# 1AC

### 1AC – Plan

#### Plan – The appropriation of outer space through the production of space debris by private entities is unjust.

#### Revising the Outer Space Treaty curbs the impact of space debris – timeframe is crucial.

Shah 20 – Sachin, 8/30/20, [“Aug 30 The International Legal Regulation of Space Debris,” CORNELL UNDERGRADUATE LAW & SOCIETY REVIEW, Administrative, Policy, Technology, <https://www.culsr.org/articles/the-international-legal-regulation-of-space-debris>] Justin

The body of legal regulations regarding the use of space (space being defined as the area above the jurisdiction of air law) by public and private entities is referred to as space law. Currently, there are only about five such regulations of space, the most significant of those being the United Nations’ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereinafter referred to as the Outer Space Treaty) of 1967. In this article, I would like to specifically describe and analyze the laws and regulations’ handling of the increasingly prevalent issue of space debris in orbit around Earth. The National Aeronautics and Space Administration (NASA) defines space debris as “any man-made object in orbit about the Earth which no longer serves a useful function.” [1] However, a major point of confusion discussed below is that the Outer Space Treaty does not explicitly define what it refers to as “space objects,” nor does it mention whether space debris are space objects. An excessive clustering of space debris is a problem for a few reasons. It may result in a phenomenon known as the Kessler Syndrome, in which there is a “cascade created when debris hits a space object, creating new debris and setting off a chain reaction of collisions that eventually closes off entire orbits.” [2] This endangerment of Earth’s future ability to explore extraterrestrial planets and life must be avoided at all costs. Furthermore, space debris in orbit around Earth limits the amount of available space for satellites to orbit, which may result in the Tragedy of the Commons: multiple actors will aggressively vie, in an arms race, for their right to space as it is a limited resource. [3] Space debris is thus a potentially pressing issue in our increasingly technological world. In this essay, I will analyze the existing regulation of space debris as outlined in the Outer Space Treaty, point out the issues with these regulations of space debris and discuss potential solutions, and, finally, discuss legal considerations for private enterprises as well.

The Outer Space Treaty of 1967 remains today’s leading regulation on the governance of outer space activities. A salient aspect of the Cold War was the space race between the United States and the Union of Soviet Socialist Republics (USSR) that occurred in the late 1960s. Before the nations engaged in their race to the moon, the United Nations enacted the Outer Space Treaty to ensure international peace by making the use of space equitable and fair. Articles VII and IX most closely deal with concepts of space debris, but it is important to note here that the Treaty does not specifically define space debris, and rather, governs the use of “space objects.” Article IX of the Treaty states that States “shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty,” and that exploration of outer space should avoid its “harmful contamination.” [4] Many scholars believe that conducting activities with regard to other States involves leaving areas free of space debris, and further that space debris constitutes a harmful contamination to the space environment. Article VII of the Treaty provides that each State is “internationally liable for damage to another State Party to the Treaty or its natural or juridical persons by such object or its component parts on the Earth.” [5] Thus, regulations are in place to incentivize States to mitigate the amount of space debris they create for fear of severe financial penalties. There are also four other international treaties on space governance: the Rescue Agreement, the Liability Convention, the Registration Convention, and the Moon Agreement. These treaties, while also important, all have fewer signatory parties and were often created for more specific activities, whereas the Outer Space Treaty was general in scope and widely adopted. [6]

While many scholars agree that the Outer Space Treaty provides rudimentary regulation of the problem of space debris, therein lies the problem: it is only rudimentary. One of the most often cited problems with the Outer Space Treaty is that it was signed in 1967 (53 years ago) and that the technological climate of the space travel industry was not as advanced as it is today, reflected in a marked lack of specificity in the writing of these laws. [7] This lack of specificity highlights another issue: the imprecise language of the Treaty leaves unclear the definition of space debris, which leaves the regulation open to interpretation. Rather than agree with most scholars that space debris constitute “space objects,” scholar Chelsea Muñoz-Patchen uses the UN Space Debris Mitigation Guidelines’ definition of space debris along with the fact that space debris is non-functional and its ownership often untraceable in order to argue that space debris should be classified as “abandoned property” instead. [8] Furthermore, non-governmental private enterprises may be inclined to legally define space debris as something other than “space objects” in order to avoid the Outer Space Treaty’s aforementioned financial penalties, as will be explained below. The Outer Space Treaty also does not account for the fact that the space debris problem, especially as of late, has been becoming worse over time. As collisions between debris and satellites continue to occur, more debris is strewn across Earth’s orbit, endangering future spacecraft from safely orbiting Earth, supporting the theory of the Kessler Syndrome. [9] Thus, the Outer Space Treaty is not a very effective legal instrument with regards to mitigating the amount of space debris in orbit around Earth.

Due to the Treaty’s weakness, many of the aforementioned scholars support revising the Outer Space Treaty by clearly defining space debris, increasing its technology-specific language to combat space debris issues, and outlining specific punishments to negate the complete lack of enforcement built into the current Treaty. While nations do recognize the danger that space debris pose to orbital operations, stronger laws must be enacted in order to de-escalate an imminent arms race and incentivize them to mitigate their debris. [10] Believing that one convention or treaty would be insufficient, N. Jasentuliyana recommends the creation of a regulatory regime to solve the growing problem of space debris. Such a regime would “effectively deal with these technical problems and establish international legal rules, standards and procedures on a continuing basis.” [11] Thus, one potential solution to the legal lack of space debris mitigation is establishing a lawmaking agency which specifically focuses on the issue of space debris. In addition to the creation of a legal agency which could hold actors accountable for the amount of space debris produced, international laws guiding the actions of private companies’ activities may also provide an answer, as will be discussed in greater detail below.

Although there do exist international laws and regulations governing the use of space for states and governmental entities (albeit weak ones), the private enterprises sending objects into space are subject to even less stringent regulations than states are. SpaceX, for example, to authorize their sending of 42,000 Starlink satellites into orbit, only had to submit paperwork to the U.S. Federal Communications Commission (FCC) and the International Telecommunication Union (ITU). [12] Paul Larsen posits that, in the face of less stringent regulations, nongovernmental satellite companies send many satellites into orbit in order to maximize their profit, which is their primary objective. Unlike the vagueness and lack of enforcement that came with written law (which is apparent in the Outer Space Treaty), the unwritten market-oriented incentives for profit by large-scale satellite providers and operators provide a reason for actors to mitigate space debris in orbit around Earth. Larsen states that “They have huge sums of money invested in each satellite, perhaps as much as a half-billion dollars, when all costs are included. Loss of one satellite is a major event. They want their assets to be safe.” [13] Thus, these satellite companies have a major stake in space traffic management and their market incentives do a better job of mitigating space debris than the existing legal regulation does. The company SpaceX, as mentioned above, plans to send 42,000 satellites into space. While doing so would likely result in significant profits for the company, many believe this will diminish astronomical visibility as well as increase the chance of collisions with space debris. [14] Due to these effects, scientists and space law experts alike have called for a legal delay to the ITU’s decision on whether or not to accept SpaceX’s proposal to launch more satellites. If these parties are successful, a precedent-setting legal case regarding space debris mitigation and satellite use in space may well provide a solution to the outdated Outer Space Treaty of 1967.

#### Private entities are non-governmental.

Dunk 11 – Frans G. von der Dunk, 2011, [“The Origins of Authorisation: Article VI of the Outer Space Treaty and International Space Law,” University of Nebraska] Justin

4. Interpreting Article VI of the Outer Space Treaty One main novel feature of Article VI stood out with reference to the role of private enterprise in this context. Contrary to the version of the concept applicable under general international law, where “direct state responsibility” only pertained to acts somehow directly attributable to a state and states could only be addressed for acts by private actors under “indirect,” “due care”/“due diligence” responsibility,18 Article VI made no difference as to whether the activities at issue were the state’s own (“whether such activities are carried on by governmental agencies” . . .) or those of private actors (. . . “or by non-governmental entities”). The interests of the Soviet Union in ensuring that, whomever would actually conduct a certain space activity, some state or other could be held responsible for its compliance with applicable rules of space law to that extent had prevailed. However, the general acceptance of Article VI as cornerstone of the Outer Space Treaty unfortunately was far from the end of the story. Partly, this was the consequence of key principles being left undefined.

#### Removal efforts are complements to the plan not the silver bullet.

Rada Popova 18, European Space Agency Project Co-Manager and PhD Faculty of Law @ Universitat zu Koln, “The Legal Framework for Space Debris Remediation as a Tool for Sustainability in Outer Space,” *Aerospace*, MDPI, doi:10.3390/aerospace5020055 \*adr = active debris removal, \*\*sdr = space debris remediation, \*\*OOS = on orbit servicing

