.R. § 450.43.

[226] *See generally,* ALLIED MARKET RSCH., SATELLITE PAYLOAD MARKET (2021), https://www.alliedmarketresearch.com/satellite-payloads-market (explaining that a satellite consists of two main components: the payload and the bus. The latter serves as a platform to transport subsystems and payloads, while the former is specifi-cally designed to carry out tasks while in orbit (e.g., communication, imaging and navi-gation). Payloads include a range of equipment, such as transponders, repeaters and cameras.).

[227] O'Reilly Media, Inc., *Satellite Communications Payload and System*, https://www.oreilly.com/library/view/satellite-communications-payload/9781118345207/chapter01.html (last visited Nov. 23, 2023).

[228] 14 C.F.R. § 415.57.

payload owner/operator has secured all necessary regulatory approvals.[229]

Although applicable, this procedure is not adequate for the Moon: the FAA's jurisdiction primarily concerns safety, and it concludes its responsibility once the launch vehicle has placed the payload into Earth orbit or the intended trajectory in outer space.[230] A specific procedure to license and supervise lunar activities, including possibly lunar satellites, should be established; in fact, these activities might require a review that is beyond the focus of the current payload determination procedure.[231] As Brian J. Egan pointed out in 2017, the payload review might not be sufficient to authorize certain lunar missions.[232] Certainly, this does not mean that all private lunar enterprises are not authorizable under the current framework, but only there is no certainty about which ones could be authorized.[233] Egan gave two examples: in 2014, a US company (Bigelow Aerospace) requested a payload review for a proposed manned lunar habitat, intended to operate over a projected twenty-year lifespan, but it was denied. Another company's request for a small lunar lander technology demonstration was approved due to its limited scope and short duration—designed to operate for a maximum of two weeks. Egan argued that even this approval was questionable.[234] Egan explained that, while it was acknowledged that the OST does not prohibit activities like the lunar habitat, determining whether the "manner" of performance would be consistent with the OST proved challenging.[235] He added that the government's ability to approve elaborate missions will hinge on establishing a more comprehensive authorization framework that allows for

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[229] *Payload Reviews*, FED. AVIATION ADMIN., https://www.faa.gov/space/licenses/payload_reviews (last visited Nov. 20, 2023).

[230] H.R. REP NO. 105-347, at 22 (1997), discussing Commercial Space Act of 1997.

[231] Practically speaking, the FAA extends its review of the payload to encompass other factors such as: public health and safety, safety of property, US national security, foreign policy interests and international obligations of the United States. *See, e.g.,* AST, Commercial Space Transportation, *FAA's Payload Authority & Planetary Protection*, https://www.nationalacademies.org/documents/embed/link/LF2255DA3DD1C41C0A42D3BEF0989ACAECE3053A6A9B/file/D4E77F0D5B30602CFC9C59B80102C04E3165AA933DA6?noSaveAs=1.

[232] *Galloway Symposium*, *supra* note 79.

[233] *Id.*

[234] *Id.*

[235] *Id.*

conditional approval when required; this framework is known as mission authorization,[236] which Egan encouraged Congress to approve. [237]

Under this perspective, the situation for a commercial actors engaged in "new space" has not changed since 2017, even if bills are pending in Congress to pass new regulation.[238] It remains unclear whether a private company's filing for payload review to put a satellite in lunar orbit would be treated more like the crewed lunar habitat, which was denied authorization, or like the small, commercial lunar lander, which was granted the authorization.

3. Frequency License

A satellite needs at least one radio frequency to operate.[239] In particular, a space object needs to communicate with its ground

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[236] Theresa Hitchens, *Space Firms Want White House Fix for Regulatory Tangle, But Disagree on How*, BREAKING DEFENSE (Nov. 22, 2022), https://breakingdefense.com/2022/11/space-firms-want-white-house-fix-for-regulatory-tangle-but-disagree-on-how/ (arguing that the term "mission authorization" now refers to a proposed regulatory authority, aiming to bridge the current regulatory gap between emerging commercial space ventures and the existing licensing procedures).

[237] To be exact, Egan encouraged Congress to approve either "Mission Authorization" (OFF. OF SCI. & TECH. POL'Y, MISSION AUTHORIZATION (2016), https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/csla_report_4-4-16_final.pdf) or the Bridenstine Bill (American Space Renaissance Act, H.R. 4945, 114th Cong. (2016)). *Galloway Symposium*, *supra* note 79.

