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Outer Space: How Shall the World's Governments Establish Order Among Competing Interests?

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OUTER SPACE: HOW SHALL THE WORLD'S GOVERNMENTS ESTABLISH ORDER AMONG COMPETING INTERESTS?

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Abstract: We are in a period of transition in outer space; it is becoming increasingly congested. As one example, small satellites are beginning to interfere with astronomical observations. The objective of this article is to examine and evaluate how the various outer space interests interact, coordinate or conflict with each other. This article examines legal order options and the consequences of choosing among those options.

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I. INTRODUCTION: WHY ORDER IN OUTER SPACE?

Outer space seems unlimited; at least it so appeared in 1957 when Sputnik was launched. Since then, space activities have blossomed and many more are coming. There are now approximately 2000 functional satellites. On May 23, 2019 Space-X launched a mission that placed 60 more satellites into low Earth orbit ("LEO"). Space X plans to launch 12,000 satellites. Blue Origin will launch another 4,000 satellites. One Web is launching 650 satellites. Military planners intend to orbit hundreds of new spacecraft.[1] Other launch operators of different nationalities have announced launch plans for

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[1] Sandra Erwin, *As It Plans LEO Constellations, DOD Must Prepare to Deal with Congestion*, SPACENEWS, June 10, 2019, at 30 [hereinafter *LEO Constellations*]. For further discussion, see generally: Paul B. Larsen, *Space Traffic Management Standards*, 83 J. AIR L. & COM. 359, 359–87 (2018) [hereinafter *Space Traffic*]; Paul B. Larsen, *Solving the Space Debris Crisis*, 83 J. AIR. L. & COM 475, 475–519 (2018) [hereinafter *Solving*]; Paul B. Larsen, *Minimum International Norms for Managing Space Traffic, Space Debris and Near Earth Object Impacts*, 83 J. AIR L, & CON 739, 739–785 (2019) [hereinafter *Managing*]; Paul B. Larsen, *International Regulation of Near Earth Objects*, 67 GER. J. AIR & SPACE L. 105, 105 (2018) [*hereinafter Regulation*]; Paul B. Larsen, *Small Satellite Legal Issues*, 82 J. AIR L. & COM. 275, 275–309 (2017) [hereinafter *Small Satellite*]; *and* Paul B. Larsen, *Outer Space Arms Control, Can the USA, Russia and China Make this Happen?*, 23 J. CONFLICT AND SECURITY L. 137, 137–159 (2018) [hereinafter *Arms Control*].

thousands of additional functional satellites. Many small satellites are destined to form large constellations.

Space traffic congestion is a present problem and getting worse. The U.S. military considers outer space to be dangerously congested. The congestion consists not only of the large number of orbiting satellites; it includes more than one million pieces of uncontrolled orbiting space debris that must be avoided by functional satellites. Functional satellites need to be deorbited and replaced regularly by new satellites. Frequent launches and deorbits through crowded Low LEO pose another traffic problem. Satellite operators agree that space traffic management ("STM") is needed.[2] Removal of existing space debris is not yet feasible. The Kessler Syndrome looms unless space debris can be controlled.[3] While existing COPUOS space debris guidelines promise to diminish the generation of new debris, that will not be adequate.[4] More extensive debris control is needed in order to avoid the foreclosure of outer space. Another space traffic concern is the danger of losing control over orbiting satellites due to cyberattacks. Operators need to protect their computer systems from being hijacked by outsiders.[5]

Space is legally non-sovereign.[6] No one country is permitted to control all moving objects in outer space, because outer space cannot be appropriated

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[2] *LEO Constellations*, *supra* note 1, at 30.

[3] The Kessler Syndrome predicts the foreclosure of outer space unless the current trend in space debris is reversed. *See* Donald J. Kessler & Burton G. Cour-Palais, *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt*, 83 J. J. GEOPHYSICAL RES. 2637, 2637 (1978) [hereinafter *Collision Frequency*]. According to the Kessler Syndrome, space debris of critical mass will fragment in further collisions, leading to cascading chain activity. *See* Donald J. Kessler et al., *The Kessler Syndrome: Implications to Future Space Operations*, 33RD ANN. AAS GUIDANCE & CONTROL CONF., at 2 (Feb. 6–10, 2010), http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.394.6767&rep=rep1&type=pdf [hereinafter *Kessler Syndrome*]. The unending fragmentation chain reaction may eventually foreclose access to outer space, which is a danger to all outer space activities. *See Kessler Syndrome*, WIKIPEDIA, https://en.wikipedia.org/wiki/Kessler_syndrome (last visited Dec. 20, 2019).

[4] *See* Inter-Agency Space Debris Coord. Committee, IADC Space Debris Mitigation Guidelines (Sept. 2007), https://www.iadc-online.org/index.cgi?item=docs_pub [hereinafter Mitigation Guidelines]. *See also COPUOS Space Debris Guidelines*, *in* 3 COLOGNE COMMENTARY ON SPACE LAW 605 (Stephan Hobe, Bernhard Schmidt-Ted, & Kai-Uwe Schrogl eds., 2013).

[5] Ingo Bauman et al., *GNSS Cybersecurity Threats, An International Law Perspective*, INSIDE GNSS MAGAZINE June 3, 2019, at 30.

[6] The relevant space law treaties include: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty]; Convention on Registration of Objects Launched Into Outer Space , Nov. 12, 1974, 1923 U.N.T.S. 15 [hereinafter UN Registration Convention]; Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 961 U.N.T.S. 187 [hereinafter Liability Convention]; Agreement on Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 672 U.N.T.S. 119 [hereinafter Rescue and Return

by any one state. Each state can legally only govern its own orbiting space objects.[7] Therefore, an internationally agreed upon legal order will be required to manage traffic in outer space.

While no one can appropriate space, nevertheless there are many stakeholders. They compete and often conflict with each other. Each seeks to hold outer space open for its own legal outer space activities. This paper identifies the main stakeholders. How do they interact? How could they possibly accommodate each other to extend the uses of outer space to all authorized users of all nationalities?

First, the paper considers the option of no legal order in outer space; activity would be on a first come, first serve basis. The second legal order is based on freedom of scientific investigation in outer space. A third order considers outer space as a global commons. A fourth is the order established by outer space treaties. A fifth is the order already established by the International Telecommunication Union for navigation of satellites by use of radiofrequencies. A sixth is the military order, which views outer space purely as a military domain. A seventh is the commercial order in outer space being created as thousands of small commercial satellites are launched into orbit by Space-X, Blue Origin, One Web and others. An eighth order is established through the United Nations by international codes and guidelines intended to enable users to accomplish their tasks and protect their investments. This confused situation may lead to chaos, with winners who dominate outer space and losers who will be pushed aside. Ultimately, the entire Earth-Space infrastructure needs coordinated order allowing co-existence.

The United Nations started us on the right path by approving the 2008 space debris guidelines now being adopted by all the countries. However military engagements by China and India have already added thousands of debris into outer space. Moreover, the thousands of small satellites now being launched to improve communication and for remote sensing, when added to existing military debris, may eventually block access to outer space.[8]

Agreement]; and Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, July 11, 1984, 1363 U.N.T.S. 3 [hereinafter Moon Agreement].

[7] Outer Space Treaty art. VIII, *supra* note 6, at 209; *see also* Space Policy Directive-3, National Space Traffic Management Policy, 83 Fed. Reg. 28,969 (June 18, 2018) [hereinafter STM]; Presidential Memorandum on Space Policy Directive-3, National Space Traffic Management Policy (June 18, 2018), https://www.whitehouse.gov/presidential-actions/space-policy-directive-3-national-space-traffic-management-policy/ [hereinafter Space Policy Directive–3].

[8] *Kessler Syndrome*, WIKIPEDIA, *supra* note 3.

Currently outer space activities are disturbing the natural Earth-Space relationship.[9]

II. THE OLD ORDER: GOVERNMENT DOMINATION

There are a variety of stakeholders in outer space that compete and often conflict with each other. Each stakeholder seeks to make its own space activities possible. The objective of this section is to identify the main stakeholders to understand how they interact.

A. Government Stakeholders

Governments were the first stakeholders. They potentially are involved in all space activities ranging from activities in which they participatice to activities they merely authorize. Included are commercial satellite operators, surface users of satellite communication services, Global Navigation Satellite Services ("GNSS"), astronomers, and military satellite operators. In 1957, when the Russian Sputnik satellite was orbited, governments and exploring scientists were the main stakeholders. The governmental interest followed naturally from the development of military launch rockets during World War II by Germany. The military rockets eventually became the launch vehicles for satellites. The rockets were military craft and their military potential was their main importance to the states that operated them. Russia and the USA were the major stakeholder countries in 1957.

Today some developed countries, in particular the United States, have a keen interest in facilitating space activities by non-governmental commercial operators.[10] Space activities by non-governmental operators are growing rapidly. Most of the activities relate to commercial remote sensing satellites and communication satellites. The expectation is that there will be huge growth in small satellites active primarily in LEO. In addition to the United States, other countries that also authorize significant commercial space traffic include Luxembourg, United Kingdom, Germany and France.

Under the Outer Space Treaty ("OST") Art. VI, the individual countries are responsible for compliance of their non-governmental operators with the OST. Under OST Art. VII, states assume liability for all damages caused by

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[9] *Id.*

[10] *See* STM, *supra* note 7; Space Policy Directive–3, *supra* note 7.

their military, civilian, and other non-governmental operators.[11] The 1972 Liability Convention[12] further implements the international law of state liability. These laws gave the governments significant stakes in all outer space with a consequence of minimizing governmental liability.

Most space technology is dual use (joint commercial and military); there is frequent interchange of technology between military and civilian functions. The distinction between governmental stakes in civilian and military uses was made at the beginning of the space age. Governmental outer space activities were originally military in nature. In 1958, the United States separated civilian and military space activities by establishing the National Astronautics and Aeronautics Administration ("NASA"), responsible for civilian outer space activities,[13] while the Department of Defense retained control over military activities.

Military authorities are motivated by their interest in effective and successful war fighting and in military activities short of war. In 1967, at the time of the adoption of the Outer Space Treaty, the interest of military strategists was to ensure that adversaries did not gain exclusive control of outer space.[14] Subsequent to 1957, military space technology leaped forward. Thus, at the present time (2019), the three major military space powers—the United States, Russia, and China—are actively competing with each other to develop their outer space military capabilities.[15] They have recently been joined by India. Altogether, they invest increasingly in military space technology.[16]

The United Nations is an important forum for governments to assert claims to authority in outer space. Non-military issues are discussed in the United Nations Committee for the Peaceful Uses of Outer ("COPUOS").

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[11] Outer Space Treaty art. III, *supra* note 6, at 208.

[12] Liability Convention, *supra* note 6; 2 COLOGNE COMMENTARY, *supra* note 4, at 83–202; Paul B. Larsen, *Does New Space Require New Liability Laws?*, 68 GER. J. AIR & SPACE L. 196, 196 (2019).

[13] National Aeronautics and Space Act of 1958, Pub. L. No. 85-568, 72 Stat. 426, 426 (1958) (codified at 42 U.S.C. § 2451(a) (2006)).

[14] Outer Space Treaty art. II, *supra* note 6, at 208 (mandating that outer space cannot become the sovereign territory of any one state); *Outer Space Treaty*, *in* 1 COLOGNE COMMENTARY, *supra* note 4, at 613. *See generally* FRANCIS LYALL AND PAUL B. LARSEN, SPACE LAW: A TREATISE (2nd ed. 2017).

[15] *See* LYALL & LARSEN, *supra* note 14, at 447–81.

[16] Jen DiMascio & Lee Hudson, *A Shakeup in U.S. Military Space, Aviation and Space Technology*, AVIATION WEEK (April 15, 2009) https://aviationweek.com/print/defense/shakeup-us-military-space. *See also* Paul B. Larsen, *Outer Space Arms Control: Can USA Russia and China Make This Happen*, 23 J. OF CONFLICT SECURITY L. 137, 137–58 (2018).

Multilateral military outer space claims are discussed in the UN Disarmament Conference which meets in Geneva, Switzerland. Claims of authority are similarly asserted in bilateral negotiations.[17]

B. Developing Countries' Claims to Explore and Use Outer Space

The principle of sovereign equality prevails in UN decision-making.[18] The United States, China, Luxembourg, Ghana, and Cameroon each have one vote in UN negotiations. This parallels how COPUOS operates on the basis of equality of states.[19] The space powers need the support of the non-space-powers to obtain approval for their proposals.[20] The developing states used their voting power to their advantage in the OST negotiations in 1967. They have continued to use this voting power to their advantage in the negotiation of the UN Sustainability Guidelines.[21] The developing countries can benefit from the non-governmental space services of the space powers. Operators in developed countries make satellite communication, remote sensing, and GNSS technology available to the developing countries at a price. For example, the communication company One Web plans to make Internet connection available where it does not exist in Africa.[22] However, a 2019 conference of African states in South Africa indicated that the interest of the African states cannot be fully realized by private companies from the developed world. The African countries agreed that they must assert their equal rights in outer space to their advantage and must work together to maintain their socioeconomic interests in outer space. That requires them to use their voting powers in COPUOS to assert their claims to authority. To make effective use of their rights, these nations need technical and economic capabilities that they do not yet have. They can insist on receiving technology and economic resources by negotiating directly with the commercial

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[17] *Disarmament*, UNITED NATIONS, https://www.unog.ch/80256EE600585943/(httpHomepages)/6A03113D1857348E80256F04006755F6 (last visited Aug. 24, 2019). Outer Space Treaty art. VII was negotiated in COPUOS. *See* LYALL & LARSEN, *supra* note 14, at 13–18.

[18] *See* U.N. Charter.

[19] *See Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, https://www.unoosa.org/oosa/en/ourwork/copuos/index.html. *See also* LYALL & LARSEN, *supra* note 14, at 14–18.

[20] COPUOS makes decisions by consensus.

[21] Comm. on the Peaceful Uses of Outer Space, Draft Rep. of the Legal Subcomm. on Its Sixty-Second Session, Annex II, Guidelines for the Long-term Sustainability of Outer Space Activities, U.N. Doc. A/AC.105/L.318/Add.4 (2019).

[22] ONEWEB, https://www.oneweb.world/ (last visited July 15, 2019).

companies.[23] They can also benefit from obtaining capacity building from the developed world through COPUOS.[24] Thus, the developing countries have a keen interest in the international regulation of outer space activities by operators from developed countries, and those interests must be accommodated.

C. The Nineteen States Parties to the 1979 Moon Agreement[25]

The 1979 Moon Agreement repeats many of the legal principles of the Outer Space Treaty, such as the principle that the moon and the celestial bodies cannot be appropriated. However, OST Article I does not include the notion of common exploitation of lunar resources.[26] The Moon Agreement, Article 11, pronounces that the Moon and celestial resources are the "common heritage of mankind." The States Parties to the Moon Agreement are committed to protect this basic principle on use and exploitation of lunar and celestial resources.

Several US commercial companies have recently expressed intentions to extract lunar mineral resources. New US law recognizes the legal right of commercial companies to own lunar resources as being compatible with the OST.[27] However, the US has not joined the Moon Agreement and does not accept the Moon Agreement's legal principle of the Moon being the "common heritage of mankind." Claims of legal entitlement to celestial mining raise the question of unilateral appropriation of outer space resources. By adopting this new law, the US appears to claim stakes in the Moon and other celestial bodies. That claim differs from the claimed stakes of the 19 countries which are parties to the Moon Agreement. The differences go to the heart of the way outer space shall be regulated. Subsequently, because the technology

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[23] *See* Peter Martinez & Ian Christensen, *African Perspectives on the Space Resources Dialogue*, SECURE WORLD FOUNDATION NEWSLETTER (Secure World Foundation, Broomfield, CO), June 5, 2019, info@swfound.org.