In outer space, any launch creates space debris. Since the first man-made object was launched into space in 1957, more than 5600 launches have taken place [2]. In addition, incidents and collisions create additional space debris. As a result, human activities have caused significant negative effects on outer space, as during the past six decades near-Earth orbits have been filled with functional and non-functional objects, the overwhelming majority of which are debris. Of course, this observation is not relevant for the whole of outer space. For the purposes of this article, and of space law in general, the subject of interest is naturally restricted to the orbital regions that are accessible for man-made spacecraft and are used for space activities. The farthest space mission so far—Voyager-I—has left the solar system and entered interstellar space. Nevertheless, most human activities take place in low-Earth orbit (LEO) in an altitude between 200 and 2000 km used for the International Space Station, Earth observation satellites as well as some telescopes, medium-Earth orbit (MEO) in an altitude approximately between 2000 and 36,000 km mostly used for navigation, geodetic and communication satellites as well as geostationary Earth orbit (GEO) at approximately 36,000 km. Currently, there are 1738 functional satellites, of which 1071 are in LEO, 531 in GEO, 97 in MEO and 39 in elliptical orbits [3]. Currently, only 6% of the catalogued orbital population are functional objects. The number of non-functional objects that are trackable and contained in the Space Surveillance Network catalogue show that there are more than 21,000 larger than 10 cm. For smaller sizes, the estimates are based on statistical models, such as the NASA Standard Breakup Model [4] and in-situ measurements. The estimates include 150 million objects larger than 1 mm and 600,000 objects up to 1 cm. Moreover, 700,000 to 750,000 pieces of space debris larger than 1 cm have resulted from more than 200 on-orbit defragmentations [5]. As a consequence of the vast orbital velocity in LEO (8 km/s = 28,800 km/h), impacts with the smallest objects of 1 mm might cause degradation and damage to functional spacecraft. So far, shielding options have been developed, but they are only effective for fragments not larger than 1 cm. Impacts with larger objects have the potential to destroy functional satellites. This is linked to the decisive factor for the constant growth in debris: the ‘Kessler syndrome’—a cascade effect describing the fact that collisions between space debris result in an exponential growth in the orbital debris population which, once collisional break-up begins, will increase even if no new launches take place [6,7]. In the near future, a further “growth factor” which might additionally influence space debris propagation are so-called ‘mega-constellations’ that will consist of hundreds of small satellites with a short operational lifetime and restricted manoeuvring capability [8,9,10]. Table 1 lists recently announced satellite constellations aiming to provide global internet communications which have attracted much publicity. Some commonalities include: (1) the orbital altitudes above the popular 800–900 km Sun-synchronous orbits where atmospheric drag is non-existent; and (2) the compact mass of objects below 500 kg which suggests low-thrust electrical propulsions for orbital manoeuvers. The list of announced constellations could easily be extended. However, it is unlikely that all announced plans turn into reality. In such global business scenarios, typically the first-in-the-market along with two or three competitors apportion the market among themselves. This happened in the 1990s, when several global communication LEO constellation systems were announced of which only Iridium, Globalstar and Orbcomm made it into orbit. Keeping in mind that approximately 1000 active satellites are in LEO today, with the announced OneWeb mega-constellation this number will almost double [11], and if all three constellations on the list are launched, this would result in a tenfold increase in the LEO satellite population. The scope of challenges posed by orbital debris pollution is further underlined by the restricted cataloguing possibilities and the relative effectiveness of space situational awareness systems. The catalogue maintained by the US Space Surveillance Network provides information on 16,000 objects [13]. The Space Awareness System of the European Space Agency (ESA) can track objects bigger than 10 cm in low-Earth orbits and 0.3–1 m in geostationary orbits [14]. Thus, only a small fraction of the overall debris population can be detected. Furthermore, even if a collision probability can be calculated, manoeuvring may not be feasible, e.g., due to restricted time for reaction or lack of manoeuvring capabilities or control over the satellite. Unlike the environment of the Earth that might be cleaned-up and restored to a previous state, outer space is governed by celestial mechanics which make it practically impossible to clean-up debris through natural orbital decay and thereby bring the orbital environment to its original state. The natural decay of space debris is dominated by the drag caused by the residual atmosphere. The effect is dependent on the mass, the cross-sectional area, and the orbital position of the space object. Space debris at 800 km may remain in orbit for the next few centuries [15] and space debris orbiting at more than 1500 km will practically remain in outer space forever as there is not enough drag from Earth’s atmosphere any more at this altitude [16]. All of these factors make for an alarming picture. In general, one can distinguish between collisions (in which two objects are involved) and break-up events (which can occur if a satellite is breaking up by itself because of residual fuel in the tanks or a self-destruct mechanism). Although so far only a few on-orbit collisions have occurred [17] (e.g., the 2007 anti-satellite missile test conducted by China on its Feng-Yun 1C satellite and the 2009 collision between the inactive Russian satellite Cosmos 2251 and the active US satellite Iridium 33), a dramatic growth in the space debris population has been caused by these accidents. Alone the 2009 collision led to the creation of a space debris cloud of 2000 pieces of debris larger than 10 cm and thousands of smaller pieces which might remain in orbit for years [18]. The number of collisions that will lead to further incidents will grow over time. This risk is particularly high for near-polar LEO orbits at around 800–900 km and the GEO region, as approximately 62% of functional satellites are in LEO and 31% in GEO [3,19]. As LEO is the region of greatest concern for the uncontrolled growth of debris, currently, the following mechanisms are considered vital to mitigate the debris population to a sustainable level: (1) post-mission disposal; (2) passivation; and, (3) active debris removal. While a few years ago, less than 50% of the missions in GEO were compliant with space debris mitigation standards [20], in 2016, more than 80% successful clearance attempts were undertaken in GEO and 66% in LEO [21]. It has been estimated that compliance with mitigation rules, e.g., through ensuring that 90% of the launches are in compliance with the 25-year rule of post-mission disposal as provided by the Space Debris Mitigation Guidelines of the Inter-Agency Space Debris Coordination Committee (IADC) [22] and no new on-orbit explosions occur, will not be enough to reverse the negative trend in the most used orbits. These findings were studied in detail by the IADC in simulation campaigns among the participating partners, and recently confirmed by reference simulation in the frame of the H2020-ReDSHIFT project [23]. Furthermore, even if up to 10 large objects are removed from low-Earth orbit per year, the debris growth in LEO is still likely to evolve negatively in the next 200 years [1]. Long-term reference scenarios conducted recently within the H2020-ReDSHIFT project used a space debris population from LEO to GEO and a projection time frame of 200 years. Assuming 2–3 self-induced in-orbit explosions over the next 15 years, a post-mission disposal success rate of 60% (on 25-year orbits in LEO and to graveyard orbits in GEO) and collision avoidance against all objects in LEO, the results show that remediation of two objects per year decreases 12% of the final population [24]. Thus, it is expected that a combination of mitigation and remediation measures is needed to overcome the negative trends which will, with time, evolve into a catastrophic state if no effective action is undertaken. While an established (voluntary) framework for non-binding mitigation measures and some state practice exists through the adoption of specific measures for space debris mitigation in the national space laws of some states [25], the legal implementation of space debris remediation (SDR) is still in the making. The reasons for the slow pace of this development are, on the one hand, of a technological nature and, on the other, are due to the complex legal problems posed by SDR. In the following sub-section, an overview of the legal framework and the main challenges for establishing rules on SDR will be given. 2.2. The Legal Framework for Space Activities The legal framework for outer space activities consists of five international treaties (the 1967 Outer Space Treaty (OST) [26], the 1968 Rescue Agreement [27], the 1972 Liability Convention [28], the 1975 Registration Convention [29], and the 1979 Moon Agreement [30]) adopted in the period between 1967 and 1979, resolutions of the General Assembly of the United Nations adopted since 1982, and the national space legislation of more than 20 countries. Since 1996, a tendency can be observed to adopt sets of measures and instruments on the international level that re-interpret concepts entailed in earlier Treaties [31]. The Outer Space Treaty is sometimes referred to as a “Constitution” of space law as it contains the basic principles for space activities, provides the basis for the next four treaties, and has gained significant support, with 107 signatories as of January 2018 [32]. Thereby the Outer Space Treaty is considered to contain principles of customary international law, which bind not only state parties to the treaty but also non-signatories [33]. Such customary principles are Articles I–IV, VI, VII, VIII and arguably also Art. IX OST and have served as a basis for the development of the further treaties on space law. International law designates outer space and celestial bodies the status of a global common—a domain beyond national jurisdiction which is not subject to national sovereignty. This is laid down in Art. I para. 1 of the 1967 Outer Space Treaty [26], according to which the use and exploration and use of outer space should be regarded as the ‘province of all mankind’. While it is difficult to define this notion in concrete terms, there is no doubt that outer space should be open to the use of all states, regardless of their current economic or technological development [34]. Thus, the use of outer space as a global common, including economic and non-economic uses as well as scientific exploration of outer space and celestial bodies, should be free—in the sense of remaining accessible for all states and their nationals on the same terms, without discrimination of any kind. Accessibility as a means to carry out space activities should be preserved not only in the short-term perspective, but on a long-term basis as the dependency of humans on outer space will only grow in the future. As a consequence, the sustainability of space activities must be ensured. It is, therefore, worthwhile discussing whether, if such activities are endangered by the negative consequences of orbital pollution, the rights of states to freely exercise their activities in outer space as stipulated in the Outer Space Treaty can be safeguarded. ● The Freedoms vs. the Usability of Outer Space The principles contained in the Outer Space Treaty and the subsequent four treaties on space law set out a framework for human activities in space that can be characterized as a system of freedoms and limitations. Art. I of the OST provides that there shall be freedom of the exploration, use and scientific investigation of outer space and celestial bodies. “Use” means both the economic and non-economic use of outer space [35]. The term “exploration”, however, stipulates not so much consuming or profiting from space but rather the discovery of something new or yet unknown. Scientific investigation might but must not necessarily overlap with “exploration” as scientific activities might be aimed also at already discovered objects or areas. The term “freedom” means that all addressees of these provisions (primarily states and also nationals of states, in as much as states entitle them to do so through national space legislation) are entitled to use, explore or scientifically investigate outer space without the need to ask for permission from other states or an international entity. At the same time, this means that such activities shall not be hampered, e.g., by harmful interference or other impairment. However, the freedoms of outer space are not absolute, as they are not limitless. Limitations are certain exceptions contained in Article I of the OST itself as well as in other treaty provisions of the corpus iuris spatialis. Such as, inter alia, the common benefit clause (Art. I para 1 OST), Art. III OST and Article 2 UN Charter, Art. IV para 1 OST, Art. VII OST and Art. 2 and 3 Liability Convention. Some of these limitations are specifically relevant for the sustainable use and exploration of outer space and celestial bodies, and thus for SDR, as sustainability is an indispensable condition for the usability of outer space. It is thereby required that the use of outer space by present generations takes place on the basis of responsibility towards future generations, which is reiterated by the specific nature of outer space as a global common. ● The notion of the “province of mankind” In Art I para 1 of the OST and Art. 4 of the Moon Agreement the use and exploration of space and celestial bodies are declared to be the “province of mankind”. Although no definition of the term “mankind” has been provided, this notion is an expression of the equal right of all states (regardless of the fact that they are space-faring or developing countries) and all generations (present and future) in the use and exploration of outer space and celestial bodies [36]. ● The Common Heritage of Mankind (CHM) concept (Art I para 1 OST, Art. 11 MOON) The purpose of this doctrine, which is not restricted only to space law, is the protection of certain areas of great importance outside national territory and ensuring their integrity for future generations. It is reflected the United Nations Convention on the Law of the Sea [37] and can also be found in the Preamble of the Antarctic Treaty [38] without being explicitly mentioned there. As with the province of mankind clause, the notion of CHM brings forward the particular status of outer space as a domain which should be open and preserved for all states and generations. ● Military uses of outer space Another important limitation to the freedoms of outer space is contained in Art. IV of the OST. Certain military uses of outer space, such as the placement of nuclear weapons and weapons of mass destruction in orbit around the Earth, their installment as well as the establishment of military bases and the testing of weapons on celestial bodies or their stationing anywhere in space, are prohibited. Furthermore, para 2, Art. IV provides that outer space may be used for “peaceful purposes only”. While the exact meaning of the term “peaceful purposes” is contested, the leading opinion interprets it as non-aggressive, meaning that some military activities are acceptable if exercised lawfully (e.g., the right to self-defence, Art. 51 UN Charter) [39]. This provision is relevant especially as e.g., anti-satellite testing and other military destructive activities can produce a considerable amount of debris. ● The environmental protection of outer space A further limitation is contained in Art. IX of the OST, which is considered the basis for the environmental protection of outer space. By providing that states parties “shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other states” [40], this provision reaffirms the common character of outer space. Furthermore, it provides that the “harmful contamination” of outer space and celestial bodies shall be avoided (Art. IX sent. 2 OST) and, in case activities can potentially cause “harmful interference with activities of other states parties”, consultations should be undertaken before the activity is carried out or continued (Art. IX sent. 3 and 4 OST). Although the concepts used in Art. IX are difficult to define, it expresses the idea that there shall be protection of space activities from all forms of interference that might cause harm or pose a risk of harm to other states [40]. Thereby, Art. IX of the OST contains the principle of co-operation (Art. IX sent. 1 OST) which is also found in Articles III and X of the OST and was further developed in the other four treaties on space law. However, no specific requirements for states as to how to exercise their activities in a manner that would ensure that the standard of care towards of activities of other states are provided. Thus, the legal framework provides for some general direction for co-operation between the users of outer space but concrete instruments on how to ensure sustainability need to be formulated in more detail. In fact, the treaties on space law neither expressly prohibit the creation of space debris nor impose an obligation on states and their space actors to remove space objects from orbit. Mitigation measures have so far only been adopted as voluntary, non-binding instruments and have been partly adopted in the national laws of some states [25]. In sum, it can be stated that a general obligation to protect the environment of outer space results from the common interest of the community of states to access and use outer space. If a narrow interpretation of the theory of erga omnes obligations is followed, it is the currently 107 State parties to the OST [32] which represent the community having a common interest in the protection of the usability of outer space. If the view is followed, that due to the broad support and the principle-based character of some of its norms, the Outer Space Treaty has at least partly customary character, it can be argued that the 107 State Parties represent the global community so that the global community has a legal interest in the environmental protection of outer space., but a concrete, binding way of action for SDR cannot be derived from existing space law [41]. 2.3. The Future of the Outer Space Environment 2.3.1. Sustainability as a Condition for the Usability of Outer Space What, then, can be done? In the context of the work of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), the sustainability of outer space is defined by the stability and safety of its environment which shall be “open for exploration, use and international cooperation by current and future generations (…)” [42], based on non-discrimination. Thus, sustainability is a condition for any future access to and use of outer space. On the technical level, both mitigation and remediation concepts **have been developed** in order to facilitate the protection of near-Earth space from space debris aiming to “maintain the conduct of space activities indefinitely in the future” [43]. Out of the factors playing a role in the creation and distribution of space debris (orbit dynamics, air-drag on the residual atmosphere, on-orbit explosions, collisions, surface degradation slag from solid rocket motor firings, launch rates of future missions, operational practices and mitigation practices) a few will be tackled here that are the direct result of man-made activities. In the style of the “leave no trace” paradigm of sustainable outdoor activities in nature here on Earth, several guidelines have been formulated as well for space activities; for instance, guidelines for the disposal of defunct satellites which are to be removed from LEO within 25 years after their end-of-life. In practice, this typically is realized by a final orbit maneuver which lowers the perigee as much as possible to ensure it will re-enter within 25 years. Such an action at the end of a mission is also beneficial with respect to another paradigm, which calls for a minimum impact on the environment. In a last orbit maneuver, all the leftover fuel can be used, which is one element of the passivation of satellites at their end-of-life. In general, passivation covers all forms of stored energy on board, let it be kinetics of the gyros, charge of batteries, and also fuel in the tanks. Passivation aims at the minimization of self-induced break-ups and it is expected that the number of explosions can be controlled very well by proper passivation and their severity can be significantly reduced (because e.g., the residual fuel cannot self-ignite when the tank corrodes and lead to a complete destruction). That said, post-mission disposal considerations are to be seen in opposition to the space mission operators’ desire to extend the nominal mission operation. Naturally, this is also a sustainable approach. It is usually better in terms of global sustainability to continue using old equipment (and accepting additional maintenance to a certain economic level) instead of throwing it away and replacing it. In space, however, maintenance is not easily done. Therefore, the risk of a critical failure on-board a satellite increases towards longer mission durations. From the sustainability point of view, it remains unclear when it is best to simply extend a mission and accept the higher risk of losing control over the satellite and not being able to perform disposal at all or to terminate the mission with a proper disposal maneuver and passivation. The aforementioned example highlights that, as in other domains, there is a usually a conflict of interest between the immediate needs of spacecraft operators and the higher good of preserving the space environment in accordance with the treaties on space law. Space mission designers will always assess the collision probability due to space debris and define a tolerated risk threshold for their assets. In case the desired target orbit is already too densely populated with debris, it is possible to re-design and move to other, higher orbits. What is yet to be done is to strike an agreement at a global level to define acceptable inflictions on the space environment that are tolerable. An analogy can be drawn to the consensus on the two-degree goal in climate change. Maybe it is possible to discuss and formulate similarly memorable and easily understandable goals for the outer space environment. Although it is unlikely that the final sentence will state “Two collisions per year are tolerable”, such goals would provide the necessary foundation for further action. 2.3.2. The Need to Act As any significant accident in outer space leads to irreparable damage in orbital stability, it is not enough to mitigate the production of new space debris. In particular, the fact that in higher altitudes objects may remain over hundreds or even thousands of years, means that a potentially catastrophic effect for functional objects remains. Mitigation can indeed contribute to stabilizing the outer space environment, but further measures are necessary. For example, in LEO mitigation measures can only slow down the pace of growth but are not enough to stop it. Therefore, further measures aiming at reducing the existing space debris population through remediation are needed if the most used orbits are to remain usable. For example, a long-term scenario with five ADR missions per year clearly shows that remediation for large objects would lower the number of collisions in densely populated orbital regions from 10 to 5 and is, thus, advantageous [23].