[238] As of December 2023, two competing bills for mission authorization and supervision are pending in Congress: (1) a bill proposed by Rep. Frank Lucas and Rep. Brian Babin, which aims to designate the Department of Commerce (DoC) as the singular regulatory body overseeing all private sector space endeavors. It seeks to effectively replace current licensing procedures with a more streamlined certification process that essentially assumes approval (H.R. 6131, the Commercial Space Act of 2023); (2) a bill by the White House National Space Council, which would divide regulatory control for emerging forms of commercial space operations between the DoC and the Transportation Department (DoT). In particular, this bill would expand the DoT's oversight, extending its safety jurisdiction to cover not just launch and reentry but also safety in orbit, on commercial space stations, and around celestial bodies. Additionally, it would expand the DoT's licensing authority to include in-space transportation. The proposal would also broaden DoC's licensing for remote sensing satellites to encompass include new space activities —such as assembly, manufacturing and debris removal—unrelated to human missions or under the DoT's jurisdiction. *See, e.g.*, Theresa Hitchens, *White House asks Congress to Split 'New Space' Authority* B*etween Commerce, Transportation*, BREAKING DEFENSE (Nov. 15, 2023), https://breakingdefense.com/2023/11/white-house-asks-congress-to-split-new-space-authority- between-commerce-transportation/.

[239] *Supra*, Part III(A)(4).

station, with signals going up and down: downlink signals from the space object to the ground station and uplink signals from ground station to the space object.[240]

The Communications Act[241] mandates that any commercial communications sent via satellite within, to, or from the United States must be licensed. Satellite communication requires both a space station and an Earth station to establish the link. Consequently, the FCC issues licenses for both space stations and Earth stations. This means that satellites, including those orbiting the Moon, must secure a frequency license from the FCC,[242] which is the authority responsible for granting these licenses. [243]

This paper does not discuss the procedure for licensing; sufficient to say that if a space company launches a satellite without a frequency authorization, sanctions will follow.[244] There are basically two types of authorizations for space.[245] Both can be in the form of a license or a special temporary authority:[246] 1) Experimental Radio Service/Part 5 authorization (for which the FCC's Office of Engineering and Technology is competent),[247] which does not grant protected spectrum access; and 2) Satellite Communications/Part 25(a commercial authorization from the Satellite Division of International Bureau) for which public notice must be given and which grants some protection in spectrum.[248] While it is not expressly provided, Part 25 was designed for satellites in Earth's orbit; in fact, Part 25 continuously mentions "Earth" and not the

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[240] Usually, space objects and ground stations have their own authorization from the FCC. *See, e.g.,* Hywel Curtis, *Spotlight: How to Secure a License for Your Space Mission Ground Segment, with Leaf Space*, SATSEARCH BLOG (July 30, 2020), https://blog.satsearch.co/2020-07-30-how-to-secure-a-license-for-your-space-mission-ground-segment (last updated June 29, 2021).

[241] 47 U.S.C. §§ 151-615.

[242] *Satellite*, FED. COMMC'NS COMM'N, https://www.fcc.gov/general/satellite (last visited Nov. 20, 2023).

[243] 47 U.S.C. § 301.

[244] *Unauthorized Operation in Wireless and Satellite Services - ULO*, FED. COMMC'NS COMM'N, https://www.fcc.gov/tags/unauthorized-operation-wireless-and-satellite-services-ulo (last visited Nov. 20, 2023).

[245] Amateur radio service requires a third type of authorization (47 C.F.R. Part 97) which does not apply here.

[246] 47 C.F.R. §§ 5.61, 25.120.

[247] 47 C.F.R. Pt. 5. 47 C.F.R. § 5.64 also allows special provisions for satellite systems.

[248] 47 C.F.R. Pt. 25.

Moon.[249] Also, Part 25 categorizes satellites into geostationary-satellite orbit systems (GSOs) and non-geostationary-satellite orbit (NGSOs); these categories refer to satellites in Earth's orbit.

4. Remote Sensing License

Following the Land Remote Sensing Policy Act of 1992,[250] 15 C.F.R. Part 960 implemented the Secretary of Commerce's "authority to license the operation of private remote sensing space systems."[251] The Secretary fulfills his/her responsibility through NOAA; therefore, remote sensing satellites must obtain a license from NOAA.[252] 15 C.F.R. § 960.11 indicates the condition for a remote sensing license.

The US regulatory system for commercial remote sensing generally aligns with UN principles, considering them as international obligations. It obligates operators licensed in the US to adhere to the principle of data accessibility.[253]

The question is: does a lunar satellite for remote sensing operation need a license under 15 C.F.R. Part 960? The response must be negative since this regulation would seem to apply only to Earth's observation satellites. In fact, 15 C.F.R. § 960.4 defines "remote sensing" as "the collection of unenhanced data *by an instrument in orbit of the Earth* which can be processed into imagery of surface features of the Earth."[254] 15 C.F.R. Part 960, however, contains important provisions for the protection of US national interest that could be useful also for remote sensing from lunar satellites.[255]

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[249] *Id.*

[250] Land Remote Sensing Policy Act of 1992, Pub. L. No. 102-555, 106 Stat. 4163.

[251] 15 C.F.R. § 960.1.

[252] 15 C.F.R. § 960.2 (stating that § 960 concerns only the operation of private remote sensing space systems within the US or by a US person and does not extend to instruments used for "mission assurance or other technical purposes").