[24] *Id*.

[25] Moon Agreement, *supra* note 6.

[26] *See* LYALL & LARSEN, *supra* note 14, at 59.

[27] U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704, 721 (2015). Luxemburg also recognizes the legal right of commercial companies to own lunar resources. *See* Franz Schilling, *Fishing in Outer Space – The Luxembourgish Interpretation of the Appropriation of in-Situ Resources*, 68 ZLW 248, 253–60 (2019).

necessary for lunar mining has not yet developed, tensions between the two groups have abated for the moment.[28]

D. The Equatorial States Parties to the 1976 Bogotá Declaration[29]

The OST does not define the border between air space and outer space. Equatorial states are of the view that the geostationary orbit ("GSO") is not part of outer space; they claim sovereign rights to the GSO above their territories. A number of equatorial states met in Bogotá, Colombia in 1976 to declare that the GSO above their territories is their sovereign space. By doing so, they claimed jurisdiction over property rights in their GSO and now demand that satellites in GSO orbit above their territory obtain special permits from the subjacent government. These equatorial states also treat the GSO as the border between their sovereign and non-sovereign space; all activities in their sovereign space would be subject to their domestic laws. This would limit their stake and their interest in international regulation of outer space to all space beyond the GSO. Their claim has not been adopted by other stakeholder states.

E. International Organizations

International governmental organizations approve of the COPUOS claim precedential jurisdiction for creating order in outer space.[30] As a committee of the UN General Assembly, COPUOS has a unique stake in outer space order as the major forum for international discussion of international space activities. The work of the Committee is divided between its Scientific and Technical Subcommittee ("STSC") and its Legal Subcommittee ("LSC"). COPUOS is serviced by the United Nations Office of Outer Space Affairs ("UNOOSA"),[31] which administers several special outer space subject groups. These include the United Nations Register of Objects Launched into Outer Space and the UN Platform for Space-Based Information for Disaster Management and Emergency Response ("UN-SPIDER"). UN-SPIDER in

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[28] Michael Bruno, *Is Space Due for Some Bootstrapping?*, AVIATION WEEK & SPACE TECHNOLOGY (Feb. 28, 2018) (report on Deep Space Industries and Planetary Resources—two companies involved in lunar mining); *see also* Brian Israel, *Space Resources in the Revolutionary Course of Space Lawmaking*, 113 AJIL UNBOUND 114, 118 (2019) (2018 COPUOS Legal Subcommittee failed to put the issue on its agenda because the commercial market for asteroid and lunar mining has not developed).

[29] LYALL & LARSEN, *supra* note 14, at 160–62; 1 COLOGNE COMMENTARY, *supra* note 4, at 55.

[30] *Committee on the Peaceful Uses of Outer Space*, U.N. OFF. FOR OUTER SPACE AFF. (UNOOSA), http://www.unoosa.org/oosa/en/ourwork/cpuous/index.html (last visited June 30. 2019) (reports to the Fourth UN Committee by COPUOS); *see infra* note 209.

[31] UNOOSA, http://www.unoosa.org (last visited June 20. 2019).

turn administers the UN Disaster Charter and serves as nerve center for international disaster relief.

The International Telecommunication Union ("ITU") is an organization to which virtually all the states are members.[32] The ITU regulatory activities are authorized by the ITU Constitution[33] (a treaty instrument) and by its administrative regulations.[34] Although ITU is a specialized agency of the United Nations, it is governed by its separate treaty instruments.[35] ITU's claim to authority in outer space is founded on the need for exclusive radiofrequencies for guidance of satellites. Operators need to navigate their satellites unhindered by radio interference. The key phrase is "harmful interference."[36] Radio interference with a radiofrequency renders a satellite unnavigable and, thus, useless. The problem and its solution are spelled out in Art. 44 of the ITU Constitution:[37]

> Radio frequencies and orbits are limited natural resources and they shall be used rationally, efficiently and economically . . . so that countries or groups of countries may have equitable access to both taking into account the special needs of the developing countries and the geographic situation of particular countries.

A plenipotentiary conference of states meets every 4 years to review current ITU regulation and to make fundamental changes in the treaty structure. Being a treaty organization, only states can become members of the ITU. However, being a technical organization, the ITU needs the technical expertise of non-governmental operators. Thus, non-governmental agencies and operators may become members of specialized sector activities of the ITU.

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[32] LYALL & LARSEN, *supra* note 14, at 194–95.

[33] *See* Int'l Telecomm. Union [ITU], *Constitution of the International Telecommunication Union, reprinted in* COLLECTION OF THE BASIC TEXTS OF THE INTERNATIONAL TELECOMMUNICATION UNION ADOPTED BY THE PLENIPOTENTIARY CONFERENCE, http://perma.cc/WC8J-JMAX (2015) [hereinafter ITU Constitution].

[34] LYALL & LARSEN, *supra* note 14, at 194–95.

[35] *Id.*

[36] ITU, RADIO REGULATIONS, art. 1.169 (2016), http://www.itu.int/pub/R-REG-RR-2016 (defining harmful interference as "[i]nterference which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations (CS).") [hereinafter RADIO REGULATIONS]; *see* Ingo Baumann, *GNSS Cybersecurity Threats: An International Law Perspective*, INSIDE GNSS MAG. (June 3, 2019), https://insidegnss.com/gnss-cybersecurity-threats-an-international-law-perspective/.

[37] *See* ITU Constitution art. 44, *supra* note 33, at 49.

The European Space Agency ("ESA") is an example of a regional governmental organization with a significant stake in organization and use of outer space resources. Several other international organizations also assert jurisdiction in outer space, including the World Meteorological Organization ("WMO") and the European Organization for Meteorological Satellites ("EUMETSAT").[38]

F. Non-Governmental Commercial Satellite Operators

Non-governmental commercial operators have significant stakes in regulation of outer space. Examples are INTELSAT, SES, Eutelsat, INMARSAT, Planet, One Web, etc. Commercial satellite operators are primarily motivated by profit. For their operation, they need access, radiofrequencies, orbital slots, and assurance that other commercial operators will not interfere with their radio frequencies, orbits, and conducting of business in outer space. Additionally, they need a secure business environment; space situational awareness, which requires transparency about other traffic as well as military traffic. They also need to know the locations of dangerous space debris. Finally, they may require protection from their governments when pressed by governmental and non-governmental operators from other countries. Commercial operators assert their interests through trade organizations and individually in dealings with each other and with governments.

Non-governmental operators' profit motivations drive them to compete fiercely with each other. The intensity of competition among the commercial satellite operators is illustrated by the recent Space-X application to the U.S. Federal Communication Commission ("FCC") to relocate 1484 small satellites from orbits in the 690–823 mile range from Earth to lower Earth orbits in the 347-mile range. Several other commercial operators (Planet, Spire Global, Astro Digital) plan to orbit in the lower range now allocated to Space-X.[39] Consequently, these commercial operators filed protests with the FCC claiming hardship resulting from the FCC decision, arguing that the

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[38] *Who We Are*, EUMETSAT, (Nov. 17, 2019, 12:32 PM), https://www.eumetsat.int/website/home/AboutUs/WhoWeAre/index.html.

[39] LYALL & LARSEN, *supra* note 14, at 223; *see* Communications Act of 1934, 47 U.S.C § 307 (2004) (FCC decides whether granting an application is in the public interest); *see* Irene Klotz, *Showdown at LEO: FCC Approves Lower Orbit for Space-X Satellites*, AVIATION WK. & SPACE TECH. (May. 6, 2019), at 50 [hereinafter *Showdown*] (Space-X will ultimately launch more than 12,000 satellites); *see* Irene Klotz, *Small Satellites, Big Data*, AVIATION WK. & SPACE TECH , July 30–Aug. 19, 2018, at 48, 49 [hereinafter *Small Satellites*].

operators of non-navigable small satellites would not be able to change orbits to avoid conjunctions with the mass of Space-X satellites. The recent FCC application by Amazon to launch 3,236 satellites will further increase the congestion and the competition for slots in LEO.[40] Ultimately, ITU will only clear orbits which are free of radio interference.[41] That may be difficult because of the multitude of applications for radiofrequencies and related orbits.[42]

A variety of trade associations represent non-governmental satellite operators. Large operators, such as INTELSAT, SES and EUTELSAT, operating mainly in high Earth orbits, have formed the Space Data Association to coordinate their common interests.[43] This association has formed subcommittees on traffic data sharing, safety, procedural developments, interference with radio frequencies, operations, flight dynamics, and government liaisons. Other satellite operators, receiving funding from the Defense Advanced Research Projects Agency ("DARPA"), have formed the Consortium for Execution of Rendevouz and Servicing Operations ("CONFERS") to coordinate long term sustainability, safety, technical standards, and satellite flight operations.[44] The Commercial Smallsat Spectrum Management Association is yet another group of small satellite companies operating in LEO such as Planet, One Web, and Blacksky.[45] This association represents the radio spectrum management's interests of the small satellite operators in their joint dealings with the FCC and through the FCC with the International Telecommunication Union ("ITU").

There are limits to the ability of non-governmental trade associations to establish order in outer space. They cannot legally agree to limit competition among themselves.[46] They may also be ineffective in regulating safety for themselves individually and within their trade associations because of overriding profit motives.[47]

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[40] Klotz, *Showdown*, *supra* note 39, at 50; *see* Klotz, *Small Satellites*, *supra* note 39, at 48.

[41] *See infra* Part IV.E for discussion of ITU.

[42] *See infra* Part IV.E.

[43] *Committees and Working Groups*, SPACE DATA ASS'N (June 15, 2015), https://www.space-data.org/sda/committees-and-working-groups/.

[44] CONFER, http://www.satelliteconfers.org/ (last visited June 15, 2019).

[45] CSSMA, https://cssma.space/ (last visited June 15, 2015).

[46] *See infra* Part IV.E for discussion of ITU.

[47] Sherman Act, 15 U.S.C §§ 1–7 (2004); Boeing 737 MAX 8 disaster is example of product being marketed, with FAA acquiescence, before being adequately tested for safety. *See* Jim Hall and Peter Goetz, *The Boeing 737 Max Crisis Is a Leadership Failure*, N.Y. TIMES (Jul. 17, 2019),

G. Manufacturers of Space Equipment

Manufacturers of satellites, launch vehicles, or outer space weaponry who are in the business of supplying outer space equipment have a significant stake in the successful space operations of their customers. Some of the manufacturers, such as Space-X, are also operators of space equipment. Space equipment manufacturers do significant business with domestic as well as foreign governments; they may have competing interests in the success of the space activities of different governments. Some of the manufacturers, like Boeing, Airbus, Lockheed, and Space-X have significant leverage to assert their stakes in outer space, because of their size. Small manufacturers are further down the supply line.[48] They assert themselves most effectively through their trade associations.[49]

The so-called "military-industrial complex" is an example of how special interests can assert leverage in outer space. The rapidly growing military investments in outer space are good business for the manufacturers of space equipment. Therefore, manufacturers have an interest in continuing and even increasing their military business. U.S. President Eisenhower, in his farewell address to the nation in 1961, warned that the joint interests of the military establishment and the manufacturers of military equipment enables them to threaten other interests by promoting national investment in military equipment.[50] The military-industrial complex can apply unique leverage when marketing space technology, because most space equipment is dual use, serving both civilian and military sectors. The current military space race among the United States, Russia, and China encourages the military-industrial complexes in the competing states to promote military investments.[51] This competition may result in promoting use of weaponry in outer space and/or to conduct military activities short of war.

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https://www.nytimes.com/2019/07/17/opinion/boeing-737-max.html; *see also* David Gelles, *Boeing Says Charges Tied to 737 Max Grounding to Reach $8 Billion*, N.Y. TIMES (Jul. 18, 2019), https://www.nytimes.com/2019/07/18/business/boeing-737-charge.html. The disaster is estimated to cost Boeing $7.8 billion.

[48] *See* Dwight D. Eisenhower, *1961 Farewell Address*, https://www.ourdocuments.gov/doc.php?flash=false&doc=90&page=transcript (last visited July 15, 2019).

[49] *Id.*

[50] *Id.*

[51] *Arms Control*, *supra* note 1, at 157.

The major space powers' investments in military space technology are currently increasing.[52] In 2019, the US Department of Defense asked Congress for a $14.1 billion increase in military space expenditures.[53] Russia and China are engaged in corresponding increases in military spending.[54] This increase in militarization of outer space creates the danger of war in outer space. Arms control and disarmament would save government spending and lower international tensions.[55]

H. Scientists and Astronomers

The 1967 Outer Space Treaty's primary objective is to make possible exploration of outer space including the Moon and other celestial bodies.[56] The space age opened outer space for scientific exploration and created exciting prospects for astronomical explorations and research. Space scientists and explorers are important stakeholders who need ample room and opportunity to acquire and use data without interference from the other users.[57] Science observation of Earth from outer space is also becoming increasingly important to understanding how to maintain the health of the planet.

Scientists and astronomers coordinate extensively though their private organizations, such as the International Astronomical Union, the Committee for Space Research ("COSPAR") and the International Astronautical Federation. They also coordinate and contribute to the work of the COPUOS Scientific and Technical Subcommittee on space debris, planetary protection, and many other outer space issues. Scientific transparency is advantageous for users of outer space, contributing to expanded scientific exploration of outer space.

The recent discovery and visualization of black holes at the center of galaxies illustrates the importance of continuing exploration and discovery.

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[52] *Id*.

[53] DiMascio & Hudson, *supra* note 16.

[54] Arms Control, *supra* note 1, at 156-158.

[55] *Id.*

[56] Outer Space Treaty art. I, *supra* note 6, at 207–08.

[57] *Id*.; *see also* Jeff Foust, *Can Satellite Megaconstellations Be Responsible Users of Space?*, SPACENEWS (Sep. 2, 2019), https://spacenews.com/can-satellite-megaconstellations-be-responsible-users-of-space/ (the President of the American Astronomical Society expressed that he was "very worried" about lights of small satellites interfering with astronomical observations); Kenneth Chang, *NASA Rover on Mars Detects Puff of Gas That Hints at Possibility of Life*, N.Y. TIMES (June 22, 2019), https://www.nytimes.com/2019/06/22/science/nasa-mars-rover-life.html.

Further exploration and discovery are also needed for the protection of the Earth from threats such as asteroid strikes. Sixty million years ago, the Earth was struck by an asteroid that extinguished 99.9% of all life on Earth, and it will be struck by asteroids again. Most asteroids are currently unidentified, and the danger of collision they pose needs to be established.[58] Some asteroids have been identified and astronomers track their locations.

Scientists have also pointed to the dangers of climate change. The phenomenon and causes of climate change must be closely observed by remote sensing from outer space in order to be countered. Observation by satellite is a major source of information about the effects of climate change on Earth and whether states are adequately complying with limits on global warming established by the 2015 Paris Agreement.[59] Many people are and will be affected by rising seas, increasingly drastic weather patterns, and loss of arable land. Monitoring of global warming and weather patterns by remote sensing satellites benefit all people on Earth.

The danger of solar flares is also noted by scientists. Flares may suddenly disrupt customary electricity services.[60] The 1859 Carrington solar flare event proved the likelihood that the Earth will repeatedly experience the effects of future solar eruptions.[61] Eruptions will disturb communication and electrical systems on Earth and in space. The sun must be watched for solar eruptions so that warnings can be issued and precautions taken.[62] Electronic equipment needs to be improved to resist interruptions from solar flares.

Scientific observations are further necessary in preparation for the ultimate transfer of life from Earth to another part of the universe. Scientists must prepare for the eventual exit from planet Earth when life on Earth becomes impossible due to global warming, asteroid collision, or when the Sun eventually burns up. Scientists have recently discovered other planet

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[58] LYALL & LARSEN, *supra* note 14, at 234–39. *See also Regulation*, *supra* note 1, at 104–09, 123–25.