#### Exemptions destroy the coercive power of legal regimes – causes circumvention across the board.

Hickman and Dolman 2 – John and Everett, 2002, Associate professor in the Department of Government and International Studies at Berry College in Mt. Berry, [“Resurrecting the Space Age: A State–Centered Commentary on the Outer Space Regime,” Volume 21 Number 1, <https://doi.org/10.1080/014959302317350855>] Elmer Recut Justin

Thus a state party need merely announce its intention to withdraw and then wait one year. Withdrawal of a single state party to the treaty, however, would not necessarily terminate the treaty between the other state parties. Yet, the decision of an important state not to be bound by a regime–creating treaty obviously endangers the entire treaty. The decision of the United States or China to withdraw from the OST would have far greater implications for the survival of the international space regime than the same decision by Bangladesh, Burkina Faso, or Papua New Guinea—the equality of states under international law remains nothing more than a useful  ction. For the OST to remain good international law, it must be accepted as such by the major space faring states of the 21st Century: the United States, Russia, the European Union, Japan, and China. One defection from the regime by a member of this group would no doubt lead to its effective collapse, as the remaining space faring states are unlikely to use the kind of coercion necessary to enforce the regime. A more likely response to such a defection is a scramble to make similar claims to sovereignty, based on historical precedent and effective occupation. Similar rushes to stake claims for territory sovereignty in other celestial bodies might follow.

### 1AC – Adv – Debris

#### The advantage is debris:

#### Massive satellite development incoming and cascades debris – lack of regulations raises the risk and turns any reason satellites are good.

Hattenbach 19. Jan Hattenbach sat down with Stijn Lemmens, Senior Space Debris Mitigation Analyst at the European Space Agency (ESA) in Darmstadt, Germany, to talk about how Starlink plays into the space junk problem. 6/3/19. [Sky Telescope, “DOES STARLINK POSE A SPACE DEBRIS THREAT? AN EXPERT ANSWERS,” <https://skyandtelescope.org/astronomy-news/starlink-space-debris/>] Justin

Jan Hattenbach: The recent launch of the first 60 “Starlink” satellites has sparked outrage on social media. Some critics claim the “mega-constellation” of satellites by the U.S. company SpaceX will increase the risk of creating more space junk, even calling it a threat to space flight itself. What is your opinion — is this criticism justified or exaggerated?

Web around the worldWhen up and running Starlink will provide internet access to locations across the planet. SpaceX

Stijn Lemmens: We're talking about a constellation that — if it ever comes to full fruition — would include up to 12,000 members. Several nations have launched almost 9,000 satellites over the past six decades. Of these, about 5,000 are still in orbit. So we are talking about doubling the amount of traffic in space over a couple of years, or over a decade at most, compared to the last 60 years.

However, the space debris issue is mostly caused by the fact that we leave objects behind in orbit, which are then a target for collisions either with fragments of a previous collision event or with big, intact objects. Currently, most space debris comes from explosive break-up events; in the future, we predict collisions will be the driver. It's like a cascade event: Once you have one collision, other satellites are at risk for further collisions.

Over the past two decades, there has been a lot of effort to establish guidelines and codes of conduct. For low-Earth orbit (LEO), there is a well-known guideline to take out your spacecraft, satellite, or launch vehicle upper stage, within 25 years after the end of mission.

To have a reasonable shot at having a stable space environment, the goal is to have at least 90% of the satellites and launch-vehicle upper stages with lifetimes longer than 25 years take themselves out of orbit, or put themselves into orbits with lifetimes less than 25 years.

However, we are not really good at doing this at the moment. We’re talking about success rates of 5% to 15% for satellites (launch vehicle orbital stages do notably better, with success rates of 40-70% in low-Earth orbit). Already with current traffic, we have reasonable concerns that we're creating a real debris issue out there.

If we're now thinking about putting another couple of thousands of satellites up there, with levels of compliance similar to what we've been doing so far, then we're talking about a possible catastrophe.

Operators of any type of large satellite constellation would have to behave far better than most current actors in spaceflight have been doing. And this is the concern: Before you launch, operators can of course say and demonstrate that they are going to comply with all international norms and guidelines. But it's only after launch that we know how responsible their behavior actually was.

JH: Do you have the impression that SpaceX is aware of their responsibility?

SL: They are certainly aware of the problem. For example, to get a license to launch in the U.S. with a mission like theirs, where they are exchanging data between the mainland, space, and other operators, you need to request a license, in this case from the Federal Communications Commission (FCC). To obtain this license, they must demonstrate what they will do with respect to space debris mitigation. So they needed to demonstrate a certain adherence to the norms.

But the real question is whether the current norms are actually sufficient for large constellations, or if we are putting the bar too low with respect to future sustainability. We are talking about thousands of new satellites — the risk is that the cumulative effect is not captured in the current level of guidelines. So SpaceX would have to voluntarily demonstrate higher levels of commitment.

JH: When asked about these issues, SpaceX responded that they believe they have the “most advanced system” for space debris mitigation, e.g. that the Starlink satellites are “designed to be capable of fully autonomous collision avoidance – meaning zero humans in the loop.” Are you confident that such a system will work, especially considering the numbers?

SL: I have no technical visibility on how they implement their system, so I cannot make a judgment if it will work with their satellites or not. What I can say is that it will require a certain improvement on the current state-of-the-art. On the other hand, if a pair of Starlink satellites does collide within the operation orbit, SpaceX will be the first one who will be badly affected by the fragmentation cloud the collision generates. It's in their own best interest to make sure their system works.

JH: You mentioned the launch license issued by the FCC, which is a federal commission of the United States. However, space is not the property of the U.S. or any other country. Is there an international body that has a say in these matters?

SL: Five outer space treaties, established in the 1960s, 70s and 80s, do not mention space debris. Instead, there is a lot of coordination, first of all on the agency level. The Inter-agency Space Debris Coordination Committee coordinates 13 of the world's space agencies, including the ESA, NASA, the China National Space Administration, and Russia’s Roscosmos,to come up with debris mitigation guidelines, share best practices, and try to address the problem in a way that makes sense to everyone. The United Nations Committee on the Peaceful Uses of Outer Space has taken on these guidelines . This committee includes politicians from many countries, including those not currently flying in space. Industries in many countries likewise discuss these issues within the International Organization for Standardization.

So there is a lot of coordination internationally to make sure that we play by the same rules and implement the same set of standards. But right now there is no way to directly interface with any nation's sovereignty over what it launches — the outer space treaties make nation states responsible for the behavior of their individuals or private companies.