[253] Michael R. Hoversten, *U.S. National Security and Government Regulation of Commercial Remote Sensing from Outer Space*, 50 A.F. L. REV. 253, 264 (2001).
July 31, 2000, the Department of Commerce issued an interim final rule which became effective on August 30, 2000. The interim final rule requires a commercial remote sensing operator to obtain at least three and possibly four different licenses: (1) a remote sensing operating license; (2) a radio frequency license; (3) a launch license; and (4) an export license (if required). *Id.* at 267.

[254] 15 C.F.R. § 960.4 (emphasis added).

[255] In 15 C.F.R. § 960, provisions important for safeguarding US national interests include rigorous national security reviews for license applications (e.g., 15 C.F.R. § 960.10), measures for protecting and controlling the dissemination of remote sensing

Therefore, this is probably an unintended regulatory gap (determined by the novelty of the use of non-governmental lunar satellites).

5. Title IV of the 2005 US Commercial Space Launch Competitiveness Act

In 2015, Congress passed the US Commercial Space Launch Competitiveness Act. [256] The most innovative aspect of SPACE is Title IV,160 which governs space resource utilization.[257]

The law tackled a concern that existed for space resource activities, i.e., the legality of the appropriation of the extracted resources.[258] Reaffirming the longstanding interpretation given by the US to Article II OST, the Act made clear that commercial actors acquire rights to resources they gather in space.[259] The Act does not deal with non-Earth orbiting satellites. The term "space resource" is defined as "an abiotic resource in situ in outer space"[260] and "includes water and mineral."[261] The definition does not include lunar orbit orbits, so Title IV does not apply to them.

Because lunar orbits are a scarce resource, it would be appropriate to pass a similar law to clarify (again reaffirming the US position on Article II OST) that satellite operators that lawfully position satellites in lunar orbit have a right to maintain that orbit clear from interference of others.

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data (e.g., 15 C.F.R. § 960.20), export controls (e.g., 15 C.F.R. § 960.30), compliance with international agreements (e.g., 15 C.F.R. § 960.40), and mechanisms for monitoring and enforcing regulations (e.g., 15 C.F.R. § 960.50).

[256] Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90 (2015) (intended to facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating more stable and predictable regulatory conditions).

For a detailed discussion of the Act, *see*, *e.g.*, Michael Dodge, *The U.S. Commercial Space Launch Competitiveness Act of 2015: Moving U.S. Space Activities Forward*, 29 AIR & SPACE LAW. 4 (2016) (making the point that the federal government must implement the CSLCA's substantial changes to existent law).

[257] Frans von der Dunk, *The US Space Launch Competitiveness Act of 2015*, JURIST (Nov. 30, 2015) (characterizing it as "the most innovative and disputed part of the Act, certainly in an international context."). Title IV was codified as 51 U.S.C. § 51301 et seq.

[258] *See, e.g.*, Giannoni-Crystal, *supra* note 1.

[259] SPACE Act, *supra* note 83, § 51303.

[260] 51 U.S.C. § 51301(2)(A).

[261] 51 U.S.C. § 51301(2)(B).

B. Suggested Solutions at the Domestic Level

A series of changes should be implemented domestically. The regulation should parallel whatever policies the United States will adopt for its governmental missions to the Moon, this paper argues that those same policies should be imposed on commercial missions; in fact, no reasons exist for commercial entities to be exempted from complying with policies, the compliance with which should become conditions for licensing.

In deciding what and how to regulate (while avoiding unnecessary regulation),[262] the UN Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space should be considered.[263]

This paper offers suggestions directed to the United States. In fact, many other countries do not have regulations at all or have regulations that are less developed than the US ones.[264] This paper argues that all countries should adopt or amend regulations based on the principles that follow.

1. Suggestions Regarding Payload Review

The current payload review is insufficient for commercial missions beyond the Earth's atmosphere. This paper advocates for passing a specific framework for authorizing novel activities in space (including satellites beyond Earth's orbit). A unified procedure for authorizing activities beyond Earth's orbit is a viable solution for offering certainty and efficiency; it might also be required

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[262] *See e.g.*, *Testimony of Laura Montgomery*, *supra* note 192, at 14 (arguing on the need to avoid excessive and unnecessary regulation or blank delegation of regulatory power).

[263] G.A. Res. 68/74, Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space (Dec. 11, 2013) (calling for national regulatory frameworks to cover various listed space activities, ensuring compliance with international obligations and safeguarding against risks; also emphasizing the need for ongoing supervision through procedures like on-site inspections or reporting requirements.)