[59] LYALL & LARSEN, *supra* note 14, at 359–86. Parties agreed to limit temperature increases to less than two degrees in the 2015 Paris Agreement on Climate Change. *Paris Agreement*, EUROPA.EU, https://ec.europa.eu/clima/policies/international/negotiations/paris_en (last visited July 26, 2019); *Paris Agreement*, UNITED NATIONS, https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf (last visited July 15, 2019).

[60] Christopher Klein, *A Perfect Solar Superstorm: The 1859 Carrington Event*, HISTORY (Aug. 22, 2018), https://www.history.com/news/a-perfect-solar-superstorm-the-1859-carrington-event.

[61] *Id.*

[62] *Id*.

systems sufficiently close to Earth which can be examined for possible future habitation.[63]

I. The "Average Person" on the Earth

Few people on Earth pay close attention to outer space activities. The "Average Person" is busy with the events of daily life. Those "average" people's eyes are on the Earth, not on the skies. However, events in outer space can suddenly command attention to these everyday Earthlings. In 2013, the people in the Siberian city of Chelyabinsk were astonished when they watched an asteroid explode above their city, breaking every window in the town.[64] Thousands of people were hurt by flying glass and debris. No one was killed, although the blast caused significant property damage. Such an asteroid strike would have caused much more damage if it had happened over New York City or other heavily inhabited locations.[65]

Satellite tracking of life on Earth by GNSS is an example of reliance on outer space activities. GNSS has revolutionized timing and navigation both on Earth and in outer space. There are now four global navigation systems,[66] and it has been declared to be a "national critical function" by the US Government.[67] The locations of individual persons are tracked from outer space by GNSS.[68] Privacy concerns of Average Persons is always at stake whether or not people know that they are affected. GNSS tracking devices are connected to people's telephones and cars, and other equipment is used to track lost people, children, or animals. GNSS tracking raised criminal concerns in the case of *United States v. Antoine Jones*, in which the police implanted a GNSS device in Mr. Jones' car and tracked him for an entire

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[63] *See generally* CHRISTOPHE GALFARD, THE UNIVERSE IN YOUR HAND: A JOURNEY THROUGH SPACE, TIME, AND BEYOND 3–50 (2015); *Astronomers Are Probing Faraway Planets with Greater Sophistication*, THE ECONOMIST (Aug. 3, 2019), https://www.economist.com/science-and-technology/2019/08/03/astronomers-are-probing-faraway-planets-with-greater-sophistication.

[64] *Chelvabinsk Meteor*, WIKIPEDIA, https://en.wikipedia.org/wiki/Chelyabinsk_meteor (last visited May 7, 2019).

[65] *Regulation*, *supra* note 1, at 196. The Earth has in the past experienced serious asteroid strikes. An asteroid strike 66 million years ago probably extinguished 99.9% of all life on Earth. It is known that asteroid strikes will reoccur and that governmental, as well as private, scientists must study the nature and orbits of asteroids to observe and prepare for the arrival of so-called Near-Earth Objects ("NEOs") which are the asteroids most dangerous to Earth

[66] LYALL & LARSEN, *supra* note 14, at 337. There are now four global GNSS systems: the U.S. Global Positioning System ("GPS"), Russian Glonass, European Galileo, and Chinese Beidou.

[67] Dee Ann Divis, *Homeland Security Says PNT a "National Critical Function"*, INSIDE GNSS, (May 6, 2019), https;//insidegnss.com/homeland-security-says-pnt-a-national-crtical-function.

[68] *Id*.

month without obtaining a warrant from a court.[69] Private persons, other than police, also use GNSS to monitor their children, spouses, and employees.[70] Yet another significant use of satellites involves the so-called "unstoppable-surveillance-industrial complex," [71] which resulted from the 2015 USA Freedom Act.[72] Active US government surveillance of individuals continues in spite of the constraints of the USA Freedom Act. A recent report by the Director of U.S. National Intelligence showed that the organization logged 19.4 million telephone numbers between May and December 2018.[73]

Satellite surveillance has commercial value. For example, the owner of a rental car may wish to track its location. Many people have become dependent on the existence of global navigation systems to navigate roads and streets. However, the GNSS satellite signals are very weak and are easily subject to jamming and spoofing.[74]

In addition to "average" daily activities, there are global orders that affect everyone. People on the Earth are generally dependent on the safety and security provided from outer space. Security of people is affected by military defense which increasingly includes making decisions about how to employ military equipment in outer space.

Among the current trends, the Average Person's interests are not well represented; there are no organizations promoting such interests. Thought needs to be given to how best to represent this affected but unrepresented group, as the impacts of outer space grow. Other stakeholders cannot be expected to represent them.

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[69] United States v. Jones, 132 S. Ct. 945, 945 (2012). *See* LYALL & LARSEN, *supra* note 14, at 337.

[70] *See* Paul Larsen, *International Regulation of Global Navigation Satellite Systems*, 80 J. AIR. L. & COM. 388, 388–90 (Regulation of GNSS Tracking Private Issues).

[71] Steven Nelson, *NSA Whistleblowers Oppose Freedom Act, Endorse Long-Shot Bill*, U.S. NEWS (Apr. 27, 2015), https://www.usnews.com/news/articles/2015/04/27/nsa-whistleblowers-oppose-freedom-act-endorse-long-shot-bill.

[72] Uniting and Strengthening America by Fulfilling Rights and Ensuring Effective Discipline over Monitoring Act (USA FREEDOM Act) of 2015, Pub. L. No. 114-23, 129 Stat. 268 (codified as amended in various sections of 18 and 50 U.S. Code).

[73] Charlie Savage, *N.S.A. "Unmaskings" of U.S. Identities Soared Last Year, Report Says*, N.Y. TIMES (Apr. 30, 2019), https://www.nytimes.com/2019/04/30/us/politics/nsa-unmaskings-surveillance-report.html.

[74] *See NAVISP Projects Target SATNAV Interference*, EUR. SPACE AGENCY (Aug. 5, 2019), http://www.esa.int/Applications/Navigation/NAVISP_projects_target_satnav_interference.

III. SHARED OUTER SPACE VALUES

The order for outer space activities should reflect the shared values of the stakeholders and participants in outer space activities.

The Outer Space Treaty of 1967 ("OST") lists and establishes basic values agreed to be shared by outer space stakeholders. OST Article VI provides that these values ("provisions") shall apply to both government and nongovernmental activities. These shared values are:

1. Freedom of scientific exploration[75]

2. Free and unrestricted freedom of access to and use of outer space on the basis of equality[76]

3. Sharing of benefits among all the peoples of the world regardless of their degree of economic and scientific development[77]

4. No appropriation of outer space[78]

5. Peace in outer space and development of friendly relations among the world's peoples and countries[79]

New shared values have developed since 1967, caused by congestion and concerns for safety of outer space activities. Such changes in these basic values include:

1. Space debris management to prevent foreclosure of outer space[80]

2. Space traffic management to prevent collisions and interferences with outer space traffic[81]

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75 Outer Space Treaty art. VI, *supra* note 6, at 209.
76 *Id.*
77 *Id.*
78 *Id*. *See generally* RADIO REGULATIONS, *supra* note 36, arts. 2 & 5.
79 *See* Outer Space Treaty arts. I, III, IV, X, & XII, *supra* note 6, at 207–09.
80 Mitigation Guidelines, *supra* note 4.
81 *Id.*; *cf.* Space Policy Directive-3, *supra* note 7.

Some shared values regarding uses of outer space are in stages of development; they are:

1. Shared guidelines for uses of outer space resources[82]

2. Shared guidelines for human habitation of outer space[83]

Many values are not shared among stakeholders. It is apparent that the stakeholders and the existing different orders of outer space uses overlap and sometimes conflict in places. That will be evident from the following discussion.

IV. THE NEW ORDER: COMPETITION FOR DOMINION IN OUTER SPACE

A. No Order in Outer Space

1. Precedent: Exploration and Exploitation of the Americas

Outer space is known as the final frontier. It is still being explored and exploited and parts of it may become the ultimate habitat of humankind. Discovery of new frontiers brings into comparison similar historical examples in early Earth explorations. For example, in 1492, Columbus "sailed the ocean blue"[84] and discovered America. Should we follow the example of the Spanish conquistadores in the Americas? At the time of Columbus, the lust for gold and silver was the major motivation of Hernan Cortez and his Spanish soldiers in conquering the land of the Aztec Indians in Mexico.[85] That was also the motivation of Francisco Pizarro in his conquest of the Incas.[86] The exploits of Cortez and Pizarro were authorized by the Kingdom of Spain, which benefitted from the American riches. The conquests resulted in the disruption and suppression of the native population. This early exploitation in the Americas raises the basic issue of whether exploration and exploitation of outer space should occur without regulation based on the order of first come first served.

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[82] *See generally* Guidelines for the Long-term Sustainability of Outer Space Activities, *supra* note 21.

[83] *Id.*

[84] As the classic nursery rhyme goes.

[85] *See* Christopher Minster, *10 Notable Spanish Conquistadors Throughout History*, THOUGHTCO (Jul. 3, 2019), https://www.thoughtco.com/the-conquistadors-2136575. *See generally* W.H. PRESCOTT, THE CONQUEST OF MEXICO (J.M. Dent & Sons, Ltd., 3rd ed. 1965).

[86] *See generally* W.H. PRESCOTT, THE CONQUEST OF PERU (Dolphin Books, 1962).

2. Effect of No Order in Outer Space

Exploration unrestricted by order would only serve a few early arriving outer space stakeholders, to the exclusion of latecomers. Scientific exploration of outer space would suffer from this model. The first-come explorers would appropriate valuable resources and leave less for the later explorers. Consequently, benefits would not be shared. Explorations by the conquistadores did not result in peaceful relations with the American Indians. Such freedom of exploitation would be counter to virtually all agreed-upon existing values and orders in outer space.

Unrestricted exploitation of outer space could have been an option when outer space access opened with the orbit of Sputnik in 1957. At that time, only a few stakeholders were involved. However, outer space is now a more sophisticated environment involving many different stakeholders—both countries as well as individuals. Thus, the no order option should be discarded; although it could become the only option if the excessive space debris forecloses access to outer space.

B. Astronomers' and Scientists' Exploration of Outer Space

1. Current Order Governing Astronomers' and Scientists' Exploration of Outer Space

The advancement of astronomy and other sciences in outer space is a widely shared value. We need to understand the universe. Astronomy and science brought us information about the thirteen-billion-year-old "big bang" that began the development of the planets and introduced such phenomena as dark matter and anti-matter. Gravity is another science phenomenon under continued investigation. The galaxies are in continuous movement circling around black holes in which yet unknown physical rules apply.[87] Astronomical observations have identified planets which may be habitable by humans and more such planets are being found. The habitability of the Earth is endangered by activities such as industrial production of carbon dioxide causing global warming, which will eventually make the Earth

[87] *See* Dennis Overbye, *Darkness Visible, Finally: Astronomers Capture First Ever Image of a Black Hole*, N.Y. TIMES (Apr. 10, 2019), https://www.nytimes.com/2019/04/10/science/black-hole-picture.html.

uninhabitable.[88] Earth is also endangered by sunspots resulting in excessive radiation.[89]

Other dangers to Earth are the hundreds of thousands of asteroids in the asteroid belt, some of which visited the Earth in the past causing near extinction of all life forms. Dangerous asteroids, known as near earth objects ("NEOs"), are gradually being identified with the hope that they can be diverted before colliding with Earth.[90] The Earth and the solar system, of which it is part, will collapse in the far future. If humans are alive at that time they will have left the Earth. Ways to escape from Earth are part of continued research not only by astronomers but also by philosophers, medical experts, psychologists, and other scientists who would need to make possible the transfer of human beings to habitable planets.[91] The order that astronomers and other scientists recommend must be protected from military and commercial encroachments. Consequently, exploration of outer space has received legal priority in the OST Article I as follows:

> The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries irrespective of their degree of economic or scientific development, and shall be the province of mankind.

Article I of the OST furthermore guarantees "freedom of scientific investigation in outer space."[92] Thus, exploration of outer space is protected by international law. Outer space research is also protected by national laws. In 1958, the United States separated outer space research from military research and activities by establishing NASA.[93]

Early participants in outer space exploration assumed space to be unlimited and thus able to accommodate all uses without limits. Scientific outer space explorations like Voyager I and II could be launched without

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[88] *See* MARTIN REES, ON THE FUTURE: PROSPECTS FOR HUMANITY 37–43 (Princeton Univ. Press, 2018).

[89] *Id.*

[90] David A. Koplow, *Exoatmosheric Plowshares: Using a Nuclear Explosive Device for Planet Defense Against an Incoming Asteroid*, 23 UCLA J. INT. L. & FOREIGN. AFFAIRS 76, 81–95 (2018).

[91] REES, *supra* note 88, at 37–43.

[92] Outer Space Treaty art. I, *supra* note 6, at 207–08.

[93] *See* National Aeronautics and Space Act of 1958, Pub. L. No. 85-568, 72 Stat. 426, 426 (1958) (codified at 42 U.S.C. § 2451(a) (2006)).

concerns about competing users. Commercial users like INTELSAT, INMARSAT, SES, the global navigation satellite services ("GNSS"), the military outer space operators, as well as LANDSAT and other remote sensing operators all launched without much concern about competing users. However, they all acknowledge the need for radiofrequencies that are free of signal interference. Virtually all the states, as parties to the ITU Constitution Art. 44, now acknowledge that outer space radiofrequencies and related orbital slots are scarce resources that shall be "used rationally, efficiently and economically [so that] all countries may have equitable access to both."[94]

Many states and operators may continue to view outer space as limitless and will accommodate all users and uses allowing expansion without restraints. However, the new commercial space race and the expanding military uses of outer space have changed the human understanding of how many activities can be accommodated in the space surrounding the Earth. For example, there is about to be a stunning change, from approximately 2000 operating satellites in outer space to, as widely expected, many thousands of operating satellites that will be orbited and deorbited frequently. Furthermore, military uses of outer space are increasing.[95] Some of these activities will be detrimental to scientific investigations.[96] Space is becoming congested.[97] Need for greater order is evidenced by the United Nations COPUOS space debris guidelines, now being enforced as mandatory regulations by some states.[98]

2. Evaluation of Astronomers' and Scientists' Access to Outer Space

Exploration of outer space requires adequate funding by governments. Astronomers and scientists need unhindered access to outer space for observations and experiments. Conflicts exist between science and other uses and orders in outer space. An example of commercial interference with freedom of scientific exploration is the Space-X launch of 12,000 small satellites to provide internet access. This interferes with radiofrequencies used by astronomers to map gas in the universe and also with astronomers' visibility of the stars. Plans by Blue Origin to launch thousands of small

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[94] ITU Constitution art. 44, *supra* note 33, at 49.

[95] Deanna Paul, *Space: The Final Legal Frontier*, WASH. POST (Aug. 31, 2018), https://www.washingtonpost.com/technology/2019/08/31/space-final-legal-frontier/.

[96] *Id.*

[97] *LEO Constellations*, *supra* note 1, at 30; *see* Saadia Pekkanen, *The New Space Race*, 113 AJIL Unbound 92, 109 (2019).

[98] *See* discussion *infra* Part IV.F.

satellites for competing internet business further threatens scientific activities in outer space.[99] Likewise, military activities, such as the recent ASAT destruction of a satellite by India, result in added waves of space debris and will also interfere with scientific explorations.[100] Moreover, military dominance of outer space, to the exclusion of other uses, limits scientific exploration. Continued increase of space debris may ultimately foreclose access to outer space. Furthermore, any future mining and habitation of celestial bodies may need protective regulation of their environments to facilitate future scientific explorations.