#### Democratization of technology spurs rapid development – feedback loops ensures debris cascades

BERNAT 20. Pawel @ Military University of Aviation. 11/4/20. [SAFETY ENGINEERING OF ANTHROPOGENIC OBJECTS, “ORBITAL SATELLITE CONSTELLATIONS AND THE GROWING THREAT OF KESSLER SYNDROME IN THE LOWER EARTH ORBIT,” Volume 4, PDF] Justin

The second decade of the 21st century has brought a dynamic and somewhat surprising development of the space industry. Since 1972 – the Apollo 17 crew mission to the Moon, the humankind has not left the safe environment of Earth’s orbit, and for years the global space sector has been progressing in slow but steady pace run by a few largest space agencies like American NASA, European ESA, Japanese JAXA, and Chinese CNSA. The most significant achievement of the “old ways” of managing outer space exploration is the International Space Stations (ISS) that has facilitated more than 20 years of continuous crewed operations.

The situation started to change at the turn of the century when new generations of private entrepreneurs began to invest in and develop space technologies like rocket boosters, spaceships, and what most important for the subject of the paper – satellites and their constellations. This new shift is known among the space industry as “Space 2.0”, and its emergence is dated around 2000-2002 when the companies like SpaceX, Blue Origin, and Virgin Galactic were established. (Pyle, 2019). The real change, however, came in 2012 when the first SpaceX commercial mission was successfully launched to the ISS (NASA, 2012).

Since then, the participation of the private sector in the space industry has skyrocketed, especially in the United States. Today, SpaceX is the only entity that provides reusable rockets (first stage and fairings) that is capable of vertical launch and landing. Their current flagship rocket – Falcon 9 has carried out 23 successful missions in 2020 (SpaceX, 2020) and another four are planned for December of that year (Weitering, 2020). Moreover, thanks to Crew Dragon spaceship developed by the company, Americans have regained this year the capacity of sending astronauts from their own soil after nine years of buying the seats on Russian Soyuz capsule. SpaceX is now in the process of building a communication satellites constellation that will be addressed and analyzed in the paper.

Nowadays, in the space industry, we witness a very productive cybernetic feedback look between the development of space technologies, the democratization of those technologies, and a substantial reduction of prices. The latter is even more significant if we compare the cost of launching cargo into orbit now and 20 years ago – Falcon 9 is over ten times cheaper than Space Shuttle (Jones, 2018). This, of course, directly translates into the mass and number of objects that we are able to put in the orbit viably. Once the constellations consisting of thousands of satellites were unthinkable, but in the current environment, they become a reality.

Space 2.0 also has brought new threats and challenges in the sphere of national and international security. The increase in launch capacity, among other factors, has led to progressive militarization and weaponization of space and new arms race (Bernat, 2019), which has also contributed to the growing numbers of orbiting objects.

The goal of the paper is to present the argumentation that the threat posed by the cascading collisions in the Earth’s orbit (Kessler syndrome) is becoming more severe due to the construction of orbital satellite constellations; the threat that presents a real danger for people during their EVAs and orbital infrastructure, which may bare immediate consequences for safety and security systems on Earth. In order to provide the theoretical context for the above claim, the following issues will be presented and discussed: (1) space debris, (2) the Kessler syndrome, (3) orbital debris models, (4) the legal issues related to space debris and mitigation actions against their proliferation, and (5) the planned and being currently developed orbital satellite constellations and how they contribute to the growing threat of the Kessler syndrome.

#### Privatization drive rivalries and exponentially increases debris – lack of regulations spikes it.

BERNAT 20. Pawel @ Military University of Aviation. 11/4/20. [SAFETY ENGINEERING OF ANTHROPOGENIC OBJECTS, “ORBITAL SATELLITE CONSTELLATIONS AND THE GROWING THREAT OF KESSLER SYNDROME IN THE LOWER EARTH ORBIT,” Volume 4, PDF] Justin

5. Orbital satellite constellations and the growing threat of the Kessler syndrome

Space 2.0 – the new era of space exploration that we witness now in the 21st century means, in words of Buzz Aldrin, “moving human enterprise into space” (Pyle, 2019, p. xiv). The process of commercialization of outer space has already begun and is not limited to private companies providing technologies and services for national or international space agencies, as it was in the past. On the contrary, private companies from the space sector have now matured to carry out their own independent projects.

As for 2020, SpaceX is a company that serves as the best example – it launches satellites to the orbit, both for state and private contractors, it successfully realized two crew missions to the International Space Station, and is in the process of constructing Starlink satellite constellation that will provide high-speed internet access across the planet.

Each satellite weighs around 260 kg, is equipped with an ion propulsion system, autonomous collision avoidance system, and orbits Earth at approximately 540-560 km altitude (Starlink, 2020). At the beginning of November 2020, more than 860 Starlink satellites were orbiting the Earth (Jewett, 2020). Immediate plans include launching 12,000 satellites, but they assume a potential later extension to 42,000 (Henry, 2019a). Of course, SpaceX has employed, at least declaratively, all necessary measures to keep the space clean – the satellites are equipped with the deorbiting system, and in the event of inoperability of the propulsion system (Starlink, 2020). The orbital collisions are, however, inevitable. As it was shown before, the possibility of collisions grows with the number of orbital objects. Bastida Virgili with the team compared (2016, p. 154-155) orbital debris environment development without and with a large hypothetical constellation consisting of merely 1080 satellites, distributed across 20 orbital planes at 1,100 km altitude (Fig. 5).

Chart, line chart

Description automatically generated

Figure 5. Comparison of long term evolution of the number of objects in LEO with and without the constellation (Virgili et al., 2016, p. 155)

It has to be noted that although SpaceX’s Starlink is the only constellation that is being built in orbit, it is not the only one planned. There are at least a few initiatives aiming at the same goal – to construct internet infrastructure at the Earth’s orbit. The planned Kuiper Systems LLC, which is a subsidiary of Amazon and intends to place 3,236 broadband satellites in the LEO, is one of Starlink’s biggest competitors (Henry, 2019b). Now, there is even a rivalry between the two companies because Kuiper’s lowest orbital shell is planned to be 590 km, with a tolerance of 9 km either above or below (Cao, 2020), which is the altitude of Starlink satellites. Moreover, the race for space in orbit is now at the beginning.

The outer space is vast. It increasingly becomes more cluttered with both operational satellites and space debris. The threat of collisions increases and no institution or body has enough power to license, coordinate and regulate what is sent to the orbit. The UNOOSA has not such power. National states decide what the companies from the space industry can launch to space. In the United States, which is most advanced in the area of private constellations, it is the Federal Aviation Administration (FAA) that issues the appropriate approvals. The race to put broadband internet satellites bears similarities to the gold rush – there are no rules, at the global level, apart from first-come, first-served.

#### Models are rigorous—inserted below.

Virgili et al. 16. Bastida, J.C. Dolado, H.G. Lewis, J. Radtke, H. Krag, B. Revelin, C. Cazaux b , C. Colombo, R. Crowther, M. Metz. 4/26/16. [Act Astranautica “Risk to space sustainability from large constellations of satellites,” <https://sci-hub.se/10.1016/j.actaastro.2016.03.034>.] Justin

1.3. Simulation approach and result analysis A Monte Carlo (MC) approach was used to simulate the evolution of the object population over a period of 200 years under different post-mission disposal requirements, with four different tools (MEDEE – Modelling the Evolution of Debris on Earth's Environment [9], LUCA – Long Term Utility for Collision Analysis [10], DAMAGE – Debris Analysis and Monitoring Architecture to the Geosynchronous Environment [11] and DELTA – Debris Environment Long Term Analysis [12]). For analysis purposes, the effective number of objects was used where the contribution to the population by each object was weighted by the proportion of the orbital period spent in LEO. In a first step, four different evolutionary models performed an analysis of two reference scenarios. One scenario considered only the evolution of the background population and non-constellation traffic. The second scenario augmented the first with the addition of the representative constellation, with the requirement that 90% of the constellation satellites achieved post-mission disposal to orbits with remaining lifetimes of 25 years. The manoeuvres performed at the mission end to meet the disposal requirement are assumed to be impulsive (i.e. instantaneous) and result in an eccentric orbit with the apogee near the original (constellation) altitude and the perigee at an altitude such that the effects of atmospheric drag would cause the orbit to decay within 25 years. Two of the models considered an apogee remaining at the operational constellation altitude, while the other two reduced the apogee by 50 km. The purpose of these scenarios is to provide a cross-comparison of the models in terms of their predictions of the total object population, which take into account the effects of the constellation. As the distribution of the MC results for the models is of the same nature and the results are independent, a bootstrapping [20] approach is used to derive the mean, the standard deviation and the confidence levels at 95% of the combined results of all the MC runs from the four models (cf. Fig. 1), although not all the models performed the same number of MC runs (see Table 1). The main source of variation inside a particular model's MC runs included the randomness in collision activity, while the different models used their own solar activity forecast.

#### Conflicts of orbits turns good usages of satellites—responsible behavior is key to satellite effectiveness.

Hattenbach 19. Jan Hattenbach sat down with Stijn Lemmens, Senior Space Debris Mitigation Analyst at the European Space Agency (ESA) in Darmstadt, Germany, to talk about how Starlink plays into the space junk problem. 6/3/19. [Sky Telescope, “DOES STARLINK POSE A SPACE DEBRIS THREAT? AN EXPERT ANSWERS,” <https://skyandtelescope.org/astronomy-news/starlink-space-debris/>] Justin

JH: What about competitors like OneWeb or Amazon, who want to set up a similar system as Starlink? Who “owns” the orbits – whoever comes first?

SL: According to the Outer Space Treaty there is no appropriation of space. But of course if you put a large constellation into a certain orbit, it means that a lot of coordination is required with anybody else who wants to operate near that constellation or even has to pass through those orbital regions. You can take this even further: If an object of a constellation fragments for whatever reason, these fragments will not remain limited to the region of the constellation itself. It will affect operators below and above. So from this perspective, putting a large number of satellites in orbit does influence the other activities that can take place.

JH: Politics and law aside, is there a physical limit of how many constellations of thousands of satellites can operate at the same time. How much space is there in space?

SL: If we don't keep the current guidelines mentioned above, we will run into the so-called “Kessler syndrome,” which is the name of this cascading effect. And at that point, there would indeed be regions that even without large constellations would become so packed with debris that it would become impractical to put your satellites there. This is why we actively promote a notion that space is a shared resource, and it's a limited resource. It is not infinite when we think about it in terms of how many objects we can put there. Exactly where this threshold is is in certain cases computable, but it depends on the behavior of operators. So you cannot say a priori that several thousand satellites are too much. That amount might be feasible, but it would need to come with stringent requirements for responsible behavior, which have yet to be demonstrated.

#### That drives a space arms race which enhances the risk of debris cascades, closes off space exploration, and causes conflict.

