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#### Interp: Appropriation is defined as exclusive and permanent.

Taylor 19 (Kurt Taylor, [Writer for the Emory international law review] 2019, “Fictions of the Final Frontier: Why the United States SPACE Act of 2015 Is Illegal“, Emory Law, accessed: 1-23-2022, https://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?article=1966&context=flr) ajs

The broad text in Article II of the Outer Space Treaty provides an ordinary and unambiguous meaning free from absurdity.90 The language of Article II is short: “[o]uter space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.”91 At first glance, the language clearly intends to bar ownership over all aspects of outer space, with the only wrinkle of confusion being the meaning of “national appropriation.” Stephen Gorove, a space law expert, has suggested it is better to first define appropriation before determining how “national” modifies the term.92 Broadly, appropriation is “the taking of property for one’s own or exclusive use with a sense of permanence.”93 In this regard, appropriation is of a “national” character when it is by an entity under the sovereignty of the state from which they come or represent.94 Even though Article II uses the “national” language, its ordinary meaning is most closely linked to all sovereignties and the individuals and entities that attain property rights under the authority of a sovereign.

#### Violation: They don’t meet the “exclusive” portion – orbital slots aren’t because the ITU grants temporary, forfeitable licenses

Blodger 16 {JD Candidate, 2016, University of Minnesota Law School; BA Hillsdale College, 2013. I would like to thank Professor Carbone and the MJLST editors and staff for their feedback, edits, and guidance throughout this process. "Reclassifying Geostationary Earth Orbit as Private Property: Why Natural Law and Utilitarian Theories of Property Demand Privatization." <https://scholarship.law.umn.edu/cgi/viewcontent.cgi?article=1006&context=mjlst>]

This does not preclude the extension of a countrys legal jurisdiction into the sea, but only precludes the state and private individuals from exercising an ownership interest in the sea.80 This limitation is expressed in the Outer Space Treaty.81 The non-appropriation principles of the treaty are based on the theory that space, like the sea, is a potential medium of transport, and that the occupation of one small part of the area will not foreclose anothers use of the remaining portions of space.82 The current GEO regulation regime also follows the exception proposed by Grotius, that a person may use a common area he occupies for as long as the occupation lasts, as shown by the fact that the ITU only grants temporary, forfeitable licenses to use areas of GEO.83 While these licenses do not confer a property right, they do purport to confer a right to use an area of space; and, even though the ITU likely has no authority to exclude others from operating in the same space, the mere presence of the satellite would deter and likely prevent others from attempting to occupy the same location.84 Thus, the Outer Space Treaty not only relies on Grotius theory as an initial basis for preventing private ownership, but also employs the exceptions Grotius identifies.

#### Limits – they expand the topic to anything that can take up a specially temporal spot – any form of rocket, launches, and individual weapons, asats, shuttles, all become topical and topic DAs like innovation, mining good, deterrence assumes permanence

No new 1ar articulation of a defintion – that’s cheating bc they don’t have a def in the 1ac

#### Constellations can be hundreds of satellites which proves other objects can be in the same orbit

Hidalgo (Sebastian Hidalgo, [Research Coordinator for Cloudflight], ND, “Why satellite mega-constellations could be a problem – Cloudflight“, Cloudflight, accessed: 1-29-2022, https://www.cloudflight.io/expert-views/why-satellite-mega-constellations-could-be-a-problem-47440/) ajs

The term mega-constellation describes a constellation consisting of several hundreds or thousands of satellites orbiting Earth

#### More evidence from astrophysicists:

Hainaut ND — (Olivier R .Hainaut, Astronomer, specialized in observations of distant minor bodies in the outer solar system. Twenty years of experience in developing and implementing challenging observation programs, in real-time optimization of the observations, in trouble-shooting and finding work-around or long-term solutions to hardware, software, scientific, operation problems ---from off-the-shelf to outside-the-box. Ten years of experience in operation management of observatories, including staffing, budget, scheduling, optimization of the operations. This includes dealing with staff from very broad multi-cultural origins, optimizing the assignments to staff capabilities and aspirations, resolving inter-personal and inter-departmental conflicts.. Five year experience in outreach and science communication, with emphasis on scientific correctness of the outreach products, and on the creation of top outreach astronomical images. Coordination of a network of communicators over 20+ countries. , “Large Satellite Constellations and their Impact on Astronomy“,Available Online at https://www.eso.org/~ohainaut/satellites/, accessed 3-22-2022, HKR-AR) // this article cites reports in 2022, but does not list a date on the website.