Exploration of outer space will continue to be a priority for outer space activities. Other stakeholders, including commercial and military operations, must allow room for science exploration. That includes both ample support for science activities and interference-free space for scientific observations and experiments. Congestion of small satellites in LEO may preclude astronomy in outer space. If so, then governments must take this issue into consideration in authorizing launches.

C. Viewing Outer Space as a Global Commons

1. Potential Order Based on Global Commons Principle

The concept of a global commons is linked to Art. I of the Outer Space Treaty statement that outer space is free for use by all states. The original idea of common ownership of land is associated with the historic existence of the agricultural 'commons' in English villages. The agricultural commons idea later applied to international global commons resources such as the high seas, air, and outer space. If viewed as a global commons, the common uses of all outer space would be respected. Military strategists believe the global commons concept allows their uses.[101]

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[99] Shannon Hall, *After SpaceX Starlink Launch, a Fear of Satellites That Outnumber All Visible Stars*, N.Y. TIMES (Jun. 1, 2019), https://www.nytimes.com/2019/06/01/science/starlink-spacex-astronomers.html. *See also* Foust, *Can Megaconstellations Be Responsible Users of Outer Space?*, *supra* note 57.

[100] Jeff Foust, *NASA Warns Indian Anti-Satellite Test Increased Debris Risk to ISS*, SPACENEWS (Apr. 8, 2019), https://spacenews.com/nasa-warns-indian-anti-satellite-test-increased-debris-risk-to-iss/.

[101] *See* Brian Weeden, *The Economics of Space Sustainability*, THE SPACE REVIEW (Jun. 4, 2012), http://www.thespacereview.com/article/2093/1 ("Outer space is often referred to as being a 'global commons' in public statements, particularly by the military and closely linked to the perceived global commons of the Earth's atmosphere, oceans, and the Internet."). *See generally* Cassandra Steer, *Global Commons, Cosmic Commons: Implications of Military and Security Uses of Outer Space*, 18 GEORGETOWN J. INT'L AFFAIRS 9 (2017).

Some economists have contrasted the idea of the commons with the idea of private ownership, arguing that private ownership is the more productive use of property and thus a logical and desirable replacement for common ownership.[102] This free market economy line of thinking might lead the reader to conclude that individual commercial exploitation of unappropriated outer space is a preferable model for order in outer space. However, past experience with private enterprise exploitation of fisheries in the ocean global commons led to overfishing and mismanagement of ocean resources. As such, economist Elinor Ostrom suggests eight requirements for successful management of common property:[103]

1. Clearly defined boundaries.

2. Congruence between appropriation and provision rules and local conditions.

3. Collective-choice arrangements allowing for the participation of most of the appropriators in the decision-making process.

4. Effective monitoring by monitors who are part of or accountable in the appropriations.

5. Graduated sanctions for appropriators who do not respect community rules.

6. Conflict-resolution mechanisms which are cheap and easy to access

7. Minimal recognition of rights to organize (e.g., by government authorities)

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[102] *See generally* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968).

[103] Jay Walljasper, *Elinor Ostrom's 8 Principles for Managing a Commons*, COMMONS MAG.: ON THE COMMONS (Oct. 2, 2011), http://www.onthecommons.org/magazine/elinor-ostroms-8-principles-managing-commmons#sthash.btEJhHrA.dpbs; *see also* Simon Fairlie, *A Short History of Enclosure in Britain*, THE LAND, http://www.thelandmagazine.org.uk/articles/short-history-enclosure-britain (visited July 16, 2019); *The Hague International Space Resources Governance Working Group*, INT'L INST. OF AIR AND SPACE LAW, https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group.

8. In case of large common property management protocols: Organization in the form of multiple layers of protocols.

Two international management arrangements would satisfy the management criteria proposed by Professor Ostrom.[104] First, the ITU Radio Regulations Board is the universally accepted international management of a global resource, the radiofrequencies. As described below, the ITU Board supervises international allocation and registration of radio frequencies. The international management of this global resource is particularly relevant because it is founded on the assumption that the receiving satellite operators do not become owners of the allocated radiofrequencies and related orbits. They merely obtain use. Thus, ownership of global commons resources, such as lunar mining, is not an issue. Second, another international common resource management arrangement is that of deep-sea mining of the oceans arranged by the 1994 Protocol to the Law of the Seas ("LOS") Convention. The high seas, like outer space, are not subject to national appropriation by claims of sovereignty. Briefly, the 1994 LOS Protocol establishes: (1) a management council that would include the United States, with voting rights commensurate with its economic interests; (2) a managing council which will not unduly limit productivity; (3) no direct transfer of technology requirement; (4) access to commercial opportunities on a first come first served basis; (5) a reasonable management fee, and (6) market oriented management policies.[105] The United States accepted the 1994 Protocol but has not yet ratified it because the market demand for deep sea mining has not developed as hoped.[106] Adoption of either of these two international resource management arrangements for outer space have the benefit of avoiding ruinous disputes over desirable market opportunities. Unilateral regulation of commercial activities in outer space is not effective because outer space is not sovereign. International agreement or consensus can establish an orderly marketplace. Managed uses of the global commons could also ease spoliation of outer space resources.

Outer space is fragile. Unlike Earth, outer space is not able to heal itself from abuses such as deposits of space debris of space objects launched from

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[104] *See* discussion *infra* Part IV.E.

[105] *See generally* Bernard H. Oxman, *The 1994 Agreement and the Convention*, 88 AM. J. INT'L L. 687 (1994); Maureen Williams, *The Moon Agreement in the Current Scenarios*, 53 PROC. INT'L INST. SPACE L. 117 (2010).

[106] Lunar mining has also not developed as hoped. *See generally* Williams, *supra* note 105.

Earth. Overall management is needed.[107] The vastness of outer space is no longer sufficient reason to allow unlimited uses. Mismanagement of outer space resources is a current and increasing problem to the extent that it threatens to foreclose access to outer space.[108] The Kessler syndrome foretells that the dangerous increases in space debris will impede and eventually stop access to outer space.[109] Intentional destruction of satellites by China, the United States, and, most recently, India have exacerbated the space debris problem.[110] Another problem is the scarcity of suitable slots in the geostationary orbit that is already populated by many military and communications satellites, in mid-Earth orbit as well as global navigation satellite systems. Certain low-earth orbits are already populated by remote sensing and communications satellites.[111]

a. Evaluation of the Global Commons Principle

The global commons order of non-sovereign outer space is based on the idea that outer space cannot be appropriated by any one state or commercial enterprise. It is free for use by military as well as civilian users.[112] Outer space is inherently common and should be accepted as such. A global commons regime for outer space would be subject not only to the management of its users, but also to existing laws and regulations. A managed global commons would support continued scientific exploration, while providing unrestricted freedom of access to the users. It would share outer space benefits among the users. It could resolve current conflicts among states about the right to own and exploit the resources including mining of celestial bodies. However, it could conflict with demands of military authorities who view outer space as an exclusive military domain. Similar to the discussion about the English commons, a big issue raised is whether common management of outer space resources can match or do better than unilateral private enterprise. In the past, under commercial management, there has been excessive exploitation of non-

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[107] Space Policy Directive–3, *supra* note 7; *Managing*, *supra* note 1, at 99.

[108] *See generally Kessler Syndrome*, *supra* note 3.

[109] *Id*.

[110] *Solving*, *supra* note 1, at 475.

[111] *LEO Constellations*, *supra* note 1, at 30.

[112] The Moon Agreement states a basic global commons principle that "the Moon and its natural resources are the common heritage of mankind." Moon Agreement, *supra* note 6, at 25. That represents a conflict between the nineteen states parties to the Moon Agreement and those states, like the United States and Luxembourg, which favor the commercial order of first-come-first-served. *See* discussion *infra* Part IV.G; *see also* 2 COLOGNE COMMENTARY, *supra* note 9, at 325.

sovereign resources such as over-fishing of the oceans, and exhaustive mining of resources.

Ultimately, there needs to be international agreement on space resource management in order that mining of the Moon and all other celestial bodies can proceed. Two management options are suggested: (1) Creation of an intentional management council modeled on the ITU Radio Regulations Board that avoids the issue of direct ownership, or (2) management drawing on experience with the 1994 Law of the Seas Protocol.[113]

Existing users recognize the need for overall management of space debris and space traffic.[114] The huge increase in the number of satellites in outer space expected in the next ten years has made management of all the moving satellites in outer space a major concern.[115] Some aspects of outer space are already subject to international management. For example, the commercial uses of radiofrequencies and related orbits are subject to international control through the International Telecommunication Union (ITU) which organizes the use of radiofrequencies and related orbits for all satellites.[116]

D. Outer Space Order Established by Current International and National Law

1. Existing International Legal Order[117]

Outer Space is not "lawless" and open to unbridled exploitation by conquistadors like the Americas were in the 1500s. In 1967 the United Nations adopted as fundamental doctrine that outer space must be governed by international law.[118] Importantly, a foundational framework governing outer space was established by the Outer Space Treaty.[119] The OST is in the nature

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[113] *See supra* text accompany notes 105 and 106.

[114] *See generally* Hague Space Res. Governing Working Grp., Draft Building Blocks for the Dev. of an Int'l. Framework on Space Res. Activities (2017). *See also Managing*, *supra* note 1, at 99.

[115] *Small Satellite*, *supra* note 1, at 276–80. The new space race questions the legal principles established by the OST, in particular its Article II prohibition of national appropriation of outer space. *See* Saadia Pekkanen, *The New Space Race*, *supra* note 97, at 93–97.

[116] *See* discussion on ITU *infra* Part IV.E.

[117] *See, e.g.*, relevant space law treaties cited *supra* note 6.

[118] Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, G.A. Res. 1962 (XVIII), U.N. Doc. A/RES/18/1962 (Dec. 13, 1963).

[119] *See* relevant space law treaties cited *supra* note 6. These are supplemented by the UN Charter and other international laws, including customary international law. *See* LYALL & LARSEN, *supra* note 14, at 27–48.

of a constitution for outer space rather than a minutely-detailed law establishing order in outer space. Importantly, the OST preamble explains that its objective is to further space exploration and use for the benefit of all the peoples of the world.[120] Article I states that the Treaty's priority is discovery and exploration and that uses of outer space must be based on equality of states and be used for the benefit of humankind. Free access to outer space is guaranteed. Additionally, Article II provides that outer space is not subject to national appropriation by states.[121] The OST is a framework, the details of which will be filled in by further international and national law, including standards and guidelines. An example of such further implementation would be the establishment of an order in outer space that resolves the current traffic congestion caused by the huge increase in moving objects.

The focus of the OST was on governmental rather than on non-governmental outer space activities. Arguments have been made that non-governmental operators are outside the Treaty because they are not specifically mentioned in Art II. However, that argument is not accepted by states. OST, Art. VI clearly provides that OST binds non-governments as well as governmental entities. The States are obligated to apply all the provisions of the Treaty to all its national non-governmental commercial operators. Accordingly, governments are required by the treaty to authorize and continuously supervise all nongovernmental activities in outer space.

Furthermore, Art. III of the OST makes international law, in particular the UN Charter, applicable in outer space. OST Art. IV restricts military uses of outer space. Art IV prohibits placing nuclear weapons and other weapons of mass destruction in orbit around the Earth and it demilitarizes all celestial bodies. Thus, at the time of its adoption, the OST was considered the most important disarmament treaty since WWII.[122]

OST Art. VII makes states internationally liable for all damages caused by any space objects which they launch or procure to be launched. Under Art. VIII, states retain jurisdiction over objects that they launch into outer space and Art. IX provides that States must pay due regard to each other regarding

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[120] Outer Space Treaty preamble, *supra* note 6, at 207.

[121] *Id.* at 208.

[122] Statement by the President Announcing the Reaching of an Agreement on an Outer Space Treaty, 2 PUB. PAPERS 1441 (Dec. 8, 1966) (US President Lyndon Johnson referred to the Outer Space Treaty as the most important disarmament treaty of the cold war); *see also* James Reston, *Let 'Em Eat Missiles*, N.Y. TIMES, Dec. 9, 1966, at 46; Koplow, *supra* note 90, at 105.

their activities while in outer space. The Liability Convention further regulates the liability of outer space activities.[123] The Registration Convention requires all space objects to be nationally and internationally registered for identification purposes.[124]

This is a thumbnail sketch describing the basic applicable international law order to which all outer space activities are subject. In implementing the OST, States have further agreed to be subject to generally applicable international regulations limiting the amount of space debris that their outer space activities may cause.[125] Also, outer space activities will likely be subject to STM and other generally applicable rules of behavior in order to make possible the large mixture of space activities expected to exist in the future.[126]

The outer space treaties have been generally adopted by all the space faring states as well as by all other interested states, thus raising an expectation that they are so generally accepted that they have become customary international law. In fact, some of these treaty principles have already been declared customary international law. As such they become universally applicable.[127]

2. National Legal Order

In 2013 COPUOS prepared, and the UN General assembly adopted, its Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space, UNGA Res. 68/74. Consequently, many countries adopted national laws implementing the space law treaties in varying forms.[128] A number of countries, for example India, simply make the international space law treaties apply directly without adoption of implementing national laws. Whereas, other states directly apply their national laws to govern the outer space activities of both governmental and non-governmental space objects.

The United States implemented most of the OST by national law, establishing basic governmental regulation and supervision by the Federal

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[123] *See* Liability Convention, *supra* note 6.

[124] *See generally* Registration Convention, *supra* note 6.

[125] *See generally* Mitigation Guidelines, *supra* note 4.

[126] *See generally* STM, *supra* note 7; *Space Traffic*, *supra* note 1.

[127] LYALL & LARSEN, *supra* note 14, at 63.

[128] Setsuko Aoki, *Domestic Legal Conditions for Space Activities in Asia*, 113 AJIL UNBOUND 103, 103 (2019).

Aviation Administration ("FAA") of all non-governmental launches of space objects. Although the U.S. Constitution Article VI makes international treaties "the Supreme Law of the Land,"[129] U.S. space launch laws presently only require governmental authorization for launches and reentry of satellites.[130] Importantly, the governmental licensing process makes it possible for the government to influence the establishment of order among all space's competing interests. The United States is expected to adopt regulations governing the activities of non-governmental operators in outer space as well. Furthermore, U.S. satellite operators are subject to FCC regulations of radiofrequencies and related orbits used by non-governmental operators while in outer space. The FCC issues radiofrequency licenses to satellite operators in accordance with its determination whether granting a license is in the public interest.[131] Thus, the FCC can influence order among the competing interests in outer space.

It can happen that Individual states adopt laws governing activities of their non-governmental operators that interpret and potentially conflict with the Outer Space Treaty's rights of free use of outer space. For example, Luxembourg went further by adopting legislation approving appropriation of outer space resources by individual states and operators. The United States has tried to limit such potential conflicts by prescribing that national space laws shall be applied so as to conform with international laws, but some other nations have questioned its compliance.[132]

National regulation authorizing outer space activities raises the question of whether individual states authorizing non-governmental operators to launch satellites also possess the resources to supervise its authorized operators, thus enforcing its regulations in outer space. [133] The large space powers such as the United States, Russia, and China, have ample enforcement resources, but many small states do not have sufficient enforcement resources. Nevertheless, under the Outer Space Treaty, all member states have equal

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[129] U.S. CONST. art. VI.

[130] *See* Commercial Space Launch Activities, 51 U.S.C. § 509 (2015) (the United States has not yet made the U.S. Space Launch Act applicable in outer space. It only applies to launches and deorbits).