[264] *See* Milton "Skip" Smith, *supra* note 212. Many countries do not have any regulation for space, and those that have space regulations lack specific laws concerning lunar satellites. *See*, *e.g.*, Tanja Masson-Zwaan, *The Space Law Review: Netherlands*, The L. Revs. (Jan. 5, 2023) (principally discussing the Netherlands' Space Activities Act). Even countries with laws on space resources do not deal with non-Earth-orbiting satellites. For example, Luxembourg's space resource law excludes from its scope "satellite communications, orbital positions or the use orbital positions. Luxembourg Space Resources Act, *supra* note 83, art. 2.

by Article VI OST. Indeed, the overwhelming view about this provision is that it requires, as a matter of international obligation, authorization and supervision of private actors by member States and this implies passing appropriate regulation [265]

A unified procedure of authorization is also in the interest of operators.[266] In fact, the current inadequacy in the authorization procedure could result in a problem for operators.[267] Even if "no license, authorization, or permit is required" under 51 U.S.C. § 50904, the US government could still prevent a launch for several reasons, including national security and *foreign policy interest*.[268]

At least to resolve the inadequacy of the payload review, a viable - although less satisfactory alternative to a comprehensive framework - could be an integration of the current payload review, which could be modified in order to allow the FAA to impose

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[265] *See*, *e.g.*, Frans G. von der Dunk, *The Origins of Authorisation: Article VI of the Outer Space Treaty and International Space Law*, *in* NATIONAL SPACE LEGISLATION IN EUROPE (Frans G. von der Dunk ed., 2011) and Goehring, *supra* note 192, at 106. *Contra*, *Testimony of Laura Montgomery*, *supra* note 192, at 1- 2 (arguing that Article VI is not self-executing and therefore the same as prohibiting operations in outer space without government authorization and supervision would be a misunderstanding).

[266] Space industry stakeholders hold differing views on the need and structure of a unified regulatory procedure for new space activities. During a virtual session of the National Space Council on November 21, 2022, commercial space companies suggested various approaches. These included establishing a "clearinghouse" or a centralized "one-stop shop" under the Department of Commerce, or advocating for a "permission-less" phase similar to the early internet regulation moratorium. *See* Hitchens, *supra* note 238. While the "clearinghouse" or the "one-stop shop" ideas could be effective, the proposal for a "permission-less" period is not advisable due to concerns about potential international legal disputes regarding Article VI of the OST.

[267] *See e.g.*, *Testimony of Laura Montgomery*, *supra* note 192, at 8 (arguing that given the legal and regulatory ambiguity surrounding the interpretation of Article VI, Congress must clarify this uncertainty by instructing regulatory agencies not to reject payload reviews, launch or reentry licenses, or satellite transmission or remote sensing authorizations solely due to the absence of federal oversight of a specific activity.)

[268] 51 U.S.C. § 50904 (c) *Preventing Launches and Reentries*.

> The Secretary of Transportation shall establish whether all required licenses, authorizations, and permits required for a payload have been obtained. *If no license, authorization, or permit is required, the Secretary may prevent the launch* or reentry if the Secretary decides the launch or reentry would jeopardize the public health and safety, safety of property, *or national security or foreign policy interest* of the United States.

Id. (emphasis added).

additional requirements and conditions on lunar operators,[269] including a generalized requirement to comply with COSPAR's Policy on Planetary Protection and a commitment to debris mitigation.[270] However, this paper advocates for a more ambitious solution: the Department of Commerce should obtain overseeing authority on all private sector space endeavors, including lunar satellites.[271] Several reasons support this stance. Firstly, the FAA primarily focuses on safety, and if it were designated as the regulator for emerging space endeavors, there is a concern it might hinder their development. Secondly, Commerce has extensive experience (through the National Oceanic and Atmospheric Administration, NOAA) already licenses activities in orbit,[272] whereas the FAA's jurisdiction basically ends at launch, lacking experience in regulating activities beyond that point. Thirdly, Commerce, through NOAA, is familiar with licensing payloads for remote sensing and regulating their activities in orbit.[273] Fourthly, the FAA has demonstrated reluctance towards novel activities in previous cases, such as its handling of Bigelow Aerospace,[274] indicating its possible inappropriateness for regulating in-orbit activities. Fifthly, in areas like manufacturing, space mining and commercial space stations, transportation is less significant compared to other aspects, making it more logical to entrust regulation to an agency focused on promoting commerce. Sixthly, the Dept. of Commerce is well-positioned to balance national interests with innovation and commerce in novel space operations.[275]

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[269] Egan points out that the government needs a mechanism to provide authorization subject to conditions that would ensure conformity with US obligations under the Outer Space Treaty. *Galloway Symposium*, *supra* note 79.

[270] For example, actors could broadly have to comply with NASA's Procedural Requirements for Limiting Orbital Debris and Evaluating the Meteoroid and Orbital Debris Environments, which is currently imposed only on certain commercial entities that cooperate with NASA. *See* NAT'L AERONAUTICS & SPACE ADMIN., NASA PROCEDURAL REQUIREMENTS FOR LIMITING ORBITAL DEBRIS AND EVALUATING THE METEOROID AND ORBITAL DEBRIS ENVIRONMENTS 3 (2017), https://soma.larc.nasa.gov/SIMPLEx/pdf_files/N_PR_8715_006B_.pdf.

[271] This is substantially in line with the bill proposed by Rep. Lukas and Rep. Babin. H.R. 6131, the Commercial Space Act of 2023.

[272] 51 U.S.C. §§ 60101-60123.

[273] *Id.*

[274] *See supra* Part IV(A)(2).