Shah 20. Sachin Shah is a write for Cornell Undergraduate Law and Society Review. 8/30/20 [CORNELL UNDERGRADUATE LAW & SOCIETY REVIEW “The International Legal Regulation of Space Debris,” <https://www.culsr.org/articles/the-international-legal-regulation-of-space-debris>] Justin

The body of legal regulations regarding the use of space (space being defined as the area above the jurisdiction of air law) by public and private entities is referred to as space law. Currently, there are only about five such regulations of space, the most significant of those being the United Nations’ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereinafter referred to as the Outer Space Treaty) of 1967. In this article, I would like to specifically describe and analyze the laws and regulations’ handling of the increasingly prevalent issue of space debris in orbit around Earth. The National Aeronautics and Space Administration (NASA) defines space debris as “any man-made object in orbit about the Earth which no longer serves a useful function.” [1] However, a major point of confusion discussed below is that the Outer Space Treaty does not explicitly define what it refers to as “space objects,” nor does it mention whether space debris are space objects. An excessive clustering of space debris is a problem for a few reasons. It may result in a phenomenon known as the Kessler Syndrome, in which there is a “cascade created when debris hits a space object, creating new debris and setting off a chain reaction of collisions that eventually closes off entire orbits.” [2] This endangerment of Earth’s future ability to explore extraterrestrial planets and life must be avoided at all costs. Furthermore, space debris in orbit around Earth limits the amount of available space for satellites to orbit, which may result in the Tragedy of the Commons: multiple actors will aggressively vie, in an arms race, for their right to space as it is a limited resource. [3] Space debris is thus a potentially pressing issue in our increasingly technological world. In this essay, I will analyze the existing regulation of space debris as outlined in the Outer Space Treaty, point out the issues with these regulations of space debris and discuss potential solutions, and, finally, discuss legal considerations for private enterprises as well.

#### Space exploration solves a laundry list of threats.

GREEN 21. Brian Patrick Green, director of technology ethics @ Markkula Center for Applied Ethics, Santa Clara University, “Space Ethics,” 2021, Rowman, pp. 5

Gaining access to new critical resources may be another reason to go into space. Earth is a finite planet, and certain elements on Earth are very rare in the planetary crust, particularly platinum group metals that are very dense and siderophilic (iron-loving) and so have tended to sink toward the core over the natural history of the planet. However, asteroids and other objects in space (for example, planets, comets, and moons) can sometimes have these elements in abundance and in more available locations, making them potentially excellent sources for these valuable materials. Now-defunct asteroid-mining startup Planetary Resources once estimated that one “platinum-rich 500 meter wide asteroid contains . . . 1.5 times the known world-reserves of platinum group metals (ruthenium, rhodium, palladium, osmium, iridium, and platinum).” 7 In addition to returning elements to a resource-hungry Earth, further exploration and development of space will require access to resources that are not purely sourced from Earth. In particular, it will be necessary to gain access to water, which is relatively rare in the inner solar system and which would be far too costly to transport in any significant amounts from the Earth’s surface.

Another reason that humans may want to explore space would be to create a “backup Earth” to hedge against global catastrophic and existential risks (risks that may cause widespread disaster or human extinction, respectively) on our home planet. 8 Earth has always been a dangerous place for humans, with asteroid impacts, supervolcanic eruptions, pandemic disease, and other natural hazards threatening civilization. Now, in addition to these natural threats, human-made hazards such as nuclear weapons, climate change, biotechnology, nanotechnology, and artificial intelligence may threaten not only the viability of technological civilization but perhaps the survival of human life itself. A serious global-scale catastrophe could set back civilization many decades or centuries, and the worst disasters could cause human extinction. In one scenario, in which 100 percent of humanity dies, all of human effort for all of history would be for nothing. However, were the same global catastrophe to happen to Earth, yet humans were a multiplanetary species with just one self-sustaining settlement off-Earth, it would not result in the end of human civilization or human extinction. Instead while the same unimaginable fate would befall the Earth (certainly no mere triviality, with perhaps the deaths of 99.999 percent of all humans and possibly the destruction of the ecosphere and everything in it), at least all of human and planetory history would not be for nothing. Human life and culture would go on elsewhere, as well as other Earth species. This is a dire fate, but less terrible than the first.

#### Immeasurable value outweighs.

Baum 16 [Seth D. Baum, Executive Director of the Global Catastrophic Risk Institute, “The Ethics of Outer Space: A Consequentialist Perspective,” 2016, Springer, pp. 115-116, EA]

Space colonization is notable because it may be able to bring utterly immense increases in intrinsic value. Early colonies might start small, given that other planets and moons have inhospitable environments. However, it may be possible to build large indoor colonies or create more hospitable outdoor environments (i.e., terraforming). Even just on other planets and moons in the Solar System, space colonies could multiply the total area available for human habitation. And there are many more planets around other stars, as ongoing research on exoplanets is now learning. One recent study estimates 22 % of Sun-like stars have Earth-like exoplanets (Petigura et al. 2013), implying billions to tens of billions of potentially habitable planets across the galaxy.

Opportunities at any given star may also be quite a bit greater than those available only on planets. Earth only receives about one two-billionth of the Sun’s radiation. To collect all the Sun’s radiation, humanity would need a Dyson swarm (named after Dyson 1960), which is a series of structures that surrounds a star, collecting its radiation to power a civilization. A Dyson swarm around the Sun could potentially enable a civilization a billion times larger than is possible on Earth. Likewise, Dyson swarms around one billion stars would bring humanity approximately 1018 (one billion–billion) times more energy per unit time.

Space colonies could also increase the amount of time available for human civilization. Earth will remain habitable for a few billion more years (O’Malley-James et al. 2014). Stars will continue shining for about 1014 more years (Adams 2008). That gives us an additional 105 times more energy, for a total of 1023 times more energy than is available on Earth. After the stars fade, other energy sources may be available. And even if our current universe eventually becomes uninhabitable, it may be possible to move to other universes (Kaku 2005). The physics here is speculative, but it cannot be ruled out, and hence there is a nonzero chance of a literally infinite opportunity for space colonization (Baum 2010a).

Whether the opportunity is infinite or merely, say, 1023 times larger than what can be done on Earth, the opportunity is clearly immense. As long as space colonization is an improvement (Sect. 8.3.1), then it would seem that the consequentialist should prioritize space colonization. The sooner space colonization begins, the more of its immense opportunity can be gained. Indeed, Ćirković (2002) estimates 5 × 1046 human lifetimes are lost for every century in which space colonization is delayed.

There can also be large value for space colonization under ecocentric intrinsic value. It is sometimes argued that Earth would be better off without humans. For example, the Voluntary Human Extinction Movement states that “Phasing out the human race by voluntarily ceasing to breed will allow Earth’s biosphere to return to good health” (http://vhemt.org, accessed 25 October 2015). However, this makes sense only if extraterrestrial locations are not intrinsically valued. Otherwise, exterminating humanity ruins the opportunity for humans to bring flourishing ecosystems into outer space. Terraforming other planets or bringing ecosystems into Dyson swarms could bring immense amounts of ecosystem flourishing.

#### Satellites solves the grid and every extinction scenario.

Pellegrino & Stang 16. Massimo Pellegrino, Master’s Degree in Space Studies from ISU, with Gerald Stang, Senior Associate Analyst at the EUISS, holds BSc and MSc degrees in chemical engineering from the University of Saskatchewan and an MA in international affairs from the School of International and Public Affairs at Columbia University (“Space Security for Europe”, *EU Institute for Security Studies*, published July 2016, <https://www.iss.europa.eu/content/space-security-europe>, accessed 7-10-2019) bm

Modern societies are highly dependent on the continuous operation of critical infrastructure to ensure the provision of basic goods and services. They consist of assets, systems or parts thereof which are so vital, that their disruption would significantly impact the economy, national security, public health, safety, or social well-being. Examples of critical infrastructure include energy, water, food supply, communication, transportation, and waste processing systems. Space assets are so deeply embedded in developed economies that a day without fully functioning space capabilities would severely restrict or even endanger our lives.

Space systems are critical for running energy grids and telecommunication networks, border and maritime surveillance, crisis management and humanitarian operations, environmental and climate monitoring, verification of international treaties and arms control agreements, and the fight against organised crime and terrorism. Space assets also provide the technological backbone for other critical infrastructures. The synchronisation of power grids and telecommunication networks, for example, is heavily dependent on GNSS timing signals and any disruption would create a domino effect on other critical infrastructures (see Figure 5).

Satellites also play a central role in supporting defence systems and military operations. They are force multipliers that provide intelligence, surveillance, and reconnaissance (ISR) capabilities, as well as communication, navigation, positioning and timing signals. Armed forces do not only use their own space systems, but are also significant consumers of space services provided by private operators. In fact, about 90% of US military communications traffic passes through civilian satellites, many of which privately owned, rather than through dedicated systems designed to withstand attempted interruptions.1 The reliance of both civilian and military users on space systems therefore places them firmly in the area of critical infrastructure. Some critical space systems, such as the American GPS, are under foreign control, and the governments controlling those systems retain the authority to disrupt services, even for allies, in case of a national emergency. While the United States announced that it has no intention of ever intentionally degrading public GPS signals (also known as ‘Selective Availability’) and that the next generation of GPS satellites will not include this feature, other governments might still do so.2

These dependences engender new and growing vulnerabilities. Reliance on space is likely to increase further as space capabilities and services improve in diversity, quality and affordability. Close to 1,500 satellites with a launch mass of over 50 kg are expected to be launched over the next decade; an increase of 50% compared to 2005-2014. This estimate excludes both the expected proliferation of smaller satellites (such as CubeSats), but also the planned OneWeb and Steam mega-constellations for global internet broadband service. Advances in small satellite capabilities and in launch technology (e.g. SpaceX’s Falcon rocket family) have already lowered the cost of access to space. About 45% more CubeSats were launched in 2014 than in 2013 (130 vs. 91), accounting for 63% of all satellites launched3 . However, just as the reliance on space increases, so too do threats and vulnerabilities. Therefore, in order to realise the full potential of investments in space, critical space systems need to be adequately protected and the space environment properly managed.

#### Grid security is an impact filter.

Denkenberger 21 [David Denkenberger, Anders Sandberg, Ross John Tieman, and Joshua M. Pearce, \* assistant professor of mechanical engineering at University of Alaska Fairbanks, “Long-term cost-effectiveness of interventions for loss of electricity/industry compared to artificial general intelligence safety,” 2021, *European Journal of Futures Research*, Vol. 9, Issue 1, https://doi.org/10.1186/s40309-021-00178-z, EA]

Civilization relies on a network of highly interdependent critical infrastructure (CI) to provide basic necessities (water, food, shelter, basic goods), as well as complex items (computers, cars, space shuttles) and services (the internet, cloud computing, global supply chains), henceforth referred to as industry. Electricity and the electrical infrastructure that distributes it plays an important role within industry, providing a convenient means to distribute energy able to be converted into various forms of useful work. Electricity is one component of industry albeit a critical one. Industry provides the means to sustain advanced civilization structures and the citizens that inhabit them. These structures play a critical role in realizing various futures by allowing humanity to discover and utilize new resources, adapt to various environments, and resist natural stressors.

