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Mega-Constellations: Disrupting the Space Legal Order

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MEGA-CONSTELLATIONS: DISRUPTING THE SPACE LEGAL ORDER

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INTRODUCTION: MEGA-CONSTELLATIONS OF SMALL SATELLITES DISRUPT THE
EXISTING SPACE LEGAL ORDER

Since the first active communications satellite was put into orbit in 1962, communications satellites have become smaller, more advanced, and less expensive, enabling operators like Starlink and OneWeb to mass produce and launch thousands of small satellites into low-earth orbit.¹ So-called “mega-constellations” of small satellites in low-earth orbit (MegaLEOs) can deliver high-speed internet to areas previously unserviceable by internet providers at speeds faster than traditional, higher-orbit internet satellites.² But in order to operate in low-earth orbit, thousands of these satellites must work in concert; therefore, the proliferation of MegaLEOs in the coming years will disrupt the existing order of satellites in orbit and pose a series of significant legal implications along with it. Although the legal consequences associated with significant MegaLEO deployment have existed since the dawn of the Space Age and are not unique to MegaLEOs alone, these consequences are exacerbated in such a way that poses a unique danger to the international community and parties interested in space exploration and exploitation.³

This Comment, in Part I, discusses the history of space law, determines what MegaLEOs are, and asks whether they are in airspace or outer space, and if that has bearing over a state’s ability to govern satellites overhead. Parts II–V focus on the most relevant legal challenges caused by the proliferation of MegaLEOs and their accompanying possible solutions.

The emergence of MegaLEOs has caused and will cause a multitude of challenges to the existing international legal system, including: light pollution from satellites which may impair astronomical observations from ground-based telescopes⁴ and disproportionately affect indigenous communities whose rituals

¹ *Mission Monday: Five Fast Facts About Telstar, The World’s First Active Communications Satellite*, SPACE CENTER HOUSTON (July 6, 2020), <https://spacecenter.org/mission-monday-five-fast-facts-about-telstar-the-worlds-first-active-communications-satellite/>.

² See AJ Dellinger, *Elon Musk’s Starlink Is Quietly Expanding, But Speeds Are Getting Worse*, FORBES (Dec. 23, 2021, 7:45 PM), <https://www.forbes.com/sites/ajdellinger/2021/12/23/elon-musks-starlink-is-quietly-expanding-but-speeds-are-getting-worse/?sh=310ae7e52419> (noting that Starlink’s download speed leads the pack with 87.25 Mbps, followed by HughesNet with 19.30 Mbps).

³ See generally Mark Garcia, *60 Years Ago, The Space Age Began*, NASA (Oct. 5, 2017), <https://www.nasa.gov/feature/60-years-ago-the-space-age-began> (noting that the Space Age began on October 4, 1957, with the Soviet Union’s launch of Sputnik, the world’s first artificial satellite).

⁴ Nicola Davis, *Light Pollution from Satellites ‘Poses Threat’ to Astronomy*, GUARDIAN (Mar. 30, 2021, 10:37 AM), <https://www.theguardian.com/science/2021/mar/30/light-pollution-satellites-astronomy-mega-constellations>.

depend on night sky observation;⁵ determining whether a different set of legal protections would be afforded to state-run and operated MegaLEOs versus privately-run and operated MegaLEOs; and the role hackers and criminal organizations may play in hacking the satellites. These challenges, while important, will not be addressed by this Comment.

Part II examines the legal implications and possible solutions of states' ability to censor internet from MegaLEOs, essentially asking whether a state can restrict the internet transmission from MegaLEOs, given their unique ability to circumvent internet censorship. Part III examines the legal implications and possible solutions of MegaLEOs causing more space debris to occur, asking if international law mandates mitigation to space pollution and holds polluters liable. Part IV examines the legal implications and possible solutions of the growing threat of collisions in low-earth orbit resulting from the proliferation of MegaLEOs, asking whether the international community needs to create new law and regulatory authorities to combat a lack of space traffic management which threatens satellites, the orbital environment, and astronauts. Part V asks if MegaLEOs' indefinite access to exclusive orbital slots threatens the non-appropriation principle in the Outer Space Treaty, which bars states from asserting exclusive rights in outer space and analyzes potential solutions. Understanding these four issues and how they cooperate with one another is crucial to understanding the role MegaLEOs will play in shaping and redefining the international order in space. Part VI looks back on these questions and concludes that the new space race among space companies requires more international cooperation on establishing practices and norms, or even legislation, for orbital operations and remedying the consequences of MegaLEOs.

I. BACKGROUND AND HISTORICAL PERSPECTIVE

A. *"Mega-Constellations" of Small Satellites in Low-Earth Orbit (MegaLEOs) in Detail*

A "mega-constellation" of small satellites in low-earth orbit, or MegaLEO, is a group of dozens to thousands of individual artificial satellites, which operate to cover a vast span or even the whole of the Earth's surface.⁶ Hundreds, if not

⁵ Becky Ferreira, *SpaceX's Satellite Megaconstellations Are Astrocolonialism, Indigenous Advocates Say*, VICE MEDIA GRP. (Oct. 5, 2021, 9:00 AM), <https://www.vice.com/en/article/k78mz/spacexs-satellite-megaconstellations-are-astrocolonialism-indigenous-advocates-say>.

⁶ Soumyaa Rawat, *What is a Satellite Mega-Constellation? Advantages and Disadvantages*, ANALYTICS STEPS (May 8, 2021), <https://www.analyticssteps.com/blogs/what-satellite-mega-constellation-advantages-and->

thousands, of satellites are required to provide sufficient connectivity for a given area because satellites in low-earth orbit (LEO) are in constant motion in their orbits, cover small areas of surface with each pass, and are mostly only visible for twenty to thirty minutes per pass.⁷

Business entities and governments deploy small satellites into low-earth orbit to expand internet access for a multitude of reasons. Smaller satellites requiring less fuel can be sent into LEO as compared to medium-Earth orbit (MEO).⁸ Especially for communications and navigation satellites, these objects experience a shorter communication time lag (low latency) and higher bandwidth when they are closer to the ground.⁹

SpaceX's Starlink is a private broadband MegaLEO operator, which has launched upwards of 2,500 satellites as of May 2022,¹⁰ with clearance to launch up to 12,000 into orbit by 2027, and has applied for regulatory approval of another 30,000 satellites.¹¹ U.K.'s OneWeb plans to operate a MegaLEO of 648 satellites by the end of 2022.¹² Amazon's Project Kuiper plans to operate a MegaLEO of 3,236 satellites to extend broadband internet to the rural United States.¹³ As previously mentioned, the Chinese government plans to oversee a "national network" satellite broadband project, or "Guowang," with a total of 12,992 satellites.¹⁴ MegaLEO projects will only increase in frequency and intensity, as private companies and governments realize MegaLEO satellites can deliver high-speed internet to rural areas, areas that cannot support ground terminals, or areas where ground terminals are too expensive to transmit internet, thus providing near-global coverage to the populated world.¹⁵

disadvantages; Krystal Dredge et al., *LEO Constellations and Tracking Challenges*, *SATELLITE EVOLUTION GRP.*, Sept./Oct. 2017, at 36-37.

⁷ Dredge, *supra* note 6, at 37.

⁸ *Id.* at 36.

⁹ Matt Williams, *What is Low Earth Orbit?*, *UNIVERSE TODAY* (Jan. 6, 2017), <https://www.universetoday.com/85322/what-is-low-earth-orbit/>; Dredge, *supra* note 6, at 36-37.

¹⁰ Stephen Clark, *SpaceX Passes 2,500 Satellites Launched for Starlink Internet Network*, *SPACEFLIGHT NOW* (May 13, 2022), <https://spaceflightnow.com/2022/05/13/spacex-passes-2500-satellites-launched-for-companys-starlink-network/>.

¹¹ Amy Borrett, *Satellite Broadband Is the Future of the \$1trn Space Economy*, *TECH MONITOR* (Mar. 2, 2021), <https://techmonitor.ai/technology/cloud/satellite-broadband-future-1trn-space-economy>.

¹² *Id.*

¹³ *Id.*

¹⁴ Andrew Jones, *China is Developing Plans for a 13,000-satellite Megaconstellation*, *SPACENEWS* (Apr. 21, 2021), <https://spacenews.com/china-is-developing-plans-for-a-13000-satellite-communications-megaconstellation/>.

¹⁵ Herb Lin, *The Geopolitical Ramifications of Starlink Internet Service?*, *THE LAWFARE INST.* (June 30, 2020, 8:01 AM), <https://www.lawfareblog.com/geopolitical-ramifications-starlink-internet-service>.

B. *Satellites' Historical Role in Telecommunications*

Knowledge was historically transmitted via the spoken word, then the written word, and not until recently, by electric and electronic signals. The internet is perhaps the single most significant advancement in the Information Age, allowing people from all over the world to connect, interact, and learn.¹⁶ Although the internet has and will provide this extraordinary service of interconnection, about forty percent of the world's total population remains offline.¹⁷ It should be noted, however, that internet connectivity has been increasing steadily in areas that remain largely unconnected.¹⁸

The United States and Europe were first connected via undersea telegraph cables on July 29, 1858.¹⁹ Today, upwards of ninety-five percent of intercontinental global internet traffic similarly travels through undersea cables.²⁰ The solution to serving areas with low internet connectivity with access to high-speed internet lies with satellite internet. It is critical for the next generation of high-speed internet to come from constellations of satellites in LEO. LEO satellites can deliver high-speed internet with reduced lag compared to traditional satellite internet.²¹ LEO satellites can deliver high-speed internet to rural areas, areas that cannot support ground terminals, or areas where ground terminals are too expensive to transmit internet, thus providing near-global coverage to the populated world.²² Satellite enterprises, including SpaceX, Amazon, OneWeb, and the Chinese state-run “Guowang” constellation, plan to extend global internet coverage and reduce the price of internet access.²³ As of March 2021, the number of satellites, both active and defunct, in LEO is about

¹⁶ Manuel Castells, *The Impact of the Internet on Society: A Global Perspective*, MIT TECH. REV. (Sept. 8, 2014), <https://www.technologyreview.com/2014/09/08/171458/the-impact-of-the-internet-on-society-a-global-perspective/>; see MANUEL CASTELLS, *THE RISE OF THE NETWORK SOCIETY INFORMATION AGE* 42–43 (2d ed. 2010) (noting that the launch of Apple computers in 1976 became the “founding legend of the Information Age”).

¹⁷ Simon Kemp, *6 in 10 People Around the World Now Use the Internet*, DATAREPORTAL (Apr. 26, 2021), <https://datareportal.com/reports/6-in-10-people-around-the-world-now-use-the-internet>.

