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Regulating Science Fiction: The Regulatory Deficiencies in a Rapidly Growing Commercial Space Industry

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REGULATING SCIENCE FICTION: THE REGULATORY DEFICIENCIES IN A RAPIDLY GROWING COMMERCIAL SPACE INDUSTRY

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ABSTRACT

This Comment explores the deficiencies of the legal framework governing commercial space with the advent of satellite mega-constellations. The scope and size of these so-called constellations are completely unlike anything the space industry has contemplated since the first rocket was launched into orbit. Moreover, these constellations are an extremely new phenomenon—the prime movers in the industry are just beginning to create these massive man-made wonders in space. As such, the legal framework was designed around space operations that were much smaller in scope. That framework has struggled to keep pace with the rapidly growing commercial space industry generally and the constellation industry specifically.

This Comment begins by explaining some of the pressing concerns regarding space exploration roused by the addition of tens of thousands of small satellites primarily within Earth's lower orbit. It then lays out the relevant regulatory framework. It discusses how that framework has operated in the past, how it has been applied to commercial satellite constellations so far, and how it has changed over the past few years. Finally, this Comment discusses the reality of satellite constellation regulation—that it is being largely self-regulated by the industry. It analyzes the benefits and negative aspects of that reality, and it concludes with a proposal on how to move forward with space regulation such that the continued viability of space exploration and the protection of relevant stakeholders will be assured well into the future.

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I. INTRODUCTION

SINCE THE FIRST SATELLITE launch in 1957, there have only been a total of about 13,630 satellites launched into space, a significant number of which can be attributed to recent launches by SpaceX and others.[1] As of May 2022, 5,465 of those satellites are currently operating in space.[2] SpaceX, the private space-exploration company leading the charge, plans to send over 40,000 satellites into space on its own as a part of its Starlink project, the ultimate purpose of which is to provide global high-speed internet.[3] SpaceX claims that it is "meeting or exceeding all regulatory and industry standards."[4] Indeed, that claim is very likely true. However, are projects that greatly exceed the total number of satellites ever launched within the scope of those regulations and industry standards? Moreover, will those regulations and standards be sufficient to protect *all*

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[1] *Compare* Adam Mann, Tereza Pultarova & Elizabeth Howell, *SpaceX Starlink Internet: Costs, Collision Risks and How It Works*, SPACE.COM (Apr. 14, 2022), https://www.space.com/spacex-starlink-satellites.html [https://perma.cc/9AM2-4D8M], *with Space Debris by the Numbers*, EUR. SPACE AGENCY (Aug. 11, 2022), https://www.esa.int/Safety_Security/Space_Debris/Space_debris_by_the_numbers [https://perma.cc/9AM2-4D8M] [hereinafter *Space Debris by the Numbers*].

[2] *UCS Satellite Database*, UNION CONCERNED SCIENTISTS, https://www.ucsusa.org/resources/satellite-database [https://perma.cc/7GZ6-4NBV] (May 1, 2022).

[3] Mann et al., *supra* note 1.

[4] *World's Most Advanced Broadband Satellite Internet*, STARLINK, https://www.starlink.com/satellites [https://perma.cc/8MCH-YST6].

stakeholders' interests[5] in light of these massive projects? Obviously, key players such as SpaceX will protect their own interests to the best of their abilities, but the coordination of tens of thousands of satellites launched by other entities poses a monumental challenge that extends beyond the efforts of a few key players. The margin of error is slim, and the risks are extreme.[6]

A satellite mega-constellation is a group of satellites—potentially numbering in the thousands—that communicate with each other and receivers on Earth, with an aim to provide worldwide services.[7] Many of those satellites will operate in low Earth orbit (LEO), and there is significant concern over the amount of "real estate" these man-made constellations will occupy in LEO due to the risk of potential collisions.[8] Further, there is growing concern that the current regulatory structure has allowed private companies with significant resources such as SpaceX and Blue Origin to begin capitalizing on the low regulatory bar by launching massive amounts of satellites before the regulatory regime can slow them down.[9] Skirting environmental review during licensing, for example, is something that may change before long.[10] Indeed, the Federal Communications Commission (FCC) is being sued by two SpaceX competitors for authorizing SpaceX's launch of thousands of small satellites into

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[5] "Stakeholders" in this context means anyone affected by the consequences of space operations. At its narrowest, the term refers to astronomers as a class—i.e., people whose jobs, livelihoods, or industries are directly affected by space operations. At its broadest, the term refers to almost everyone on the planet in that there is a shared interest in the continued innovation and expansion of space operations. *See, e.g.*, *Stakeholder*, MERRIAM-WEBSTER, https://www.merriam-webster.com/dictionary/stakeholder [https://perma.cc/MT6H-NAMY] (defining "stakeholder" in the abstract as "one that has a stake in an enterprise" or "one who is involved in or affected by a course of action").

[6] *See* Mann et al., *supra* note 1 (reporting that in 2019, the probability of collision was 1 in 1,000, but in August 2021, "Starlink satellites were involved every week in about 1,600 encounters between two spacecraft closer than 0.6 miles").

[7] 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/ [https://perma.cc/9UFV-3FP5].

[8] *Id.*; 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, 2–3 (J. Pelton ed., 2020).

[9] Peggy Hollinger & Clive Cookson, *Elon Musk Being Allowed to 'Make the Rules' in Space, ESA Chief Warns*, FIN. TIMES (Dec. 5, 2021), https://www.ft.com/content/7d561078-37c7-4902-a094-637b81a26241 [https://perma.cc/6ZXN-ULFZ].

[10] Ramon J. Ryan, *The Fault in Our Stars: Challenging the FCC's Treatment of Commercial Satellites as Categorically Excluded from Review Under the National Environmental Policy Act*, 22 VAND. J. ENT. & TECH. L. 923, 924–27 (2020).

LEO without an environmental review.[11] Absent a judicial stay on SpaceX launches, however, SpaceX will continue to launch satellites in batches of several dozen at a time.[12]

Commentators have raised various specific issues regarding the controversy surrounding mega-constellations. While some predicted the FCC would be brought into litigation over mega-constellations and have offered suggestions on how private companies should navigate the legal framework to avoid litigation,[13] others have adamantly argued that legislation like the National Environmental Policy Act (NEPA) has no application to activities solely within the province and jurisdiction of space.[14] While these commentaries offer insightful analysis of the current regulatory framework—just as current litigation against the FCC is testing that framework—an important question remains unanswered: Why is there not a more satisfactory regulatory framework through which these issues can be resolved?

The FCC has been, for all intents and purposes, grandfathered into its regulatory power over satellites from a general authorization to regulate radio use.[15] The notion that Congress intended for the FCC to regulate the launch of tens of thousands of satellites while enjoying its categorical exemption from NEPA review seems questionable at best. Further, to say that NEPA is the best way to protect environmental and other legitimate interests on Earth is telling as to the utter inadequacy of space regulation in its current form. Critics have a legitimate argument that NEPA should not extend to activities in space.[16] However, the suggestion that *nothing* should regulate space activity or the effects that such activity may have on Earth in the ab-

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[11] Khorri Atkinson, *FCC Ripped at DC Circ. over SpaceX's Satellite Launch*, LAW360 (Aug. 9, 2021, 7:21 PM), https://www.law360.com/articles/1410921/fcc-ripped-at-dc-circ-over-spacex-s-satellite-launch- [https://perma.cc/Y96D-3KC5]; *see generally* Final Brief of Appellants Viasat, Inc. and the Balance Group. at 1–2, Viasat, Inc. v. FCC, Nos. 21-1123, -1125, -1128 (D.C. Cir. Oct. 26, 2021).

[12] Atkinson, *supra* note 11; Amy Thompson, *SpaceX Lofts 49 Starlink Internet Satellites to Orbit in 1st Launch of 2022*, SPACE.COM (Jan. 6, 2022), https://www.space.com/spacex-starlink-launch-success-january-2022 [https://perma.cc/2548-EFXM].

[13] Ryan, *supra* note 10, at 949–50.

[14] MICHAEL J. ELLIS, THE HERITAGE FOUND., KEEP ENVIRONMENTAL RED TAPE OUT OF OUTER SPACE, 1, 1 (2021), https://www.heritage.org/government-regulation/report/keep-environmental-red-tape-out-outer-space [https://perma.cc/H8L8-G3KG].

[15] DANIEL MORGAN, CONG. RSCH. SERV., R45416, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 11–12 (2018).

[16] ELLIS, *supra* note 14, at 3–5.

sence of NEPA is a wholly untenable position. So, why is there nothing better to turn to?

Frankly, the current regulatory framework was not prepared for the new and intense commercial interest in mega-constellations. Rather than tightening its regulatory grip on the industry to ensure space enterprises are proceeding safely and intelligently, the government has opted to let the industry regulate itself—an admittedly common administrative stance.[17] But can self-regulation be left unfettered in the fragile context of space exploration? This Comment proposes that the current litigation between the FCC, Viasat, and others[18]—regardless of the outcome—highlights the dysfunctionality and inadequacy of current space regulation. The fate of space exploration should not be left to a haphazard jumble of outdated, incoherent regulatory constraints while the industry forges ahead at breakneck pace to secure its place in the stars, potentially dooming the industry in the process. Efforts must be made immediately and tactfully to guide commercial space enterprises in their pursuit to make science fiction a reality.

This Comment will first walk through the basics: Part II will discuss mega-constellations, the concerns surrounding those constellations, and the enterprises and entities that are sending or planning to send small satellites into orbit. Part III will then walk through the international and domestic frameworks, including recent changes to those frameworks. Part IV will analyze what could be expected from those frameworks based on analogous settings. It will weigh the pros and cons of the current frameworks in the unique context of satellite constellations. It will also offer potential modifications to tailor the frameworks towards growing needs and concerns.

II. MEGA-CONSTELLATIONS, CONCERNS, AND KEY PLAYERS EXPLAINED

A. Satellite Mega-Constellations[19]

Satellite mega-constellations are vast systems of satellites that use hundreds, thousands, or even tens of thousands of similar satellites that aim to provide global internet access, among other

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[17] *See infra* Parts III–IV.

[18] For a refresher on this litigation, see *supra* note 11 and accompanying text.

[19] The terms "satellite mega-constellation(s)," "satellite constellation(s)," or simply "constellation(s)" are used interchangeably throughout this Comment except where stated otherwise.

things.[20] Rather than using larger satellites at higher, fixed positions (i.e., geostationary orbit)—the traditional method of satellite internet service—these satellite constellations orbit Earth at a much lower altitude (i.e., non-geostationary orbit) and are much closer together.[21] Since these satellites are much closer to Earth, they do not have the same latency issues as their larger, farther away predecessors, which makes them an attractive choice for internet provision.[22] Since so many satellites make up a constellation, a net of seamless connectivity is possible between the satellite system and receivers that can be placed virtually anywhere on the planet and still connect to the web of satellites above.[23] Satellite internet generally allows for easier access in rural and underserved areas of the globe because there is no need to physically lay down cable connections for those areas to receive internet.[24]

Thus, through satellite mega-constellations like Starlink, "[p]eople across the globe [can] . . . gain access to education, health services and even communications support during natural disasters."[25] Indeed, in a powerful display of Starlink's capabilities, SpaceX CEO Elon Musk reported that Starlink internet services were available within just a few hours of the Ukrainian Deputy Prime Minister's plea for internet to help combat Russia's invasion of Ukraine.[26] Thus, it is easy to see the benefits these satellite systems can provide, and they could be a huge step in the advancement of telecommunications. There are, however, some concerns that have been raised by astronomers and other scientists based on the sheer number of planned satellites at such a low orbit.