[131] 47 U.S.C. §§ 301, 307 (1982) (under the U.S. Communications Act, the FCC decides whether granting an application is in the public interest). The FCC enforces the ITU Radio Regulations. See Christian Zur, *Small Satellites are Big Business*, SPACENEWS, Aug. 7, 2019, at 28 (in 2018 the FCC issued 13,237 satellite operating licenses in accordance with its regulation). The FCC is presently debating whether to change its regulations, further liberalizing licensing of small satellites. .

[132] *See generally* Schilling, *supra* note 27.

[133] *Id*. LYALL & LARSEN, *supra* note 14, at 416–17; *see also Small Satellite*, *supra* note 1, at 289–91.

authority under Art. VI to authorize access to and use of outer space by non-governmental operators. That raises the possibility of rogue non-governmental operators from other states obtaining operating authorization from so-called "flag-of-convenience" states that do not have adequate regulation and enforcement capabilities.[134] For example, a flag-of-convenience state may authorize launch of dangerously fragile foreign satellites likely to fail or disintegrate into debris in outer space. The rapidly increasing volume of space debris increases danger of collisions with satellites in outer space.[135]

3. Evaluation

a. International Space Law

The 1967 Outer Space Treaty established the basic order for outer space activities. However, it needs to be updated to meet current and future requirements. Such activities include many current outer space uses, such as mining on celestial bodies, space debris accumulation, space traffic management, and liability for collisions and other interference. Uniform international standards and recommended practices must be allowed to develop for these activities.

International space law was adopted in the early part of the outer space age when the adopting states did not foresee the future development of non-governmental satellite operations in outer space.[136] Space technology has developed rapidly since then. Failure of the Moon Agreement to attract major space powers shows the difficulty of coming to international agreement in the current space age. There is urgent need for international agreement on doing business in outer space and diminishing the military space race. The prospective plans for humans to live in outer space require international agreement. It is as if the world is waiting for some major disaster in outer space to happen before the states can accept the need for further international agreement about their co-existence in outer space.

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[134] *See* Guidelines for the Long-term Sustainability of Outer Space Activities, *supra* note 21 (urging such states to develop adequate capabilities from the expertise of international organizations and states with developed oversight capabilities).

[135] *Solving supra* note 1, at 477.

[136] LYALL & LARSEN, *supra* note 14, at 417.

b. National Space Law

International space law requires compliance by the states. National legal enforcement and implementation of international law is an important way for the governments to influence order among the competing outer space interests. However, divergent national interpretations of the existing international legal framework are beginning to develop. The reason is that new space technology and outer space uses have developed subsequent to adoption of the existing legal principles. There will be increasing confusion as these interpretations bump up against one another.[137]

The individual states will have important functions to enforce and implement international standards and recommended practices. That will include significant opportunities to establish order among the competing interests in outer space.

E. Regulation of Outer Space by the International Telecommunication Union[138]

1. ITU Order

For numerous reasons, radio frequencies are limited outer space resources. Besides a state's need for exclusive frequencies, only higher range radio frequencies can be used for satellite communication and navigation. Another reason is the huge and increasing demand for frequencies. Furthermore, military use of frequencies is not subject to ITU regulation. The ITU will only recognize and register cleared radiofrequencies in its Master International Frequency Register.[139] The Master International Frequency Register is the only registry of international frequencies in the world and the competition for registration is intense. Satellite operators must check the ITU registry for radiofrequencies that are free of harmful interference before

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[137] *See* LYALL & LARSEN, *supra* note 14, at 413–46. Another example is mining of celestial bodies. Some states have adopted legislation granting commercial operators legal right to mined resources resulting from celestial mining, thus raising the question of whether celestial mining is permitted in light of the OST Article II prohibition on appropriation of non-sovereign celestial bodies. *See also* Bruno, *Is Space Due for Some Bootstrapping?*, *supra* note 28 (the major asteroid mining companies no longer exist due to economic decline of asteroid mining).

[138] LYALL & LARSEN, *supra* note 14, at 195–220.

[139] P. J. Blount, *Space Traffic Management: Standardizing On-Orbit Behavior*, 133 AJIL UNBOUND, 122, 125 (2019).

applying for use of a specific frequency. Thus, the ITU Register is extremely useful in planning future outer space activities. But

Radio frequencies and related orbits are subject to final regulation and allocation by the individual ITU member states. Potential conflict exists that radiofrequencies used by 5G wireless signals may significantly interfere with weather satellites' data collection.[140] The US Federal Communication Commission has begun to auction off frequencies for 5G service that could result in interference with weather satellites. The FCC plans to deregulate and expedite frequency applications by small satellites.[141] The ITU becomes concerned when one state's frequency assignments affect, overlap, or in other ways cause harmful interference with assignment of radio frequencies by another state. The competing countries and operators may negotiate among themselves for use of specific frequencies in order to file for cleared frequencies in the ITU Register. One solution for competing requests for frequencies may be for one applicant to agree to become a secondary user accessing a frequency only to the extent that it does not interfere with the frequency use of the primary user.[142]

The ITU Radio Regulations Board administers the rules of procedure for frequency registrations.[143] The Board maintains oversight of the ITU staff, which administers registrations into the International Frequency Register. The Board consists of no more than twelve members who are nationals of ITU members, but they must all be of different nationalities. Individual members may not participate in any matters affecting their own states.[144] The Board is elected by the ITU Plenipotentiary Conference from among the ITU members. These members are required to have the expertise necessary to conduct their technical duties and administer the rules governing registrations. Ultimately,

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[140] See Robin McKie, *5G Signal Could Jam Satellites that Help with Weather Forecasting*, THE GUARDIAN (May 4, 2019), https://www.theguardian.com/world/2019/may/04/5g-mobile-networks-threat-to-world-weather-forecasting.

[141] Michael Bruno, *Smallsats Go Big*, AVIATION WK. & SPACE TECH., July 29–Aug. 18, 2019, at 57 (explaining that the FCC imposed a heavy fine on Swarm Technologies for launching untrackable small satellites without FCC authorization); *see also* Yousaf Butt, *Avoiding Collisions in Outer Space*, N.Y TIMES (Mar. 19, 2018), https://www.nytimes.com/2018/03/19/opinion/space-race-regulation.html.

[142] *See generally* ITU, Final Acts WRC-97 of the World Radiocommunication Conference (Geneva, 1997).

[143] *Radio Regulations Board*, ITU, https://www.itu.int/en/ITU-R/conferences/RRB/Pages/default.aspx (last visited Dec. 17, 2019).

[144] *Id*.

the Board maintains oversight of registrations to avoid harmful interferences with already registered frequencies.

While the ITU authorizes registration of radio frequencies free of harmful interference on a first-come first-served basis,[145] there are restrictions and qualifications. The 1979 ITU Administrative Radio Conference [146] clarified that the states, and in turn their authorized operators, do not own allocated radio frequencies and related orbital slots.[147] Allocated ownership would be contrary to OST Article II, which prohibits permanent appropriation of outer space. Furthermore, the 1985–1988 ITU World Administrative Radio Conferences pre-allocated one orbital slot on the GSO to each state for direct broadcast purposes. However, the Conferences did not recognize the claims of the Bogota Declaration countries to sovereign rights in the GSO.[148] It is also important to note the constitutional mandate in Article 44 that allocations shall be distributed "rationally, efficiently and economically"[149] and that the special needs of the developing countries must be taken into consideration in the distribution of radiofrequencies and related orbital slots.

2. Evaluation

Decision-making in the ITU is independent of and differs from that of COPUOS. The ITU regulates only radiofrequencies and related orbits. It is governed by its separate legal regime reflecting its values, only. Thus, the ITU does not necessarily share the same outer space values that are linked to the OST listed in Part Two above. ITU's decision-making may differ or even conflict with that of COPUOS. Secondly, the ITU regime affects only non-military frequencies, although military authorities tend to pay attention to ITU's register of frequencies for reasons of safety. Thirdly, non-governmental communication satellite operators have considerable influence through their participation in the ITU sectors. Thus, the distribution of frequencies may be influenced by nongovernmental operators.

The ITU serves the unique function of making satellite navigation possible through its oversight of radiofrequencies used for the navigation of satellites. Satellite operators can operate in outer space thanks to the ITU

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[145] RADIO REGULATIONS, *supra* note 36, art. 5; *see* LYALL & LARSEN, *supra* note 14, at 189–226 (discussion of ITU).

[146] *See* ITU, Final Acts WRC-97 of the World Radiocommunication Conference (Geneva, 1997).

[147] *Id.*

[148] *Id.*

[149] ITU Constitution art. 44, *supra* note 33, at 49.

provision of radiofrequencies free of radio interference. Radio interference is a violation of the ITU legal regime, but the ITU does not have a police force to enforce its regulations. Regulation enforcement is mainly the responsibility of individual states that are under great pressure to provide licenses for the large number of small satellites now being launched. The temptation to launch without an FCC license is great, but enforcement must prevail to prevent dangerous chaos.[150]

F. Military Order of Outer Space

1. Military Regime

Military users form yet another order in outer space. Its special rules can conflict with other uses and orders. U.S., Chinese, and Russian military authorities consider outer space to be an operational "military domain."[151] This is further evidence of the fragmented uses and regulations of outer space, resulting in potentially conflicting uses. Outer space provides military strategists with the proverbial high grounds from which to dominate the Earth's surface.[152] Unilateral domination of outer space to the exclusion of other users is particularly valued. Weaponry may be stationed in outer space to destroy weaponry of others in outer space or to strike the Earth. Ballistic missiles may be launched from Earth's surface to strike targets in outer space or on distant places on the Earth. Additionally, outer space is very important for gathering intelligence by remote sensing satellites about other states' deployment of weaponry and plans for military actions. Most outer space equipment can be used for both military and civilian activities.

Military activity in outer space is increasing drastically because the United States, Russia and China are competing with each other without

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[150] *See* Marina Koren, *Launching Rogue Satellites Into Space Was a "Mistake,"* THE ATLANTIC (Sept. 7, 2018), https://www.theatlantic.com/technology/archive/2018/09/spacebees-swarm-unauthorized-satellite-launch/569395/; LYALL & LARSEN, *supra* note 14, at 189–226 (ITU depends on individual governments to enforce its registration regime); s*ee also* Butt, *supra* note 141.

[151] U.S. Space Policy Directive-4, issued February 19, 2019, requires "unfettered use of space for United States national security purposes." The directive asserts U.S. "freedom of operation in, from, and to the space domain" consistent with applicable law, including international law. Presidential Memorandum on Space Policy Directive-4, Establishment of the United States Space Force (Feb. 19, 2019), https://www.whitehouse.gov/presidential-actions/text-space-policy-directive-4-establishment-united-states-space-force/ [hereinafter Space Policy Directive-4]. *See also* Matthew T. King & Laurie R. Blank, *International Law and Security in Outer Space: Now and Tomorrow*, 113 AM. J. INT'L L. 125, 126 (2019).

[152] LYALL & LARSEN, *supra* note 14, at 447.

constraints.[153] Military authorities consider access to outer space to be increasingly competitive as well as dangerously congested.[154] Lately India, France, and Japan have joined the competition.[155] Consequently, the military uses of outer space easily overlap and compete with uses of outer space by other orders. New military competitors are reacting to the domination of the outer space high ground by the three major space powers. Countries other than the United States, Russia, and China feel insecure and consequently have begun to acquire military outer space capabilities.[156] India's anti- satellite test is evidence of the growing military counterspace movement.[157] The growth of military technology also results in competition and possible friction with commercial satellite operators who are also expanding their outer space activities.[158]

Military use is subject to a special set of treaties, agreements and rules such as the Rules of War and the Limited Test Ban Treaty.[159] In particular, it is subject to the peacekeeping rules of the UN Charter and, in turn, subject to the peacekeeping oversight of the UN Security Council. In this context, it is important that the Article 103 of the UN Charter provides that the UN Charter will prevail over other treaties in the event of a conflict. Thus, in the event of a conflict between the UN Charter and the Outer Space Treaty or the 1963 Test Ban Treaty, the decisions of the UN Security Council will apply and be enforced.[160]

Under Article 51 of the UN Charter, individual states retain the right of self-defense in outer space.[161] Thus, states may deter unfriendly activities of

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[153] Larsen, *Arms Control*, *supra* note 1, at 157.

[154] *LEO Constellations*, *supra* note 1, at 30.

[155] *See* Debra Werner, *Boycott Indian Launchers? Industry Reacts to India's Anti-satellite Weapon Test*, SPACENEWS (Mar. 27, 2019), https://spacenews.com/reactions-to-indian-asat/; Norimitsu Onishi, *France Nudges Europe Into Space Race, Where it Lags Behind*, N.Y. TIMES (July 18, 2019), https://www.nytimes.com/2019/07/18/world/europe/france-europe-space-race-apollo-11-anniversary.html?searchResultPosition=12 (France President Emmanuel Macron stated that the French initiative "would ensure our defense of space within space"); Saadia M. Pekkanen, All Eyes on China, *But Japan May Be The Space Power to Watch*, FORBES (May 30, 2015, 9:45 AM), https://www.forbes.com/sites/saadiampekkanen/2015/05/30/all-eyes-on-china-but-japan-may-be-the-space-power-to-watch/#68f445b14a8f.

[156] Larsen, *Arms Control*, *supra* note 1, 157.

[157] Werner, *supra* note 155; Onishi, *supra* note 155; Pekkanen, *All Eyes on China*, *supra* note 155.

[158] *See* FIFTH PSSI SPACE SECURITY CONFERENCE, http://spacesecurity.eu/ (last visited July 10, 2019).

[159] Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, Aug. 5, 1963, 14 U.S.T. 1313, 480 U.N.T.S. 43 (entered into force Oct. 10, 1963).

[160] U.N. Charter art. 103; *see also* King & Blank, *supra* note 151, at 126; LYALL & LARSEN, *supra* note 14, at 447–81.

[161] U.N. Charter art. 51.

other states consistent with Article 51. However, the legal right of self-defense is not unlimited. The right of self-defense exists only until the UN Security Council takes measures to maintain international peace and security. Threats to use force in outer space are subject to Security Council jurisdiction under the UN Charter Chapter VII.[162] As a practical matter, the Security Council will need time to evaluate disputed situations before making decisions. In the meantime, Article 51's authority controls, meaning that individual states retain the right to engage in military outer space activities.

Arms control is a fundamental part of the Outer Space Treaty; former United States President Lyndon B. Johnson characterized the Outer Space Treaty as the "most important arms control development" of the Cold War.[163] OST Article I requires outer space to be used for the benefit of all people. This article adds to the specific restrictions in Articles II, III, IV, VI, and IX. Article II prohibits military appropriation of celestial bodies. Article III makes outer space, including celestial bodies, subject to both the UN Charter and international treaties on maintaining international peace and security. Article VI permits "use of military personnel for scientific research or for any other peaceful purposes" on celestial bodies.[164] Significantly, the United States interprets the OST to apply to non-aggressive uses of outer space rather than to non-military uses, thus allowing military uses that are not aggressive.[165] Article IV prohibits the placement of weapons of mass destruction in orbit and demilitarizes all celestial bodies. Article VI requires states to not only comply with the OST, but also to ensure that their non-governmental bodies comply with the OST. Furthermore, Article IX requires states to pay "due regard" to the corresponding interests of other states in outer space[166]

The Liability Convention Article II holds states liable for the loss of life and property damages on the Earth's surface and air that are caused to other states and their nongovernmental entities. Article III makes states similarly liable for outer space damages, but this assessment is based on a finding of

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[162] U.N. Charter ch. VII (dealing with actions with respect to threats to the peace, breaches of the peace and acts of aggression and stating that the Security Council must determine existence of threats to the peace and acts of aggression).

[163] Statement by the President Announcing the Reaching of an Agreement on an Outer Space Treaty, *supra* note 122.

[164] Outer Space Treaty art. VI, *supra* note 6, at 209.