¹⁸ *Id.*

¹⁹ James Griffiths, *The Global Internet Is Powered by Vast Undersea Cables. But They're Vulnerable.*, CNN (July 26, 2019, 7:30 AM), <https://www.cnn.com/2019/07/25/asia/internet-undersea-cables-intl-hnk/index.html>.

²⁰ Justin Sherman, *Cyber Defense Across the Ocean Floor: The Geopolitics of Submarine Cable Security*, ATLANTIC COUNCIL (Sept. 13, 2021), <https://www.atlanticcouncil.org/in-depth-research-reports/report/cyber-defense-across-the-ocean-floor-the-geopolitics-of-submarine-cable-security/>.

²¹ John Dille, *The Past, Present, and Future of Satellite Internet*, SATELLITEINTERNET.COM (Apr. 26, 2019), <https://www.satelliteinternet.com/resources/history-and-future-of-satellite-internet/>.

²² Lin, *supra* note 15.

²³ Borrett, *supra* note 11; Jones, *supra* note 14.

5,000.²⁴ Tens of thousands more communications satellites in low-earth orbit are awaiting permission from regulatory agencies and are expected to enter into orbit in the coming years.²⁵

C. *Laws of Space*

The law governing MegaLEOs once in orbit is international space law, a branch of public international law, which is the body of law concerning outer space, objects in space, and space-related activities.²⁶ Five international treaties and five sets of declarations and legal principles comprise much of existing space law.²⁷ These five treaties are the “Outer Space Treaty,” “Rescue Agreement,” “Liability Convention,” “Registration Convention,” and “Moon Agreement.”²⁸ The five declarations and legal principles in space law are the “Declaration of Legal Principles,” “Broadcasting Principles,” “Remote Sensing Principles,” “Nuclear Power Sources Principles,” and “Benefits Declaration.”²⁹ This discussion is particularly related to the Outer Space Treaty.

Fundamental principles widely understood to encompass space law are “the notion of space as the province of all humankind, the freedom of exploration and use of outer space by all states without discrimination, and the principle of non-appropriation of outer space.”³⁰ Some have argued that space law is short, inadequate, obsolete, and unenforceable.³¹ While largely true, these treaties and other agreements give guidance to how the international community should respond to the threats posed by MegaLEOs.

²⁴ Aaron C. Boley & Michael Byers, *Satellite Mega-Constellations Create Risks in Low Earth Orbit, the Atmosphere and on Earth*, 11 SCI. REPS., May 20, 2021, at 1.

²⁵ *Id.*

²⁶ *Space Law*, UNITED NATIONS OFF. FOR OUTER SPACE AFFS., <https://www.unoosa.org/oosa/en/ourwork/spacelaw/index.html> (last visited Oct. 25, 2021); Louis de Gouyon Maignon, *The Delimitation Between Airspace and Outer Space*, SPACE LEGAL ISSUES (July 23, 2019), <https://www.spacelegalissues.com/the-delimitation-between-airspace-and-outer-space/>; Martha Mejia-Kaiser, *Space Law and Hazardous Space Debris*, PLANETARY SCI. (Jan. 30, 2020), <https://oxfordre.com/planetaryscience/view/10.1093/acrefore/9780190647926.001.0001/acrefore-9780190647926-e-70>.

²⁷ UNITED NATIONS OFF. FOR OUTER SPACE AFFS., *supra* note 26.

²⁸ *Space Law Treaties and Principles*, UNITED NATIONS OFF. FOR OUTER SPACE AFFS., <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html> (last visited Oct. 25, 2021).

²⁹ *Id.*

³⁰ UNITED NATIONS OFF. FOR OUTER SPACE AFFS., *supra* note 26.

³¹ Christopher D. Johnson, *Deficiencies and Pressing Issues in the Existing Legal Regime of Outer Space: the incompleteness of the legal order for space*, U. N. OFF. FOR OUTER SPACE AFFS. (Sept. 24, 2019), https://www.unoosa.org/documents/pdf/spacelaw/activities/2019/T3-2-CJ_Deficiencies_and_Pressing_Issues_in_the_Existing_Legal_Regime_of_Outer_Space.pdf.

D. Where Does Airspace End and Outer Space Begin?

Defining the delimitation between airspace and outer space is crucial to understanding whether MegaLEOs in orbit are under the sovereign jurisdiction of a state or not. According to the “Outer Space Treaty,” “[o]uter space[, including the Moon and other celestial bodies,] is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.”³² Under the Convention on International Civil Aviation, “[e]very state has complete and exclusive sovereignty in the airspace above its territory . . . Territory of a state shall be deemed the land areas and territorial waters adjacent thereto.”³³ If space begins at an altitude too low, then states cannot regulate MegaLEOs overhead. If space begins at an altitude too high, then states may have too much power to regulate MegaLEOs.

Importantly, the delimitation between airspace and outer space is not explicitly defined in treaties.³⁴ Outer space is defined in the dictionary as “space immediately outside the earth’s atmosphere.”³⁵ Using this simple definition, celestial bodies like the Moon and Mars exist in outer space, and surely anything beyond the Earth’s outer layer of the atmosphere at around 6,700 miles above the surface would count as outer space.³⁶ Objects in geosynchronous orbit (GSO) around Earth, at 22,236 miles above Earth’s equator, operate in outer space.³⁷ The hard questions exist on the margins, so to truly determine where outer space begins is to know where airspace ends.³⁸

Given that the United States and other countries have not produced a formal delimitation of the boundary between air and space, the scientific community uses the Kármán line to set an imaginary boundary.³⁹ The Kármán line is roughly one hundred kilometers or sixty-two miles above sea level and is recognized by

³² Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies art. 2, Jan. 27, 1967, S. TREATY DOC. No. 90-4, 861 U.N.T.S. 187 [hereinafter O.S.T.].

³³ Convention on International Civil Aviation art. 1-2, Dec. 7, 1944, 14 CFR 91.03, 15 U.N.T.S. 295.

³⁴ de Gouyon Matignon, *supra* note 26.

³⁵ *Outer Space*, MERRIAM-WEBSTER, <https://www.merriam-webster.com/dictionary/outer%20space> (last visited Oct. 25, 2021).

³⁶ See Skye Gould & Sean Kane, *Here’s Where Outer Space Actually Begins*, TECH INSIDER (July 8, 2016, 9:00 AM), <https://www.businessinsider.com/where-does-space-begin-2016-7>.

³⁷ See Elizabeth Howell, *What is a Geosynchronous Orbit?*, SPACE.COM (Apr. 24, 2015), <https://www.space.com/29222-geosynchronous-orbit.html>.

³⁸ de Gouyon Matignon, *supra* note 26.

³⁹ Nadia Drake, *Where, Exactly, Is the Edge of Space? It Depends on Who You Ask.*, NAT’L. GEOGRAPHIC (Dec. 20, 2018), <https://www.nationalgeographic.com/science/article/where-is-the-edge-of-space-and-what-is-the-karman-line>.

the Federation Aeronautique Internationale (FAI).⁴⁰ Despite widespread recognition of the Kármán line as the delimitation between air and space, the Federal Aviation Administration, U.S. Air Force, National Oceanic and Atmospheric Administration, and National Aeronautics and Space Administration (NASA) generally use eighty kilometers or fifty miles as the boundary, with the Air Force granting astronaut wings to flyers who go higher than this mark. At the same time, NASA Mission Control places the line at 122 kilometers or seventy-six miles.⁴¹

MegaLEOs exist in low-earth orbit, which includes altitudes between 160 and 1,000 kilometers, safely above any definition of outer space.⁴² As such, once in their orbits, MegaLEOs are not in territorial airspace and, thus, may not be subject to airspace regulations of the state beneath the MegaLEO. According to the Outer Space Treaty, privately-run activities operated in space are under the jurisdiction and control of the state who sponsors the project.⁴³ Therefore, MegaLEOs are only subject to the jurisdiction and control of the state which authorizes and supervises the entity.⁴⁴

II. INTERNET AND INFORMATION CENSORSHIP

A. *Legal Issue Presented by Censorship*

MegaLEOs and their operators are uniquely positioned to deliver internet to areas all over the world, including areas historically without access to outside internet. With just a user terminal and a computer, an individual can bypass traditional firewalls and access the internet unimpeded thanks to MegaLEOs like Starlink.⁴⁵ This emerging technology poses an enormous threat to governments that wish to censor certain material, implicating two core legal issues in this field. First, is the free flow of information recognized as a fundamental individual right in international law? The second issue concerns state

⁴⁰ *Id.*

⁴¹ *Id.*

⁴² Linn Boldt-Christmas, *Low Earth Orbit*, THE EUR. SPACE AGENCY (Mar. 2, 2020), https://www.esa.int/ESA_Multimedia/Images/2020/03/Low_Earth_orbit (noting the boundaries of low-earth orbit).

⁴³ O.S.T., *supra* note 32, art. 6 (“States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty.”).

⁴⁴ *Id.*

⁴⁵ Lin, *supra* note 15.

sovereignty, i.e., do states have a sovereign right to censor information for their citizens? Then as a sub-issue, if states possess the ability to censor information, can the transmitting operators be held liable, and by extension, are the states internationally responsible for those operators?

States have jammed signals since the advent of the printing press, advancing to telecommunication censorship of the telegraph, radio signals, and satellite signals.⁴⁶ States may filter or censor telecommunications for a variety of reasons, including national security, securing the power of the government, promoting state propaganda, preventing the spread of misinformation, and instilling “local culture [and] morality.”⁴⁷ In fact, internet censorship occurs in almost every state, given that most, if not all, restrict torrenting.⁴⁸ Indeed, many states heavily restrict, censor, and sanction internet access, such as China, or even forbid access to the internet, like North Korea.⁴⁹

Governments face difficulties in censoring internet content transmitted via MegaLEOs due to the lack of ground-based internet terminals,⁵⁰ which can prevent a traditional firewall from filtering the free flow of content.⁵¹ New Starlink satellites with laser-based interconnects allow satellites to communicate with each other, rather than with users and ground stations, and allow satellites to provide service across long distances, far from any ground station.⁵² All that is needed for laser connections between satellites to grant users internet connection is a user terminal the size of a pizza box, which is “smaller, portable, and easier to conceal, smuggle, and infiltrate.”⁵³ Thus, those “with a user terminal and a computer become[] an access point for the broader internet to penetrate the nation’s closed information borders.”⁵⁴ Authoritarian regimes fear that users with terminals can “cheaply and quickly” circumvent internet

⁴⁶ Jonathon W. Penney, *The Cycles of Global Telecommunication Censorship and Surveillance*, 36 U. PA. J. INT’L L. 693, 698 (2015).

⁴⁷ *Id.* at 739-40.

⁴⁸ Paul Bischoff, *Internet Censorship 2022: A Global Map of Internet Restrictions*, COMPARITECH (Jan. 25, 2022), <https://www.comparitech.com/blog/vpn-privacy/internet-censorship-map/>.