Though industry is capable of resisting small stressors, a sufficiently large event can precipitate cascading failure of CI systems, resulting in a collapse of industry. If one does not temporally discount the value of future people, the long-term future (thousands, millions, or even billions of years) could contain an astronomically large amount of value [18]. Events capable of curtailing the potential of civilization (existential risks, such as human extinction or an unrecoverable collapse) would prevent such futures from being achieved, implying reducing the likelihood of such events is of the utmost importance [100]. Reducing the prevalence of existential risks factors; events, systemic structures, or biases which increase the likelihood of extinction but do not cause extinction by themselves is also highly valuable. Complete collapse or degraded function of industry would drastically reduce humanity’s capacity to coordinate and deploy technology to prevent existential risks, representing an existential risk factor. Consequently, interventions preventing loss of industry, reducing the magnitude of impacts, or increasing speed of recovery could be extremely valuable.

Existential risk research is, by nature, future focused, requiring the investigation of events that have not yet occurred. Futures studies methodologies are often applied to uncover salient trends or events, and explore potential causal structures [54, 123]. Probabilistic modeling techniques can then be used to determine the likelihood of such events occurring, including adequate treatment of uncertainty [101]. The cost-effectiveness modeling approach outlined in this paper is an example of this, attempting to assess the marginal utility of losing industry interventions on improving the long-term future. This approach could guide future efforts to assess the relative cost-effectiveness of interventions for different risks, existential or otherwise. More practically, this research can inform prioritization efforts of industrialized countries by providing estimates of the cost of global industrial collapse, and the utility of resilience interventions. This is relevant to the European Union which has a highly industrialized economy, providing $2.3 Trillion USD of the $13.7 Trillion USD global total of value add manufacturing [122]. The EU has shifted toward a more proactive foresight approach about natural and man-made disasters, noting the importance of rare high-impact events, systemic risks, and converging trends requiring better data and forecasting to drive a more ambitious crisis management system [47]. Still, it is clear that most academic and institutional emphasis has been on “ordinary” rather than extreme disasters, and risks from industry to the public and environment rather than widespread failures of industrial services causing harm.

The integrated nature of the electric grid, which is based on centralized generation makes the entire system vulnerable to disruption.1 There are a number of anthropogenic and natural catastrophes that could result in regional-scale electrical grid failure, which would be expected to halt the majority of industries and machines in that area. A high-altitude electromagnetic pulse (HEMP) caused by a nuclear weapon could disable electricity over part of a continent [16, 48, 66, 93]. This could destroy the majority of electrical grid infrastructure, and as fossil fuel extraction and industry is reliant on electricity [49], industry would be disabled. Similarly, solar storms have destroyed electrical transformers connected to long transmission lines in the past [117]. The Carrington event in 1859 damaged telegraph lines, which was the only electrical infrastructure in existence at the time. It also caused Aurora Borealis that was visible in Cuba and Jamaica [70]. This could potentially disable electrical systems at high latitudes, which could represent 10% of electricity/industry globally. Though solar storms may last less than the 12 h that would be required to expose the entire earth with direct line of sight, the earth’s magnetic field lines redirect the storm to affect the opposite side of the earth [117]. Lastly, both physical [6, 8, 69, 89, 111] and cyber attacks [3, 63, 90, 96, 118, 128, 130] could also compromise electric grids. Physical attacks include traditional acts of terrorism such as bombing or sabotage [130] in addition to EMP attacks. Significant actors could scale up physical attacks, for example by using drones. A scenario could include terrorist groups hindering individual power plants [126], while a large adversary could undertake a similar operation physically to all plants and electrical grids in a region. Unfortunately, the traditional power grid infrastructure is simply incapable of withstanding intentional physical attacks [91]. Damage to the electric grid resulting in physical attack could be long lasting, as most traditional power plants operate with large transformers that are difficult to move and source. Custom rebuilt transformers require time for replacement ranging from months and even up to years [91]. For example, a relatively mild 2013 sniper attack on California’s Pacific Gas and Electric (PG&E) substation, which injured no one directly, was able to disable 17 transformers supplying power to Silicon Valley. Repairs and improvements cost PG&E roughly $100 million and lasted about a month [10, 102]. A coordinated attack with relatively simple technology (e.g., guns) could cause a regional electricity disruption. However, a high-tech attack could be even further widespread. The Pentagon reports spending roughly $100 million to repair cyber-related damages to the electric grid in 2009 [57]. There is also evidence that a computer virus caused an electrical outage in the Ukraine [56]. Unlike simplistic physical attacks, cyber attackers are capable of penetrating critical electric infrastructure from remote regions of the world, needing only communication pathways (e.g., the Internet or infected memory sticks) to install malware into the control systems of the electric power grid. For example, Stuxnet was a computer worm that destroyed Iranian centrifuges [73] to disable their nuclear industry. Many efforts are underway to harden the grid from such attacks [51, 63]. The U.S. Department of Homeland Security responded to ~ 200 cyber incidents in 2012 and 41% involved the electrical grid [103]. Nations routinely have made attempts to map current critical infrastructure for future navigation and control of the U.S. electrical system [57].

The electric grid in general is growing increasingly dependent upon the Internet and other network connections for data communication and monitoring systems [17, 112, 118, 127, 135]. Although this conveniently allows electrical suppliers management of systems, it increases the susceptibility of the grid to cyber-attack, through denial of webpage services to consumers, disruption to supervisory control and data acquisition (SCADA) operating systems, or sustained widespread power outages [3, 72, 118, 120]. Thus global or regional loss of the Internet could have similar implications.

#### Cyberattacks on the grid spiral to all-out nuclear conflict.

Klare 19 [Michael; November 2019; Professor emeritus of peace and world security studies at Hampshire College; “*Cyber Battles, Nuclear Outcomes? Dangerous New Pathways to Escalation*,” Arms Control Association, <https://www.armscontrol.org/act/2019-11/features/cyber-battles-nuclear-outcomes-dangerous-new-pathways-escalation>] Justin

Yet another pathway to escalation could arise from a cascading series of cyberstrikes and counterstrikes against vital national infrastructure rather than on military targets. All major powers, along with Iran and North Korea, have developed and deployed cyberweapons designed to disrupt and destroy major elements of an adversary’s key economic systems, such as power grids, financial systems, and transportation networks. As noted, Russia has infiltrated the U.S. electrical grid, and it is widely believed that the United States has done the same in Russia.12 The Pentagon has also devised a plan known as “Nitro Zeus,” intended to immobilize the entire Iranian economy and so force it to capitulate to U.S. demands or, if that approach failed, to pave the way for a crippling air and missile attack.13

The danger here is that economic attacks of this sort, if undertaken during a period of tension and crisis, could lead to an escalating series of tit-for-tat attacks against ever more vital elements of an adversary’s critical infrastructure, producing widespread chaos and harm and eventually leading one side to initiate kinetic attacks on critical military targets, risking the slippery slope to nuclear conflict. For example, a Russian cyberattack on the U.S. power grid could trigger U.S. attacks on Russian energy and financial systems, causing widespread disorder in both countries and generating an impulse for even more devastating attacks. At some point, such attacks “could lead to major conflict and possibly nuclear war.”14

#### Aff solves better.

David 21 – Leonard, 4/14/21, Leonard David is author of Moon Rush: The New Space Race (National Geographic, 2019) and Mars: Our Future on the Red Planet (National Geographic, 2016). He has been reporting on the space industry for more than five decades, [“Space Junk Removal Is Not Going Smoothly,” Scientific American, <https://www.scientificamerican.com/article/space-junk-removal-is-not-going-smoothly/>] Justin

“From my perspective, the best solution to dealing with space debris is not to generate it in the first place,” says T. S. Kelso, a scientist at CelesTrak, an analytic group that keeps an eye on Earth-orbiting objects. “Like any environmental issue, it is easier and far less expensive to prevent pollution than to clean it up later. Stop leaving things in orbit after they have completed their mission.” There simply is no “one-size-fits-all solution” to the problem of space junk, Kelso says. Removing large rocket bodies is a significantly different task than removing the equivalent mass of a lot more smaller objects, which are in a wide range of orbits, he observes. Meanwhile innovations by companies such as SpaceX are dramatically lowering launch costs, opening the floodgates for far more satellites to reach low-Earth orbit, where some will inevitably fail and become drifting, debris-generating hazards (unless they are removed by ELSA-d-like space tugs). “Many of these operators are starting to understand the difficulty and complexity of continuing to dodge the growing number of debris.” Space junk ranges from nanoparticles to whole spacecraft such as the European Space Agency’s Envisat, which is the size of a double-decker bus and at the top of everyone's removal hit list, says Alice Gorman, a space archaeologist and space junk expert at Flinders University in Australia. There are also objects such as despin weights, which are solid lumps of metal, and thermal blankets, which are paper-thin. “They’ll cause different types of damage and may need different strategies to remove. There is no way that a one-size-fits-all approach is going to do it,” Gorman says. The most serious risks, she says, come from debris particles between one and 10 centimeters in size. “There’s far more of them than whole defunct spacecraft, and there is a far greater probability of collision,” Gorman says. “While debris this size might not cause a catastrophic breakup, collision with it can certainly damage working satellites and create new debris particles.” Turning her attention to satellite mega constellations, Gorman worries about their effects in a low-Earth orbital environment that is already congested. “We also know that orbital dynamics can be unpredictable,” she says. “I want to see some of these mega constellation operators releasing their long-term modeling for collisions as more and more satellites are launched.” There is no doubt that active orbital debris removal is technically challenging, Gorman says. “However, the big issue is that any successful technology that can remove an existing piece of debris can also be used as an antisatellite weapon,” she says. “This is a whole other can of worms that requires diplomacy and negotiation and, most importantly, trust at the international level.” Indeed, the ability to cozy up to spacecraft in orbit and perform servicing or sabotage has spurred considerable interest from military planners in recent years, says Mariel Borowitz, an associate professor at the Georgia Institute of Technology’s Sam Nunn School of International Affairs. “These rapidly advancing technologies have the potential to be used for peaceful space activities or for warfare in space,” she says. “Given the dual-use nature of their capabilities, it’s impossible to know for sure in advance how they’ll be used on any given day.” TAKING UP SPACE For now, according to Moriba Jah, an orbital debris expert at the University of Texas at Austin, the business case for space debris removal is not monetizable and is more a “PowerPoint talk” than a real marketplace. “I think people are hoping that government basically comes to some common sense to help create and establish a marketplace for industries to engage in these sorts of activities,” Jah says. In order for that to happen, he believes that spacefaring nations have to agree that near-Earth space is an ecosystem like land, air and the ocean. “It’s not infinite, so we need environmental protection,” he says.

#### Debris triggers miscalculated war.

Acton and McDonald 21. James M. Acton is co-director of the Nuclear Policy Program and holds the Jessica T. Mathews Chair at the Carnegie Endowment for International Peace. Thomas D. MacDonald is a fellow in the Nuclear Policy Program. 12/10/21. [Defense One, “Nuclear Command-and-Control Satellites Should Be Off Limits,” <https://www.defenseone.com/ideas/2021/12/nuclear-command-and-control-satellites-should-be-limits/187472/>] Justin

When Russia blew up an old satellite with a new missile on November 15, it created an expanding cloud of debris that will menace the outer space environment for years to come.