[275] On this last point, *see e.g.*, Karina Drees, *Why the Office of Space Commerce Should Supervise Novel Commercial Space Activities,* SPACENEWS (March 14, 2023),

2. Suggestions Regarding Frequency License

The current situation is unsatisfactory for the growing commercial sector and needs to change.[276]

In 2020, to accommodate small satellites,[277] the FCC introduced a "new authorization process tailored specifically to small satellite operations, keeping in mind efficient use of spectrum and mitigation of orbital debris."[278] The new rules, recognizing the specificity of smallsats, streamlined the procedure for smallsats license application. [279] In this regulation, the FCC mentions non-Earth smallsats,[280] recognizing their peculiarity and including small spacecrafts in Part 25.[281] This is a step in the right direction, but it is recommendable that a similar specific authorization process is adopted for lunar satellites

To adapt 47 C.F.R. Pt. 25 for licensing of lunar satellites, several changes and additions would be necessary to accommodate the unique characteristics and challenges of satellite communications in lunar orbit. Just to give some examples: In § 25.103 (Definitions),[282] new definitions should be added for terms specific to lunar satellite communications, such as "Lunar Satellite,"[283] "Lunar

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https://spacenews.com/why-the-office-of-space-commerce-should-supervise-novel-commercial-space-activities/.

[276] See *supra* Part IV(33).

[277] 85 Fed. Reg. 43711 (Aug. 1, 2019) (amending 47 C.F.R. Pts. 1 & 25). For a complete discussion of the amendments, *see* https://www.govinfo.gov/content/pkg/FR-2020-07-20/pdf/2020-12013.pdf. The FCC had previously recognized that the rules of 47 C.F.R. Pt. 25 were generally not developed with small satellite systems in mind, and that its fees and regulatory requirements were instead only appropriate to "expensive, long-lived missions." *See* FED. COMMC'NS COMM'N, STREAMLINING LICENSING PROCEDURES FOR SMALL SATELLITES (2018) (IB Docket No. 18-86), https://www.fcc.gov/document/streamlining-licensing-procedures-small-satellites.

[278] 85 Fed. Reg. 43711, *supra* note 277.

[279] For an overview of the smallsats rules, *see* Anusuya Datta, *New FCC Rules Make Small Satellite Licensing Easier, Faster, and Cheaper*, GEOSPATIAL WORLD (Aug. 22, 2020), https://www.geospatialworld.net/blogs/new-fcc-rules-make-small-satellite-licensing-easier-faster-and-cheaper/.

[280] In the new rules, the FCC recognized that its streamlined, small satellite procedures could apply to non-Earth orbit missions. 85 Fed. Reg. 43711, *supra* note 277, at 43713.

[281] 47 C.F.R. § 25.103 (defining a "small spacecraft" as a NGSO (non-geostationary orbit) space station that operates beyond Earth's orbit and which is eligible for authorization under the application process described in § 25.123).

[282] 47 C.F.R. § 25.103.

[283] "Lunar Satellite" for example could be defined as "A satellite stationed in orbit around the Moon, intended for communication, navigation, scientific, or other purposes".

Orbit,"[284] "Lunar Surface Station,"[285] and so on. Also, the existing definitions should be modified to include provisions for lunar operations where applicable. Subpart B (Applications and Licenses),[286] the authorization process for lunar satellite operations should be specified, including licensing requirements for transmitting energy or communications signals from lunar space stations and include provisions for coordination with relevant international space agencies or organizations for lunar satellite operations. In Subpart C (Technical Standards),[287] technical standards for lunar satellite communication systems should be introduced, in consideration of the unique challenges of lunar orbit (e.g., radiation exposure, temperature variations and communication latency). Subpart C should also define frequency bands suitable for lunar satellite communications,[288] considering interference and spectrum allocation issues. In addition, it would be appropriate to develop protocols for mitigating interference between lunar satellite systems and existing terrestrial or space-based communication networks and to define coordination procedures for minimizing signal interference among lunar satellites and with Earth-based systems.[289]

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[284]"Lunar Orbit" for example could be defined as "The elliptical path followed by a satellite around the Moon".

[285] "Lunar Surface Station" for example could be defined as "A facility located on the surface of the Moon for communication, research, or other activities".

[286] 47 C.F.R. Part 25 Subpart B.

[287] 47 C.F.R. Part 25 Subpart C.

[288] *Id.*

[289] For example, the following could be added in Subpart C:

§ 25.XX Technical Standards for Lunar Satellite Communications

(a) The Federal Communications Commission shall establish technical standards for the operation of lunar satellite communication systems, considering the unique challenges and characteristics of lunar orbit, including radiation exposure, temperature variations, communication latency, and vacuum conditions.

(b) Frequency bands suitable for lunar satellite communications shall be designated by the Commission, taking into account interference, spectrum allocation considerations, and compatibility with existing Earth-based and space-based systems.

(c) Technical specifications for lunar satellite equipment, including power levels, antenna designs, modulation schemes, and error correction techniques, shall be prescribed by the Commission to ensure reliable and efficient communication in the lunar environment.