⁴⁹ *Id.*

⁵⁰ Lin, *supra* note 15.

⁵¹ Chandaphan Suwijak & Shouping Li, *Legal Challenges to the Construction and Operation of Small Satellite Constellations*, 14 J. E. ASIA & INT’L L. 131, 143 (2021).

⁵² Derek Wise, *How SpaceX Starlink Could Resolve Rising Government-Controlled Internet Shutdowns*, SPACE EXPLORED (Sept. 2, 2021, 2:48 PM), <https://spaceexplored.com/2021/09/02/how-spacex-starlink-could-resolve-rising-government-controlled-internet-shutdowns/>.

⁵³ *Id.*; Michael Schuille and Scott Fisher, *Satellite Internet Services – Fostering the Dictator’s Dilemma?*, THE RAND BLOG (Apr. 12, 2021), <https://www.rand.org/blog/2021/04/satellite-internet-services-fostering-the-dictators.html>.

⁵⁴ Lin, *supra* note 15.

ensorship controls to access information and place phone calls.⁵⁵ Internet access via MegaLEOs strikes at the weaknesses of authoritarian governments who are eager to control the dissemination of information.⁵⁶

Authoritarian governments often shutdown the internet after protests to control dissent, with twenty-nine states resorting to internet shutdowns in 2020.⁵⁷ To prevent bypassing of government internet censorship controls, those governments have a variety of tools at their disposal. States may deploy and manage their own MegaLEOs, such as China, which is planning to build its own 13,000-satellite MegaLEO.⁵⁸ Governments can try to stop terminals from entering their borders, seize terminals from citizens, arrest citizens who are in possession of terminals, jam signals used to carry the internet signals,⁵⁹ launch cyber-attacks against the MegaLEO operator,⁶⁰ or “blow up” the satellites themselves.⁶¹ Governments can also exert their influence at the World Radiocommunication Conferences of the International Telecommunications Union (ITU) to prevent the ITU from allocating radio frequencies for satellites.⁶² In the Russo-Ukrainian War, satellite jamming and the delivery of satellite terminals have revolutionized the spread of information in wartime.⁶³

⁵⁵ Schwille & Fisher, *supra* note 53.

⁵⁶ *Id.*

⁵⁷ Michael Caster, *Why Elon Musk Won't Save Us from Internet Shutdowns*, VICE (May 10, 2021), <https://www.vice.com/en/article/5dbbe5/elon-musk-satellite-internet>.

⁵⁸ Eric Berger, *Russia May Fine Citizens Who Use SpaceX's Starlink Internet Service*, ARS TECHNICA (Jan. 12, 2021), <https://arstechnica.com/science/2021/01/russia-may-fine-citizens-who-use-spacexs-starlink-internet-service/>; Jones, *supra* note 14.

⁵⁹ Lin, *supra* note 15.

⁶⁰ See Vilius Petkauskas, *Space Security in 2022: Expect a Hacked Satellite*, CYBERNEWS (Jan. 3, 2022), <https://cybernews.com/security/space-security-in-2022-expect-a-hacked-satellite/> (explaining the fear that satellite operators have concerning cyberattacks).

⁶¹ Dave Mosher, *Elon Musk's Plan to Blanket Earth in High-Speed Internet May Face a Big Threat: China*, BUS. INSIDER (Nov. 22, 2016), <https://www.businessinsider.com/spacex-internet-satellite-constellation-china-threat-2016-11> (quoting Starlink founder, Elon Musk, “If they get upset with us, they can blow our satellites up, which wouldn't be good. China can do that. So probably we shouldn't broadcast there.”).

⁶² See Caster, *supra* note 57 (explaining the purpose of the ITU); *ITU-R: Managing the Radio-Frequency Spectrum for the World*, INT'L TELECOMMS. UNION (Oct. 2021), <https://www.itu.int/en/mediacentre/backgrounders/Pages/itu-r-managing-the-radio-frequency-spectrum-for-the-world.aspx> (explaining World Radiocommunication Conferences and their purpose).

⁶³ See Raphael Satter, *Satellite Outage Caused 'Huge Loss in Communications' at War's Outset – Ukrainian Official*, REUTERS (Mar. 15, 2022), <https://www.reuters.com/world/satellite-outage-caused-huge-loss-communications-wars-outset-ukrainian-official-2022-03-15/> (explaining how digital sabotage against satellite terminals has affected the war between Russia and Ukraine); James Pearson, *Russia Downed Satellite Internet in Ukraine – Western Officials*, REUTERS (May 10, 2022), <https://www.reuters.com/world/europe/russia-behind-cyberattack-against-satellite-internet-modems-ukraine-eu-2022-05-10/> (highlighting a Russian attack on Ukrainian internet satellites); Elizabeth Howell, *Elon Musk Says Russia is Ramping Up Cyberattacks on SpaceX's Starlink Systems in Ukraine*, SPACE.COM (May 12, 2022), <https://www.space.com/starlink-russian-cyberattacks-ramp-up-efforts-elon-musk> (restating Elon Musk's

As the war over Ukraine continues, Russia has tightened its control over its domestic internet, while at the same time, international firms have removed their services from Russia.⁶⁴ It is nearly impossible for independent Russian media outlets to report on the war in Ukraine because a March 2022 law allows for the imprisonment of journalists who deviate from the Kremlin's portrayal of the war.⁶⁵ Similarly, Russia has attempted to control internet access in Ukraine.⁶⁶

Russia aimed to disrupt Ukrainian communications and military strategic capabilities when it engaged in a cyberattack against Viasat's KA-SAT network in late February 2022.⁶⁷ As a result of the cyberattack, many satellite internet users across Europe had to manually replace their modems and the Ukrainian military was left with a "huge loss in communications in the very beginning of war," according to Ukrainian cybersecurity official Victor Zhora.⁶⁸ The KA-SAT satellite is a telecommunications satellite in geostationary orbit.⁶⁹ Since February 2022, SpaceX, aided by the United States Agency for International Development (USAID), has sent over 5,000 Starlink terminals to war-torn Ukraine.⁷⁰ USAID said the Starlink terminals provide Ukraine with "unlimited, unthrottled data connectivity," to maintain open communications for the government and citizens alike, "even if Putin's brutal aggression severs Ukraine's fiber optic or cellular communication infrastructure connections."⁷¹ SpaceX CEO Elon Musk has tweeted about reprioritizing SpaceX for cyber defense and overcoming signal jamming⁷² and made the following statement on

assertions that Russia is targeting Starlink's satellites); Tom Simonite, *How Starlink Scrambled to Keep Ukraine Online*, WIRE (May 11, 2022, 7:00 AM), <https://www.wired.com/story/starlink-ukraine-internet/> (illustrating the importance of Starlink to the Ukrainian war effort).

⁶⁴ Arjun Kharpal, *Russia May Aspire to a China-Style Internet, But It's a Long Way Off*, CNBC (Mar. 16, 2022, 10:39 PM), <https://www.cnbc.com/2022/03/17/russia-ukraine-war-internet-censorship-china-great-firewall.html>.

⁶⁵ Robert McMahon, *Russia Is Censoring News on the War in Ukraine. Foreign Media Are Trying to Get Around That.*, COUNCIL ON FOREIGN RELS. (Mar. 18, 2022, 11:55 AM), <https://www.cfr.org/in-brief/russia-censoring-news-war-ukraine-foreign-media-are-trying-get-around>; UGOLOVNYI KODEKS ROSSIJSKOI FEDERATSII [UK RF] [Criminal Code] art. 207.3 (Russ.).

⁶⁶ See Howell, *supra* note 63.

⁶⁷ Pearson, *supra* note 63.

⁶⁸ *Id.*

⁶⁹ *KA-Sat Satellite*, VIASAT, <https://www.viasat.com/space-innovation/satellite-fleet/ka-sat/> (last visited May 29, 2022).

⁷⁰ Howell, *supra* note 63.

⁷¹ Stefanie Waldek, *SpaceX and USAID Deliver 5,000 Starlink Internet Terminals to Ukraine*, SPACE.COM (Apr. 7, 2022), <https://www.space.com/spacex-usaid-starlink-terminals-ukraine>.

⁷² Elon Musk (@elonmusk), TWITTER (May 4, 2022, 11:59 PM), <https://twitter.com/elonmusk/status/1499972826828259328?s=20&t=MEpLnyw9o0-NYTckJpGVA>, ("SpaceX reprioritized to cyber defense & overcoming signal jamming. Will cause slight delays in Starship & Starlink V2.")

Twitter: “Important warning: Starlink is the only non-Russian communications system still working in some parts of Ukraine, so probability of being targeted is high. Please use with caution.”⁷³ It seems that satellite internet from MegaLEOs has given the Ukrainian government and citizens telecommunications capabilities where they would otherwise not exist, but the overall effect of MegaLEOs on the Russo-Ukrainian War remains to be seen.

Although internet access via MegaLEOs may appear to be the saving grace among exporters of democracy who wish to free oppressed peoples from the yoke of tyranny, deploying MegaLEOs likely will not transmit a free flow of information to every corner of the globe. To the Western eye, it would seem that authoritarian regimes should not be allowed to censor information transmitted from MegaLEOs; however, international law must balance the “free flow of information” doctrine enshrined in article nineteen of the 1948 United Nations Universal Declaration of Human Rights (UDHR) and a state’s sovereign right to censor content to “reflect[] local culture, morality, and security.”⁷⁴ International law concerning internet censorship is not extensive but concerns two seemingly irreconcilable principles: “rights to information and expression and states’ sovereign right to police their territories.”⁷⁵

After the Second World War and the widespread adoption of high frequency radio, a strong international consensus promoted a “free flow of information” doctrine.⁷⁶ The international community believed that the free flow of information doctrine could undermine both state propaganda and censorship by diversifying information sources.⁷⁷ The free flow of information doctrine was imparted into the UDHR, which codified fundamental human rights to be universally protected.⁷⁸ The UDHR states: “[e]veryone has the right to freedom of opinion and expression . . . and to seek, receive and impart information and ideas through any media and regardless of frontiers.”⁷⁹ Similarly, the International Covenant on Civil and Political Rights article nineteen guarantees

⁷³ Elon Musk (@elonmusk), TWITTER (May 3, 2022, 2:49 PM), <https://twitter.com/elonmusk/status/1499472139333746691?s=20&t=cD1cBM8g3mQIAeZ6j0nDrw>.

⁷⁴ Penney, *supra* note 46, at 739–40.

⁷⁵ *Id.* at 700 (suggesting that these principles are completely irreconcilable).

⁷⁶ Penney, *supra* note 46, at 722.