Hypersonic fragments from the collision with Moscow’s ground-launched, anti-satellite weapon risk destroying other satellites used for communications, meteorology, and agriculture. They even pose a danger to China’s Tiangong Space Station and the International Space Station, where personnel—including Russia’s own cosmonauts—were forced to don spacesuits and flee into their escape capsules ahead of approaching debris.

But the greatest danger that this careless stunt highlighted is to a different potential target: high-altitude satellites used for nuclear command and control. Those critical satellites face the threat of being attacked by co-orbital anti-satellite weapons, that is, other spacecraft with offensive capabilities. Destroying a nuclear command-and-control satellite, even unintentionally, could lead a conventional conflict to escalate into a nuclear war. As such, the United States, China, and Russia have a shared interest in ensuring the security of each other’s high-altitude satellites.

Satellites are integral to the United States’ nuclear command-and-control system. They would be the preferred means to transmit a presidential order to use nuclear weapons and would provide the first warning of an incoming nuclear attack. Russia uses satellites for similar purposes, even if it appears not to rely on them quite as much as the United States. While little is publicly known about China’s nuclear command-and-control system, the U.S. Department of Defense has assessed that China is in the process of developing a space-based early-warning system.

The most important nuclear command-and-control satellites—those for communications and early warning—are located in high-altitude orbits. Fortunately, most are strung out about 22,500 miles above the equator—far above the debris from Russia’s ground-launched anti-satellite weapon test. These satellites, however, are growing more vulnerable, particularly to co-orbital anti-satellite weapons.

Nuclear command-and-control satellites might be attacked deliberately, as the prelude to a nuclear war. In a conventional conflict, if China, Russia, or the United States decided to use nuclear weapons first—or believed that its opponent was about to do so—it might try to degrade the adversary’s nuclear command-and-control system preemptively. China, for example, might attack U.S. early-warning satellites to weaken the United States’ homeland missile defenses. Conversely, the United States might target Chinese communication satellites to interfere with Beijing’s ability to wield its nuclear forces.

In a conventional war, however, nuclear command-and-control satellites might be attacked and threatened for altogether different reasons—creating the risk that nuclear war might be triggered inadvertently.

The United States, in particular, is deeply reliant on satellites to enable conventional operations. Moreover, most, if not all, nuclear command-and-control satellites also support nonnuclear missions—making them tempting targets even in a purely conventional conflict. For example, some U.S. satellites transmit orders to both U.S. conventional and nuclear forces. Russia might attack these satellites to try to undermine the United States’ ability to prosecute a conventional war, but with the added and unintended effect of degrading the U.S. nuclear command-and-control system.

Washington would be hard pressed to determine the intent behind such attacks. It could easily misinterpret them as preparations for a nuclear war and respond accordingly. It might threaten to use nuclear weapons unless its adversary backed off. In fact, the Trump administration’s nuclear policy explicitly threatened the use of nuclear weapons in precisely this circumstance. The Biden administration can and should remove this threat as part of its ongoing Nuclear Posture Review.

To make matters worse, it might not take actual attacks against nuclear command-and-control satellites to spark this kind of escalation. Satellites in high-altitude orbits are periodically moved to different positions to optimize their performance. Especially in a conventional conflict, a repositioning operation that led one spacecraft to approach a nuclear command-and-control satellite might appear to the latter’s owner as the beginning of an attack against its nuclear command-and-control system. Once again, the potential consequences could be catastrophic.

#### Public pressure forces retaliation.

Nancy Gallagher 15. Interim director of the Center for International and Security Studies in Maryland, previous Executive Director of the Clinton Administration’s CTBT Treaty Committee, an arms control specialist at the State Dept., and a faculty member at Wesleyan, “Antisatellite warfare without nuclear risk: A mirage,” May 29, Bulletin of Atomic Scientists, <http://thebulletin.org/space-weapons-and-risk-nuclear-exchanges8346>

In recent decades, however, as space-based reconnaissance, communication, and targeting capabilities have become integral elements of modern military operations, strategists and policy makers have explored whether carrying out antisatellite attacks could confer major military advantages without increasing the risk of nuclear war. In theory, the answer might be yes. In practice, it is almost certainly no. Hyping threats. No country has ever deliberately and destructively attacked a satellite belonging to another country (though nations have sometimes interfered with satellites' radio transmissions). But the United States, Russia, and China have all tested advanced kinetic antisatellite weapons, and the United States has demonstrated that it can modify a missile-defense interceptor for use in antisatellite mode. Any nation that can launch nuclear weapons on medium-range ballistic missiles has the latent capability to attack satellites in low Earth orbit. Because the United States depends heavily on space for its terrestrial military superiority, some US strategists have predicted that potential adversaries will try to neutralize US advantages by attacking satellites. They have also recommended that the US military do everything it can to protect its own space assets while maintaining a capability to disable or destroy satellites that adversaries use for intelligence, communication, navigation, or targeting. Analysis of this sort often exaggerates both potential adversaries’ ability to destroy US space assets and the military advantages that either side would gain from antisatellite attacks. Nonetheless, some observers are once again advancing worst-case scenarios to support arguments for offensive counterspace capabilities. In some other countries, interest in space warfare may be increasing because of these arguments. If any nation, for whatever reason, launched an attack on a second nation's satellites, nuclear retaliation against terrestrial targets would be an irrational response. But powerful countries do sometimes respond irrationally when attacked. Moreover, disproportionate retaliation following a deliberate antisatellite attack is not the only way in which antisatellite weapons could contribute to nuclear war. It is not even the likeliest way. As was clearly understood by the countries that negotiated the Outer Space Treaty, crisis management would become more difficult, and the risk of inadvertent deterrence failure would increase, if satellites used for reconnaissance and communication were disabled or destroyed. But even if the norm against attacking another country’s satellites is never broken, developing and testing antisatellite weapons still increase the risk of nuclear war. If, for instance, US military leaders became seriously concerned that China or Russia were preparing an antisatellite attack, pressure could build for a pre-emptive attack against Chinese or Russian strategic forces. Should a satellite be struck by a piece of space debris during a crisis or a low-level terrestrial conflict, leaders might mistakenly assume that a space war had begun and retaliate before they knew what had actually happened. Such scenarios may seem improbable, but they are no more implausible than the scenarios that are used to justify the development and use of antisatellite weapons.

#### Convergence of factors guarantee space escalation.

Thomas González Roberts 17. A space security researcher at the Center for Strategic and International Studies, and host of [Moonstruck](https://www.moonstruckpodcast.com/), a podcast about humans in space. "Why We Should Be Worried about a War in Space ," 12-15-2017. Atlantic, <https://www.theatlantic.com/science/archive/2017/12/why-we-should-be-worried-about-a-war-in-space/548507/>

One hundred miles above the Earth’s surface, orbiting the planet at thousands of miles per hour, the six people aboard the International Space Station enjoy a perfect isolation from the chaos of earthly conflict. Outer space has never been a military battleground. But that may not last forever. The [debate in Congress](https://docs.google.com/document/d/1e6zH3AfZHs4hLpGaKwmxAVxR-LfWk0110THq9tIhgOU/edit?ts=5a2f95e8?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25) over whether to create a Space Corps comes at a time when governments around the world are engaged in a bigger international struggle over how militaries should operate in space. Fundamental changes are [already underway](https://www.csis.org/analysis/congress-creating-military-space-corps?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25). No longer confined to the [fiction shelf](https://best-sci-fi-books.com/23-best-military-science-fiction-books/?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25), space warfare is likely on the horizon. While agreements for how to operate in other international domains, like the open sea, airspace, and even cyberspace, have already been established, the major space powers—the United States, Russia, and China—have not agreed upon a rulebook outlining what constitutes bad behavior in space. It’s [presumed](http://intercrossblog.icrc.org/blog/twmzia1cp84kv2c29bi4iz6q4u03in?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25) that International Humanitarian Law would apply in outer space—protecting the civilian astronauts aboard the International Space Station—but it’s unclear whether damaging civilian satellites or the space environment itself is covered under the agreement. With only a limited history of dangerous behavior to study, and few, [outdated guidelines](http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25) in place, a war in space would be a war with potentially more consequences, but far fewer rules, than one on Earth. Although there has never been a military conflict in space, the history of human activity above our atmosphere is not entirely benign. In 1962, the United States [detonated a 1.4 megaton nuclear weapon](https://www.smithsonianmag.com/history/going-nuclear-over-the-pacific-24428997/?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25) 250 miles above the Earth’s surface. The blast destroyed approximately one third of satellites in orbit and poisoned the most used region of space with radiation that lasted for years. Although the United States, Russia, and others soon agreed to a treaty to prevent another nuclear test in space, China and North Korea never signed it. In 2007, China [tested an anti-satellite weapon](http://www.washingtonpost.com/wp-dyn/content/article/2007/01/18/AR2007011801029.html?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25), a conventionally-armed missile designed to target and destroy a satellite in orbit. In the process, it annihilated an old Chinese weather satellite and created high-velocity shrapnel that still threatens other satellites. Even though demonstrations like this have consequences for everyone, countries are free to carry them out as they see fit. No treaties address this kind of test, the creation of space debris, or the endangerment of other satellites. The U.S. has the most to lose in a space-based conflict With by far the most satellites in orbit, the U.S. has the most to gain by establishing norms, but also the most to lose. Almost half of all operational satellites are owned and operated by the United States government or American commercial companies. That’s twice as many as Russia and China, combined. Space may seem distant, but what happens there affects our everyday lives on the ground. When we use our phones to plan a trip, we depend on American GPS satellites to guide us. When the U.S. military deploys troops overseas, satellite communications connect forces on the ground to control centers. When North Korea launches an intercontinental ballistic missile, the U.S. and its allies depend on early-warning satellites to detect it. On one hand, if the global space powers agreed to put limits on space-based weapons and other related technologies, it could make space safer for everyone. But because the U.S. may have spent time and resources [developing](https://www.theatlantic.com/technology/archive/2017/05/why-so-secretive/525969/?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25) exactly the type of weapons that a code of conduct would ban**,** it could also curtail the most advanced space-based developments, erasing years of research and progress. There are more players in space—and less consensus In the [first space age](https://www.csis.org/analysis/escalation-and-deterrence-second-space-age?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25), from the launch of the first human-made satellite in 1957 through the fall of the Soviet Union, the United States and the USSR were responsible for over 90 percent of all satellites. Their race to perfect space technology, dominated by both national security interests and scientific discovery, far outpaced everyone else. The second space age, from 1990 to today, looks remarkably different. Now, more satellites are operated by private companies than militaries, and more space launches and new satellites come from countries other than the United States and Russia. More players in space—particularly more unpredictable players—means more opportunities for aggressive behavior, like developing anti-satellite technologies or hacking satellite communications. Countries like Iran or North Korea that are newer to space can choose to operate in a way we’ve never seen before. And if their nuclear programs on Earth are [any guide](https://www.theatlantic.com/international/archive/2017/10/iran-northk-korea-nuclear/542673/?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25), they could pose serious threats if left unchecked. Efforts have been made to create a modern-day space rulebook, but so far none have gained traction. In 2008, when Russia and China both proposed norms of behavior, the United States [refused to sign on](https://www.theatlantic.com/science/archive/2017/04/space-war/521910/?utm_source=masthead-newsletter&utm_medium=email&utm_campaign=member-newsletter-20171213-20&silverid=%25%25RECIPIENT_ID%25%25). Similarly, when the United States supported a 2014 European Union proposal to govern the use of conventional weapons in orbit, Russia and China didn’t agree with the terms. Since the congressional debate about a Space Corps, people have been taking the prospect of a war in space seriously, in a way we haven’t seen before. Now we should start talking about how to avoid that war. To prevent conflict in the upper atmosphere, all potential adversaries—the United States, China, North Korea, Iran, Russia, the EU—need to align, and agree on norms of behavior. They need rules.