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[20] *See What Is a Satellite Constellation?*, SODAH, https://www.sodahconstellation.eu/what-is-a-satellite-constellation/ [https://perma.cc/2E8J-RZNH]; *Satellite Constellations*, INT'L ASTRONOMICAL UNION (Feb. 12, 2020), https://www.iau.org/public/themes/satellite-constellations/ [https://perma.cc/Q6ZM-J7VL].

[21] *See* SODAH, *supra* note 20.

[22] *See id.*

[23] *Id.*

[24] *Id.*

[25] *Order Starlink*, STARLINK, https://www.starlink.com/ [https://perma.cc/UA82-R4ZZ].

[26] *See* Natalia Kniazhevich, *Elon Musk Activates Starlink Satellites in Response to Ukraine Plea*, BLOOMBERG (Feb. 26, 2022, 6:28 PM), https://www.bloomberg.com/news/articles/2022-02-27/musk-activates-starlink-satellites-in-response-to-ukraine-plea [https://perma.cc/H57Q-93YX].

B. Mega-Constellations Concerns

There are several concerns over mega-constellations that impact both celestial and earthbound interests. Importantly, these concerns are not merely academic, nor do they only affect a small group of stakeholders. Indeed, the private and public entities that could benefit the most from these systems of satellites also have the most to lose should something go wrong. This Section first explores potential environmental impacts such as pollution and ozone threats, then discusses the dangers posed by space debris, and finally analyzes recent research that shows how all of those concerns could be interrelated.

To start, a recent article published in the *Vanderbilt Journal of Entertainment & Technology Law* brought into focus the FCC's categorical exemption from NEPA and how a court would likely strike down that exemption should the FCC apply it to the authorization of satellite mega-constellations.[27] The article's author, Ramon Ryan, argued that the cumulative effects that massive satellite systems could have on the environment should impose an obligation upon the FCC to conduct an environmental review as a part of the authorization process.[28]

Prompted by the article,[29] SpaceX competitors Viasat and Dish Network filed suit against the FCC claiming that it violated NEPA by not conducting an environmental review prior to authorizing SpaceX's request to lower the orbit of thousands of satellites that form its ongoing project, Starlink.[30] Viasat argued that SpaceX's satellite system warrants a detailed environmental review because (1) the satellites will dump massive amounts of pollutants upon re-entry into Earth's atmosphere, and (2) the satellites will be so numerous that the light pollution caused by the sun reflecting off of them will significantly alter the night sky.[31]

Some have posited that Viasat's argument should fail because "[w]ithout any relevant conduct inside of the United States, NEPA would not extend into outer space."[32] In other words, NEPA's jurisdiction is limited to conduct that takes place in the United States and simply does not extend to space.[33] While this

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[27] *See* Ryan, *supra* note 10, at 924–27.
[28] *Id.*
[29] *See* Ellis, *supra* note 14, at 7.
[30] *See* Atkinson, *supra* note 11.
[31] *Id.*
[32] Ellis, *supra* note 14, at 4.
[33] *See id.*

argument may be a good legal argument to make against Viasat and others who bring suit, the underlying concerns are still legitimate—satellite constellations dump pollutants into the atmosphere and interfere with people's ability to stargaze and research the night sky.[34]

NEPA may offer even less recourse for astronomers regarding the added light pollution from satellite constellations.[35] Astronomers' ability to study the night sky has been significantly altered by the addition of thousands of reflective aluminum objects in orbit.[36] Legal experts have said that those astronomers have little to no legal mechanisms at their disposal to prevent or alter satellite constellations,[37] and the Viasat litigation is testing that conclusion in federal court.[38] Despite initially dismissing the concern about light pollution,[39] industry leaders such as SpaceX are addressing the matter and trying to make satellites less reflective.[40] But the mere fact that this incident happened is concerning. It seems obvious in retrospect that thousands of reflective metal objects could have a significant impact on astronomy, but that consequence was either overlooked or ignored.[41]

These arguments and counterarguments over the environmental impact of mega-constellations highlight a couple of im-

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[34] Shannon Hall, *After SpaceX Starlink Launch, a Fear of Satellites That Outnumber All Visible Stars*, N.Y. TIMES (June 1, 2019), https://www.nytimes.com/2019/06/01/science/starlink-spacex-astronomers.html [https://perma.cc/L78G-CACV]; Tereza Pultarova, *Challenge for Astronomy: Megaconstellations Becoming the New Light Pollution*, SPACE.COM (Oct. 22, 2021), https://www.space.com/megaconstellations-disruption-astronomy-like-light-pollution [https://perma.cc/NCR6-Z5DY].

[35] *See* Jeff Foust, *Little Legal Recourse for Astronomers Concerned About Starlink*, SPACENEWS (June 3, 2019), https://spacenews.com/little-legal-recourse-for-astronomers-concerned-about-starlink/ [https://perma.cc/G8NJ-CGSQ].

[36] *See id.*

[37] *See, e.g.*, *id.*

[38] *See* Atkinson, *supra* note 11.

[39] Jonathan O'Callaghan, *Elon Musk: Starlink Will Cause 'Zero' Problems for Astronomy*, FORBES (Mar. 9, 2020, 7:23 PM), https://www.forbes.com/sites/jonathanocallaghan/2020/03/09/elon-musk-starlink-will-cause-zero-problems-for-astronomy/?sh=6cf7efd036b7 [https://perma.cc/AKG3-HQJW].

[40] *See SpaceX to Make Starlink Satellites 'Invisible' After Light Pollution Complaints from Astronomers*, SKYNEWS (May 7, 2020, 1:13 PM), https://news.sky.com/story/spacex-to-make-starlink-satellites-invisible-after-light-pollution-complaints-from-astronomers-11984439 [https://perma.cc/E4EF-57LN].

[41] *See* Chaneil James, *Dark-Coated Starlink Satellites Are Better but Not Perfect, Say Astronomers*, PHYSICS WORLD (Jan. 13, 2021), https://physicsworld.com/a/dark-coated-starlink-satellites-are-better-but-not-perfect-say-astronomers/#:~:text=IN%20response%2C%20the%20third%20round,special%20anti%2Dreflective%20dark%20coating [https://perma.cc/48GW-MAMX]; O'Callaghan, *supra* note 39.

portant details regarding space regulation: (1) NEPA has proved one of the only viable routes to protect earthbound interests in space, and (2) NEPA is hardly an ideal mechanism for protecting those interests. Distilled from those two points is a somewhat obvious conclusion: Regulations that actually hold jurisdiction in space should be put in place, through which earthbound stakeholders may seek to protect their legitimate interests. More on that is ahead.

Another prominent concern surrounding satellite mega-constellations is space debris.[42] According to the European Space Agency (ESA), there are more than 100 million debris objects orbiting Earth, 36,500 of which are greater than 10 centimeters in size.[43] There are over 130 million pieces of space debris between 1 millimeter and 1 centimeter.[44] While those objects are small relative to the space they are in, the National Aeronautics and Space Administration (NASA) points out that "[s]ince both the debris and spacecraft are traveling at extremely high speeds (approximately 15,700 mph in low Earth orbit), an impact of even a tiny piece of orbital debris with a spacecraft could create big problems."[45] Indeed, "[e]ven tiny paint flecks can damage a spacecraft when traveling at these velocities."[46] Collisions between debris and spacecraft can add thousands of large pieces of debris into orbit that can pose a threat for decades afterwards.[47] Alarmingly, some estimates hold that the amount of space debris could increase 50 times by the end of the century.[48]

The major issue with space debris is that there comes a point when the amount of debris in space reaches critical mass and "cascades."[49] Known as the Kessler Syndrome, this phenomenon is like a domino effect—one collision occurs in space, which cre-

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[42] *See* DANIEL MORGAN, CONG. RSCH. SERV., R45416, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 15 (2018) ("Debris in Earth orbit poses a serious risk to both commercial and government spaceflight.").

[43] EUR. SPACE AGENCY, *supra* note 1.

[44] *Id.*

[45] *Space Debris and Human Spacecraft*, NASA (May 26, 2021), https://www.nasa.gov/mission_pages/station/news/orbital_debris.html [https://perma.cc/7B2B-EKXH].

[46] *Id.*

[47] *Id.*

[48] Jonathan O'Callaghan, *What If Space Junk and Climate Change Become the Same Problem?*, N.Y. TIMES (May 12, 2021), https://www.nytimes.com/2021/05/12/science/space-junk-climate-change.html [https://perma.cc/VS4W-SGV2].

[49] Mike Wall, *Kessler Syndrome and the Space Debris Problem*, SPACE.COM (Nov. 15, 2021), https://www.space.com/kessler-syndrome-space-debris [https://perma.cc/6FPF-R992].

ates thousands of other objects that then hurtle around the Earth at over 15,000 miles per hour, which in turn cause more collisions until a belt of debris is left orbiting Earth.[50] That scenario may sound overly bleak bordering on fatalistic, but it is a primary concern among scientists and politicians alike.[51] Space debris is something operators are already having to deal with—NASA has conducted a couple dozen maneuvers to avoid space-debris collisions over the past two decades.[52] In fact, some scientists are concerned the Kessler Syndrome process may have already started.[53]

Similarly, there is concern that launching so many aluminum-based satellites into space could cause unknown and undesirable effects on the Earth's atmosphere and atmospheric composition.[54] Satellites are mostly made of aluminum.[55] When the satellites burn up upon reentry, they release chemical pollutants that damage the planet's ozone layer.[56] Interestingly, the added aluminum content in the atmosphere could actually increase the Earth's reflective value, thereby cooling the planet by blocking the amount of UV light that enters the atmosphere.[57] Some scientists have posited that this could be a potential method for counteracting global warming, but the scientific community at large has dismissed the viability of the idea since the other effects of adding aluminum compounds into the atmosphere are unknown.[58] Importantly, reentry is the main form of space debris mitigation for low orbit satellites.[59] In other words, reentry is

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[50] *See id.*

[51] *See id.*; Space Policy Directive-3, National Space Traffic Management Policy, 83 Fed. Reg. 28969, 28969 (June 21, 2018) ("Today, space is becoming increasingly congested and contested, and that trend presents challenges for the safety, stability, and sustainability of U.S. space operations.").

[52] *See* Wall, *supra* note 49.

[53] *See id.*

[54] Tereza Pultarova, *Air Pollution from Reentering Megaconstellation Satellites Could Cause Ozone Hole 2.0*, SPACE.COM (June 7, 2021), https://www.space.com/starlink-satellite-reentry-ozone-depletion-atmosphere [https://perma.cc/XS58-YZV5].