(d) The Commission shall develop protocols for mitigating interference between lunar satellite systems and existing terrestrial or space-based communication networks. This shall include defining coordination procedures for minimizing signal interference among lunar satellites and with Earth-based systems.

However, of course, licenses at the national level need to be coordinated with the ITU rules, which for the moment, do not provide the possibility of allocating commercial licenses to lunar satellites.[290] Until the ITU changes its regulations, member States (including the US) can only assign research/experimental radio frequencies to lunar satellites. Once the ITU changes its rules to reckon with lunar activities, the FCC regulations must promptly adapt.

3. Suggestions Regarding Remote Sensing Regulation

The NOAA regulation of license of remote sensing satellites should be amended to expand the definition of "remote sensing" in 15 C.F.R § 960.4 to include lunar satellites. The language could be as follows: "the collection of unenhanced data by an instrument in orbit of the Earth or the Moon which can be processed into imagery of surface features of the Earth or the Moon" (additions underlined). In this way, a license under 15 C.F.R. Part 960 would be required for lunar remote sensing and the provisions for protection of the US national interest would apply to lunar remote sensing.

Other provisions of 15 C.F.R. Part 960 might need to be amended to make them suitable for lunar satellites. For example, the regulations should explicitly state that they apply to the licensing of lunar satellite systems.[291] Because one day lunar satellites could be operated directly from the Moon § 960.2[292] should be amended to clarify that the regulations cover the operation of private lunar satellite systems, including instruments used for navigation, communication and data transmission. Under §§ 960.5-6[293] dealing with license application submission and categorization, modifications would be needed to accommodate the unique aspects of applying for licenses for lunar satellite systems, including considerations for lunar mission profiles and data collection. The

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[290] *Supra*, Part III(A)(4).

[291] 15 C.F.R. § 960.1 (Purpose).

[292] 15 C.F.R § 960.2 (Jurisdiction) ("(a) The regulations in this part set forth the requirements for the operation of private remote sensing space systems within the United States or by a U.S. person.")

[293] 15 C.F.R. § 960.5 (Application submission) and § 960.6 (Application categorization).

sections dealing license conditions (§ 960.8-10)[294] would require substantial revisions to address the specific requirements and obligations related to the operation of lunar satellite systems, including data sharing, national security and compliance with international agreements regarding lunar exploration. Under § 960.14,[295] amendments would be necessary to establish procedures for routine compliance monitoring and reporting specific to lunar satellite operations. In addition, under § 960.16 (Prohibitions)[296] amendments would also be appropriate to ensure that those that applied for and obtained a NOAA license because they were operating within the US but at a later time begin to operate from the Moon are still subject to NOAA's jurisdiction.[297] Section 960.16[298] should also be revised to incorporate prohibitions against interfering with international lunar exploration efforts or disturbing culturally or scientifically significant lunar sites with the introduction of § 960.16(e)). These are only examples and other changes are likely recommendable.

By incorporating the above discussed changes (and possibly others), the regulations can be appropriately adapted to address the complexities and requirements of lunar satellite operations, ensuring compliance with international space law and sustainable operation of lunar satellites.

V. A PROPOSAL: GUIDELINES FOR LUNAR SATELLITES

Because the current geopolitical situation makes the adoption of new treaties or the modification of ones in force difficult, this article recommends the development of Guidelines for Lunar Satellites (Lunar Satellite Guidelines) to address uncertainties that can lead to unnecessary conflict. The Lunar Satellite Guidelines should be followed as best practice by lunar stakeholders and could be incorporated into domestic law by as many countries as possible.

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[294] 15 C.F.R. § 960.8 (Standard license conditions for all tiers); § 960.9 (Additional standard license conditions for Tier 2 systems); § 960.10 (Additional standard and temporary license conditions for Tier 3 systems).

[295] 15 C.F.R. § 960.14 (Routine Compliance and Monitoring).

[296] 15 C.F.R. § 960.16.

[297] *Id.* ("Any person who operates a system from the United States and any person who is a U.S. person shall not, directly or through a subsidiary or affiliate. […]") (emphasis added).

[298] 15 C.F.R. § 960.16(a-d).

The essence of the proposal is to use the Building Blocks[299] and the Artemis Accords[300] as a model. While the Building Blocks deal with resources activities on the Moon and expressly exclude satellite orbits and radio spectrum,[301]some of the proposed "blocks" can be used for lunar (and generally non-Earth orbiting) satellites.

The Artemis Accords have also been helpful in preparing the Guidelines. Unlike the Building Blocks, the Artemis Accords are intended to apply to lunar satellites.[302] The proposal that follows takes principles and language from both. The Guidelines also draw principles from existing UN nonbinding guidelines, such as the Space Debris Mitigation Guidelines[303] and the LTS Guidelines.[304]

The proposed Guidelines could be adapted for other non-Earth orbiting satellites, such as Martian satellites.

Proposed Guidelines for Lunar Satellites

1. These lunar satellite guidelines are intended to apply to lunar satellite activities conducted by States, international organizations and private actors.