⁷⁷ *Id.*

⁷⁸ The Foundation of International Human Rights Law, UNITED NATIONS, <https://www.un.org/en/about-us/udhr/foundation-of-international-human-rights-law> (stating that the UDHR “represents the universal recognition that basic rights and fundamental freedoms are inherent to all human beings, inalienable and equally applicable to everyone”).

⁷⁹ G.A. Res. 217 A (III), Universal Declaration on Human Rights, art. 19, U.N. Docs. A/RES/3/217 (Dec. 10, 1948).

the “right...to seek, receive and impart information and ideas of all kinds, regardless of frontiers...through any...media.”⁸⁰ Article nineteen, however, carves out two exceptions to the free flow doctrine: “[f]or respect of the rights or reputations of others; [f]or the protection of national security or of public order (ordre public), or of public health or morals.”⁸¹ Even when there is international consensus on the free flow doctrine, it appears that states have the ability to independently stop the flow of information.

From 1948 through the end of the Cold War, the Soviet Union and its allies jammed Western broadcasts.⁸² Today, states are censoring and monitoring the internet, clamping down even harder on information disseminated through the medium.⁸³ The international community is currently engaged in a race for internet security capabilities to tackle the threat of cyberwarfare.⁸⁴ International law is created by states to govern the conduct between states.⁸⁵ States are inherently sovereign actors, and the principle of state sovereignty remains, to this day, a bedrock principle of international law.⁸⁶ Though it may be unpleasant to see totalitarian governments crack down on internet usage, states may censor or filter internet material for reasons in the vein of public morality or national security under the bedrock principle of state sovereignty.⁸⁷

If a censoring state holds a MegaLEO firm liable for its illegal activity, then the principle of state accountability in Article VI of the Outer Space Treaty assigns state responsibility to the state under which the firm is engaging in activities in outer space.⁸⁸ Article VI is a unique provision in that it mentions non-governmental entities that engage in activities in outer space.⁸⁹ If a censoring state prevails in court against a state responsible for a MegaLEO firm, the censoring state could also seek prospective remedies to supervise the firm in

⁸⁰ International Covenant on Civil and Political Rights, Dec. 16, 1966, art. 19, ¶ 2, S. TREATY DOC. No. 95-20 (1977).

⁸¹ *Id.* ¶ 3.

⁸² Penney, *supra* note 46, at 723.

⁸³ *Id.* at 736.

⁸⁴ *Id.*

⁸⁵ *International Law*, ENCYCLOPEDIA BRITANNICA, <https://www.britannica.com/topic/international-law> (last visited Aug. 18, 2022).

⁸⁶ Penney, *supra* note 46, at 740.

⁸⁷ *Id.*

⁸⁸ O.S.T., *supra* note 32, art. 6 (“States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty.”).

⁸⁹ *Id.*

its ongoing activities to make sure that such incidents do not reoccur, citing the continuing supervision clause in Article VI.⁹⁰

Of all the legal challenges this Comment addresses, liability of non-governmental entities is the only non-physical challenge. Unlike space debris, traffic management, and the appropriation of space, this issue does not intensify with an increase in the number of satellites. The issue of internet censorship from MegaLEOs will remain no matter the size or quantity of MegaLEOs, as long as they sufficiently deliver internet.

B. Potential Solutions for Mitigating Censorship and Balancing Sovereignty

Promoting and allowing the free flow of information is difficult to balance with the doctrine of state sovereignty in the field of internet censorship. The conflict of those two competing ideas presents deep legal, philosophical, and moral questions. Indeed, free flowing information and speech is vital to ensuring a well-informed population in a vibrant, lasting society. Nonetheless, states have the inherent right to censor certain speech which may affect rights and reputations, national security, public order, public health, and national morals.

As we have seen, SpaceX, with the aid of the U.S. government, is working to bypass internet jamming and censorship by providing Ukraine with Starlink terminals,⁹¹ thereby subjecting itself to civil or criminal penalties by Russia.⁹² Yet, this example should not suggest that MegaLEO operators will come to the aid of any state or group facing internet censorship. SpaceX's intervention in Ukraine is unique because much of the Western world's governments and businesses are united in sanctioning, punishing, and pulling business out of Russia.⁹³ SpaceX may be inclined to believe that it will not receive economic retaliation, political blowback, or little if any legal liability, especially given its partnership with the U.S. government. MegaLEO operators like Elon Musk and Jeff Bezos would expectedly take much greater apprehension before providing internet to an authoritarian state such as China, which may choose to restrict the trade of Tesla cars and Amazon products. There is a unique political appetite in

⁹⁰ *Id.*

⁹¹ Howell, *supra* note 63.

⁹² Gabrielle Tétrault-Farber & Tom Balmforth, *Radio Free Europe Seeks Court Defence from Russian Crackdown*, REUTERS (Apr. 16, 2021), <https://www.reuters.com/business/media-telecom/radio-free-europe-seeks-court-defence-russian-crackdown-2021-04-16/>.

⁹³ *A Look at How the West Is Punishing Russia for Its Invasion on Ukraine*, BUSINESS STANDARD (Mar. 4, 2022, 6:40 AM), https://www.business-standard.com/article/international/a-look-at-how-the-west-is-punishing-russia-for-its-invasion-on-ukraine-122030400093_1.html.

the West to retaliate against Russia, and that appears to be why MegaLEO intervention to bypass censorship is occurring.⁹⁴

United States firms and the United States government can look to Radio Free Europe for guidance if they wish to transmit internet to areas under oppressive control. Radio Free Europe is a “radio broadcasting organization created by the United States government in 1950 to provide information and political commentary to the people of communist eastern Europe and the Soviet Union.”⁹⁵ The broadcast broke through communist censors, transmitted information to some thirty-five million listeners, and is credited with helping bring about the demise of communist regions in eastern Europe.⁹⁶

Since the Cold War, Radio Free Europe has been allowed to operate in most of the states it broadcasts.⁹⁷ To highlight the risks of transmitting illegal information or information perceived to be of a nefarious nature or intent, Russia has fined the Moscow bureau of Radio Free Europe, which is allowed to broadcast in Russia, for “performing the functions of a foreign agent.”⁹⁸ Radio Free Europe has appealed the fine and label to the European Court of Human Rights, citing its full editorial independence.⁹⁹ State censorship and violation of censorship laws is an issue of national law. Therefore, a state can punish offenders how it wishes under its own laws.

Ultimately, it is within states’ prerogative to censor information; however, the United States or U.S. private entities with aims to provide counter-narrative information to oppressed people may still choose to transmit internet to those states which censor information if their political benefits outweigh the negative legal and political consequences. Political or economic retaliation for violating censorship laws is more likely to occur than legal retaliation, if history dictates, given the absence of legal disputes initiated by censoring states and ability to hold violating transmitters accountable.

⁹⁴ See *id.* (explaining how the West has reacted to Russia’s invasion of Ukraine).

⁹⁵ *Radio Free Europe*, ENCYCLOPEDIA BRITANNICA (May 16, 2018), <https://www.britannica.com/topic/Radio-Free-Europe>.

⁹⁶ *Id.*

⁹⁷ *Id.*

⁹⁸ Gabrielle Tétrault-Farber & Tom Balmforth, *Radio Free Europe Seeks Court Defence from Russian Crackdown*, REUTERS (Apr. 16, 2021), <https://www.reuters.com/business/media-telecom/radio-free-europe-seeks-court-defence-russian-crackdown-2021-04-16/>.

⁹⁹ *Id.*

III. SPACE DEBRIS

A. *Legal Issue Presented by Space Debris*

Another critical challenge MegaLEOs pose to international law and space law is their exacerbation of the already existing concern of space debris. Space debris is a grave threat to the future of space exploration and orbital operations and has pre-dated the emergence of MegaLEOs. MegaLEOs will probably intensify the dangers of space debris, because MegaLEO projects are a significant contributor to the increasing growth of satellites in low-earth orbit.¹⁰⁰ What may result is an economic catastrophe known as the “Tragedy of the Commons,” whereby actors, acting in their own self-interest, ultimately ruin a shared resource: space.¹⁰¹ There is no international law which expressly says that space debris must be mitigated or that polluters are liable for their pollution, but, as explained below, plans are in the works to develop such laws and frameworks.¹⁰²

From April 2020 to April 2021, the number of satellites launched into orbit increased by twenty-eight percent.¹⁰³ With more rockets jettisoning more satellites into orbit, pieces of metal, parts of rocket, explosive bolts, as well as inoperable satellites will contribute to a larger graveyard of junk in orbit. The danger of millions of pieces of junk flying in orbit calls upon the international community and stakeholders in space exploration to join forces and come up with solutions to mitigate the effects of space debris.

¹⁰⁰ Tanishka Goswami & Shikhar Aggarwal, *SpaceX, OneWeb and the ‘Mega’ Effect of Mega-Constellations on International Space Law*, JURIST (May 31, 2021, 2:15 AM), <https://www.jurist.org/commentary/2021/05/goswami-aggarwal-international-space-law/>; see Jones, *supra* note 14 (explaining China’s plans for launching thousands of LEO satellites); Lin, *supra* note 15 (explaining Starlink’s production goals for thousands of LEO satellites).

¹⁰¹ See *‘Orbit Tax’ Proposed to Tackle Growing Problem of Space Junk*, SKY NEWS (May 26, 2020, 11:35 AM), <https://news.sky.com/story/orbit-tax-proposed-to-tackle-growing-problem-of-space-junk-11994748>.

¹⁰² See *id.*; INTER-AGENCY SPACE DEBRIS COORDINATION COMM., IADC STATEMENT ON LARGE CONSTELLATIONS OF SATELLITES IN LOW EARTH ORBIT (July 2021); Anton de Waal Alberts, *The Degree of the Lack of Regulation of Space Debris Within the Current Space Law Regime and Suggestions for a Prospective Legal Framework and Technological Interventions*, in SPACE SECURITY AND LEGAL ASPECTS OF ACTIVE DEBRIS REMOVAL 93, 100 (Annette Froehlich ed., 2019); Gordon Chung, *Jurisdiction and Control Aspects of Space Debris Removal*, in SPACE SECURITY AND LEGAL ASPECTS OF ACTIVE DEBRIS REMOVAL 31, 32 (Annette Froehlich ed., 2019); RAM S. JAKHU & JOSEPH N. PELTON, GLOBAL SPACE GOVERNANCE: AN INTERNATIONAL STUDY 345-46 (2017); I.H. PH. DIEDERIKS-VERSCHOOR & VLADIMÍR KOPAL, AN INTRODUCTION TO SPACE LAW 9-10 (2008); Michael Lobban, *Custom, Common Law Reasoning and the Law of Nations in the Nineteenth Century*, in THE NATURE OF CUSTOMARY LAW: LEGAL, HISTORICAL AND PHILOSOPHICAL PERSPECTIVE 274 (Amanda Perreau-Saussine & James Bernard Murphy eds., 2007).