[55] *Id.*

[56] *Id.*

[57] *Id.*

[58] *Id.*

[59] *Mitigating Space Debris Generation*, EUR. SPACE AGENCY, https://www.esa.int/Safety_Security/Space_Debris/Mitigating_space_debris_generation [https://perma.cc/Z75J-3LAD] ("In order to remove mass from densely populated orbits, it is recommended that satellites and orbital stages be commanded to reenter Earth's atmosphere within 25 years of mission completion, if their deployment orbit altitude is below 2000 km (in the LEO region)."); *see also Project Kuiper Announces Plans and Launch Provider for Prototype Satellites*, AMAZON (Nov. 1, 2021),

a *desirable* result for satellites at the end of their lives in orbit. Thus, the release of these chemicals is an intended, calculated consequence of launching satellites into LEO.[60]

Disturbingly, part of the mitigation process for space debris implemented by entities like SpaceX may actually end up making the space debris problem even worse because climate change may be increasing the longevity of debris in space. Typically, over time, space debris enters Earth's orbit, burns up, and is no longer a collision threat.[61] However, recent studies suggest that climate change may be lessening the atmospheric drag that ultimately brings objects into Earth's atmosphere from low orbit.[62] The research suggests that a worst-case scenario would reduce the atmospheric drag to the point where orbital lifetimes could increase by up to forty years.[63] The FCC relied on the assumption that atmospheric drag would help mitigate the space debris problem when it authorized SpaceX to decrease Starlink's orbit, the subject matter of the litigation between Viasat and Dish against the FCC.[64] If that assumption proves faulty and the mitigation programs in place prove to be dramatically less effective than anticipated, the results could be disastrous. Indeed, if space debris is left suspended in space for years longer than expected at launch, a catastrophic Kessler Syndrome scenario is not a matter of "if" but "when."[65]

This recent finding exemplifies how little is known about space exploration and its potential repercussions. All this is to say: Despite massive amounts of money and research, commercial space ventures can lead to unintended, unforeseen consequences. Moreover, where known consequences pose no threat of liability exposure,[66] operators may simply dismiss or ignore those consequences.[67]

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https://www.aboutamazon.com/news/innovation-at-amazon/project-kuiper-announces-plans-and-launch-provider-for-prototype-satellites [https://perma.cc/BN3J-KKN2] ("Amazon is committed to being a responsible steward of Earth and space . . . KuiperSat-1 and KuiperSat-2 are designed for atmospheric demise and will be actively deorbited after the mission . . .").

[60] *See* Pultarova, *supra* note 54.

[61] EUR. SPACE AGENCY, *supra* note 59.

[62] *See* O'Callaghan, *supra* note 48.

[63] *See id.*

[64] *Id.*

[65] *See* Wall, *supra* note 49.

[66] *See* Foust, *supra* note 35.

[67] *See* O'Callaghan, *supra* note 39.

C. The Key Players and Their Plans for the Near Future

To better understand the scope of the booming commercial satellite industry, it is helpful to discuss some of the key players in the space-exploration game and their plans to construct satellite constellations. SpaceX, being one of the first and primary actors to date and the focus of ongoing litigation, has already been discussed to some extent in this Comment.[68] SpaceX's constellation project, Starlink, has multiple phases. Its first phase will consist of 12,000 satellites,[69] nearly 2,000 of which had been launched by December 2021.[70] The company aims to launch 50 payloads in 2022 with a few dozen satellites per payload.[71] SpaceX is therefore planning to launch upwards of 2,500 more satellites in 2022.[72] The second phase will consist of up to 30,000 more satellites to be launched in the near future.[73]

Astra, a newcomer in the satellite space race,[74] filed an application with the FCC in November 2021 requesting authorization to launch over 13,600 LEO satellites for its constellation.[75] Amazon's Project Kuiper, currently in its early stages, appears to be much smaller than Starlink—it hopes to deploy 3,236 satellites into Earth's lower orbit.[76] Arianespace's OneWeb plans to launch 648 satellites into low orbit and has already launched

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[68] *See* discussion *supra* Part I & Sections II.A.–.B.

[69] Pultarova, *supra* note 54.

[70] *See* Amy Thompson, *SpaceX Launches Falcon 9 Rocket on Record 11th Flight Carrying 52 Starlink Satellites*, Space.com (Dec. 18, 2021), https://www.space.com/spacex-starlink-launch-record-falcon-9-11th-flight [https://perma.cc/RZN2-5DEK].

[71] Jeff Foust, *SpaceX Launches Starlink Satellites to Higher Orbit*, SpaceNews (Feb. 21, 2022), https://spacenews.com/spacex-launches-starlink-satellites-to-higher-orbit/ [https://perma.cc/VN6J-B3PS].

[72] *See id.*

[73] Pultarova, *supra* note 54.

[74] Mike Wall, *Astra Goes Public, Becomes 1st Launch Company to Trade on NASDAQ*, Space.com (June 30, 2021), https://www.space.com/astra-launch-company-public-nasdaq [https://perma.cc/A5WD-8M44].

[75] Jeff Foust, *Astra Files FCC Application for 13,600-Satellite Constellation*, SpaceNews (Nov. 5, 2021), https://spacenews.com/astra-files-fcc-application-for-13600-satellite-constellation/ [https://perma.cc/YDM2-CKHV].

[76] *See* Adam Clark Estes, *The Complicated Promise of Amazon's Space Internet*, Vox (Nov. 3, 2021, 11:20 AM), https://www.vox.com/recode/2021/11/3/22761345/project-kuiper-satellite-amazon-space-internet [https://perma.cc/2QLG-QSR3]; Michael Sheetz, *Amazon Plans to Launch Its First Internet Satellites in Late 2022*, CNBC, https://www.cnbc.com/2021/11/01/amazons-project-kuiper-launching-first-internet-satellites-in-q4-2022.html [https://perma.cc/U4PH-MF2K] (Nov. 1, 2021, 4:29 PM).

more than half of them.[77] Telesat, a Canadian company, seeks to launch 298 satellites beginning in 2023.[78] The FCC recently granted Boeing authorization to build, launch, and operate 132 LEO satellites.[79] LeoSat plans on launching 108 low orbit satellites.[80] Many of these constellations are intended to provide broadband internet, but one startup, Privateer, somewhat ironically plans to send "several hundred satellites" into space to study space debris.[81]

Public entities are also looking at launching satellite megaconstellations. For instance, China has filed for international approval of a plan for almost 13,000 LEO satellites.[82] While there is no figure yet available for the number of planned satellites, the European Union is in the planning stages for a $7.3 billion constellation project.[83] The project is still in its early stages and seems to be struggling to gain solid footing, but the project will probably include about 100 satellites in LEO.[84]

Thus, there are roughly 75,000 satellites planned to go up into space from private enterprises and public entities around

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[77] *See* Mike Wall, *Arianespace Launches 36 New OneWeb Internet Satellites into Orbit on Soyuz Rocket*, SPACE.COM (Oct. 14, 2021), https://www.space.com/arianespace-soyuz-rocket-oneweb-11-launch [https://perma.cc/4AYR-SPWP].

[78] Steve Scherer, *Canada's Telesat Takes on Musk and Bezos in Space Race to Provide Fast Broadband*, REUTERS (Apr. 11, 2021, 8:34 AM), https://www.reuters.com/technology/canadas-telesat-takes-musk-bezos-space-race-provide-fast-broadband-2021-04-11/ [https://perma.cc/5M6C-8EM5].

[79] Dan Swinhoe, *FCC Approves Boeing LEO Satellite Constellation*, DATA CTR. DYNAMICS (Nov. 5, 2021), https://www.datacenterdynamics.com/en/news/fcc-approves-boeing-leo-satellite-constellation/ [https://perma.cc/NM4B-U9ME].

[80] *See* LEOSAT, https://www.leosat.com/ [https://perma.cc/BG9V-M825].

[81] Mike Wall, *Steve Wozniak's Startup Privateer Plans to Launch Hundreds of Satellites to Study Space Debris*, SPACE.COM (Nov. 18, 2021), https://www.space.com/steve-wozniak-privateer-hundreds-satellites-space-debris [https://perma.cc/J3VW-EJTK].

[82] *See* 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/ [https://perma.cc/NAY8-U5D7].

[83] Jonathan O'Callaghan, *Europe Wants to Build Its Own Satellite Mega Constellation to Rival SpaceX's Starlink*, FORBES (Dec. 23, 2020, 1:35 PM), https://www.forbes.com/sites/jonathanocallaghan/2020/12/23/europe-wants-to-build-its-own-satellite-mega-constellation-to-rival-spacexs-starlink/?sh=62f493981252 [https://perma.cc/D6FQ-JBR4].

[84] *See* Jeff Foust, *European Union Advances Broadband Constellation Despite Negative Assessments*, SPACENEWS (Feb. 16, 2022), https://spacenews.com/european-union-advances-broadband-constellation-despite-negative-assessments/ [https://perma.cc/97DE-HTTW].

the world in the near future.[85] As will be explored in the Part III, the regulatory framework that needs to be in place must address numerous competing concerns as the industry matures. The need for such a framework should be obvious from the preceding Sections—the planned satellite systems will dwarf the roughly 14,000 satellites launched since the beginning of satellite use in space.[86] Moreover, major players such as SpaceX are moving forward at dizzying speeds and making the rules that everyone else will have to play by as they go.[87]

The list of concerns in the previous Section has not been overlooked by these players or regulatory entities. Companies such as SpaceX[88] and Amazon[89] are actively working to make collisions less likely by investing in onboard propulsion systems so satellites can move out of the way of any incoming debris. SpaceX is also researching and implementing methods to make satellites less reflective to minimize interference with astronomical endeavors on Earth.[90] However, relying on the goodwill of private companies may not be an adequate answer moving forward, especially with so many different operators seeking to send up an ever-growing number of satellites in orbit.[91]

III. THE CURRENT REGULATORY FRAMEWORK

A good understanding of the current legal framework is crucial for grasping how it is inadequate to handle the emergence of satellite mega-constellations.[92] The current international reg-

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[85] *See supra* notes 69–84 and accompanying text.

[86] *See* Nibedita 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/.

[87] Hollinger & Cookson, *supra* note 9; *see generally* Hjalte Osborn Frandsen, *Customary International Law as a Vessel for Global Accord: The Case of Customary Rules-of-the-Road for Governing the Orbital Highways of Earth*, 87 J. AIR L. & COM. 705 (2022) (explaining the role that private actors could play in developing customary international law due to the increase in commercial space activity and lack of adequate international governance).

[88] *Updates: Astronomy Discussion with National Academy of Sciences*, SPACEX (Apr. 28, 2020), https://www.spacex.com/updates/starlink-update-04-28-2020/index.html [https://perma.cc/G3XP-34UT].

[89] *See* KUIPER SYSTEMS LLC, REQUEST FOR EXPERIMENTAL AUTHORIZATION NARRATIVE STATEMENT 41–42 (2021), https://apps.fcc.gov/els/GetAtt.html?id=285359&x= [https://perma.cc/L7B6-AQ9N].