2. Lunar satellites "should be exclusively for peaceful purposes"[305] and lunar satellite activities should be "in accordance with relevant international law."[306]

3. Lunar satellite activities should be conducted employing sustainable technology and in pursuance of sustainable development.

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[299] BUILDING BLOCKS, *supra* note 1.

[300] Artemis Accords, *supra* note 1.

[301] BUILDING BLOCKS, *supra* note 1, § 2.1 (defining "space resource" as "an extractable and/or recoverable abiotic resource *in situ* in outer space," which - in the understanding of the members of the Working Group, as expressed in footnote 2 of the BUILDING BLOCKS - includes water, mineral and volatile materials, but excludes satellite orbits and radio spectrum).

[302] The Artemis Accord apply to "*civil space activities* conducted by the civil space agencies of each Signatory [which] may take place on the Moon, Mars, comets, and asteroids, including their surfaces and subsurfaces*, as well as in orbit of the Moon* or Mars, in the Lagrangian points for the Earth-Moon system, and in transit between these celestial bodies and locations" (emphasis added). Artemis Accords, *supra* note 1, § 1.

[303] SPACE DEBRIS MITIGATION GUIDELINES, *supra* note 6.

[304] LTS Guidelines*, supra* note 164.

[305] Artemis Accords, *supra* note 1, § 3.

[306] *Id.*

4. "Non-governmental lunar"[307] satellite "activities shall require prior authorization and continuing supervision by the appropriate State"[308] (including "monitoring of any harmful impacts resulting"[309] from satellite activities). The authorization will require the operators to comply with these guidelines, the United Nations Debris Mitigation Guidelines, and the LTS Guidelines,[310] as applicable to lunar satellite activities "with appropriate changes to reflect the nature of operations beyond low-Earth orbit."[311]

5. Lunar satellites shall be registered by means of an entry in an appropriate registry, which each launching State shall maintain. The registry shall be kept in a manner to privilege "transparency,"[312] therefore, if possible, through shared ledger technology (blockchain or similar). This registry can be the same one in which Earth-orbiting satellites are registered.

6. The country of registry of a lunar satellite shall furnish to the Secretary-General of the United Nations, as soon as practicable, but anyway no later than 3 months, the following information concerning each lunar satellite carried on its registry: (a) name of launching State or States; (b) an appropriate designation of the satellite or its registration number; (c) date and territory or location of launch; (d) basic orbital parameters, including: (i) nodal period; (ii) inclination; (iii) apogee; (iv) perigee; and (e) general function of the satellite.

7. The State's authorization will provide "the attribution of priority rights to an operator"[313] for placing its satellite in lunar orbit "for a maximum period of time"[314] upon registration in the registry indicated in Guideline 5. The priority period shall not be more than 6 months.

8. By conducting satellite operations on and around the Moon, the satellite operators acknowledge the principle of quasi-territoriality as expressed in Article VIII of the Outer

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307 BUILDING BLOCKS, *supra* note 1, § 5(b).
308 *Id.*
309 *Id.* § 12.1.
310 Artemis Accords, *supra* note 1, § 11.2.
311 *Id.*
312 *Id.* § 4.
313 BUILDING BLOCKS, *supra* note 1, § 7.
314 *Id.*

Space Treaty and therefore acknowledge that intellectual property rights are governed by the law of the country of registry.

9. Satellite operators subject themselves to the jurisdiction of the country in whose registry their satellite is registered. Satellite operators that register their satellite in a national registry shall be recognized priority rights by any other operators. All the States shall commit to mutual recognition of such priority rights.

10. Lunar resources, including radio frequencies and orbits, should be used "in a sustainable, rational, efficient, and economic"[315] way. No application for a frequency should be made if not in furtherance of a concrete and viable project for placing a satellite in lunar orbit and in furtherance of a detailed implementation plan. A satellite should be placed in orbit within one year of obtaining the frequency.

11. Frequency assignments for lunar orbit shall be communicated "for recording in the Master International Frequency Register in accordance with the Radio Regulations of the International Telecommunication Union."[316]

12. Lunar satellites activities shall be conducted in a manner not to cause "harmful interference"[317] to the radio services or communications of other lunar satellite operators which operate pursuant to a license of proper authorities. A lunar satellite operator with reason to believe that it may suffer, or has suffered, harmful interference, may request consultations with any other lunar satellite operator or any State authorizing the activity.

13. Lunar satellite activities should be conducted in compliance with the "due regard" principle expressed in Article IX of the Outer Space Treaty. If a lunar satellite operator has reason to believe that "any potentially harmful interference"[318] (including interference with radio frequency and orbit) "may be

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[315] *Id.* § 4.2(f).
[316] *Id.* § 14(f).
[317] *Id.* § 11.3.
[318] *Id.* § 4.3(c).

caused,"[319] it shall initiate appropriate consultations under Article IX OST.