[165] King & Blank, *supra* note 151, at 126.

[166] The Precautionary Principle is relevant to the interpretation of OST Article IX. *See generally* Paul B. Larsen, *Application of the Precautionary Principle to the Moon*, 71 J. AIR L. & COM. 295, 295–306 (2006); LYALL & LARSEN, *supra* note 14, at 245–80.

fault. Thus, Chinese and Indian ASATS in outer space would be subject to liability for damages. Furthermore, the Registration Convention requires UN registration of all space objects, including military space objects.[167]

Military uses are subject to several special international treaty obligations. The United States and other countries operate under the Law of Armed Conflict in outer space activities in accordance with DOD Directive 2311.O1E. The DOD Manual provides that the Law of Armed Conflict regulates "the conduct of hostilities in outer space."[168] Other states may or may not agree with the United States. The United States applies the Law of Armed Conflict to confrontations short of war; however, such application is subject to the legal requirement of proportionality of responses.[169] The OST Article IV prohibition on deployment of weapons of mass destruction in Earth's orbit, including celestial bodies, and demilitarization of celestial bodies allows the individual state some flexibility to do as it wishes. The United States takes advantage of this flexibility, although it involves risk of conflict.[170]

Outer space military technology is primarily concentrated in four space powers: United States, Russia, China and now India.[171] That leaves the remaining countries in the position of being subject to the predominance of these four countries. Historically, the United States has predominated in outer space, but is now being challenged by the other powers. These countries compete fiercely for military dominance over the non-sovereign outer space. The competing countries have, or are in the process of establishing, specialized military space forces similar to the United States' Army, Navy, and Air Force. The reason for this development is that outer space is no longer peaceful but "has become a battle ground where the ability to destroy satellites is a key capability in warfare."[172] One United States decisionmaker states that governments must now be able to recognize the necessity of a special military

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[167] Registration Convention, *supra* note 6; LYALL & LARSEN, *supra* note 14, at 463. However, inadequate national compliance remains a problem, see *infra* text accompanying note 216.

[168] U.S. GENERAL COUNSEL OF THE DEP'T. OF DEF., LAW OF WAR MANUAL ¶ 14.10.4 (2016), https://dod.defense.gov/Portals/1/Documents/pubs/DoD%20Law%20of%20War%20Manual%20-%20June%202015%20Updated%20Dec%202016.pdf?ver=2016-12-13-172036-190.

[169] King & Blank, *supra* note 151, at 127.

[170] *Id*.

[171] See Jeff Faust, *NASA Warns Indian Anti-Satellite Test Increased Debris Risk to ISS*, *supra* note 100.

[172] *See* Dominic Gates, *Defense Official Talks Space Force and How Military Will Leverage Tech Giants*, THE SEATTLE TIMES (Nov. 1, 2018), https://www.seattletimes.com/business/deputy-defense-secretary-talks-space-force-and-how-military-will-leverage-local-tech-giants/. *See also* Space Policy Directive-4, *supra* note 151.

space force to defend the nation and to protect space commerce and civil space exploration.[173]

Each space power increases its military presence commensurate with increases of its competitors. This competition results in continued escalation. ASAT exercises in outer space by these states have resulted in substantial increases in space debris. Further military activities will have additional detrimental effect to the extent that it could trigger the Kessler Syndrome, [174] which forecasts an ultimate foreclosure of access to outer space due to space debris. Foreclosure of access into outer space would also cause future foreclosure for military weaponry. The alternative would be to enter into agreement on outer space arms control but leave room for remote sensing. Such agreement could best be negotiated directly among the four space powers. However, military uses of outer space are a core aspect of the general arms race; it is so integrated into other military systems that they are difficult to select out for special arms control.[175]

2. Evaluation

Military uses tend to exclude other uses and easily conflict with non-military uses of outer space. Military uses consider outer space to be "military domain," subject to the Law of Armed Conflict, rather than space law governing non-military activities. Different rules apply in outer space for the military.[176] Thus, peace in outer space and development of friendly relations among the world's peoples and countries are not the prevailing military value. The Outer Space Treaty can be preempted. Article 103 of the UN Charter makes the Charter preeminent of other treaties and therefore enables the UN Security Council to prevail over the provisions of the Outer Space Treaty. UN Charter Article 51 allows the individual countries the right of military self-defense if attacked. The OST itself is subject to special interpretation for military uses, because countries, like the United States and other militarily powerful countries, interpret the OST Article IV provision on peaceful uses to

[173] *See* Jeff Foust, *Cruz Criticizes House for Lack of Action on Commercial Space Legislation*, SPACENEWS (Oct. 31, 2019), https://spacenews.com/cruz-criticizes-house-for-lack-of-action-on-commercial-space-legislation/.

[174] *See Kessler Syndrome*, WIKIPEDIA, *supra* note 3.

[175] LYALL & LARSEN, *supra* note 1, at 449.

[176] *See generally* King & Blank, *supra* note 151.

mean non-aggressive rather than non-military uses. That interpretation would limit the scope of the OST.[177]

Military activities, such as the destruction of a Chinese satellite by a Chinese ASAT and the recent destruction of an Indian satellite by an Indian anti-satellite missile, have greatly increased space debris of the sort that can lead to the ultimate foreclosure of outer space as predicted by the Kessler Syndrome.[178] Such added space debris also presents increased collision danger for all non-military space traffic.

A final source of conflict between military and other uses and orders in outer space is that military and civilian uses are discussed and decided in different UN fora. Military uses are discussed and decided in the UN Conference on Disarmament in Geneva. Civilian matters are discussed in COPUOS located in Vienna, Austria. These separable fora may lead to further difference in sharing of outer space values.[179]

The claimed military domain is now expanding at the expense of non-military activities. Until recently, military presence in outer space was mostly concentrated in the geostationary orbit. Military presence is moving into the low Earth orbit, which is already congested with commercial and scientific activities, such as the International Space Station. United States announced that outer space is the next war-fighting domain and US military experts now regard outer space as a "degraded and operationally-limited environment" where it contests with other users.[180] The expansion of military order at the expense of other uses is potentially a serious problem, because (1) it tends to be exclusive, and (2) exclusive claims are not legitimate in non-sovereign outer space. There are, however, modifying factors. In times of peace, the military makes extensive use of non-military uses, such as civilian communication and reconnaissance satellites. Secondly, the military tends to observe civilian operating procedures for reasons of safety.

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[177] Katie Rogers & Helene Cooper, *Trump Authorizes a Space Command. Next, He Wants a Space Force*, N.Y. TIMES (Aug. 30, 2019), https://www.nytimes.com/2019/08/29/us/politics/trump-space-command-force.html?auth=login-email&login=email (quoting L. R. Blank, military space law expert at Emory University, stating "we are ready to do what we need to do and counter what our adversaries are doing"); LYALL & LARSEN, *supra* note 14, at 468–69.

[178] *See Kessler Syndrome*, WIKIPEDIA, *supra* note 3.

[179] UN Disarmament Conference, *supra* note 12. *Arms Control*, *supra* note 2, at 155–56.

[180] AFSPC Public Affairs, *AFSPC Commander Announces Space Enterprise Vision*, AIR FORCE SPACE COMMAND (Apr. 11, 2016), https://www.afspc.af.mil/News/Article-Display/Article/730817/afspc-commander-announces-space-enterprise-vision/; *see also Arms Control*, *supra* note 143–45.

G. The Commercial Order in Outer Space

1. Light Touch Commercial Space Order

The light touch commercial approach is presently advocated for by the United States National Space Council, and is implemented by government agencies as mandated by the 2018 United States Space Policy Directives 2 and 3.[181] This commercial approach stresses the importance of accepting the lead of the commercial operators in outer space order, because "the rules and values of space, like every frontier, will be written by those who get there first."[182] The thinking is that free enterprise and its profit-making objective should be the basic values reflected in any regulation of outer space activities. Any existing restrictive regulation should be treated with a light touch regulatory approach that assures national freedom of action and maximizes the industry's ability to innovate.[183] This approach is designed to establish a stable environmental for commercial activities. The commercial light touch model, applicable to govern the private practices of the commercial space industry, would also be applied to governmental military operators.[184] Such liberal regulation of commercial outer space activities would be extended to military "friends and allies."[185]

The 2015 United States Commercial Space Launch Competition Act,[186] is stated as an example of light touch commercial order.[187] It expresses current United States policy. The Act grants United States citizens the right to keep "space resources" as their private property.[188] The Act asserts conformation

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[181] Presidential Memorandum on Space Policy Directive-2, Streamlining Regulations On Commercial Use of Space (May 24, 2018), https://www.whitehouse.gov/presidential-actions/space-policy-directive-2-streamlining-regulations-commercial-use-space/ (mandating the FAA to consider: (i) requiring a single license for all types of commercial space flight launch and re-entry operations; and, (ii) replacing prescriptive requirements in the commercial space flight launch and re-entry licensing process with performance-based criteria); Space Policy Directive-3, *supra* note 7 (mandating that "the US Government should streamline processes and reduce regulatory burdens that could inhibit commercial sector growth and innovation"); *see also* Dr. Scott Pace, Exec. Sec'y, Nat'l Space Council, Keynote Address at the IISL Galloway Space Law Symposium (Dec. 13, 2017).

[182] Space Policy Directive-2, *supra* note 181; Milton Friedman, *The Social Responsibility of Business Is to Increase Its Profits*, N.Y. TIMES MAG. (Sept. 13, 1970), *available at* http://www.umich.edu/~thecore/doc/Friedman.pdf

[183] Friedman, *supra* note 182.

[184] Sandra Erwin, *Infighting over Space Reforms Spills into Public View*, SPACENEWS (May 6, 2019), https://spacenews.com/on-national-security-infighting-over-space-reforms-spills-into-public-view/.

[185] Pace, *supra* note 181.

[186] U.S. Commercial Space Launch Competitiveness Act, *supra* note 27.

[187] *Id*.

[188] Pace, *supra* note 181.

with United States obligations under the 1967 Outer Space Treaty Article VI to authorize and supervise non-governmental commercial operators.[189] The intent of the United States' space policy is to adopt United States non-binding light touch governmental regulations that the Government hopes will become adopted by international consensus rather than through new treaty obligations. This space policy model firmly rejects the idea that outer space constitutes a global commons, or that it is a 'common good."[190] In granting launch licenses, the FAA has been obligated to enforce United States treaty obligations under the Outer Space Treaty, in addition to enforcing existing national laws on health, safety, and national security, resulting in a balance of interests from launch to reentry in addition to the public interest.

In the Presidential Space Policy Directive 2, the FAA on April 15, 2019 proposed new space launch regulations, liberalizing United States launch and reentry licensing regulations. All launch and reentry regulations will be placed in one part—14 CFR Part 450. This would result in licensing regulations becoming more flexible. New commercial satellite operators, such as Space-X and Blue Origin, continue to push for more flexibility. More flexibility would keep more safety-related decisions within the industry, basing regulations more on operator performance rather than on FAA prescriptive requirements. These commercial operators argue that space flight is comparable to air travel and thus can be regulated in the methods. However, outer space safety is a crucial issue because of the increasing congestion. Furthermore, the FAA's recent safety certification experience with the Boeing 737 Max 8 may well influence the final outcome of this rulemaking, because negligent licensing by a launching state may trigger governmental liability of the launching state under the Liability Convention.[191] Safety is of fundamental value to both military and civilian operations in outer space.

Under the light touch commercial order approach, there would be adequate room for commercial operators to conclude agreements or contracts among themselves to regulate their commercial and operational activities with each other. Under this scheme, one author suggests that commercial operators

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[189] *Id*.

[190] *Id.*; *see* discussion of global commons model *infra* Part IV.C.

[191] Space Policy Directive-2, *supra* note 181; *see also* Sandra Erwin, *ULA and Its Commercial Competitors in Pitched Fight Over Launch Regulations*, SPACENEWS (July 29, 2019), https://spacenews.com/ula-and-its-commercial-competitors-in-pitched-fight-over-launch-regulations/; *see also* discussion of Boeing 737 Max 8 *supra* note 40. *See generally* C. Johnson, D. Porras, S Hearsey & S O'Sullivan, *The Curious Case of the Transgressing Tadigrades*, THE SPACE REV. (Aug. 26, 2019), http://www.thespacereview.com/article/3783/1?mc_cid=374a0744a4&mc_eid=c460034b2c.

could create a system of private law by initially contracting among companies regarding all aspects of outer space activities.[192]Therefore, hypothetically, one operator would contract for the launch of space objects; another operator would agree to operate the objects in outer space; a third operator would purchase the same space object for a different business purpose; and finally, a fourth operator would be hired to service the space object while in space. Each of these contractors could be of different nationality. Contracts would provide which country's laws govern specific tasks. Blocktrain contracts would supplement existing international law. [193] Such agreements would be delimited by existing international and national laws, such as national anti-trust and anti-competition regulations.[194]

An argument in favor of this commercial approach would be that it would allow maximum room for initiatives of visionaries like Elon Musk, who is actively preparing for human exploration and settlement of the planet Mars. His commercial company, Space-X, is a main United States link to the International Space Station and to exploring Mars. Another such visionary and innovator is Amazon's Chief Executive Officer, Jeff Bezos, [195] whose commercial space company initiated reusable space launch technology. This company, Blue Origin, is also planning for possible migration of humans to other planets as life on Earth becomes more and more difficult. Both Musk and Bezos are able and willing to use their own ample resources to fund their visions for outer space. Without their visionary activities, some new space technology and plans might not come into existence. Furthermore, their concentrated focus on outer space development maintains a stability in space development that annually appropriated government funds tend to lack.

The commercial approach would be to the advantage of the states most equipped for and interested in commercial exploitation of outer space, such as the United States, Luxembourg, Netherlands, the United Kingdom, and Germany, which have a keen interest in facilitating space activities by non-

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[192] Brian R. Israel, *Space Resources in the Evolutionary Course of Space Lawmaking*, 113 AJIL UNBOUND 114, 118 (2019).

[193] *Id*.

[194] Pace, *supra* note 181; *see* Israel, *supra* note 193, at 118.

[195] Jeff Foust, *The Cosmic Vision of Jeff Bezos*, SPACENEWS (Feb. 2, 2018), https://spacenews.com/the-cosmic-vision-of-jeff-bezos/; *see Space Law is Inadequate for the Boom in Human Activity There*, THE ECONOMIST (Nov. 11, 2019), https://www.economist.com/international/2019/07/18/space-law-is-inadequate-for-the-boom-in-human-activity-there.

governmental commercial operators. However, it may conflict with the military's view of its exclusive domain order.[196]

2. Evaluation of the Light Touch Commercial Space Order

Commercial placement of thousands of satellites in low Earth orbit may interfere with scientific observation and exploration of outer space in the same way the astronomers complained about Space-X.[197] The commercial light regulatory approach would maximize innovation and freedom of commercial enterprise. The light regulation would be primarily linked to regulation by individual states, such as the United States, although all governments would be obligated to apply existing international laws and regulations. However, making free enterprise the first priority of outer space may conflict with legal orders prohibiting appropriation of outer space resources, particularly if appropriation is unilateral. Such a prioritization may also conflict with environmental orders restricting debris generation. Unregulated uses and orbits may interfere with ITU regulation of non-military radiofrequencies and related orbital slots.[198] Additionally, another potential problem with light touch commercial order is that if commercial activities and consequent light touch regulation prioritizes profit over safety of human life, it may interfere with outer space navigation by multiple competitors.[199] Additionally, outer space order based on the profit motive may deviate from the Outer Space Treaty's Article I mandate of sharing benefits among people across the world, regardless of their degree of economic and scientific development.[200]

The light touch commercial order advocated by the United States tends to view outer space in terms of national interests. However, the large space industries such as Boeing, Amazon, Space-X, and Airbus are basically international companies interested in international commerce. Outer space business is inherently international. It would be impossible for one country to establish light touch international commercial order for all international space commerce.