[90] James, *supra* note 41.

[91] *See supra* Section II.C.

[92] The information in this Part is nothing particularly new. Legal analysts such as Christopher D. Johnson of the Secure World Foundation helpfully have laid

ulatory framework for space is actually fairly simple. In fact, it is so straightforward that clarity is wanting and ambiguities are numerous.[93] The primary governing document is the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, more commonly referred to as the Outer Space Treaty (OST),[94] promulgated by the United Nations in 1966 and ratified by 111 nations at the close of 2021.[95] The OST essentially allows states that are parties to the Treaty the right to freely explore and use space subject to a few key limitations.[96] Those limitations bar sovereign states from appropriating space and place certain affirmative obligations upon states, such as not polluting space with debris that could affect the climate on Earth and not interfering with other states' free use or exploration of space.[97] However, as an example of ambiguity in the treaty, the OST offers no guidelines or clarification on what might actually constitute "appropriation" of space.[98]

Important to the commercial space context, the OST makes sovereign states liable for the actions of private entities within those states that operate in space, and "the behavior of private entities is also bound by the terms of the treaty."[99] Thus, private entities operating in space "shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space . . . with due regard to the correspond-

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out the framework of international space law in other publications. *See, e.g.*, Johnson, *supra* note 8. This Part borrows heavily from the works of such commentators to provide a lens through which a better framework may be envisioned.

[93] *See, e.g.*, Prakash Chandra, *Outer Space Treaty Has Ambiguities Allowing Unhindered Exploitation of Celestial Bodies*, ECON. TIMES, https://economictimes.indiatimes.com/news/science/outer-space-treaty-has-ambiguities-allowing-unhindered-exploitation-of-celestial-bodies/articleshow/46238718.cms [https://perma.cc/B4DL-PYKY] (Feb. 14, 2015, 4:12 AM).

[94] *See* Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

[95] Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on the Status and Application of the Five United Nations Treaties on Outer Space, at 10, Sixtieth Session, U.N. Doc. A/AC.105/C.2/2021/CRP.10 (2021) [hereinafter U.N. Status Report].

[96] *See* Outer Space Treaty, *supra* note 94, art. I; Johnson, *supra* note 8, at 4.

[97] *See* Johnson, *supra* note 8, at 4–5.

[98] *See id.* at 5.

[99] *Id.* at 9 (citing Outer Space Treaty, *supra* note 94, art. IX.).

ing interests of all other States Parties to the Treaty;"[100] they "shall pursue studies of outer space . . . and conduct exploration of [the moon and other celestial bodies] so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose;"[101] and they shall not appropriate space "by means of use or occupation, or by any other means."[102]

The International Telecommunications Union (ITU) has been an integral international governing entity for over a century and a half[103] and has played a prominent role in space regulation.[104] The ITU helps coordinate the frequencies at which certain satellites communicate and the orbital positions of those satellites.[105] It is then left to organizations like the FCC that regulate frequency use on the national scale to implement the ITU's regulations.[106] International governing entities like the ITU are essential to the free use of space because they act as a single point of reference that ensures nations comply with their "obligations of cooperation, mutual assistance, and due regard" owed under the OST.[107] The ITU has played a very prominent role in the issuance of orbital slots and coordination of geostationary satellites due to the nature of those satellites—there are a limited number of slots for geostationary satellites, so international coordination is necessary to avoid conflict.[108] However, since Earth's lower orbit is not nearly as limited as its geostationary orbit, international regulation regarding the lower orbit has been largely unnecessary until now and is therefore significantly lacking.[109]

Since states are responsible to all other states party to the OST, the U.S. government must ensure compliance with the

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[100] *Cf.* Outer Space Treaty, *supra* note 94, art. IX (noting that party states are bound by those obligations).

[101] *Cf. id.*

[102] *Cf. id.* art. II.

[103] *History*, ITU, https://www.itu.int/en/about/Pages/history.aspx [https://perma.cc/ML9E-CT8J].

[104] *See* Johnson, *supra* note 8, at 9.

[105] *Id.*

[106] *Id.*

[107] *See id.*

[108] *Id.* at 10–11.

[109] *Id.* at 11.

OST or face exposure to liability,[110] which can be great considering the scope and cost of many space projects.[111] Thus, the regulatory framework in the United States should revolve around such compliance, at least as a baseline.[112] The primary federal agencies involved with overseeing and authorizing space operations are the Federal Aviation Administration (FAA), the Departments of Commerce and State, and the FCC.[113] There are some other involved agencies, but their functions do not warrant in depth discussion here.[114] The functions of the FAA, FCC, and the National Oceanic and Atmospheric Administration (NOAA) within the Commerce Department are most relevant to this Comment and will be discussed more fully below.

The FAA, through the Office of Commercial Space Transportation (AST), "licenses commercial launch and reentry vehicles (i.e., rockets and spaceplanes) as well as commercial spaceports."[115] AST was established "to ensure compliance with international obligations of the United States, and to protect the public health and safety, safety of property, and national security and foreign policy interests of the United States."[116] Commercial launches—i.e., launches by private entities and not performed through a contract with NASA[117]—are relatively new. The first licensed launch occurred in 1989,[118] over 20 years after the United States signed the OST.[119] As an apparent reflection of the OST liability language, the FAA requires insurance before it will license launches, with the government agreeing to indem-

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[110] *See generally* Edwin Kisiel, *Law as an Instrument to Solve the Orbital Debris Problem*, 51 ENV'T L. 223, 228–229 (2021).

[111] The Hubble Space Telescope mission alone, for example, has cost around $16 billion. *See, e.g.*, Brian Dunbar, *About – Facts Hubble FAQs*, NASA, https://www.nasa.gov/content/about-facts-hubble-faqs [https://perma.cc/NSH7-TD2D] (May 5, 2022).

[112] *See* Johnson, *supra* note 8, at 7–10.

[113] DANIEL MORGAN, CONG. RSCH. SERV., R45416, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 2 (2018).

[114] *See id.* at 2–14.

[115] *Id.* at 1.

[116] *About the Office of Commercial Space Transportation*, FAA, https://www.faa.gov/about/office_org/headquarters_offices/ast [https://perma.cc/Y2DF-QXKS].

[117] MORGAN, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 2.

[118] *Id.* at 3.

[119] *See* U.N. Status Report, *supra* note 95, at 9.

nify the launch company for any loss that exceeds the statutory cap of $500 million.[120]

Importantly, there has been recent regulatory reform in the FAA/AST licensing process. The reform streamlined the licensing process and decreased regulatory burdens.[121] The reform implements a "performance-based" approach to safety compliance, "giving launch companies the flexibility to propose alternative ways to meet safety requirements."[122] Moreover, the industry is seeking further deregulation by streamlining the environmental review process.[123]

While the FAA licenses space flight, the FCC licenses commercial satellite communications because all satellites communicate through radio frequencies.[124] The FCC has had authority to regulate radio use since the agency's inception in 1934.[125] Since practically all satellites communicate via radio waves, regulating satellites falls under the FCC's broad authority to regulate radio frequencies.[126] The FCC is also required to implement regulations promulgated by the ITU, which, as discussed above, holds an important coordination role in the international space regulatory scheme.[127] Because the ITU has no real restrictions on LEO licensing concerning frequency regulation and orbital slot allocation, and because there is no concrete definition of space appropriation, the FCC can virtually license as many satellites as it desires while remaining in compliance with international obligations.[128] Further, "FCC licensing procedures for satellites sometimes go beyond the direct regulation of radio frequency use" because of the agency's broad statutory authority to issue licenses.[129] Indeed, the FCC has a prominent role in overseeing debris mitigation.[130]

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[120] MORGAN, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 5.

[121] Jeff Foust, *FAA Publishes Streamlined Commercial Launch Regulations*, SPACENEWS (Oct. 16, 2020), https://spacenews.com/faa-publishes-streamlined-commercial-launch-regulations/ [https://perma.cc/BW8T-XNQG].

[122] *Id.*

[123] *See id.*

[124] *See* MORGAN, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 11.

[125] *Id.* at 11–12.

[126] *See id.* at 12.

[127] *Id.* at 1–12.

[128] *See* Johnson, *supra* note 8, at 11.

[129] *See* MORGAN, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 12.

[130] *Id.*

In 2020, the FCC streamlined the licensing process for small satellites.[131] The regulation expedites and makes significantly cheaper the process for obtaining licenses for qualified small satellites.[132] The intent of the regulation was to lower the barriers for small satellite providers and operators to get to space.[133] In other words, licensing through the FCC, like the FAA, is being streamlined and moderately deregulated.

Finally, NOAA is playing an important role in space-exploration regulation because it is developing the Open-Architecture Data Repository (OADR), which is a database that will supplement government data with commercial data on orbital objects to provide a more comprehensive tracking and warning system for orbital operators.[134] The service will be free and will provide a basic database for use by the commercial industry domestically and abroad while leaving open the possibility for the industry to expand on that database and provide more robust services.[135]

Interestingly, the United States has a National Space Council chaired by many of the nation's top officials; it is intended to coordinate and monitor the efforts of the numerous agencies involved in space regulation.[136] Even more interestingly, the Council has been inactive for most of its existence.[137] Having only been reestablished in 2017[138]—and meeting for the first time only a few months before the first Starlink launch[139]—the Council entered the regulation of LEO satellite constellations a

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[131] Streamlining Licensing Procedures for Small Satellites, 34 FCC Rcd. 13077, 13078 (2019); Streamlining Licensing Procedures for Small Satellites, 35 FCC Rcd. 4934, 4934 (2020); Jeff Foust, *FCC Streamlined Smallsat Licensing Regulations Published*, SPACENEWS (Aug. 12, 2020), https://spacenews.com/fcc-streamlined-smallsat-licensing-regulations-published/ [https://perma.cc/4EFA-JND7].

[132] Foust, *supra* note 131.

[133] *Id.*

[134] *See* Rahul Rao, *Avoiding Satellite Collisions: NOAA Unveils Prototype Warning System*, SPACE.COM (Feb. 21, 2022), https://www.space.com/noaa-satellite-collision-warning-system-prototype [https://perma.cc/5TLG-MGML]; Jeff Foust, *NOAA Seeking Information on Commercial Space Situational Awareness Data*, SPACENEWS (Feb. 23, 2022), https://spacenews.com/noaa-seeking-information-on-commercial-space-situational-awareness-data/ [https://perma.cc/WQB3-675J].

[135] Foust, *supra* note 134.

[136] DANIEL MORGAN, CONG. RSCH. SERV., R45416, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 14 (2018).