Wikipedia: "A satellite constellation is a group of artificial satellites working together as a system." A mega-constellation is a group of large constellation, with hundreds or thousands of individual satellites. The Starlink, OneWeb and others (see below for a list) aim at providing global telecommunication coverage, with a very low latency. The low latency implies a very low altitude, which in turns implies a very large number of satellites (see the visibility section below for details.

#### Reject their definition of LSC’s – its analyzing the orbital risk of LSCs, its not making an intrinsic claim as to what large satellite constellations constitute. Read their evidence

#### Reject defining "large LEO sats" based on risk -

#### a] circumvention -- the risk of collision is always changing for a satellite based on external factors like debris or other satellites, so either they ban all sats and link to our offense or ban none and lose on presumption. The ambiguity alone is sufficient for circumvention because of private interests that would lobby for favorable regs - thats all of their cards about the profit motive

#### b] ground -- it lets them get out of any disad link because they can define the risk threshold such that collisons would functionalyl be guaranteed and take out the disad.

#### c] their own Liang evidence talks about "satellite constellations" independent of the collision risks -- their own ev impleis that, even if there is a low collision risk, you'd still consider it a satellite

#### Our definition is far better - a clear quantitative limit is infinitly more predictable and gives us clear ground to prepare negative disads

#### Takaya definition is terrible – they’re talking about an “applicable regulation” which is imprecise and their card explicitly rules out intent to define

Takaya et al 18 “The Principle of Non-Appropriation and the Exclusive Uses of LEO by Large Satellite Constellations” Yuri Takaya-Umehara [Visiting researcher at the University of Tokyo since April 2017. She was affiliated to the Kobe University to provide a course on space law to post-graduate students (2011-2017). She chairs a working group on the formulation of global norms in space law organized by the Keio University since 2018. She obtained her Ph.D. degree at the IDEST of Paris XI University in France, LL.M. at the Leiden University in the Netherlands.] Quentin Verspieren [Ph.D. in public policy @ The University of Tokyo, Assistant Professor of Space Policy @UTokyo, General Manager, Global Strategy @ArkEdge Space Inc., Associate Research Fellow @ESPI] Goutham Karthikeyan [The University of Tokyo & Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (ISAS-JAXA)] 2018 https://www.researchgate.net/publication/328094878\_The\_Principle\_of\_Non-Appropriation\_and\_the\_Exclusive\_Use\_of\_LEO\_by\_Large\_Satellite\_Constellations SM //recut HKR-AM

* LSC = large satellite constellations
* Outlines density thresholds for exclusive use via LSCs
* Private entities are the actors of the plan – no treaty or alteration of international law would enforce a prohibition on large satellite constellations
* Exact density thresholds would be based on collision risk and determined on a constellation by constellation basis by an impartial 3rd party – candidates include the ITU or UNCOPUOS

By investigating expected large satellite constellation projects and by reviewing existing interpretations of international space law, this paper argues that the exclusive use of specific LEO orbits by a large constellation of satellite could constitute a violation of the non-appropriation principle by means of occupation and by means of use, drawing a parallel between orbits as resources and the exploitation of tangible mineral resources in space. Based on this, the important question to be raised is what constitutes an exclusive use of a specific orbit. In other words, an important hurdle in the concrete evaluation of whether a planned or established constellation potentially violates the non-appropriation principle through an exclusive use of LEO resides in the lack of clear definition on what can be considered an exclusive use. While the authors claim that legal issue can be clearly solved in abstracto, it naturally shifts towards a regulatory challenge.