14. Lunar satellite operators shall comply with the COSPAR's Policy on Planetary Protection as modified over time.

15. "Taking into account the current state of technology,"[320] lunar satellite operators "shall adopt appropriate measures with the aim of avoiding and mitigating potentially harmful impacts"[321] of their satellite activities on the Moon and shall have a plan for measures to redress such impact, if possible. Lunar satellites operators shall have adequate insurance to cover damages.

16. In particular, lunar satellite operators shall have in place measures with the aim of avoiding and mitigating: a) "Risks to the safety of persons, the environment, or property;"[322] b) "Damage to persons, the environment, or property;"[323] c) Substantial "adverse changes in the environment of the Earth,"[324] outer space, the Moon, or any other celestial bodies; d) Unacceptable level of "harmful contamination"[325] of the Moon, other celestial bodies, or empty outer space; f) "Harmful effects of the creation of space debris;"[326] g) "Harmful interference with other on-going space activities, including other"[327] satellite operations or "space resource activities;"[328] h) "Adverse changes to designated and internationally endorsed outer space natural or cultural heritage sites,"[329] as well as "designated and internationally endorsed outer space sites of scientific interest."[330]

17. If lunar satellite operators discover "any phenomena[331] in outer space that "could endanger terrestrial life or health, as

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[319] *Id.*
[320] *Id.* § 10.
[321] *Id.*
[322] *Id.* § 10(a).
[323] *Id.* § 10(b).
[324] *Id.* § 10(c).
[325] *Id.* § 10(e).
[326] *Id.* § 10(f).
[327] *Id.* § 10(g).
[328] *Id.*
[329] *Id.* § 10(h).
[330] *Id.* § 10(j).
[331] *Id.* § 14(e)(iv).

well as of any indication of extraterrestrial life,"[332] they shall communicate it to the State of their national registry.

18. Lunar satellite operators commit to establish "a plan for the mitigation of orbital debris, including the safe, timely, and efficient passivation and disposal"[333] of satellites "at the end of their missions, when appropriate, as part of their mission planning process."[334] Lunar satellite operators "commit to limit, to the extent practicable, the generation of new, long-lived harmful debris released through normal operations, break-up in operational or post-mission phases, and accidents and conjunctions, by taking appropriate measures such as the selection of safe flight profiles and operational configurations as well as post-mission disposal of space structures."[335] Lunar satellite operators shall contribute 5% of their revenues from lunar satellite activities to a national fund, to be instituted in every country of registration of lunar satellites, aimed at remediation of the debris in lunar orbits.

19. Disputes arising out of lunar satellite activities should be solved amicably among the parties and, in case an amicable composition is not possible, "through 2011 Permanent Court of Arbitration, Optional Rules for Arbitration of Disputes Relating to Outer Space Activities."[336]

VI. CONCLUSION

A new "Moon race" has started and both governmental and private missions will soon settle the Moon, with the private sector involved at an unprecedented level. Governmental programs and commercial activities on the Moon will depend heavily on lunar satellites. This paper has discussed and demonstrated the inadequacy and lack of clarity of the current international and domestic framework for non-Earth orbiting satellites. This situation could create (or worsen) potential conflicts (possibly violent ones) among the spacefaring countries and their commercial enterprises.

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[332] *Id.*
[333] Artemis Accords, *supra* note 1, § 12.1.
[334] *Id.*
[335] *Id.* § 12.2.
[336] BUILDING BLOCKS, *supra* note 1, § 19.

In fact, the lack of clear guidelines and regulations create uncertainty and, in some cases, might increase the risk of conflicts among lunar stakeholders.

The Outer Space Treaty and the other Space Treaties surely apply to non-Earth orbiting satellites, but these general principles require specifications. As discussed, some important international guidelines and international documents do not apply and should be extended to cover lunar satellites. The ITU radio frequency and associated orbit allocation rules must be updated to tackle missions to the Moon and other celestial bodies.

Domestic regulation is also inadequate. Some US regulations specifically apply only to Earth observation satellites, and under the existing licensing frameworks in the US, a private entity that is considering launching and operating a lunar (or non-Earth orbiting) satellite might find itself in a situation similar to the first privately funded commercial rocket, Conestoga in 1982.[337] Unsolved legal issues complicate the situation for the private sector.

This article argues for adoption of Lunar Satellite Guidelines, drawn from several existing documents including the Building Blocks, the Artemis Accords, the Debris Mitigation Guidelines and the LTS Guidelines. While these proposed Guidelines are drafted for lunar satellites, they might be extended to other non-Earth orbiting satellites (*in primis* Martian satellites) with proper adaptation.

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[337] Conestoga 1 was the first launch of a privately funded rocket into space. The company, Space Services, Inc. of America (SSIA), had to demonstrate to investors and customers that the federal government would permit private space launches, which was difficult: even though SSIA received the support of the Reagan Administration, it had to engage in a year-long effort to convince a variety of federal agencies to approve the proposed launch. Only in 1984 did Congress enact the Commercial Space Launch Act, which is still the law that enables private space transportation. *The Launch of Conestoga 1*, CELESTIS, https://www.celestis.com/about/conestoga-1/ (last visited Nov. 20, 2023).