[137] *Id.*

[138] *Id.*

[139] *National Space Council Meeting – Oct. 5, 2017*, NASA (Dec. 8, 2017), https://www.nasa.gov/feature/national-space-council-meeting-oct-5-2017 [https://perma.cc/64R2-W3E4].

little late in the game. Regardless of its late entrance, the Council and its member agencies have been charged with revamping important space traffic monitoring and debris mitigation policies.[140]

As discussed above, space debris presents a serious and well-recognized threat to current and future space exploration.[141] There are four guiding principles that all government agencies involved in space operations are obligated to follow regarding debris mitigation: "[1] Minimize or eliminate the debris released during normal operations. [2] Minimize accidental explosions. [3] Minimize opportunities for collisions. [4] Dispose of spacecraft and launch vehicle components at the end of mission life."[142] Interestingly, the FCC is supposed to follow all four principles, while generally the FAA only has to minimize accidental explosions.[143]

Since space debris and debris mitigation are of paramount importance to the space industry, it follows naturally that situational awareness and traffic management in space are initiatives of equal import.[144] Space situational awareness (SSA) involves tracking all satellites and known debris, and space traffic management (STM) uses that data to avoid potential collisions.[145] Once controlled by the Department of Defense, civil STM operations are now under the purview of the Commerce Department, specifically the Office of Space Commerce (OSC).[146] However, since that transfer of authority in 2018, and under a

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[140] *See Vice President Harris Convenes Renewed National Space Council*, OFF. OF SPACE COM. (Dec. 1, 2021), https://www.space.commerce.gov/vice-president-harris-convenes-renewed-national-space-council/ [https://perma.cc/3XCA-367M]; THE WHITE HOUSE, UNITED STATES SPACE PRIORITIES FRAMEWORK 7 (2021), https://www.whitehouse.gov/wp-content/uploads/2021/12/United-States-Space-Priorities-Framework-_-December-1-2021.pdf [https://perma.cc/B84L-DJM2]; Space Policy Directive-3, National Space Traffic Management Policy, 83 Fed. Reg. 28969, 28969 (June 21, 2018).

[141] *See* discussion *supra* Section II.B; MORGAN, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 15.

[142] *See* MORGAN, COMMERCIAL SPACE: FEDERAL REGULATION, OVERSIGHT, AND UTILIZATION 15.

[143] *See id.*

[144] *See id.* at 16.

[145] *Id.*

[146] *See* Jeff Foust, *Senate Appropriators Frustrated with Lack of Progress on Civil Space Traffic Management*, SPACENEWS (Oct. 20, 2021), https://spacenews.com/senate-appropriators-frustrated-with-lack-of-progress-on-civil-space-traffic-management/ [https://perma.cc/UM6V-YXHQ].

directive to revamp STM operations,[147] OSC has failed to produce an adequate framework for STM.[148] Currently, Congress is contemplating further organizational change to give OSC better direction so that it may make quicker progress on its STM initiatives.[149] Thus, in the intervening four years since President Trump's Directive that the United States needs to develop "operational standards and best practices to promote safe and responsible behavior in space,"[150] it appears very little development has actually occurred.

While the government has been floundering to come up with a framework that adequately addresses the growing debris issues in space, private startups have started tackling the problem. Startups such as Scout Space and Kayhan Space are developing more accurate space debris tracking systems and traffic management software.[151] Other startups like Privateer are planning to launch their own satellite constellations, the sole purpose of which is to track and monitor other orbiting objects.[152]

In short, the government's regulatory framework concerning SSA and STM is experiencing some immense growing pains, struggling to keep up with emergent technologies and the industry push towards commercializing Earth's lower orbit. Meanwhile, private entities are fully capitalizing on that regulatory gap to provide better SSA and STM services in the absence of clearly defined regulatory standards and best practices.[153]

The dynamic between private and public approaches to SSA and STM operations is representative of the broader current struggle to regulate space. As the foregoing discussion suggests, responsibility for space regulation is spread over at least half a dozen major government agencies,[154] which is patently ineffi-

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147 Space Policy Directive-3, National Space Traffic Management Policy, 83 Fed. Reg. 28969, 28971 (June 21, 2018).

148 Foust, *supra* note 146.

149 *See id.*

150 Space Policy Directive-3, 83 Fed. Reg. at 28971.

151 Sandra Erwin, *Startups Developing Space Traffic Monitoring System to Help Manage Growing Debris Problem*, SPACENEWS (Nov. 16, 2021), https://spacenews.com/startups-developing-space-traffic-monitoring-system-to-help-manage-growing-debris-problem/ [https://perma.cc/PV9S-VVZ5].

152 Wall, *supra* note 81.

153 *See id.*; Erwin, *supra* note 151.

154 *See* Kelcee Griffis, *Broadband Sats Are Filling the Sky. Are Regulators Ready?* LAW360 (July 19, 2021, 3:42 PM), https://www.law360.com/articles/1404323/broadband-sats-are-filling-the-sky-are-regulators-ready- [https://perma.cc/Q2RC-5RNB].

cient: Either an agency promulgates its own rules for space debris mitigation and runs the risk of conflicting with other agencies' rules on space debris mitigation or the agency waits around to see what the others do to avoid passing conflicting rules.[155] Under the first approach, the industry is left to waste resources untangling and complying with a web of conflicting rules.[156] Common sense dictates that under the second approach, many agencies may forego rulemaking measures that they may deem immediately necessary in favor of presenting a clear and cohesive set of rules across many agencies.[157] Meanwhile, the private industry is free to operate within the outdated system as it currently exists, fully taking advantage of the lack of government-imposed rules, safety standards, and best practices governing Earth's lower orbit.[158]

IV. ANALYSIS

The space regulatory framework, both domestically and internationally, simply was not prepared to take on the surge of massive non-geostationary satellite constellations in lower Earth orbit, and the U.S. government seems fully cognizant of that fact.[159] The total number of satellites launched into space before 2019 pales in comparison to the some 75,000 satellites that are slated to launch in the near future.[160] Although America seeks to "maintain U.S. leadership in space" by developing regulations that reflect the rapidly growing industry,[161] there seems to be a distinct lack of clear direction among the myriad federal agen-

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[155] *See* Kelcee Griffis, *FCC Backs Off of Aggressive Space Junk Regulations*, LAW360 (Apr. 23, 2020, 5:22 PM), https://www.law360.com/articles/1266880?scroll=1&related=1 [https://perma.cc/YTT9-GZEN].

[156] *See id.*

[157] *See id.*

[158] *See id.*; Hollinger & Cookson, *supra* note 9.

[159] *See* Space Policy Directive-3, National Space Traffic Management Policy, 83 Fed. Reg. 28969, 28969 (June 21, 2018) ("Emerging commercial ventures such as . . . new technologies enabling small satellites and very large constellations of satellites[ ] are increasingly outpacing efforts to develop and implement government policies and processes to address these new activities."); Press Release, FCC, Chairwoman Rosenworcel Welcomes Bipartisan Satellite Legislation (Feb. 11, 2022), https://docs.fcc.gov/public/attachments/DOC-380229A1.pdf [https://perma.cc/ERG3-HLJF] ("While the FCC staff has done tremendous work in reviewing applications and simultaneously updating our rules from orbital debris to commercial space launch communications, the truth is that the laws were written to address a different satellite ecosystem.").

[160] *See* discussion *supra* Part II.

[161] *See* Space Policy Directive-3, 83 Fed. Reg. at 28969.

cies charged with accomplishing that goal. In the meantime, the industry has been left largely to manage itself and has successfully fought for increased self-regulatory freedom.[162] There is no real question that the space industry is outpacing its regulatory counterpart, racing ahead while the government struggles to catch up.

Self-regulation is nothing particularly new—with the rise of the administrative state, agencies are increasingly taking on the role of facilitator rather than regulator.[163] Regulatory entities do not have the resources to effectively oversee every aspect of space exploration.[164] Thus, there must be action *by the industry* to not merely comply with existing regulations but to ensure that their ventures are sustainable for long-term space exploration. This action by the industry must be supported by the government as much as possible to facilitate and coordinate the various aspects of space operation.

Given that space regulation is trending towards self-regulation, Part IV will analyze the various benefits and negative aspects of self-regulation as it has been implemented to date. It will then provide a proposal for what could be done to modify that system to ensure the longevity of the space-exploration industry while protecting the interests of other stakeholders.

A. The Pros

Don't Look Up, the latest doomsday satire, provides an apt representation of what many fear about self-regulating industries: Private, profit-driven enterprises will invariably cut corners and skirt regulatory lines to increase profits, even in the face of disaster.[165] When the government sanctions—or even encourages—

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[162] Foust, *supra* note 121.

[163] *See, e.g.*, Virginia Haufler, A Public Role for the Private Sector: Industry Self-Regulation in a Global Economy 10–11 (2001) ("Governments increasingly view their own roles as that of facilitators of market expansion and competitiveness.").

[164] *See, e.g.*, Brian Naylor, *Not Just Airplanes: Why the Government Often Lets Industry Regulate Itself*, NPR (Apr. 4, 2019, 5:01 AM), https://www.npr.org/2019/04/04/709431845/faa-is-not-alone-in-allowing-industry-to-self-regulate [https://perma.cc/S5K4-ZJDQ]; Space Policy Directive-3, 83 Fed. Reg. at 28969.

[165] *See* Don't Look Up (Hyperobject Industries & Bluegrass Films 2021); *see also* Clifford Krauss, Manny Fernandez, Ivan Penn & Rick Rojas, *How Texas' Drive for Energy Independence Set It Up for Disaster*, N.Y. Times, https://www.nytimes.com/2021/02/21/us/texas-electricity-ercot-blackouts.html [https://perma.cc/YY3M-YGYR] (June 15, 2021) (tracing Texas's deregulation of its energy industry to the statewide freeze in February 2021 that left millions freezing and without power).

that behavior, there may be reasonable cause for concern.[166] In the wake of movies like *Don't Look Up* and news-propagating disasters such as the 2010 Deepwater Horizon oil spill[167] and the Boeing 737 MAX crashes in 2018 and 2019,[168] it can be hard to place much faith in the goodwill of private companies to do what is best, not just for themselves but for all interested parties. However, the space industry's capacity to regulate itself should not be quickly dismissed. Commercial space enterprises have a vested interest in maintaining a space environment that is free of excessive debris and safe to operate in—without it, their businesses are doomed.[169] Moreover, industry-guided standards and best practices are already common in federal regulation and have operated without much criticism for most of the past century, absent a few significant exceptions.[170]

Allowing industries to primarily regulate themselves offers several notable benefits. First, certification processes are much quicker. Indeed, delays in certification processes are often why industries push for broad regulatory autonomy.[171] Second, federal agencies simply do not have the financial or workforce resources to adequately perform all the supervision that industries currently undertake themselves.[172] Further, self-regulated industries have the intrinsic benefit of not being overregulated, a problem that can add unnecessary costs to operators and impede innovation.[173]

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166 *See* Krauss et al., *supra* note 165.

167 *See generally* Richard Pallardy, *Deepwater Horizon Oil Spill*, ENCYC. BRITANNICA, https://www.britannica.com/event/Deepwater-Horizon-oil-spill [https://perma.cc/7L4W-6AV7] (Aug. 23, 2022) (providing background information on the spill).