As indicated in recent COPUOS discussions, many developing countries do not share the United States' preference for light touch regulation

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196 *See supra* Part IV.F.
197 Klotz, *Showdown*, *supra* note 39.
198 *See supra* Part IV.E.
199 *See supra* text accompanying note 40 (discussing Boeing 737 Max 8).
200 Outer Space Treaty art. I, *supra* note 6 at 207–08.

of outer space commerce.[201] Dominion of the developed countries is resented, even though companies like One Web link African users to the internet.[202]

The light touch commercial approach can conflict with space orders based on other values ranging from science, military, environment, safety, and international law. The light touch commercial order is primarily linked to United States policy. It would have to be internationally coordinated so as not to conflict with other national orders. Furthermore, it must be subject to the international environmental codes and guidelines.

H. International Codes and Guidelines for Outer Space Activities

1. Top-down View of Codes and Guidelines

A variety of rules, guidelines, standards and practices have been, and will continue to be, adopted for activities by states and nongovernmental entities in non-sovereign outer space. Examples include the Code of Conduct proposed by the European states,[203] the 2019 Guidelines for the Long-term Sustainability of Outer Space Activities, [204] and the 2007 Space Debris Mitigation Guidelines drafted by the Inter-Agency Space Coordination Committee ("IADC"), adopted by COPUOS and approved by U.N. General Assembly Resolution 62/217.[205] These are international management rules in process of adoption by groups of individual states to establish common rules for their interactions in outer space. The underlying idea behind these rules is that it is in the self interest of all parties to be able to use outer space without interference from other parties.

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[201] *See* discussion *supra* Part I.B.

[202] *See* Martinez & Christensen, *supra* note 23.

[203] *Arms Control*, *supra* note 1, at 150–53.

[204] Guidelines for the Long-term Sustainability of Outer Space Activities, *supra* note 21.

[205] *See Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, https://www.unoosa.org/oosa/en/ourwork/copuos/index.html. *See also* LYALL & LARSEN, *supra* note 14, at 14–18.

2. European Union's Proposed Code of Conduct for Outer Space[206]

a. EU Code of Conduct

The EU's proposed Code of Conduct would establish Rules of the Road for outer space traffic. By following these rules, operators would know the locations of all space objects and be able to predict their movements. Both governmental and non-governmental operators would be subject to the rules. States, and in turn their authorized non-governmental operators, would agree to reduce risky activities that could result in harmful interference with other operators. Transparency and space situational awareness would be essential parts of the Code of Conduct. A central communications center would be established through which operators would be able to ascertain the locations and movements of other operators.[207]

b. Evaluation

The application of the proposed code to military outer space operations made states leery of becoming disadvantaged in the outer space arms race. Thus, this code is currently not moving toward completion.[208] It is mentioned in this context because the Code expresses a need for comprehensive international order in outer space. It may very well reappear in some other form.

The EU Code needs international acceptance, which was unobtainable. To become internationally acceptable, it should be limited to non-military activities. Both the EU and the United States expressed approval of such a code. The EU Code now needs different additional sponsorship showing that such an international code is in the common safety interest of everybody.

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[206] *EU Proposal for an International Space Code of Conduct, Draft*, EUROPEAN UNION EXTERNAL ACTION (Mar. 31, 2014), https://eeas.europa.eu/headquarters/headquarters-homepage/82/about-european-external-action-service-eeas_en.

[207] *Id.*

[208] *Id.*

3. The COPUOS Guidelines for the Long-term Sustainability of Outer Space Activities[209]

a. The UN Sustainability Guidelines

The purpose of the UN Sustainability Guidelines is to preserve a continuing stable, safe, peaceful outer space environment for scientific, exploration and economic uses of outer space for all countries. In 2010, a COPUOS working group was established to develop guidelines for long term sustainability.[210] In 2019, COPUOS approved 21 guidelines for adoption by the member states. Additional guidelines were discussed but the working group could not agree on them.[211] The objective of these guidelines is to supplement the existing treaty framework, particularly the Outer Space Treaty. COPUOS urges the member states to implement the guidelines for use when authorizing outer space activities by their non-governmental operators and when supervising these operators for compliance with the OST. The guidelines will apply to both governmental and non-governmental operators. While the guidelines are voluntary and non-binding, states are recommended to apply them in their national regulation. The guidelines do not constitute new legal authority but must be implemented consistently with existing legal obligations under the Outer Space Treaty. The UN Sustainability Guidelines for outer space are:[212]

> A1. To adopt and update national legislation and regulation of outer space activities in accordance with OST Art VI and consistent with UNGA Resolution 68/74 urging adoption of

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[209] Guidelines for the Long-term Sustainability of Outer Space Activities, *supra* note 21, at 2 ("The long term sustainability of outer space activities is defined as the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations").

[210] *UN COPUOS Working Group on Space Sustainability Concludes its Work with Agreement on 21 Guidelines*, SECURE WORLD FOUND. (Aug. 2, 2018), https://swfound.org/news/all-news/2018/08/un-copuos-working-group-on-space-sustainability-concludes-its-work-with-agreement-on-21-guidelines.

[211] *Id.* (COPUOS will continue working on space sustainability through its Scientific and Technical Subcommittee, which will meet again in February 2019); Press Release, *Guidelines for the Long-Term Sustainability of Outer Space Activities of the Committee on Peaceful Uses of Outer Space Adopted*, UNOOSA (June 22, 2019), http://www.unoosa.org/oosa/en/informationfor/media/2019-unis-os-518.html.

[212] Comm. on the Peaceful Uses of Outer Space, Working Paper of the Scientific and Technical Subcomm. on Its Fifty-Sixth Session, Guidelines for the Long-term Sustainability of Outer Space Activities, U.N. Doc. A/AC.105/C.1/L.366 (2019) (the numbering reflects the numbering used by COPUOS: "A" numbers refer to regulation; "B" numbers refer to safety; "C" numbers refer to international cooperation and capacity building, and, "D" numbers refer to scientific and technical research and development).

national laws and regulations consistent with peaceful exploration and use of outer space.

A2. To minimize the environmental impact of human activities on outer space particularly with regard to space debris.

A3. To actively supervise national activities in outer space so as to promote long term sustainability.

A4. To allocate radiofrequencies and related orbital slots equitably, rationally and efficiently in accordance with ITU procedures so as to avoid harmful intereferences with radiofrequencies.

A5. To promote effective registration of all space objects.

B1. To collect safety information about possible collisions and to share it widely with other users, perhaps through a safety information center maintained by COPUOS.

B2. To improve accuracy of safety information and to develop common international safety standards.

B3. To promote collection and dissemination of information about space debris.

B4. To perform conjunction assessment during all orbital phases of controlled flight.

B5. To develop practical approaches to pre-launch assessments.

B6. To monitor and share space weather information.

B7. To develop international standards and practices that will mitigate adverse space weather effects.

B8. To improve trackability of space objects in particular the difficult tracking of small satellite effects.

B9. To share information about prospective uncontrolled re-entry of hazardous space objects, and to assist endangered states.

B10. To exercise caution in the use of laser beams affecting low earth orbits and to make prelaunch evaluation thereof.

C1. To promote and facilitate international cooperation in support of long-term sustainability of outer space activities.

C2. To establish procedures for sharing and exchange of information about long-term sustainability.

C3. To support and engage in capacity building in developing countries.

C4. To raise awareness of space activities.

D1. To support scientific research, development and use of outer space.

D2. To research new ways to manage and reduce space debris.

The UN Sustainability Guidelines must be constantly updated as space technology develops. COPUOS plans to continue updating the guidelines. In the larger context, these guidelines are intended to lead to operating rules for outer space activities. They will become applicable to exploration of outer space and also for administration of outer space resources by national governments.

b. Evaluation

States will tend to follow these guidelines as they adopt domestic regulation. The appeal of the Sustainability Guidelines is that they represent a consensus among the states. Within the guidelines the states have managed to agree on common principles, therefore adoption of these guidelines would establish international predictability. In the adoption process states would streamline and facilitate government oversight. If accepted by many states, they could lead to international procedures which would significantly benefit all operators, commercial as well as military.

These guidelines are minimalist, they are voluntary, and they apply broadly rather than specifically. The states may implement the guidelines in whichever way they choose, if at all. Although they represent a consensus among states, the states are free to apply them to the extent the guidelines are within their priorities. Thus, the implementation in the form of national laws

and regulations, if any, is unlikely to be uniform. Without international oversight, the guidelines will not develop into international operational practices and therefore may not add significantly to international operating rules for space traffic and debris reduction.

4. Outer Space Guidelines on Space Debris, Space Traffic Management, and Planetary Defense

The new space age has changed views and attitudes about outer space. In 1967, at the adoption of the Outer Space Treaty, the environmental objective was to conduct outer space activities "with due regard" for the activities of other states and to conduct their activities so as to avoid harmful contamination as well as adverse changes to the environment of the Earth resulting from introduction of extraterrestrial contaminatio[213] Extraterrestrial contamination was the major environmental concern in 1967, whereas today, Earth's contamination of space is the main concern; an example is the growing accumulation of space debris caused by human activities. Space debris alone promises eventually to foreclose access to outer space according to the Kessler Syndrome, unless there is drastic restriction of old and new space debris.[214] From a space regulatory point of view, it is interesting that the demand for debris regulation stems from the demonstrated needs of the users. Space debris guidelines are grounds-up regulation rather than top-down.[215]

Another environmental concern is traffic crowding, particularly in the LEO and GEO orbits. There is more space traffic than originally imagined in 1967, when OST was adopted, and there will be even more. Satellite operators need a safe predictable environment in which to operate. Satellites are increasingly exposed to collisions and interferences from other space objects including space debris and other spacecrafts. Satellite operators, and in turn their governments, are increasingly insisting on operating rules, such as space traffic management and space debris mitigating guidelines. The power of these rules is that they originate with the users and with individual governments making these guidelines mandatory. However, national STM

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[213] Outer Space Treaty art. IX, *supra* note 6, at 209.
[214] *Kessler Syndrome*, *supra* note 3.
[215] *See Managing*, *supra* note 1, at 748–49.

guidelines are not yet the same for all users.[216] The next step is to make the guidelines into uniform rules for domestic and foreign users.[217]

a. COPUOS Space Debris Guidelines[218]

(i) The Guidelines

Voluntary guidelines specifically for limitation of space debris were adopted by COPUOS and were approved and recommended by the UN General Assembly Resolution 62/217 in 2008 for adoption by individual states.[219] These guidelines differ from the UN Sustainability Guidelines in that the debris guidelines have already been widely adopted by the UN member states as mandatory domestic regulations. There are no internationally uniform debris regulations, so the debris regulations adopted by the individual states may differ from state to state.

States widely support the voluntary guidelines because space debris is such an urgent problem, both for government operators and for non-governmental operators. [220] However, implementation of the debris guidelines varies. For example, in 2019 India, disregarding the COPUOS Space Debris Guidelines, intentionally used one of its ASATs to destroy one of its orbiting satellites thus significantly increasing the amount of debris in low Earth orbit.[221] In accordance with the Kessler Syndrome,[222] debris in space will fragment into more debris as it collides with other debris. Inevitably the space debris problem is steadily increasing.[223] Nevertheless, the existing COPUOS space debris guidelines, with a goal of restraining new debris generation, are beneficial to whatever extent they slow down further escalation of the problem.

The 2008 Space Debris Mitigation Guidelines approved by the UNGA are the following:

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[216] COPUOS Space Debris Guidelines, *supra* note 4; *see also* Mitigation Guidelines, *supra* note 4; *Managing*, *supra* note 1, at 746–50.

[217] *Managing*, *supra* note 1, at 284.

[218] COPUOS Space Debris Guidelines, *supra* note 4; see *Solving*, *supra* note 1.

[219] Mitigation Guidelines, *supra* note 4.

[220] *Id.* Space debris travels at a speed of 27,000 kilometers an hour. Even small debris can penetrate a satellite. *Space Law is Inadequate for the Boom in Human Activity There*, *supra* note 195.

[221] *See Kessler Syndrome*, WIKIPEDIA, *supra* note 3.

[222] *Collision Frequency*, *supra* note 3, at 2637.

[223] *Id.*

1. To limit the amount of debris released during normal operations;

2. To minimize the potential for break-ups and to cause minimum space debris when break-up happens;

3. To limit the probability of accidental break-up in outer space;

4. To avoid intentional destruction of space objects and other harmful activities;

5. To minimize the potential for post-mission break-up resulting from stored energy by designing spacecraft so as not to break up and spread debris including fuel;

6. To limit the long-term presence of space craft and launch vehicle orbital stages in the LEO region at the end of their mission;

7. To limit the long-term interference of spacecraft and launch vehicle in the geosynchronous Earth region at the end of their mission.

(ii)Evaluation

Stricter debris control is urgently needed. It would benefit all stakeholders. Space debris affects the safety of them all. The existing COPUOS space debris guidelines are a step in the right direction. However, debris accumulation continues to increase. There are now more than one million debris pieces in orbit. Continuing accumulation of debris may eventually trigger the Kessler Syndrome precluding access to outer space from Earth. In addition to rules governing new debris, old debris accumulation must be reduced.[224]

The space debris guidelines are actively applied and enforced by major space-faring states and constitute a beginning environmental order for outer space. They are accepted by individual states as evidenced by United States Policy Directive–3 issued on 16 June, 2018. Significantly, the Directive recognizes the drastic increase in space debris and that space debris requires regulation. It commits the United States to develop better outer space

[224] *Id.*; *Solving*, *supra* note 1, at 484–87.

standards and best practices. United States regulatory agencies will develop improved standards and best practices in domestic regulatory frameworks and use them to help shape international consensus practices and standards.[225]

b. Space Traffic Management for Outer Space[226]

(i) STM

Traffic in outer space is congested.[227] There are currently only rudimentary operating traffic rules for outer space:[228]

1. Spacecraft need interference-free radiofrequencies in order to navigate in outer space. Governments, through the ITU, are able to provide interference-free radiofrequencies and related orbits for individual satellites. Nevertheless, some experimental space objects may still be launched without prior governmental coordination;[229]

2. States and their authorized non-governmental operators are required by OST Art IX to pay due regard to the space objects of other nations' operators;

3. Large objects are currently tracked in outer space by the US Air Force.[230] While tracking is being improved, the number of objects tracked is only a very small fraction of the total number of objects in outer space. Fortunately, the US Air Force is permitted to share tracking data with civilian operators in the United States and abroad, but future sharing is subject to possible restrictions dictated by military secrecy requirements;[231]

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[225] Space Policy Directive-3, *supra* note 7*; see also Managing*, *supra* note 1, at 743 and 784.

[226] Space Policy Directive-3, *supra* note 7. *See generally Space Traffic*, *supra* note 1.

[227] *See* STM, *supra* note 7.

[228] RADIO REGULATIONS, *supra* note 36 (through state agencies, such as the FCC, the ITU regulates radiofrequencies and related orbits).

[229] However, SWARM Technology was heavily fined by the FCC for launching satellites without authorization, see Koren, *supra* note 150.

[230] The US Air Force is the major tracking institution, and tracking is being improved; but the number of objects tracked is only a miniscule fraction of the total number of objects in outer space. Mike Gruss, *Good (Space) Fences Make for Good (Orbit) Neighbors*, SPACENEWS (Sept. 19, 2016), https://spacenews.com/good-space-fences-make-for-good-orbital-neighbors/. *Space Traffic*, *supra* note 1, at 364.

[231] Mike Gruss, *supra* note 230.

4. The possibility of state liability for the activities of non-governmental operators under the Liability Convention is also a restraint on governments' authorization of launches by irresponsible nongovernmental operators.