¹⁰³ Nibidita Mohanta, *How Many Satellites Are Orbiting the Earth in 2021?*, GEOSPATIAL WORLD (May 28, 2021), <https://www.geospatialworld.net/blogs/how-many-satellites-are-orbiting-the-earth-in-2021/>.

Space debris “can be divided into two categories: (a) space debris falling to the Earth, either generated during a launch in the Earth’s atmosphere or re-entering the Earth’s atmosphere from outer space; and (b) space debris in orbit . . . [, also] known as ‘orbital space debris.’”¹⁰⁴ Of interest to this discussion is orbital space debris.

Orbital space debris consists of spent stages of launchers, component parts that detach during deployment of space objects as part of normal launch operations, space objects that reach their end of life, objects that malfunction, fragments that result from explosions or collisions and many small space objects such as screws, screw eyes, fragments of aluminum, paint flakes, aluminum oxide particles ejected from motor boosters, and sodium–potassium droplets.¹⁰⁵

There are currently about 2,000 operational space objects in Earth’s orbit, including manned space assets, which are at risk of being damaged, colliding, and dismembering into smaller parts.¹⁰⁶ The abundance of space debris currently poses a risk to launching vehicles. When tens of thousands of satellites are launched into LEO over the next couple decades, there will be an even greater risk of collision.¹⁰⁷ The Kessler syndrome, proposed by NASA scientist Donald J. Kessler in 1978, predicts a chain reaction will result when debris collide into an operational space object or another piece of debris, generating more space debris, which generates more space debris, which may potentially render space activities and satellite use impractical for many generations.”¹⁰⁸

MegaLEOs pose a grave threat to the safety of orbital operations and to the future of extraterrestrial operations. Decades of space exploration and use have cataloged over 40,000 space debris objects in orbit.¹⁰⁹ Today, the United States military has tracked over 27,000 pieces of orbital debris softball sized or larger.¹¹⁰ The energy of a softball-sized object in space is equivalent to that of a large bomb; while the energy of a three-millimeter-sized object is equivalent to

¹⁰⁴ Mejia-Kaiser, *supra* note 26.

¹⁰⁵ *Id.*

¹⁰⁶ *Id.*

¹⁰⁷ Goswami & Aggarwal, *supra* note 100.

¹⁰⁸ Donald J. Kessler & Burton G. Cour-Palais, *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt*, 83 J. GEOPHYSICAL RSCH. 2637, 2637 (1978); Louis de Gouyon Matignon, *The Kessler Syndrome*, SPACE LEGAL ISSUES (Mar. 27, 2019), <https://web.archive.org/web/20220522051149/https://www.spacelegalissues.com/space-law-the-kessler-syndrome/>.

¹⁰⁹ *Space Debris and Space Traffic Management*, THE AEROSPACE CORP. (Nov. 14, 2018), <https://aerospace.org/space-debris>.

¹¹⁰ *Space Debris and Human Spacecraft*, NASA (May 26, 2021), https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.

that of a bullet.¹¹¹ The total number of active satellites in orbit is at a record 4,000.¹¹² The rate at which satellites are launched into orbit is growing at an exponential rate, largely due to MegaLEO enterprises.¹¹³ With more rocket launches and satellites in LEO comes the risk that small collisions lead to larger and larger collisions, as predicted by Donald J. Kessler.¹¹⁴ Amazon estimates that if ten percent of the 2,326 Kuiper satellites lose capacity to perform collision avoidance maneuvers, there is a twelve percent chance that one of the satellites could collide with space debris measuring ten centimeters or larger.¹¹⁵ While satellites in MegaLEOs may be maneuverable, it may not be profitable to give this capability to thousands of satellites and track debris coming towards each of them.¹¹⁶ Further, to execute a collision avoidance maneuver, most satellite operators require hours or even days of planning.¹¹⁷

There currently exists no binding international law or international organization with enforcement power to combat the looming space debris crisis. Some scholars argue that the mitigation of space debris has been elevated into a norm of customary international law.¹¹⁸ They argue that the existence of hard law, in terms of the five space treaties, has created this custom.¹¹⁹ The Outer Space Treaty obligates member states not to contaminate space, stating that member states “conduct exploration of [outer space] so as to avoid their harmful contamination.”¹²⁰ The Outer Space Treaty also obligates member states which would cause potentially harmful interference with other member states peacefully exploring and using outer space to “undertake appropriate international consultations before proceeding.”¹²¹ Scholars have also pulled and picked from the other treaties to amalgamate some international customary laws on mitigating space debris.¹²² Assuming that there is customary international law to clean up Earth’s orbit, which is unlikely, there is no international consensus on how to conduct these operations and lack of international capacity by

¹¹¹ THE AEROSPACE CORP., *supra* note 109.

¹¹² Stephen Young, *The Number of Active Satellites in Space Skyrockets...Literally*, UNION OF CONCERNED SCIENTISTS (July 27, 2021), <https://allthingsnuclear.org/syoung/number-of-satellites-skyrockets/>.

¹¹³ *Id.*

¹¹⁴ de Gouyon Matignon, *supra* note 108.

¹¹⁵ EUR. SPACE POL’Y INST., ESPI REPORT 71 – TOWARDS A EUROPEAN APPROACH TO SPACE TRAFFIC MANAGEMENT – EXECUTIVE SUMMARY 4 (2020).

¹¹⁶ THE AEROSPACE CORP., *supra* note 109.

¹¹⁷ *Id.*

¹¹⁸ See Gordon Chung, *supra* note 102, at 32.

¹¹⁹ See JAKHU & PELTON, *supra* note 102, at 345-46; DIEDERIKS-VERSCHOOR & KOPAL, *supra* note 102, at 9-10 (2008); Michael Lobban, *supra* note 102, at 274.

¹²⁰ O.S.T. *supra* note 32, art. 9.

¹²¹ *Id.*

¹²² de Waal Alberts, *supra* note 102, at 100.

spacefaring nations. Mitigating space debris may become customary international law one day, but that will only happen once many or most spacefaring states consistently and uniformly mitigate space debris and those states accept the custom as *opinio juris*, or legally binding.¹²³

The international community has also tried to impose soft law to manage space debris. The Inter-Agency Debris Coordination Committee (IADC) exists between the space agencies of Italy, France, China, Canada, Germany, India, Japan, South Korea, the United States, Russia, the United Kingdom, as well as the European Space Agency.¹²⁴ The IADC “recommends new opportunities for cooperation, serves as the primary means for exchanging information and plans concerning orbital debris research activities, and identifies and evaluates options for debris mitigation.”¹²⁵ In applying existing space debris measures to MegaLEOs, the IADC issued considerations to mitigate space debris: (1) “Limit debris released during normal operations”; (2) “Minimize the potential for break-ups during operational phases”; (3) “Limit the probability of accidental collision in orbit”; (4) “Avoid intentional destruction and other harmful activities”; (5) “Minimize potential for post-mission break-ups resulting from stored energy”; (6) “Limit the long-term presence of spacecraft and launch vehicle orbital stages in the LEO region after the end of their mission”; (7) “Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit region after the end of their mission.”¹²⁶

The main issue with the current space debris mitigation proposals and guidelines, and for much of space law, is that they are not binding on spacefaring nations.¹²⁷

Perhaps harder than mitigating space debris is removing it. Space debris cannot be swept up and discarded in the same way as garbage on Earth. If an object is particularly large and dangerous, an intercepting space vehicle must get close and maintain the same speed as the object.¹²⁸ Then the vehicle must attach to the debris, move it into lower orbit or reenter it directly into the atmosphere,

¹²³ Statute of the International Court of Justice, art. 38, ¶ 1 (explaining that international law derives from “international custom, as evidence of a general practice accepted as law”); *North Sea Continental Shelf Cases* (Ger./Den. and Ger./Neth.), Judgment, 1969 I.C.J. 45 (Feb. 20) (noting that *opinio juris* is “a belief that [a] practice is rendered obligatory by the existence of a rule of law requiring it.”).

¹²⁴ IADC STATEMENT, *supra* note 102, at 4.

¹²⁵ *Id.*

¹²⁶ de Waal Alberts, *supra* note 102, at 101 (citing Comm. on the Peaceful Uses of Outer Space, IADC Space Debris Mitigation Guidelines, U.N. Doc. A/AC.105/C.1/L.260 (2010)).

¹²⁷ *Id.*

¹²⁸ THE AEROSPACE CORP., *supra* note 109.

so that it may burn up on reentry.¹²⁹ As it exists, no state, company, nor the international community at large is equipped to handle the current and future risks posed by space debris.

B. Possible Solutions for Mitigating Space Debris

One of the easiest to implement solutions and perhaps most narrowly tailored to the specific concern of MegaLEO space debris is to require MegaLEO operators to monitor for potential satellite collisions, share that data with the government, and install collision avoidance capabilities on each satellite. Solutions to clean up the Earth's orbit are worthwhile, however, the solution to address MegaLEOs' role in space debris must be prospective. In implementing these rules, the potential negative impact that MegaLEOs pose on the orbital environment can be greatly reduced.

The harshest way to begin dealing with the space debris issue is to prohibit worldwide spaceflight until the international community can reach a consensus on solving this issue. This solution is not feasible, nor is the situation drastic enough to call for this measure. It also does not do anything that would otherwise allow scientists to discover how to mitigate or clean up space debris.

Another remedy is to follow the IADC Space Debris Mitigation Guidelines.¹³⁰ These guidelines are a terrific starting point for mitigating space debris and do not overly encumber states or private space companies from exploring and using outer space. The IADC Space Debris Mitigation Guidelines, however, are future-focused, i.e., focused on how to prevent a proliferation of space debris. The guidelines lack any measures that the international community could take to remove space debris already in Earth's orbit. In his article, Anton de Waal Alberts suggests treating and developing the IADC Space Debris Mitigation Guidelines as customary international law and creating a new set of legal guidelines for managing space debris removal.¹³¹

Other solutions include developing and funding new technologies like satellite nets.¹³² One prototype net by the company RemoveDebris can fire a

¹²⁹ *Id.*

¹³⁰ Comm. on the Peaceful Uses of Outer Space, IADC Space Debris Mitigation Guidelines, U.N. Doc. A/AC.105/C.1/L.260 (2010).

¹³¹ de Waal Alberts, *supra* note 102 at 105.