168 *See generally* Patrice Taddonio, *In 737 Max Crashes, Boeing Pointed to Pilot Error—Despite a Fatal Design Flaw*, FRONTLINE PBS (Sept. 14, 2021), https://www.pbs.org/wgbh/frontline/article/video-clip-boeing-737-max-crashes-fatal-design-flaw-documentary/ [https://perma.cc/W5Z6-A8SK] (providing background information on the crashes); *see also* DOWNFALL: THE CASE AGAINST BOEING (Imagine Documentaries 2022).

169 *See* discussion *supra* Part II.

170 *See* Naylor, *supra* note 164.

171 *See, e.g.*, Aaron C. Davis & Marina Lopes, *How the FAA Allows Jetmakers to 'Self Certify' That Planes Meet U.S. Safety Requirements*, WASH. POST (Mar. 15, 2019, 9:25 PM), https://www.washingtonpost.com/investigations/how-the-faa-allows-jetmakers-to-self-certify-that-planes-meet-us-safety-requirements/2019/03/15/96d24d4a-46e6-11e9-90f0-0ccfeec87a61_story.html [https://perma.cc/5CXQ-VDSL].

172 Naylor, *supra* note 164.

173 *See* DANIEL CASTRO, THE INFO. TECH. & INNOVATION FOUND., BENEFITS AND LIMITATIONS OF INDUSTRY SELF-REGULATION FOR ONLINE BEHAVIORAL ADVERTISING

However, not all self-regulatory frameworks are created equal. A global look at the regulation of food and drugs provides a poignant example. Many countries allow their food and drug industries to self-regulate.[174] The Food and Drug Administration's (FDA's) framework in the United States allows big pharmaceutical companies to advertise directly to consumers and is fraught with opportunities for those companies to present the public with "potentially misleading advertisements before the FDA discovers the breach."[175] Indeed, over half of these advertisements' most emphasized claims were found to be potentially misleading.[176] In contrast, New Zealand—the only other country that allows pharmaceutical companies to advertise directly to consumers[177]—is fully compliant with its code despite being largely self-regulated.[178]

The Pharmaceutical Research and Manufacturers of America (PhRMA) in the United States publishes guidelines with stricter standards than the FDA requires, and many pharmaceutical companies voluntarily comply with PhRMA guidelines.[179] However, there are only minor enforcement measures in place for those voluntary commitments.[180] New Zealand's drug industry and advertising industry work together with the government to ensure code compliance.[181] Where the FDA does not impose any penalties for noncompliance with its stricter-than-necessary guidelines, the New Zealand media industry will not allow noncompliant advertisements to be disseminated to the public.[182] The "voluntary" vetting process is effectively mandatory, however, because the media industry will not disseminate advertising materials unless the voluntary vetting association has given

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5 (2011), https://itif.org/files/2011-self-regulation-online-behavioral-advertising.pdf [https://perma.cc/955M-CNNY].

174 *See* Chris Lo, *Drug Promotion: Does Self-Regulation Work?*, PHARM. TECH. (June 28, 2015), https://www.pharmaceutical-technology.com/features/featuredrug-promotion-does-self-regulation-work-4606510/ [https://perma.cc/NRW7-SZSX].

175 *See* Erin J. Asher, *Lessons Learned from New Zealand: Pro-Active Industry Shift Towards Self-Regulation of Direct-to-Consumer Advertising Will Improve Compliance with the FDA*, 16 ALB. L.J. SCI. & TECH. 599, 619 (2006).

176 Chris Lo, *Big Pharma and the Ethics of TV Advertising*, PHARM. TECH., https://www.pharmaceutical-technology.com/features/feature-big-pharma-ethics-of-tv-advertising/ [https://perma.cc/HXK2-V5AL] (Jan. 31, 2020, 1:50 PM).

177 *Id.*

178 Asher, *supra* note 175, at 600–01, 620.

179 *Id.*

180 *Id.* at 618.

181 *Id.* at 601.

182 *Id.* at 614–17.

its stamp of approval.[183] Thus, there is a built-in incentive for compliance—if an independent reviewing board does not approve of a company's material, the material will go nowhere.[184] Further, the FDA's preapproval process for advertisement material is much slower than New Zealand's private counterpart, and the United States does not require preapproval while New Zealand does.[185] Thus, there are much stronger incentives for full compliance in New Zealand than in the United States, and that is largely a biproduct of how self-regulation operates in each country.[186]

There are a couple of important lessons to be learned from the comparison between the United States' and New Zealand's drug advertising industries. First, voluntary commitment without enforcement is not very effective. The United States has issues with noncompliance with its voluntary commitments because the worst that happens is a light slap on the wrist for violating those commitments.[187] On the other hand, New Zealand enforces its code compliance by simply disallowing the dissemination of noncompliant materials.[188] That vetting process is particularly intriguing—a similar vetting process in the United States could be extremely effective for space regulation. Second, how self-regulatory frameworks are structured—i.e., how much and what kind of power is delegated to the industry—is an important factor in whether the framework performs adequately. Indeed, as the cons below will illustrate further, it is vitally important to be preemptive in a regulatory framework rather than reactive.

B. The Cons

Self-regulation may be common in industries that the federal government oversees, but that does not always mean it is desirable. One of the main problems with self-regulation is that it is often retrospective and responsive to social pressure rather than preemptive.[189] For instance, the oil and gas industry adopted the Coalition for Environmentally Responsible Economies' Principles on Environmental Responsibility only after the Ex-

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[183] *Id.* at 617.
[184] *See id.*
[185] *Id.* at 601, 618–19.
[186] *See id.* at 616–17.
[187] *See id.* at 618.
[188] *Id.* at 617.
[189] *See id.* at 621.

xon–Valdez oil spill sparked public outrage, especially among environmentalists.[190]

The FAA provides another illuminating example. The FAA allowed Boeing to conduct a lot of its own testing for the Boeing 737 MAX jets.[191] That same type of jet led to the tragic deaths of 346 individuals between two separate crashes.[192] Boeing did not contest the charge that it defrauded the United States by intentionally deceiving the FAA during the 737 MAX certification process.[193] Boeing knew and lied about the problems it found with its 737 MAX aircraft.[194] Boeing paid $2.5 billion in criminal penalties.[195] The FAA reformed its safety standards and certification process, as directed by Congress, in response to its lack of oversight regarding the 737 MAX.[196] One important lesson from the Boeing/FAA incident is apparent: When left to regulate themselves, private entities may be more heavily influenced by factors other than safety or the public good when those entities have invested millions, if not billions, in a particular project.[197]

Another failure of the self-regulation approach is noteworthy: The Bureau of Safety and Environmental Enforcement allowed offshore oil rigs to do their own annual certifications, which led to the Deepwater Horizon oil spill in the Gulf of Mexico in

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190 HAUFLER, *supra* note 163, at 9; Mindy S. Lubber, *30 Years Later, Investors Still Lead the Way on Sustainability*, CERES (Mar. 23, 2019), https://www.ceres.org/news-center/blog/30-years-later-investors-still-lead-way-sustainability [https://perma.cc/GZ56-2U6W].

191 *See* Naylor, *supra* note 164.

192 Ben Kesslen, *737 Max Crashes That Killed 346 Were 'Horrific Culmination' of Failures by Boeing and FAA, House Report Says*, NBC NEWS (Sept. 16, 2020, 7:30 AM), https://www.nbcnews.com/news/us-news/737-max-crashes-killed-346-were-horrific-culmination-failures-boeing-n1240192 [https://perma.cc/7DZD-GXGK].

193 *See* Press Release, U.S. Dep't of Just., Boeing Charged with 737 Max Fraud Conspiracy and Agrees to Pay over $2.5 Billion (Jan. 7, 2021), https://www.justice.gov/opa/pr/boeing-charged-737-max-fraud-conspiracy-and-agrees-pay-over-25-billion [https://perma.cc/P8XH-FBDJ].

194 *Id.*

195 *Id.*

196 David Shepardson, *FAA to Reform New Airplane Safety Approvals After 737 MAX Crashes*, REUTERS (Dec. 28, 2020, 7:58 PM), https://www.reuters.com/article/us-boeing-737max-congress/faa-to-reform-new-airplane-safety-approvals-after-737-max-crashes-idUSKBN29304N [https://perma.cc/RGY3-TSKS].

197 *See, e.g.*, John Cassidy, *How Boeing and the F.A.A. Created the 737 MAX Catastrophe*, NEW YORKER (Sept. 17, 2020), https://www.newyorker.com/news/our-columnists/how-boeing-and-the-faa-created-the-737-max-catastrophe?gclsrc=AW.ds&gclid=CJ0KCQjwnvOaBhDTARIsAJf8eVP3NB6BNABbjoLDz9S1blzcImt97NBjtLLSDo7y1K6lakpcSzUc9FQaAgIBEALw_wcB&gclsrc=AW.ds [https://perma.cc/5L5Q-6FJD].

2010.[198] The explosion that caused the spill killed eleven workers and allowed natural gas and oil to flow freely into the gulf for eighty-seven days.[199] Predictably, the disaster sparked a wave of regulatory reform "designed to better balance environmental and safety concerns with energy development."[200] A trend is apparent from the preceding three examples: Disaster first, regulatory reform after.

Generally speaking, this may be a workable, if somewhat concerning, model in which the private and public sectors operate. As discussed above, industries—not regulatory entities—tend to have the technical knowledge and resources to dictate best practices and standards.[201] The risk that industries will not implement perfect safety standards is inherent in the system. Indeed, overly restrictive safety standards would make many business ventures completely unviable.[202] Moreover, extremely technical industries, including the space industry, are precisely the ones that are in the best position to inform regulatory entities of best practices and safety standards. However, space exploration poses certain risks that simply cannot be dealt with after disaster occurs. Unlike isolated airplane crashes and oil spills—tragic though they are—a collision in space could quickly escalate into a problem that renders further space exploration impossible.[203] Post-disaster regulatory reform would be useless after a Kessler-Syndrome-inducing incident. Thus, oversight must not be delegated entirely to the industry. However, that is almost exactly what is happening.

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[198] *See generally* Sheldon Richman, *Self-Regulation in the Corporate State: The BP Spill*, FOUND. FOR ECON. EDUC., https://fee.org/articles/self-regulation-in-the-corporate-state-the-bp-spill/ [https://perma.cc/7CRU-MQW7] (May 18, 2010).

[199] HANA VIZCARRA, HARV. L. SCH., DEEPWATER HORIZON TEN YEARS LATER: REVIEWING AGENCY AND REGULATORY REFORMS 1 (2020), http://eelp.law.harvard.edu/wp-content/uploads/Deepwater-Horizon-Ten-Years-Later-v4_Final.pdf [https://perma.cc/GW5E-FBBS].

[200] *Id.* at 2.

[201] *See* Section IV.A.; *see also* Naylor, *supra* note 164.

[202] Consider Judge Learned Hand's famous *B<PL* formula for determining negligence: public policy does not demand that people exercise maximum care, only that people exercise care such that the probability of injury (*P*) multiplied by the magnitude of the injury (*L*) does not outweigh the burden (*B*) of taking a proposed safety measure. *See* United States v. Carroll Towing Co., 159 F.2d 169, 173 (2d Cir. 1947) (Hand, J.). The effect of this formula in helping to determine the standard of care is that businesses need not take every measure at great expense to avoid unlikely or insubstantial injury—an effect with crucial implications for the viability of business ventures.