There are currently about 4000 satellites in orbit.[232] Commercial operators such as Space-X, Blue Origin, One Web, and other operators have obtained permissions to launch thousands of mostly small satellites. This creates an entirely new traffic situation in outer space. These satellites need to be safely launched, operated and deorbited without colliding or interfering with each other. They must avoid collisions with existing uncontrolled debris in outer space. Small satellites must be deorbited and replaced frequently. Thus, there will be much launch and deorbit traffic across orbits of existing satellites.

Compilation and integration of traffic data into a single data system from the large number of high-speed functional space objects requires very sophisticated data record systems. It requires that the data are freely available. The analyzed traffic management data need to be transmitted to the users. Some traffic is of military nature and may not be disclosed.[233] Nevertheless, an international system, as transparent as possible, must be established so that space traffic can be safe for all stakeholders.

The United States Space Policy Directive-3 recognizes that the commercial space industry needs space traffic norms in order to operate safely and profitably.[234] The Directive commits the United States to:

> [d]evelop STM standards and best practices. As the leader in space, the United States supports the development of operational standards and best practices to promote safe and responsible behavior in space. A critical first step in carrying out that goal is to develop U.S.-led minimum safety standards and best practices to coordinate space traffic. U.S. regulatory agencies should, as appropriate, adopt these standards and best practices in domestic

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[232] *See* Debra Werner, *EU Space Envoy Calls for Satellites to Leave Orbit Soon after Mission Ends*, SPACENEWS (Oct. 4, 2019), https://spacenews.com/eu-space-envoy-calls-for-satellites-to-leave-orbit-soon-after-mission-ends/ (noting that there are currently 4,000 satellites in Earth orbit but only 1,800 are functioning).

[233] Blount, *supra* note 139, at 125.

[234] Space Policy Directive-3, *supra* note 7; *see also Managing*, *supra* note 1, at 739, 741–43.

> regulatory frameworks and use them to inform and help shape international consensus practices and standards.[235]

Significantly the 2018 United States Policy Directive-3 recognizes that these national traffic standards and practices will be most effective if they develop into international regulatory standards and practices.

(ii)Evaluation

Satellites orbit at a much greater speed than airplanes, but a useful comparison can be made between traffic regulation of the two modes of traffic. Space traffic, particularly in LEO,[236] can be made safer and more efficient. Intense space traffic management would permit more space objects to orbit and the traffic would be safer in all orbits. Areas of particular concern are: (1) the very busy geostationary orbit of the large communication satellites; (2) the secretive military orbits; (3) the global navigation satellites systems in mid-earth orbit; and (4) the thousands of small satellites now being placed in low earth orbit.[237] Space traffic control needs international standards and recommended practices like the ICAO flight standards and recommended practices for aviation.[238] There should be continual day to day STM. As with radio frequencies regulated by ITU, and in the aviation and maritime realms, space traffic control should apply to the technical aspects of civilian activities.[239]

Commercial operators and military authorities agree that the huge increase in the number of new satellites into outer space creates congestion and that traffic management is required. [240] Collisions and interferences must be avoided. There are many uncertainties to be resolved. For example, simultaneous launches of small satellites in a large group often causes the location of some launched satellites to be unknown for weeks.[241] Individual

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[235] Space Policy Directive-3, *supra* note 7.

[236] *Id.*; *LEO Constellations*, *supra* note 1, at 30.

[237] Space Policy Directive-3, supra note 7.

[238] Chicago Convention on International Civil Aviation, Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295 [hereinafter Chicago Convention] (Annex 2, Rules of the Air; Annex 3, Meteorological Service for International Air Navigation; Annex 4, Aeronautical Chart; Annex 5, Units of Measurement; Annex 8, Airworthiness; Annex 10, Aeronautical Communications; Annex 11, Air Traffic Services; Annex 13, Aircraft Accident and Incident Investigations; Annex 15, Aeronautical Information Services). *See generally Space Traffic*, *supra* note 1.

[239] Chicago Convention, *supra* note 238 (ICAO and IMO standards and recommended practices).

[240] *LEO Constellations*, *supra* note 1, at 30.

[241] *Id.*

countries can direct their own traffic but complete transparency is required to avoid space traffic conjunctions with other traffic. We need international traffic standards and recommended practices enforced by all states. Space traffic will also require more intense tracking and management than is presently available.[242]

c. Planetary Defense Against Near Earth Objects[243]

(i) COPUOS Coordination Action Plans

Life on Earth has been close to extinction several times, for example, when asteroids collided with Earth. One such collision happened 66 million years ago.[244] It is believed that the collision extinguished the dinosaurs as well as 99.9% of all life on Earth.[245] The impact fundamentally changed evolution on Earth and could be what led to evolution of human beings.[246] The Earth has been impacted many times since that collision.[247] Several hundred thousand asteroids orbit in the asteroid belt between the planets Mars and Saturn.[248] Asteroids may collide with each other and divert towards the Earth becoming classified as Near Earth Objects.[249] It is likely that Earth will be struck by asteroids again perhaps changing the course of evolution. Humans may suddenly have to escape from Earth. Astronomers continuously observe those NEOs that they can identify to warn of impending strikes, with the hope that we may be able to divert them from striking Earth.[250]

Planetary protection cannot yet submit to international guidelines, but the situation is so dangerous that cautionary protocols are being developed.[251]

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[242] See STM, *supra* note 7.

[243] Mike Gruss, *supra* note 230. *See also* LYALL & LARSEN, *supra* note 14, at 234–39;.

[244] William J. Broad & Kenneth Chang, *Fossil Site Reveals Day That Meteor Hit Earth and, Maybe, Wiped Out Dinosaurs*, N.Y. TIMES (Mar. 30, 2010), https://www.nytimes.com/2019/03/29/science/dinosaurs-extinction-asteroid.html; Brett Line, *Asteroid Impacts: 10 Biggest Known Hits*, NAT'L GEOGRAPHIC (Feb. 15, 2013), https://www.nationalgeographic.com/news/2013/2/130214-biggest-asteroid-impacts-meteorites-space-2012da14/.

[245] Broad & Chang, *supra* note 244.

[246] *Id*.

[247] *Id*.

[248] *Id*.

[249] *Id.*

[250] NATIONAL SCIENCE & TECHNOLOGY COUNCIL, U.S. NEAR EARTH PREPAREDNESS STRATEGY AND ACTION PLAN (June 2018), https://www.whitehouse.gov/wp-content/uploads/2018/06/National-Near-Earth-Object-Preparedness-Strategy-and-Action-Plan-23-pages-1MB.pdf; *see* REES, *supra* note 88, at 155 (speculating on the significance of asteroid strikes on human development); *see also* Koplow, *supra* note 90, at 158.

[251] *See also* LYALL AND LARSEN, *supra* note 10, at 234–39.

COPUOS is the forum for international coordination of asteroid warning activities. COPUOS has established the voluntary International Asteroid Warning Network ("IAWN") for the purpose of (1) tracking NEOs, (2) establishing a clearing house for information, (3) using IAWN as a computer information portal, (4) planning for observation of NEOs, (5) recommending warning policies, (6) collecting information about possible NEO strike consequences, (7) analyzing and communicating consequences of NEO strikes, and (8) advising governments.[252]

Furthermore, COPUOS established the voluntary Space Mission Planning Advisory Group ("SMPAG") to (1) formulate NEO action plans, (2) identify possible NEO impacts, (3) make plans for possible NEO impacts, (4) establish communication guidelines, (5) make plans for planetary defense, (6) establish decision-making timelines, (7) advise how to avoid NEO impact, (8) target NEOs for deflection, (9) advise on use of nuclear power to deflect NEOs, and (10) identify action tools.[253]

The United States adopted the United States National Near-Earth Object Preparedness Strategy and action in 2018. The United States strategy includes (1) NEO tracking, (2) forecasting possible strikes, (3) deflection, (4) international cooperation, and (5) emergency procedures and protocols for response to NEO strikes.[254] Other states have also developed national strategies.

(ii)Evaluation of Planetary

A NEO collided with the Earth as recently as 2013.[255] The Earth has records of many previous impacts and future impacts are certain. The COPUOS planetary defensive action plans are voluntary and tentative. However, there is no international agreement on joint planetary defense against NEOs.[256] Planetary protection is unusually well suited for shared responsibility among the States; however, more preparation in COPUOS is needed to establish effective international action. In the meantime, some individual states are adopting national action plans.

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[252] G.A. Res. 68/75, International Cooperation in the Peaceful Uses of Outer Space (Dec. 11, 2013); *see also* LYALL & LARSEN, *supra* note 14, at 234–39.

[253] *About Us*, INT'L ASTEROID WARNING NETWORK, http://iawn.net/about.shtml.

[254] U.S. NEAR EARTH PREPAREDNESS STRATEGY AND ACTION PLAN, *supra* note 250.

[255] *Regulation*, *supra* note 1, at 196; *see also* Line, *supra* note 244.

[256] *See* LYALL & LARSEN, *supra* note 14, at 234–39.

Most of the planetary defense activities are currently at the national level. NEO strikes are inherently international. They move towards Earth from non-sovereign outer space. An international action program through COPUOS should be adopted. Action should not be delayed until an actual NEO appears about to strike because then there might not be time for international agreement on action, nor would the necessary tools be available to meet the crisis.[257]

5. Overall Evaluation of International Codes and Guidelines for Outer Space[258]

States have different priorities in outer space. However, outer space is inherently international. The international codes and guidelines described above depend on adoption and implementation by each individual state. National implementation too easily results in national differences in what should be uniform international behavioral standards and operations. The experience with space debris guidelines indicates that although the states generally favor international uniformity the individual state regulation will often reflect its own priorities and peculiarities. Furthermore, states may suddenly have more important priorities. For example, India disregarded the accepted space debris guideline when it intentionally destroyed its own satellite with an ASAT in 2019, which resulted in a new wave of space debris.[259] Thus, lack of international uniformity is an inherent weakness of the voluntary international codes and guidelines.

Lack of enforcement is a second weakness of the voluntary codes and guidelines. States may need international guidelines on debris and space traffic rules, but they may be slow to adopt them and may lack resources to enforce the rules. That results in disuniformity in outer space, and ultimately leads to lack of transparency and unsafe, dangerous outer space traffic, which is contrary to the purpose of the voluntary codes and guidelines.[260]

The international guidelines and codes could be easily adopted and implemented if they were solely meant for non-military outer space activities. This is proven by ITU's success in arranging radiofrequencies and related orbital slots of civilian outer space users. This is also evidenced by the ICAO

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[257] LYALL & LARSEN, *supra* note 14, at 234–39.
[258] *Managing*, *supra* note 1, at 784.
[259] Foust, *supra* note 100.
[260] Chicago Convention, *supra* note 238, arts. 56–57.

traffic standards and recommended practices for aviation and the IMO standards and practices for maritime activities.[261] Like the ITU, aviation and maritime standards, the outer space debris and traffic rules are inherently technical and should not be burdened by the military baggage. The civilian nature of these technical standards and recommended practices will become more pronounced as the civilian space traffic swells. These are technical standards and should be treated as such. Military uses have been able to benefit from the transparency of civilian standards and practices.

In time, the guidelines and codes will need constant updating by a standing body. COPUOS is badly suited for quick updates of guidelines because COPUOS only meets once a year. Better would be a standing committee like the ICAO Navigation Commission,[262] which is composed of experts who can act immediately when the need arises. A good example was the quick action by the ICAO Navigation Commission to update flight standards after the disappearance of a Malaysia Airlines plane in the Indian Ocean.[263]

A related question is whether COPUOS is the most efficient and productive forum for negotiation of codes and guidelines. Would decision-making in an independent forum for outer space, like ICAO for aviation and IMO for maritime traffic, be more effective and productive, more technical and less influenced by politics, in particular by military considerations?[264]

V. CONCLUSION

A. Complementary and Conflicting Orders in Outer Space

The eight possible legal orders considered in this article overlap to some extent and conflict with each other. In the examination of each, it is important to keep in mind that we are now in a new phase of outer space activity. Besides continuing exploration, we are moving in the direction of normalizing outer space activities to allow room for and include science experiments, communication, earth observation, business, military activities,

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[261] *Id*.; *see* Convention on the Inter-Governmental Maritime Consultative Organization, Mar. 6, 1948, 9 U.S.T. 621, 289 U.N.T.S. 48

[262] Chicago Convention, *supra* note 238, arts. 56–57.

[263] Larsen, *Space Traffic Management Standards*, *supra* note 1, at 384. *See also Malaysia Airlines Flight 370*, WIKIPEDIA, https://en.wikipedia.org/wiki/Malaysia_Airlines_Flight_370 (last visited Dec. 17, 2019).

[264] *Space Traffic*, *supra* note 1, at 287.

environmental damage and clean-up, and meteorology. There is active interest in mining outer space celestial bodies. The sun is considered to be a source of renewable energy on Earth in place of coal and oil. The sun produces five times more energy than the total demand for energy on the Earth. Solar energy could be used to replace oil and coal as energy sources. Inexhaustible Solar energy could be used to propel satellites in outer space.[265] Plans for Living in outer space are being developed.

B. Coordination of Present and Future Outer Space Orders

The entire Earth-Space infrastructure needs a coordinated legal order. Overall order in outer space requires each lower order to fit into the larger functional order that includes all outer space orders because all the uses of outer space are part of a whole. Military security is essential for protection of life, but it should not be allowed to appropriate outer space and exclude other uses. Likewise, commercial operators must be able to move safely, but commercial uses and extraction of resources also cannot be permitted to be exclusive of other uses. There is a need to correct imbalances between the space powers and the countries that are gradually waking up to the potentials of outer space. Otherwise, the "haves" will continue to grow and the "have-nots" will fall behind. In the long term, we need to prepare for the future uses of outer space resources in ways reflecting the interests of all countries, irrespective of their degree of economic development.

The following steps should immediately be taken to improve order among the competing interests: (1) international governmental order over outer space should preferred over national governmental order because international order can even the playing field upon which developing states and individual stakeholders compete with economically developed states. (2) Future access to outer space is threatened by human activities (debris, traffic congestion, military preemptions) so scientists and astronomers should be given access to outer space to assure long-term human survival. (3) Safety in civilian and military outer space activities should be given priority, meaning national and international governmental should prioritze: (a) reduction of space debris, which is threatening the existence of all space objects (Kessler Syndrome); (b) international space traffic management, including international standards and recommended guidelines; (c) continuous safety

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[265] *See* Shannon Stirone, *LightSail 2 Unfurls, Next Step Toward Space Travel by Solar Sail*, N.Y. TIMES (July 23, 2019), https://www.nytimes.com/2019/07/23/science/lightsail-solar-sail.html. *See generally* Paul B. Larsen, *Current Legal Issues Pertaining to Space Solar Power Systems*, 16 SPACE POLICY 139, 139–44 (2000).

assessment of space launches and flights of space objects by individual governments and stakeholders; (d) COPUOS's focus should be on civilian technical safety order, and focus of the UN Disarmament Conference should be on safety and limitation of military activities; (f) ITU should carefully screen radiofrequency for radio interference that may impede safety of satellite navigation; and (g) universal space situational awareness must prevail. (4) COPUOS should develop guidelines on uses of outer space resources based on the 1994 LOS Protocols to avoid future conflicts. (5) All stakeholders should be heard. (6) Ultimately, we need to focus on the far future.

The Milky Way contains more than a billion planets that astronomers believe are suitable for human habitation. We need to study and ascertain our possibilities for escaping to those planets because our time on planet Earth is limited.[266] The need to escape our planet may happen sooner than we think, and we need to find out what escapes are possible. Now is the time to assure a sustainable future.

[266] *See generally* REES, *supra* note 88.