¹³² Thomas Moore, *Satellite Net Developed in the UK Collects Space Junk for the First Time*, SKY NEWS (Sept. 19, 2018, 7:03 AM), <https://news.sky.com/story/satellite-net-developed-in-the-uk-collects-space-junk-for-the-first-time-11501941>.

five-meter-wide net to capture space junk from six meters.¹³³ The weight of the net drags debris down into Earth's atmosphere over the span of a few months, burning up as it descends.¹³⁴ RemoveDebris plans to test navigation systems and special scanners to analyze space junk and also plans to produce harpoons and drag sails for capturing debris.¹³⁵ Astroscale, Inc. has developed "the world's first garbage truck for removing defunct satellites."¹³⁶ An Astroscale space-cleaner works by dragging a satellite from high altitudes into Earth's orbit to burn up by docking to the satellite with a magnetic plate.¹³⁷ The company has successfully tested this docking system.¹³⁸ Many economists and experts, however, fear that space cleaners and nets will not work in clearing space debris because they do not incentivize satellite operators to employ the cleanest methods.¹³⁹

Anton de Waal Alberts suggests implementing an "international launch and orbital tax" to fund the cleanup of space.¹⁴⁰ Such a tax finds parallels to the rehabilitation fund that every mine in South Africa must establish.¹⁴¹ Economists and experts published a paper in the United Kingdom's Proceedings of the National Academy of Sciences arguing for implementing just an orbital tax and not launch fees because "[l]aunch fees by themselves can't induce operators to deorbit their satellites when necessary, and it's not the launch but the orbiting satellite that causes the damage."¹⁴² An international orbital tax or launch and orbital tax system is not feasible. For these systems to work, every launching state must participate and apply the tax at the same rate.¹⁴³ If the tax is applied lower in one state or if the tax is not applied at all in one state, companies will likely flock to that state to escape regulatory constrictions and continue to contribute to the space debris crisis.

¹³³ *Id.*

¹³⁴ *Id.*

¹³⁵ *Id.*

¹³⁶ Shi En Kim, *Can the World's First Space Sweeper Make a Dent in Orbiting Debris?*, SMITHSONIAN MAG. (Aug. 25, 2021), <https://www.smithsonianmag.com/science-nature/can-worlds-first-space-sweeper-make-dent-orbiting-debris-180978515/>.

¹³⁷ *Id.*

¹³⁸ *Id.*

¹³⁹ SKY NEWS, *supra* note 102 (stating that economists claim that space operators do not currently factor in space debris into their decisions to launch, so the addition of space cleaners into orbit will not change their calculus).

¹⁴⁰ de Waal Alberts, *supra* note 102 at 105.

¹⁴¹ *Id.*

¹⁴² SKY NEWS, *supra* note 102.

¹⁴³ *Id.*

IV. SPACE TRAFFIC MANAGEMENT

A. *Legal Issue Presented by Space Traffic*

The quantity of satellites in LEO is projected to grow at an incredible rate in the coming years as more satellites and MegaLEOs are launched into orbit.¹⁴⁴ An ever-increasing number of satellites in MegaLEOs threatens other satellites, objects, and astronauts in orbit. This threat calls upon the international community to devise a better system to manage collision avoidance procedures and cooperate by collecting data and sharing space situational awareness information. Since there is currently no overarching regulatory body managing space traffic, several problems result in the field of space traffic management. These problems include questions of who has the authority to regulate traffic in Earth's orbit, and how a state or intergovernmental entity would regulate space traffic.¹⁴⁵

Space traffic management consists of monitoring, regulating, and coordinating, which are crucial to avoiding collisions, improving the utility of orbital operations, and reducing danger to spacecraft and to the humans within them.¹⁴⁶ Some argue that the emerging situation requires the international community to create a regulatory agency which can administer space traffic management standards under an analog to the International Civil Aviation Organization (ICAO).¹⁴⁷ Others, including Ruth Stilwell, an expert in space and aviation policy, argue that the international community adopt a system similar to the regulation of the high seas in the U.N. Convention on the Law of the Seas (UNCLOS) and create a decentralized system of space traffic coordination.¹⁴⁸

Space traffic cannot be managed in the same way as air traffic.¹⁴⁹ Air traffic control (ATC) is much more precise than space traffic control could ever be because ATC employs sophisticated radar systems that can observe all aircraft in a given area in real time. Space traffic is not observed by radar, but instead based on probabilistic analysis and risk tolerance several days into the future,

¹⁴⁴ Boley & Byers, *supra* note 24, at 1.

¹⁴⁵ *Space Situational Awareness: Key Issues in an Evolving Landscape: Hearing Before the H. Subcomm. on Space & Aeronautics, Comm. on Sci., Space & Tech.*, 116th Cong. 1 (2020) (statement of Ruth Stilwell, Senior Non-Resident Scholar, George Washington University Space Policy Institute).

¹⁴⁶ Brian Weeden, *Space Traffic Management: It's Complicated*, SECURE WORLD FOUND. (June 9, 2021), https://swfound.org/media/207214/bw_stm_its_complicated_f4f_june2021.pdf.

¹⁴⁷ Neel V. Patel, *To Solve Space Traffic Woes, Look to the High Seas*, TECH. REVIEW (Aug. 23, 2021), https://www.technologyreview.com/2021/08/23/1032386/space-traffic-maritime-law-ruth-stilwell/?fbclid=IwAR0rOIVgYi5QZaHUVsdlRUSs0T_UnGBWU6_-2C4PF_84YIG6I1x2YIzHyo.

¹⁴⁸ *Id.*; Ruth Stilwell statement, *supra* note 145.

¹⁴⁹ Weeden, *supra* note 146.

which cannot yield a definitive answer as to whether a collision will occur.¹⁵⁰ Space objects travel at much higher velocities than aircraft, which further complicates traffic management and collision avoidance.¹⁵¹ Furthermore, less than five percent of space traffic can maneuver in orbit, compared to one hundred percent of air traffic, which can maneuver in the sky.¹⁵² Lastly, states only have jurisdiction over objects they launch into orbit and their airspace, but not over orbital regions above their territory.¹⁵³ For airspace over the high seas, where no state exercises a claim of sovereignty, air traffic services are provided by a state with exclusive authority, in accordance with the U.N.'s International Civil Aviation Organization (ICAO) standards and recommended practices.¹⁵⁴ Some parties are working towards global regulations for space traffic by implementing a regulatory regime similar to the ICAO. The European Union, for example, prefers a multilateral-first approach.¹⁵⁵ Under an ICAO model, "every country with satellites would need to implement their own national regime/administration."¹⁵⁶ An approach that looks at maritime law is more decentralized and less concerned with implementing national regimes.

Unlike airspace, the high seas and the orbital domain are not solely for transportation.¹⁵⁷ They also allow for and guarantee the freedom to conduct commercial activity, including telecommunications and remote sensing.¹⁵⁸ There is no authority on the high seas that tells vessels that they may not operate there. Moreover, maritime law does dictate rules on collision avoidance, including priority to maneuver.¹⁵⁹ These applications from the international high seas and maritime law are perhaps the best laws to develop a foundation for space traffic management.

The threat that MegaLEOs pose to existing manmade objects in orbit, astronauts in orbit, and the orbital environment is not some distant worry. Twice in 2021, Starlink satellites drifted within three kilometers of the Chinese space station, Tianhe.¹⁶⁰ China submitted a formal notice to the United Nations

¹⁵⁰ *Id.*

¹⁵¹ *Id.*

¹⁵² *Id.*

¹⁵³ *Id.*

¹⁵⁴ Ruth Stilwell statement, *supra* note 145.

¹⁵⁵ Weeden, *supra* note 146.

¹⁵⁶ *Id.*

¹⁵⁷ Patel, *supra* note 147.

¹⁵⁸ *Id.*

¹⁵⁹ *Id.*

¹⁶⁰ Andrew Jones, *China's Space Station Maneuvered to Avoid Starlink Satellites*, SPACENEWS (Dec. 28, 2021), <https://spacenews.com/chinas-space-station-maneuvered-to-avoid-starlink-satellites/>.

Committee on the Peaceful Uses of Outer Space (UNCOPUOS) that it had to engage in collision avoidance procedures on two occasions as a result of Starlink, in so doing, accusing the United States of failing to abide by its international legal obligation to keep space safe.¹⁶¹ In 2019, a European Space Agency (ESA) satellite had to perform an evasive maneuver to avoid colliding with a Starlink satellite.¹⁶² The ESA claimed that such maneuvers will become so commonplace in the next few years that manual oversight of these operations will probably become impossible, requiring the assistance of artificial intelligence.¹⁶³ Earth's orbit, and for the purposes of this comment, Earth's low orbit, is vast and unregulated. The proliferation of small satellites into LEO causes safety concerns about how satellite traffic is managed or monitored, how collisions may be avoided, and how to protect astronauts in orbit.

Some argue that new norms and principles of responsible behavior need to be established to enhance space traffic management.¹⁶⁴ In November 2021, the U.N.'s First Committee overwhelmingly approved a resolution to create a working group to "make recommendations on possible norms, rules and principles of responsible behaviors relating to threats by States to space systems."¹⁶⁵ The effect of the sheer quantity of small satellites in LEO is very likely to influence this group's determinations on rules and principles. The larger debate in space traffic management is whether to follow a nation-based regulatory scheme, monitor for objects which may impact a nation's own satellites and inform other states of possible collision, or to create a globalized regulatory scheme which monitors and controls space traffic.¹⁶⁶ In addition to rules and guidelines about satellite conduct, the owners and operators of satellites, and those with interests in the orbital environment, are economically motivated to avoid collisions, and thus would benefit from more cooperation on data collection of space traffic and imminent collision warnings.¹⁶⁷

¹⁶¹ NEWSRADIO, *AUDIO: China Says 'Close-Encounters' with Elon Musk's Satellites Put Astronauts at Risk*, ABC NEWS, at 01:29 (Dec. 29, 2021, 1:20 AM), <https://www.abc.net.au/news/2021-12-29/china-says-close-encounters-with-elon-musks/13691676> (interview with Prof. Steven Freeland, co-chair of a working group in the UNCOUOS).

¹⁶² Mike Wall, *European Satellite Dodges Potential Collision with SpaceX Starlink Craft*, SPACE.COM (Sept. 3, 2019), <https://www.space.com/spacex-starlink-esa-satellite-collision-avoidance.html>.

¹⁶³ *Id.*

¹⁶⁴ NEWSRADIO, *supra* note 161.

¹⁶⁵ Greg Hadley, *UN Committee Advances Proposal on Rules Governing Behavior in Space*, AIR FORCE MAG. (Nov. 2, 2021), <https://www.airforcemag.com/united-nations-votes-working-group-space-rules/>.

¹⁶⁶ NEWSRADIO, *supra* note 161.

¹⁶⁷ Jeff Foust, *From Space Traffic Awareness to Space Traffic Management*, SPACENEWS (Oct. 20, 2021), <https://spacenews.com/from-space-traffic-awareness-to-space-traffic-management/>.