[203] *See* discussion *supra* Part III.

Since President Trump took office in 2016, the regulatory state has become much more deregulated.[204] Specifically, spurred by complaints from the space industry, Trump explicitly directed agencies to streamline operator licensing and certification processes, allowing the industry quicker and easier access to space by reducing regulatory burdens.[205] While these directives helped the industry by clarifying complicated and confusing regulations, they also reinforced the government's position as a market facilitator (as opposed to a regulatory overseer) because "these changes [sought to] encourage the growth and competitiveness of U.S. commercial space companies by easing regulations and speeding up approval processes."[206]

These regulatory reforms largely consolidated and clarified unwieldy, redundant, and confusing *formal* requirements that have long frustrated the industry and obfuscated access to space.[207] Streamlining and updating burdensome regulatory *formalities* is not much cause for concern. However, there is an apparent lack of *substantive* requirements to gain access to space, especially regarding large satellite constellations. As the recent Viasat litigation against the FCC illustrates, the substantive requirements for regulating tens of thousands of small satellites leave a lot to be desired.[208] For instance, companies applying for a license to operate a commercial satellite must complete Form 312, the FCC's application for satellite space stations. The form asks only one question of applicants regarding the environment: "Would a Commission grant of any proposal in this application or amendment have a significant environmental impact as defined by 47 CFR 1.1307?" As none of the FCC's three exceptions to categorical exclusion apply to orbiting commercial satellites, applicants can simply answer "no," as SpaceX did when it initially applied for approval for Starlink's first 4,425 satellites. Per the FCC's regulations, this negative response from the applicant completes the FCC's compliance with NEPA.[209]

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[204] VIZCARRA, *supra* note 199, at 1.

[205] Space Policy Directive-2, Streamlining Regulations on Commercial Use of Space, 83 Fed. Reg. 24901, 24901 (May 24, 2018); Todd Harrison & Kaitlyn Johnson, *How Might Space Policy Directive 2 Affect Commercial Space?*, AEROSPACE SEC. (May 30, 2018), https://aerospace.csis.org/how-might-space-policy-directive-2-affect-commercial-space/ [https://perma.cc/M52A-HHLN]; *see also* discussion *supra* Part III.

[206] Harrison & Johnson, *supra* note 205.

[207] *See, e.g.*, Foust, *supra* note 121.

[208] *See* discussion *supra* Section II.B.

[209] Ryan, *supra* note 10, at 931 (footnotes omitted).

Indeed, the fact that NEPA is one of the main vessels through which the alleged substantive deficiencies of a proposed or ongoing *space* operation can be challenged is—to put it mildly—kind of baffling.[210]

Moreover, the race to launch so many satellites so quickly into LEO is alarming because it demonstrates a lack of caution on behalf of the space industry. Despite SpaceX CEO Elon Musk's claim that there is room for "tens of billions" of satellites in space[211]—a statement that is concerning for a number of reasons[212]—the unknown and unintended consequences of space exploration require caution and preparation.[213] For example, SpaceX did not foresee that its original satellite design would reflect so much light back towards Earth that it would cause light pollution problems.[214] The company is now addressing the issue, but only after public outcry.[215] The point here is not that the industry must meet some perfect standard of care, but that these companies are not infallible nor can they fully predict the effects their operations will have on other stakeholders—for example, earthbound astronomers whose works are being disrupted by added light pollution from satellites.

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[210] *See* Atkinson, *supra* note 11; ELLIS, *supra* note 14, at 2; *see also* discussion *supra* Part I & Section II.B.

[211] Kate Duffy, *Elon Musk Says There Is Room for 'Tens of Billions' of Satellites, After Facing Criticism from Europe that SpaceX Is Blocking Out Rivals in Orbit*, BUS. INSIDER (Dec. 30, 2021, 4:34 AM), https://www.businessinsider.com/elon-musk-rejects-europe-criticism-starlink-satellites-blocks-rivals-space-2021-12 [https://perma.cc/L5WW-PT8A].

[212] Not the least of which is that Musk extrapolated that number from the number of cars on Earth, which he estimated at about 2 billion. *See id.* Based on that number and the fact that space's orbital shell is indeed quite a bit larger than Earth, Musk estimated that space could house "tens of billions" of satellites. *Id.* However, he apparently forgot the key concern with a crowded space environment—satellite crashes do not leave their debris sitting on the side of the road as car crashes do in the hypothetical; they send thousands of pieces of varying sizes of debris hurtling around Earth at 17,100 mph. *See* Wall, *supra* note 49. Another important fact missing from Musk's estimate is that there are nearly 7 million car accidents each year in America alone. *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., TRAFFIC SAFETY FACTS ANNUAL REPORT (2022), https://cdan.nhtsa.gov/tsftables/National%20Statistics.pdf [https://perma.cc/99RN-WXP9]. Even if the most minute fraction of that collision rate was replicated in space, it would be utterly disastrous. *See* discussion *supra* Section II.B.

[213] *See, e.g.*, Letter from Kathy Smith, Chief Couns., NASA, to Marlene Dortch, Sec'y, FCC 1 (Feb. 8, 2022), https://cdn.arstechnica.net/wp-content/uploads/2022/02/NTIA-NASA-and-NSF-Fi.pdf [https://perma.cc/6EDY-TM6L] [hereinafter NASA Letter].

[214] *See* SKYNEWS, *supra* note 40.

[215] *See id.*

Enter the need for swift government guidance and a better regulatory system to act as a check on the industry as it proceeds to self-regulate. The government's role in space regulation must be more hands-on than simply being a "facilitator[ ] of market expansion and competitiveness."[216] The stakes are too high and the margin for error is too slim to allow the industry complete control in testing the outer limits of what regulations should be in place. That does not, however, mean that the industry should be left without a say. As has been made clear by this point, the government does not have the resources to adequately oversee all aspects of space regulation, but there are steps that could be taken to reduce the government's regulatory burden in some areas, thereby leaving more resources available in other, more pressing areas. This could be done by continuing to streamline formal requirements that are outdated and cumbersome, lessening the government's burden on unnecessary and redundant administrative formalities while making those resources open for more important substantive oversight.

The pros and cons listed above cannot serve as a guide for whether or not to "choose" self-regulation as the ideal regulatory structure for space exploration because there is no real choice here—like all complex industries, the space industry must self-regulate to some extent.[217] Rather, the foregoing discussion serves as a discourse on what can be learned about self-regulation, its shortcomings, and how it can be better implemented to ensure the longevity of space exploration. It is hard to tell how effective or ineffective self-regulation is in practice.[218] It is easy to look at a few extreme examples where the system failed and write off industry self-regulation as fundamentally flawed.[219] Regardless, it is a system the general public has caught onto just recently despite its prevalence in the regulatory system for the better part of the last century.[220] Self-regulation is quickly becoming the norm as the administrative state grows

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[216] *See generally* HAUFLER, *supra* note 163, at 10–11.

[217] *See* discussion *supra* Section IV.A.

[218] *See* Jodi L. Short & Michael W. Toffel, *Making Self-Regulation More Than Merely Symbolic: The Critical Role of the Legal Environment*, 55 ADMIN. SCI. Q. 361, 387 (2010) ("[T]he paucity of research on the effects of self-regulatory structures springs from the difficulty of obtaining data on both the existence of internal compliance structures and the outcomes they produce.").

[219] *See* discussion *supra* Section IV.B.

[220] Naylor, *supra* note 164; *see also* Anil K. Gupta & Lawrence J. Tad, *Industry Self-Regulation: An Economic, Organizational, and Political Analysis*, 8 ACAD. MGMT. REV. 416, 418 (1983).

ever larger.[221] Perhaps "self-regulation has largely gone on unnoticed, because, with a few exceptions, it has been a success."[222]

C. A Way Forward: Closely Monitored Self-Regulation

While this Comment was being drafted, Congress started picking up on the need for swift and effective regulatory reform. Two Representatives have recently proposed a bipartisan bill that would streamline the formal processes of licensing while making the substantive inquiries into space debris mitigation more rigorous.[223] That kind of reform reflects the main thrust of this Comment. Streamlining formal requirements while maintaining substantively rigorous requirements is the best way forward in the space regulatory context. Further, as the current litigation against the FCC illustrates, NEPA has been one of the only mechanisms through which substantive challenges can be made against alleged deficiencies of space operations.[224] That should not be the case. Thus, as a possible reformatory model, this Comment proposes that (1) the industry should adopt stricter safety standards than are legally required; (2) licensing entities should be consolidated into a single agency; (3) an entity like NASA should assume a technical coordinative and collaborative role in the regulatory scheme such that it can act as a regulatory liaison between other agencies and the industry; and (4) legislation should be put into place that can adequately provide a mechanism for other stakeholders to air their concerns, thereby enforcing compliance and developing substantive requirements for space operation.

The key to successful self-regulation in the space industry is recognizing that the massive self-regulatory failures such as Deepwater Horizon and the 737 MAX catastrophes are incidents the commercial space industry simply cannot afford. Proactivity, not reactivity, must be the starting point and the absolute bare minimum for any viable self-regulatory plan in the commercial space context. Thus, as industries like the food and drug industry have done, the space industry must adopt stricter standards than are legally required.[225] It must also start working closely

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[221] *See* Haufler, *supra* note 163, at 9.

[222] Naylor, *supra* note 164.

[223] Jason Rainbow, *Bipartisan Legislation Seeks to Reform FCC Satellite Licensing Rules*, SpaceNews (Feb. 14, 2022), https://spacenews.com/bipartisan-legislation-seeks-to-reform-fcc-satellite-licensing-rules/ [https://perma.cc/M3RK-3Y2D].

[224] *See* discussion *supra* Part I & Section II.B.

[225] *See* discussion *supra* Section IV.A.

with the government and combine resources where possible to ensure that the myriad factors affecting commercial space exploration are being carried out safely and responsibly among the dozens of enterprises operating tens of thousands of small satellites. It is not enough for any one player to comply with the legal standards as they currently stand. Indeed, it is probably not enough even if all players fully comply with the legal standards as they currently stand because they are not substantively adequate for large satellite constellations.[226] Compliance in this context is not merely some threshold that needs to be crossed to access space, nor is it only protective of the general public. It is vitally necessary for the survival of the industry, and compliance with the current legal standards alone will not suffice.[227]

The space industry is obviously unlike other industries in many respects, but these differences have important practical and legal ramifications. For instance, the food and drug industry may have a strong incentive to voluntarily comply with strict self-imposed standards to maintain or improve their goodwill in the market because compliance correlates directly with profit.[228] Where such products are sold to consumers, that kind of goodwill goes a long way. The same motivators are somewhat absent in the space industry because its product is not disseminated directly to consumers. But there is an even more important motivator: A single bad-faith actor could render all future space exploration impossible.[229] It is in the industry's best interest to work in tandem with industry operators and the government as much as possible to make sure this does not happen.