#### **No checks on escalation.**

MacDonald 18. Bruce W. MacDonald, professor at the Johns Hopkins University School of Advanced International Studies (SAIS), ("Outer Space; Earthly Escalation? Chinese Perspectives on Space Operations and Escalation," August 2018, *NSI* white paper, <https://nsiteam.com/social/wp-content/uploads/2018/08/SMA-White-Paper_Chinese-Persepectives-on-Space_-Aug-2018.pdf>, accessed 7-14-2019) bm

Challenges across all five phases: Another escalation threat is the inexperience that nations share in the space and cyber domains, unlike in conventional domains of conflict and in the nuclear domain to a lesser extent. This inexperience gives rise to a “sorcerer’s apprentice” problem, placing leaders at risk of making potentially unwise judgment calls without a full grasp of their implications. The space and cyber domains are sufficiently new and dynamic that such decisions are highly likely. Adding to this uncertainty is the ever-growing interdependence of infrastructures within and among advanced countries, making the impact of major attacks against a country’s space and/or cyber infrastructures inherently unknowable. In considering all these factors, it is important to keep in mind that events in space do not happen in isolation. Any space conflict would likely be part of a multidimensional field of play, with space being important because of the effects it has on the earth. Significant instability in space is unlikely to lead to war if there is stability in other domains and in the larger geopolitical relationship between participants, while conflict could easily spread to a stable space domain if war in other domains appeared preferable to the alternative. While any use of nuclear weapons would pose a serious threat of escalation to full-scale nuclear war, any use of space or cyber offense would not pose a comparable escalation threat. That said, a series of reciprocal escalations could easily become unstable. No clear-cut escalation barrier exists in the space and cyber domains, and given the short-term tactical benefits of escalating ahead of an adversary, each additional escalation could create incentives for further escalation that an adversary would not always anticipate. Escalation in space, then, is a slippery slope with few off-ramps.

#### Any nuclear war causes extinction – ice age and famine.

Steven Starr 15 [Director of the University of Missouri’s Clinical Laboratory Science Program, as well as a senior scientist at the [Physicians for Social Responsibility](http://www.psr.org/). He has worked with the Swiss, Chilean, and Swedish governments in support of their efforts at the United Nations to eliminate thousands of high-alert, launch-ready U.S. and Russian nuclear weapons. “Nuclear War: An Unrecognized Mass Extinction Event Waiting To Happen.” Ratical. March 2015. <https://ratical.org/radiation/NuclearExtinction/StevenStarr022815.html>] TG

A war fought with 21st century strategic nuclear weapons would be more than just a great catastrophe in human history. If we allow it to happen, such a war would be a mass extinction event that [ends human history](https://ratical.org/radiation/NuclearExtinction/StarrNuclearWinterOct09.pdf). There is a profound difference between extinction and “an unprecedented disaster,” or even “the end of civilization,” because even after such an immense catastrophe, human life would go on.

But extinction, by definition, is an event of utter finality, and a nuclear war that could cause human extinction should really be considered as the ultimate criminal act. It certainly would be the crime to end all crimes.

The world’s leading climatologists now tell us that nuclear war threatens our continued existence as a species. Their studies predict that a large nuclear war, especially one fought with strategic nuclear weapons, would create [a post-war environment in which for many years it would be too cold and dark to even grow food](http://climate.envsci.rutgers.edu/pdf/RobockToonSAD.pdf). Their findings make it clear that not only humans, but most large animals and many other forms of complex life would likely vanish forever in a nuclear darkness of our own making.

The environmental consequences of nuclear war would attack the ecological support systems of life at every level. Radioactive fallout, produced not only by nuclear bombs, but also by the destruction of nuclear power plants and their spent fuel pools, would poison the biosphere. Millions of tons of smoke would act to [destroy Earth’s protective ozone layer](https://www2.ucar.edu/atmosnews/just-published/3995/nuclear-war-and-ultraviolet-radiation) and block most sunlight from reaching Earth’s surface, creating Ice Age weather conditions that would last for decades.

Yet the political and military leaders who control nuclear weapons strictly avoid any direct public discussion of the consequences of nuclear war. They do so by arguing that nuclear weapons are not intended to be used, but only to deter.

Remarkably, the leaders of the Nuclear Weapon States have chosen to ignore the authoritative, long-standing scientific research done by the climatologists, research that predicts virtually any nuclear war, fought with even a fraction of the operational and deployed nuclear arsenals, will leave the Earth essentially uninhabitable.

### Framing

#### The standard is maximizing expected well being. [To clarify, hedonistic act util]. Prefer –

#### Only pleasure and pain are intrinsically valuable – all other frameworks collapse.

Moen 16 [Ole Martin Moen, Research Fellow in Philosophy at University of Oslo “An Argument for Hedonism” Journal of Value Inquiry (Springer), 50 (2) 2016: 267–281]

Let us start by observing, empirically, that a widely shared judgment about intrinsic value and disvalue is that pleasure is intrinsically valuable and pain is intrinsically disvaluable. On virtually any proposed list of intrinsic values and disvalues (we will look at some of them below), pleasure is included among the intrinsic values and pain among the intrinsic disvalues. This inclusion makes intuitive sense, moreover, for there is something undeniably good about the way pleasure feels and something undeniably bad about the way pain feels, and neither the goodness of pleasure nor the badness of pain seems to be exhausted by the further effects that these experiences might have. “Pleasure” and “pain” are here understood inclusively, as encompassing anything hedonically positive and anything hedonically negative.2 The special value statuses of pleasure and pain are manifested in how we treat these experiences in our everyday reasoning about values. If you tell me that you are heading for the convenience store, I might ask: “What for?” This is a reasonable question, for when you go to the convenience store you usually do so, not merely for the sake of going to the convenience store, but for the sake of achieving something further that you deem to be valuable. You might answer, for example: “To buy soda.” This answer makes sense, for soda is a nice thing and you can get it at the convenience store. I might further inquire, however: “What is buying the soda good for?” This further question can also be a reasonable one, for it need not be obvious why you want the soda. You might answer: “Well, I want it for the pleasure of drinking it.” If I then proceed by asking “But what is the pleasure of drinking the soda good for?” the discussion is likely to reach an awkward end. The reason is that the pleasure is not good for anything further; it is simply that for which going to the convenience store and buying the soda is good.3 As Aristotle observes: “We never ask [a man] what his end is in being pleased, because we assume that pleasure is choice worthy in itself.”4 Presumably, a similar story can be told in the case of pains, for if someone says “This is painful!” we never respond by asking: “And why is that a problem?” We take for granted that if something is painful, we have a sufficient explanation of why it is bad. If we are onto something in our everyday reasoning about values, it seems that pleasure and pain are both places where we reach the end of the line in matters of value.

#### Impact calc –

#### Extinction mathematically outweighs.

MacAskill 14 [William, Oxford Philosopher and youngest tenured philosopher in the world, Normative Uncertainty, 2014]

The human race might go extinct from a number of causes: asteroids, supervolcanoes, runaway climate change, pandemics, nuclear war, and the development and use of dangerous new technologies such as synthetic biology, all pose risks (even if very small) to the continued survival of the human race.184 And different moral views give opposing answers to question of whether this would be a good or a bad thing. It might seem obvious that human extinction would be a very bad thing, both because of the loss of potential future lives, and because of the loss of the scientific and artistic progress that we would make in the future. But the issue is at least unclear. The continuation of the human race would be a mixed bag: inevitably, it would involve both upsides and downsides. And if one regards it as much more important to avoid bad things happening than to promote good things happening then one could plausibly regard human extinction as a good thing.For example, one might regard the prevention of bads as being in general more important that the promotion of goods, as defended historically by G. E. Moore,185 and more recently by Thomas Hurka.186 One could weight the prevention of suffering as being much more important that the promotion of happiness. Or one could weight the prevention of objective bads, such as war and genocide, as being much more important than the promotion of objective goods, such as scientific and artistic progress. If the human race continues its future will inevitably involve suffering as well as happiness, and objective bads as well as objective goods. So, if one weights the bads sufficiently heavily against the goods, or if one is sufficiently pessimistic about humanity’s ability to achieve good outcomes, then one will regard human extinction as a good thing.187 However, even if we believe in a moral view according to which human extinction would be a good thing, we still have strong reason to prevent near-term human extinction. To see this, we must note three points. First, we should note that the extinction of the human race is an extremely high stakes moral issue. Humanity could be around for a very long time: if humans survive as long as the median mammal species, we will last another two million years. On this estimate, the number of humans in existence in the The future, given that we don’t go extinct any time soon, would be 2×10^14. So if it is good to bring new people into existence, then it’s very good to prevent human extinction. Second, human extinction is by its nature an irreversible scenario. If we continue to exist, then we always have the option of letting ourselves go extinct in the future (or, perhaps more realistically, of considerably reducing population size). But if we go extinct, then we can’t magically bring ourselves back into existence at a later date. Third, we should expect ourselves to progress, morally, over the next few centuries, as we have progressed in the past. So we should expect that in a few centuries’ time we will have better evidence about how to evaluate human extinction than we currently have. Given these three factors, it would be better to prevent the near-term extinction of the human race, even if we thought that the extinction of the human race would actually be a very good thing. To make this concrete, I’ll give the following simple but illustrative model. Suppose that we have 0.8 credence that it is a bad thing to produce new people, and 0.2 certain that it’s a good thing to produce new people; and the degree to which it is good to produce new people, if it is good, is the same as the degree to which it is bad to produce new people, if it is bad. That is, I’m supposing, for simplicity, that we know that one new life has one unit of value; we just don’t know whether that unit is positive or negative. And let’s use our estimate of 2×10^14 people who would exist in the future, if we avoid near-term human extinction. Given our stipulated credences, the expected benefit of letting the human race go extinct now would be (.8-.2)×(2×10^14) = 1.2×(10^14). Suppose that, if we let the human race continue and did research for 300 years, we would know for certain whether or not additional people are of positive or negative value. If so, then with the credences above we should think it 80% likely that we will find out that it is a bad thing to produce new people, and 20% likely that we will find out that it’s a good thing to produce new people. So there’s an 80% chance of a loss of 3×(10^10) (because of the delay of letting the human race go extinct), the expected value of which is 2.4×(10^10). But there’s also a 20% chance of a gain of 2×(10^14), the expected value of which is 4×(10^13). That is, in expected value terms, the cost of waiting for a few hundred years is vanishingly small compared with the benefit of keeping one’s options open while one gains new information.