The entity that comes closest to a global space traffic monitor is the U.S. Space Force's 18th Space Control Command Squadron, which monitors the orbit and alerts owner-operators of satellites if a close approach is possible.¹⁶⁸ The owner-operator then does as it wishes with that information and the Squadron continues to monitor the situation.¹⁶⁹ Nonetheless, more data sharing is required to prevent accidents and threats to property and life in orbit.¹⁷⁰

B. Possible Solutions to Managing Space Traffic

As previously mentioned, there are two primary approaches to monitoring or managing space traffic and preventing collisions. One approach is to create an international regulatory body with enforcement authority to regulate space traffic. The other approach is to build upon the existing structure of monitoring for collisions, sharing data and flight trajectory, and establishing rules and norms for managing space traffic. An international regulatory body would essentially create a governing structure and traffic management system from scratch, given that parallels to aviation traffic management are not as adaptable to orbital operations as maritime law. As such, not only is the latter approach more feasible, but it is currently in progress and can draw its foundational legal principles from existing maritime law.

With no near-term expectation of a centralized space traffic control authority, a self-organized network of satellite operators, who share data and standards for collision maneuvers, is the more feasible and better approach to implement a space traffic management system.¹⁷¹ Three steps are required to set up a decentralized space traffic management system:

- (1) “[i]nternational agreement on standards of behavior for the purpose of collision avoidance”;
- (2) “[p]rocesses and agreements for the collection and sharing of space situational awareness information, including space surveillance and operator information”; and
- (3) “[e]xpansion of market for conjunction assessment and alerting services.”¹⁷²

¹⁶⁸ *Id.* (quoting Ruth Stilwell, executive director of Aerospace Policy Solutions).

¹⁶⁹ *Id.*

¹⁷⁰ *Id.*

¹⁷¹ *Id.*

¹⁷² Ruth Stilwell statement, *supra* note 145.

It is important that the international community agree on shared standards of behavior and norms for collision avoidance, whether it chooses to go the path of a centralized or decentralized space traffic management system. Just as there are the International Regulations for Preventing Collisions at Sea, the international community and MegaLEO owner-operators need to agree on norms and standards to prevent collisions in orbit.¹⁷³ Market forces would drive these MegaLEO firms to share information regarding potential collisions. One trusted global entity, like the 18th Space Control Squadron, could control data on space traffic and transmit it to interested parties. Such an arrangement, however, may not be trusted as some businesses and countries may be suspicious of handing over such power to the United States or a single entity.¹⁷⁴ One novel suggestion to keep the trade of data decentralized while trustworthy is to use blockchain to input information.¹⁷⁵ In this way, the inputter of information can be validated, and that information cannot be altered by third parties.¹⁷⁶

In a decentralized space traffic management system, governments, industries, and other entities with the capacity to collect space surveillance information would transmit that data to the collected service.¹⁷⁷ While collection and distribution of the data is ongoing, operators would be required to react to orbital risks in a predictable manner, under an agreed upon set of rules and norms.¹⁷⁸

An alternative space traffic management system looks to “near space” traffic management, under which operations fly unmanned objects above sixty kilometers for long durations; much of the airspace above twenty kilometers is uncontrolled, and market demand for that airspace is increasing.¹⁷⁹ In the “near space” field, all operators have shared situational awareness, i.e., they have knowledge of the traffic and hazards, and operators are responsible for performing avoidance maneuvers.¹⁸⁰ By looking at developments in “near space” traffic management, the international community can better determine the best policy for LEO. If space operations are not effectively managed or overseen, states which have yet to send satellites to Earth’s orbit may be

¹⁷³ International Regulations for Preventing Collisions at Sea, Jan. 19, 1977, 42 Fed. Reg. 17112, 1050 U.N.T.S. 15824.

¹⁷⁴ Patel, *supra* note 147.

¹⁷⁵ *Id.*

¹⁷⁶ *Id.*

¹⁷⁷ Ruth Stilwell statement, *supra* note 145.

¹⁷⁸ *Id.*

¹⁷⁹ *Id.*

¹⁸⁰ *Id.*

foreclosed from that opportunity, and indeed from deep space exploration and commercial activities in space.

V. MEGALEOS' THREAT TO THE NON-APPROPRIATION PRINCIPLE IN THE OUTER SPACE TREATY

A. *Legal Issue Presented by Non-Appropriation*

As previously discussed, the abundance of MegaLEOs exacerbates issues of space traffic and space debris. Tens of thousands of satellites in LEO may collide from lack of traffic management.¹⁸¹ Furthermore, junk from rockets, collisions, and nonfunctional satellites stuck in orbit threaten to limit access to the resources of outer space to states and nongovernmental actors with interests in space exploration and exploitation.¹⁸² Article I of the Outer Space Treaty established that the exploration and use of outer space is “the province of all mankind” and is done “without discrimination of any kind, on a basis of equality and in accordance with international law”¹⁸³ Therefore, the issue arises as to whether current spacefaring nations must allocate future usability of orbital slots to developing nations, which may one day desire to send satellites into orbit.

The non-appropriation principle in Article I of the Outer Space Treaty, which bars states from asserting exclusive rights in outer space, is treated as customary international law.¹⁸⁴ Some would argue that MegaLEOs create an impermissible appropriation of space. Those who read the non-appropriation principle strictly would claim that MegaLEOs exclude other actors from orbital planes. A strict interpretation asserts that orbital planes are impermissibly appropriated for several reasons.

MegaLEOs can occupy a great deal of the LEO even though the satellites are not fixed in their orbits. Satellites in MegaLEOs are granted orbital planes, however, and they may remain indefinitely in orbit for hundreds of years before falling to Earth.¹⁸⁵ This can have present and potential future effects of contaminating the orbital environment and possibly Earth's surface.¹⁸⁶ MegaLEOs are considered to be appropriating space because states are not

¹⁸¹ Mejia-Kaiser, *supra* note 26.

¹⁸² de Gouyon Matignon, *supra* note 108.

¹⁸³ Christopher D. Johnson, *The Legal Status of MegaLEO Constellations and Concerns About Appropriation of Large Swaths of Earth Orbit*, in HANDBOOK OF SMALL SATELLITES 1, 16 (Joseph N. Pelton ed., 2020).

¹⁸⁴ Goswami & Aggarwal, *supra* note 100.

¹⁸⁵ Johnson, *supra* note 183, at 15-18.

¹⁸⁶ *Id.*

properly regulating orbital operations of MegaLEOs, as it is their duty under the Outer Space Treaty to authorize and supervise private businesses in space.¹⁸⁷ MegaLEOs may also impermissibly appropriate space because the multitude of satellites prevent the use of space by other entities which have yet to reach spacefaring capabilities or develop plans for satellite operations.¹⁸⁸ MegaLEOs also pose a risk to future launches “as there would be fewer launch windows available due to thousands more satellites passing within a rocket’s planned flight path.”¹⁸⁹ Increasing unavailability of safe launch windows should be worrisome to all states, and especially to future states interested in space exploration and exploitation which may find themselves foreclosed from ever conducting space activities.

Developing nations that are not currently spacefaring or lack the capacity for large-scale space projects are particularly setback by the exponential growth of MegaLEOs.¹⁹⁰ Although there is currently plenty of space in Earth’s orbit, MegaLEOs’ exclusive orbital slots may bar these states and the companies within them from enjoying and exploring space. In 1976, seven equatorial states, Colombia, Republic of Congo, Ecuador, Kenya, Uganda, and Zaire claimed sovereignty to portions of the GSOs located above their territory to preserve their future interests in space against developed countries under the Bogotá Declaration.¹⁹¹ The Declaration did not give a legal basis justifying the assertion that portions of GSOs can be claimed by equatorial states.¹⁹² Due to international pushback to their stance, these equatorial states no longer claim exclusive rights over their portions of GSOs, but rather “preferential rights,” with Colombia comparing its preferential rights to the Exclusive Economic Zone in the Law of the Sea.¹⁹³

The International Telecommunications Union (ITU) coordinates the use of usable portions of the electromagnetic spectrum and the use of orbital slots at GSO altitude.¹⁹⁴ This coordination “is designed to foster the rational, equitable,

¹⁸⁷ *Id.*

¹⁸⁸ *Id.*

¹⁸⁹ See Elizabeth Howell, *NASA Is Concerned About SpaceX’s New Generation of Starlink Satellites*, SPACE.COM (Feb. 10, 2022), <https://www.space.com/nasa-collision-risk-starlink>.

¹⁹⁰ Goswami & Aggarwal, *supra* note 100.

¹⁹¹ Nicolas Giacomini, *The Bogotá Declaration and Space Law*, SPACE LEGAL ISSUES (Dec. 4, 2019), <https://web.archive.org/web/20220602165359/https://www.spacelegalissues.com/the-bogota-declaration-and-space-law/>; see Goswami & Aggarwal, *supra* note 100.

¹⁹² Giacomini, *supra* note 191.

¹⁹³ *Id.*; *Exclusive Economic Zone*, BLACK’S LAW DICTIONARY (11th ed. 2019) (“an area just beyond the territorial sea, extending up to 200 nautical miles from the baseline of the territorial sea, in which the coastal country enjoys special authority for economic purposes”).

¹⁹⁴ Johnson, *supra* note 183, at 10.

efficient, and economical use of these resources.”¹⁹⁵ The ITU operates under the concept of equitable access for satellites in GSO, which is the assumption that each state, spacefaring or not, has “access to space and to the necessary spectrum to communicate to and from satellites, without posing or receiving interferences to others.”¹⁹⁶ Non-GSO satellites (NGSO), similar to satellites in MegaLEOs, are not subject to the equitable access principle; rather, their allocation of orbital slots and related spectrum is subject to a first come, first served basis.¹⁹⁷ The principle of equitable access has worked for GSO satellites and is important for their operation due to their orbital limitations and optimal telecommunications applications.¹⁹⁸ Given that there is a low global demand for GSO satellites and has been an exponential increase in the number of small satellites in MegaLEOs, the equitable access principle may not be equitably applied to the future space economy.¹⁹⁹

In 2019, the 38th ITU World Radiocommunication Conference adopted a new regulatory approach for the deployment of NGSO satellites.²⁰⁰ In an attempt to facilitate NGSO satellite systems and prevent spectrum warehousing (the intentional overestimation of the amount of satellites a company intends to deploy), these systems “will be required to deploy [ten percent] of their constellations within two years from the end of the current period for bringing into use, [fifty percent] within five years, and complete the deployment within seven years.”²⁰¹ This regulatory approach, if adopted by member states, may reduce companies’ ability to unfairly lay claim to orbital slots and portions of the electromagnetic spectrum. If, however, these companies follow through on their deployment plans, then this regulatory approach may have no effect or have the effect of speeding up the congestion of MegaLEOs in orbit. Nonetheless, this regulatory scheme is not a true gamechanger, whereas applying the equitable access principle to satellites in LEO would be.