Indeed, NASA recently called on the FCC to compel SpaceX to coordinate with NASA "prior to each successive launch" to ensure SpaceX's second Starlink generation can be carried out safely.[230] Although it may increase delays and add cost to industry operations, this is not a mere formality—this type of coordination between the government and the industry is exactly the kind of substantive oversight that could ensure the longevity of space exploration. Having a single entity like NASA coordinating with all the various private actors could be an extremely effective failsafe.

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[226] *See* discussion *supra* Section II.C & Part III.

[227] *See* discussion *supra* Section II.B, Part III & Section IV.B.

[228] *See* discussion *supra* Section IV.A.

[229] *See* discussion *supra* Section II.B.

[230] NASA Letter, *supra* note 213, at 4.

This leads to the second main takeaway: When private industries work closely with their government counterparts, compliance and efficiency are maximized.[231] If NASA started playing the role of coordinator among private space enterprises by "allow[ing] [commercial space companies] to gradually prove their concept of operations [to NASA] and troubleshoot any issues that arise along the way," NASA could start collecting data that could be used "to develop a longer-term plan for conjunction and interference mitigation at a national and international level."[232] Having legislation in place that would require this kind of coordination between the private industry and NASA would go a long way towards quickly developing robust databases and providing a single point of regulatory authority with adequate experience and technical knowledge to which industry questions and concerns could be directed.

Self-regulation is particularly effective when it is (1) adopted voluntarily and (2) subject to heavy regulatory surveillance.[233] The distinction between regulatory *surveillance* and *threat* is an important one. Surveillance includes inspection and oversight, while threats are correlated with punitive action.[234] There is compelling evidence that heavy regulatory surveillance motivates companies to adhere to regulatory commitments more effectively than regulatory threats (i.e., punitive sanctions).[235] Still, the threat of regulatory sanctions is an important motivator so long as it remains in the background.[236] The threat of international liability under the OST should serve as a large enough punitive threat without extreme domestic punitive measures to ensure both adequate regulatory surveillance and private compliance.[237] Additionally, the kind of coordination proposed by NASA would serve as an important surveillance mechanism that

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[231] *See* discussion *supra* Section IV.A.

[232] NASA Letter, *supra* note 213.

[233] Short & Toffel, *supra* note 218, at 361.

[234] *Id.* at 370.

[235] *See id.* at 386.

[236] *See id.* at 387.

[237] *See* discussion *supra* Part III. This assumes, of course, that sanctions would actually be levied against OST violators. *See* Jill Stuart, *The Outer Space Treaty Has Been Remarkably Successful – but Is It Fit for the Modern Age?*, CONVERSATION (Jan. 27, 2017, 11:59 AM), https://theconversation.com/the-outer-space-treaty-has-been-remarkably-successful-but-is-it-fit-for-the-modern-age-71381 [https://perma.cc/7ZKD-NV52]. International compliance and liability may become more of a focal point for federal agencies and operators as a result of the Dish–Viasat litigation against the FCC. *See* Kelcee Griffis, *DC Circ. Probes Interference Risks of SpaceX's Starlink*, LAW360 (Dec. 3, 2021, 10:20 PM), https://www.law360.com/articles/

would accomplish a couple of important objectives: (1) it would allow the government to more adequately perform its regulatory obligation of overseeing its space operations and lessen its and the industry's potential exposure to international liability,[238] and (2) it would motivate and compel private actors to comply more strictly with voluntary and mandatory commitments. Importantly, this would fit neatly into the recently revised regulatory scheme—the industry can present "alternative ways to meet safety requirements," backed with NASA's stamp of approval.[239]

To provide the resources NASA would need to fulfill this role, the government should concede on a point that the industry has demanded: Consolidation of licensing in a single regulatory entity.[240] By doing so, the government would effectively have two main administrative branches for space regulation: a formal licensing branch and a substantive oversight branch. Further, the substantive branch (NASA) could operate as a liaison to make sure operators have met the substantive requirements for licensing and effectively give operators the stamp of approval on matters like safety-procedure viability before or during the licensing process.

Additionally, or perhaps alternatively, licensing processes could require the approval of some independent review board similar to the one used by the New Zealand drug industry. The New Zealand review board is comprised of an adjudicator and community members that quickly and effectively offer a recommendation.[241] Obviously, the space industry and its activities are more technically complex than the advertising industry and its activities. However, an independent private review board comprised of experts and stakeholder representatives could be an effective measure for vetting proposed space activities while protecting stakeholder interests. Ideally, the recommendations would be based on the stricter, industry-imposed guidelines mentioned above.[242] In theory, compliance could be voluntary, but if the licensing agencies afforded the recommendations

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1445565/dc-circ-probes-interference-risks-of-spacex-s-starlink [https://perma.cc/P47E-TVKH].

[238] *See* discussion *supra* Part III.

[239] *See* Foust, *supra* note 121.

[240] *See* Jeff Foust, *Space Industry Seeks Continued Progress on Regulatory Reform*, SPACENEWS (Oct. 30, 2020), https://spacenews.com/space-industry-seeks-continued-progress-on-regulatory-reform/ [https://perma.cc/T5DE-NDQU].

[241] *See* Asher, *supra* note 175, at 617.

[242] *See* discussion *supra* Section IV.A.

great weight in whether an operation receives authorization, this kind of voluntary compliance could increase overall code compliance.[243]

Increasing voluntary collaboration between the industry and government could also be a cheap and effective measure. There are some promising collaborative systems currently being implemented that should be emulated across more aspects of commercial space regulation. For instance, NOAA's OADR is an ideal—if somewhat late in the game[244]—collaboration between the government and the commercial industry to provide a basic database for space situational awareness free of charge.[245] This kind of open-source project offers a starting point for private companies to provide more robust situational-awareness services,[246] the development of which would naturally impose greater accountability on individual players by linking their objects to collisions or near collisions.[247]

These kinds of systems should be emulated across all aspects of commercial space regulation. NASA has asked that the FCC require SpaceX to work with NASA "to demonstrate the proposed capability with increasing volumes of satellites prior to each successive launch so that it may troubleshoot any issues that arise and make adjustments, as necessary."[248] This is the exact approach that must be taken. Licensing may well be consolidated in a single entity, but regulatory oversight must remain strong. And cooperation between domestic agencies, the commercial space industry, and international entities must be fluid, with a mind towards keeping spaceflight safe and sustainable. Thus, it is not sufficient that the industry remain code compliant in order to be licensed—third parties such as NASA (and, ideally, international entities)—should be involved in the approval process such that as many entities as possible are not only apprised of planned commercial space operations but also have an active hand in coordinating those efforts. Importantly, this is

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[243] *See* discussion *supra* Section IV.A.

[244] The project is set to be fully operational by 2025. Rao, *supra* note 134. SpaceX is aiming to launch fifty satellite payloads in 2022, with approximately forty to fifty satellites per payload. *See* Foust, *supra* note 71. If SpaceX proceeds at the same rate in 2023, upwards of 5,000 Starlink satellites *alone* could be launched before OADR is operational. *See id.* That is double the number of active satellites currently in operation. *See* discussion *supra* Part I.

[245] Foust, *supra* note 134.

[246] *See id.*

[247] *See* Mann et al., *supra* note 1.

[248] NASA Letter, *supra* note 213, at 4.

not merely another hoop to jump through or an unnecessary burden on the commercial industry's access to space, but rather a condition precedent to the viability of long-term space exploration considering the massive increase of commercial space operations in LEO, which will naturally lead to the complexity of future activities as LEO becomes more congested.[249]

Allowing NASA to become more of a coordinator would have the added benefit of lessening unintended consequences of commercial space exploration, such as light pollution.[250] Having a neutral third party such as NASA could be an effective tempering device on private companies whose interests may lie more in capturing market share than the longevity of space exploration. Indeed, NASA has a history of anticipating the unexpected—it quarantined Apollo 11 astronauts for three weeks upon their successful reentry to Earth after the moon landing to ensure they were not infected by a "moon plague" (an ailment that, it was ultimately concluded, does not exist).[251] Thus, NASA as a safety coordinator could offer a safety net for the U.S. commercial industry and provide a workable model for other countries to base their regulatory models on.

Finally, whatever substantive requirements Congress ultimately enacts need a mechanism through which other stakeholders can bring litigation to protect their own interests. Importantly, this should not take the form of vigilante enforcement whereby anybody can bring suit against space operators for noncompliance. Rather, this should merely offer a route through which affected stakeholders can challenge the validity of a proposed operation to ensure their interests will not be impeded without objection. Ideally, the proposed framework would operate to lessen the unintended consequences that led to the Viasat litigation against the FCC and astronomers' dissatisfaction over their work being affected by light pollution from satellite constellations. However, because the occurrence of the unexpected seems to be a given in space exploration, a mechanism that is designed specifically to account for the unexpected needs to be in place.

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[249] *See id.*

[250] *See supra* Section II.B.

[251] Meghan Bartels, *Apollo 11 Astronauts Spent 3 Weeks in Quarantine, Just in Case of Moon Plague*, SPACE.COM (July 24, 2019), https://www.space.com/apollo-11-astronauts-quarantined-after-splashdown.html [https://perma.cc/3GQB-CJ5B].

V. CONCLUSION

The commercial space industry is evolving extremely quickly, and this Comment only scratches the surface of the regulatory issues that need to be addressed. For instance, some have posited that SpaceX's use of tens of thousands of satellites may constitute "appropriation of space" under the OST, which would subject the United States and SpaceX to substantial liability exposure.[252] This Comment touches on, but does not fully address, how the international framework should be modified to adapt to the burgeoning commercial space industry. Indeed, many of the issues raised in this Comment can be extrapolated to an international scale. For instance, perfect compliance by one or a few does little without substantial compliance by all—perfect compliance by SpaceX does little in the presence of noncompliant orbital objects, and perfect compliance with strict standards by one country does little without similar compliance by all others.[253] Further, perfect compliance by *all* countries does little in the presence of a single bad-faith actor. Take, for example, Russia's invasion of Ukraine and SpaceX's use of Starlink to provide internet to Ukraine.[254] What if Russia decides that it does not want Ukraine to have that internet access and cares little about international liability should it disrupts that access? These are all important factors that need to be addressed but are outside the scope of this Comment.

There are a couple of main points that bear reiterating: (1) Space regulation is a pressing concern that should not be relegated entirely to the industry and that requires continual government supervision and involvement; (2) the viability of each proposed satellite mega-constellation must be considered carefully in the context of all other ongoing and future space operations; (3) the government must continuously act to protect the interests of all stakeholders; and (4) the issues raised herein need to be addressed on an international level, since international cooperation is just as fundamental as intranational cooperation. This Comment aims to serve as a launching point for a discourse on how to approach the vitally important regulatory issues that surround space exploration and its sustainability. Commercial space is a fragile environment. If that environment is rushed into without proper care or adequate precaution, the

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[252] *See* discussion *supra* Part III.

[253] *See* discussion *supra* Section II.B & Part IV.

[254] *See* Kniazhevich, *supra* note 26.

science fiction that the industry seeks to make a reality will be short-lived.