¹⁹⁵ *Id.*

¹⁹⁶ Matteo Cappella, *The Principle of Equitable Access in the Age of Mega-Constellations*, in LEGAL ASPECTS AROUND SATELLITE CONSTELLATIONS 11, 11 (Annette Froehlich ed., 2019) (citing the Constitution of the International Telecommunications Union art. 44, Dec. 22, 1992, 1825 U.N.T.S. 331).

¹⁹⁷ *Id.*

¹⁹⁸ *Id.* at 16.

¹⁹⁹ *Id.*

²⁰⁰ Sharm El-Sheikh, *ITU World Radiocommunication Conference Adopts New Regulatory Procedures for Non-Geostationary Satellites*, INT’L TELECOMMS. UNION (Nov. 20, 2019), <https://www.itu.int/en/mediacentre/Pages/2019-PR23.aspx>.

²⁰¹ *Id.*

B. Possible Solutions to Non-Appropriation

The solution to MegaLEOs' threat to the non-appropriation principle in the Outer Space Treaty lies neither with limiting orbital paths and electromagnetic frequency allocations and saving them for future spacefaring nations, nor with allowing a first come, first served system of permanent allocation: it lies in the middle. One solution is to give satellites a fixed-term lease of an orbital slot, after which the satellite must move to a different orbital slot or burn up in the atmosphere in such a way that does not produce space debris. In this way, the fixed-term lease rewards current MegaLEO operators' investments by allowing operators to maintain satellites for a given period but incentivizes operators to not engage in spectrum warehousing and to produce actual results when they apply for relicensing.

Another solution is to follow the ITU's recent regulatory approach. This approach is commendable because it prevents satellite operators from filing for more orbital slots than they can physically fill.²⁰² This solution, however, may produce more waste than intended as satellites may be designed for short shelf lives. Some argue that the ITU ought to apply the equitable access principle to satellites in LEO as well as satellites in GSO.²⁰³ This will become especially important as the demand for satellites in GSO decreases and satellites in LEO are launched by the thousands every year.

A third solution is to pass a new outer space treaty for the 21st century, which encompasses many of these issues and gives regulatory oversight of satellites in LEO to a new international agency with enforcement power. Despite this, it may not be prudent to set aside room for non-spacefaring nations or future internet operators. When the time comes for terrestrial nations to join the spacefaring community, international law can bring the international community together to fulfill the Outer Space Treaty's promise of equitable rights to outer space exploration and use.

Lastly, instead of using their limited resources to achieve a spacefaring status, non-spacefaring states can employ the resources of MegaLEO operators to provide them with high-speed satellite internet. Around 2.9 billion people have never used the internet, many of whom are in developing countries and in

²⁰² *Id.*

²⁰³ Cappella, *supra* note 196, at 11 (citing the Constitution of the International Telecommunications Union art. 44, Dec. 22, 1992, 1825 U.N.T.S. 331).

areas without internet capabilities.²⁰⁴ Satellite internet can reach areas previously inaccessible to internet. As of May 2022, SpaceX is in discussions with Brazil to provide high-speed internet to 19,000 schools in rural areas and provide economic monitoring of the Amazon rainforest.²⁰⁵ Although internet via MegaLEOs promises to spread to every corner of the world, the high price of internet access may prohibit many from obtaining it.²⁰⁶

CONCLUSION

The space race of the 21st century is unlike the space race of the late 1950s and '60s. Whereas the space race of the mid-20th century pitted the capitalist United States against the communist Soviet Union in a competition over technological, military, and space superiority, the space race we are now entering is mainly between private companies run by eccentric multi-billionaires.²⁰⁷ Three of the richest men in the world, Elon Musk, Jeff Bezos, and Sir Richard Branson, each operate a space company that engages in space tourism, satellite telecommunications, government contracting, space exploration, ISS refueling, or space colonization.. Indeed, many other smaller private companies are taking advantage of using space as a resource.²⁰⁸ This new space race is market-driven and the market for lower-cost, high-speed satellite internet will grow in the years to come.²⁰⁹

The incredible rate at which MegaLEOs are launched into orbit raises the legal concern of information censorship from “mega-constellations” with laser connections, and exacerbates existing legal concerns, including space traffic management, space debris, and non-appropriation of outer space. Current space

²⁰⁴ Ellen Francis, *1 in 3 People Around the World Have Never Used the Internet, a U.N. Report Estimates*, WASH. POST (Dec. 1, 2021, 9:44 AM), <https://www.washingtonpost.com/world/2021/12/01/global-internet-usage/>.

²⁰⁵ *Elon Musk Meets with Brazil's Jair Bolsonaro to Discuss Amazon Plans*, CBS NEWS (May 20, 2022, 3:21 PM), <https://www.cbsnews.com/news/elon-musk-jair-bolsonaro-amazon-rainforest-twitter-tesla/>.

²⁰⁶ Neel V. Patel, *Who is Starlink Really For?*, MIT TECH. REV. (Sept. 6, 2021), <https://www.technologyreview.com/2021/09/06/1034373/starlink-rural-fcc-satellite-internet/> (“One gigabit of data in sub-Saharan Africa costs 40% of the average monthly wage.”).

²⁰⁷ *The Space Race*, HISTORY.COM (Feb. 21, 2020), <https://www.history.com/topics/cold-war/space-race>.

²⁰⁸ Jamie Carter, *11 Incredible Space Missions in 2022 You Need to Know About*, FORBES (Dec. 28, 2021, 10:00 PM), <https://www.forbes.com/sites/jamiecartereurope/2021/12/28/nasa-returns-to-the-moon-europa-in-close-up-and-a-priceless-asteroid-7-incredible-space-missions-in-2022-you-need-to-know-about/?sh=13f80ca75af3>.

²⁰⁹ *Satellite Internet Market to Generate \$18.59 Billion by 2030, Predicted by Allied Market Research*, GLOBENEWSWIRE (Aug. 5, 2021, 10:39 AM), <https://www.globenewswire.com/news-release/2021/08/05/2275808/0/en/Satellite-Internet-Market-to-Generate-18-59-Billion-by-2030-Predicted-by-Allied-Market-Research.html>.

law is underdeveloped and largely unenforceable, yet it provides an important framework to help analyze these issues and their potential solutions. While some argue that space law's underdevelopment requires a "stricter institutional regime with competent jurisdiction and expert knowledge to drive the enforcement of international treaties as well as resolve ambiguities therein," others argue that the free market will incentivize businesses and governments to cooperate to achieve common goals for mitigating and removing space debris and managing space traffic.²¹⁰

Although the ability of states to censor internet signals from MegaLEOs is a frightening prospect, it is likely allowed under international law. Nevertheless, the war in Ukraine shows us how a MegaLEO operator can work with the United States to promote the free flow of information in a state where internet access is restricted by a foreign government. Internet via MegaLEOs may prove to be how citizens across the world can receive censored information.

Space debris is the most immediate and difficult issue that faces the space community, which is aggravated by the proliferation of MegaLEOs to be launched. One collision can prevent humanity from launching rockets or people into orbit for decades should a Kessler syndrome event occur. A promising solution is for MegaLEO operators to monitor for potential satellite collisions, share that data with their government, and install collision avoidance capabilities on each satellite.

Space traffic management is an issue that is similarly important but will largely be addressed between interested parties through cooperation and the development of international norms and customs. MegaLEO operators and states would work together to develop and expand on a decentralized space traffic management system that can be implemented immediately.

The threat to the non-appropriation principle is the least immediate issue that MegaLEOs currently pose. As of today, small satellites do not have the numbers to be considered appropriation of space. It is important, however, that these satellites are not granted indefinite leases to orbital paths.

²¹⁰ Feyisola Ruth Ishola et al., *Legal Enforceability of International Space Laws: An Appraisal of 1967 Outer Space Treaty*, 9 *NEW SPACE* 33, 37 (2021) (arguing for a stricter institutional regime); Neel V. Patel, *To Solve Space Traffic Woes, Look to the High Seas*, *TECH. REV.* (Aug. 23, 2021), https://www.technologyreview.com/2021/08/23/1032386/space-traffic-maritime-law-ruth-stilwell/?fbclid=IwAR0rOIVgYi5QZaHUVsdIRUSs0T_IUnGBWU6_-2C4PF_84YIG6I1x2YIzHyo (noting the influence of the free market on cooperation in space).

U.S. agencies and departments with activities in or related to space have voiced many of these same concerns about MegaLEOs. In a joint letter to the Federal Communications Commission (FCC) on February 8, 2022, the National Telecommunications and Information Administration, NASA, and the National Science Foundation expressed the following concerns about a pending FCC application from SpaceX's Starlink for an additional 30,000 satellites: (1) substantial congestion in LEO environment, (2) lack of collision avoidance coordination, (3) potential loss of launch/entry opportunities due to parking in common phasing altitudes, (4) increasing unavailability of safe launch windows, (5) long-term sustainability of space environment, and (6) impacts to NASA science and human spaceflight missions.²¹¹ In its letter, NASA expressed its wishes to collaborate further with SpaceX "at a national and international level" to improve operations and mitigate collisions.²¹²

Space must be for "the province of all mankind" and allocated "without discrimination of any kind, on a basis of equality and in accordance with international law . . ." ²¹³ And at the same time, individuals, non-governmental entities, and governments must be able to use space to improve daily life, society, and economic outcomes. Balancing those goals is difficult, but it is necessary to shape a legal regime for outer space in the 21st century.

STEVEN E. GROTCHE

²¹¹ Letter from Kathy Smith, Chief Counsel, Nat'l Telecomm. & Info. Admin. to Marlene Dortch, Secretary, Fed. Comm'n Comm'n (Feb. 8, 2022) (on file with Federal Communications Commission), <https://www.scribd.com/document/557924666/NTIA-NASA-NSF-letter-to-FCC-regarding-Starlink-Gen-2>; Letter from Samantha Fonder, NASA Representative to the Commercial Space Transportation Interagency Group to Marlene Dortch, Secretary, Fed. Comm'n Comm'n (Feb. 7, 2022) (on file with Federal Communications Commission), <https://www.scribd.com/document/557924666/NTIA-NASA-NSF-letter-to-FCC-regarding-Starlink-Gen-2>; Jonathan Williams & Ashley VanderLey, Nat'l Sci. Found. to Marlene Dortch, Secretary, Fed. Comm'n Comm'n (Feb. 8, 2022), (on file with Federal Communications Commission) <https://www.scribd.com/document/557924666/NTIA-NASA-NSF-letter-to-FCC-regarding-Starlink-Gen-2>.

²¹² Letter from Samantha Fonder, NASA Representative to the Commercial Space Transportation Interagency Group to Marlene Dortch, Secretary, Fed. Comm'n Comm'n (Feb. 7, 2022) (on file with Federal Communications Commission), <https://www.scribd.com/document/557924666/NTIA-NASA-NSF-letter-to-FCC-regarding-Starlink-Gen-2>.

²¹³ Johnson, *supra* note 183.