This regulatory challenge consists in first defining qualitatively what is the exclusive use of an orbit before translating this definition into measurable, technical rules. In this paper, the authors define an exclusive use of an orbit by a state40 as any use that would prevent/hinder the usage of the same orbit by any other state. Translating this definition into an applicable regulation could consist in defining a threshold of orbital collision risk or a threshold of density of satellites along an orbit based on its altitude, shape, relative velocity of neighbouring objects, etc. It is however not the purpose of this space law paper. What is more appropriate here is to think about which organization or forum would be in charge of elaborating this technical definition. Serious candidates could be the ITU, with excellent track-record in dealing with the use of the GEO region but which would have to review its “first come, first served” principle, or the UNCOPUOS, aiming for the widespread adoption of a new piece of international law. Moreover, even if its rules suffer from a low implementation rates, the IADC would be an appropriate discussion platform thanks to its very deep technical focus.

6. Conclusion

The various announced projects of LSC, also called mega-constellations, push existing regulations and practices to their limit, forcing researchers and practitioners around the world to rethink the applicability of existing space law principles to this new trend. In this paper, the authors, after providing background information on current LSC plans as well as recalling the legal status of the LEO region, investigate whether the deployment of an LSC having an exclusive use of an orbit constitutes a violation of the nonappropriation principle as stated in OST Article II. This paper concludes that:

The exclusive use of an orbit by an LSC constitutes a violation of the non-appropriation principle by means of occupation due to the innate nature of orbit being a specific location in space that can be occupied, but most notably by means of use, considering orbits as “limited natural resources” and invoking parallels with the exploitation of natural resources in outer space;

ITU’s “first come, first served” principle is reaching its limits with current LSC projects and should be re-evaluated;

The main challenge ahead is not legal but technical and regulatory and consists in defining precisely what can constitute an exclusive use of an orbit and in translating such definition into a clear regulation or code of conduct.

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#### Interpretation – affirmative teams must defend legal action by a government

John Bouvier 56 [The Free Dictionary, “Unjust”] [DS] [https://legal-dictionary.thefreedictionary.com/Unjust#:~:text=UNJUST.,test%20of%20right%20and%20wrong.]

Unjust Also found in: Dictionary, Thesaurus, Wikipedia. Related to Unjust: Unjust enrichment UNJUST. That which is done against the perfect rights of another; that which is against the established law; that which is opposed to a law which is the test of right and wrong.

#### This is clear

Black’s Law Dictionary ND [DS] [https://thelawdictionary.org/unjust/]

UNJUST Contrary to right and justice, or to the enjoyment of his rights by another, or to the standards of conduct furnished by the laws.

#### Violation – the aff fiats private self-restriction, which is not a method of correcting injustice nor an enactment of a law.

#### Ground – generics on this topic must be tied to the actor, not the action, because each space appropriation is unique. A topic where the unifying thesis is countries legislating restrictions on space appropriation is much better than one about private actors self-restricting – their interp skirts multilat good/bad, K’s of IR and global governance, and CP’s to reform the

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#### Counterplan:

#### Private entities in Asia should significantly invest in the exclusive use of Low Earth Orbit via Large Satellite Constellations for the purposes of emergency communications in the event of disaster relief or external shocks.

#### All other private entities ought not engage in the exclusive and permanent use of Low Earth Orbit via Large Satellite Constellations

#### SpaceX, OneWeb, Google, Amazon, and Telesat should immediately halt their engagement in the exclusive use of Low Earth Orbit via Large Satellite Constellations.

#### Private entities that engage in the exclusive use of Low Earth Orbit via Large Satellite Constellations should substantially harden their cybersecurity by instituting the following measures: Multi check for IoT devices, Identity and Access Management, Intrusion Detection System, Immediate Kill-Switch of Satellites that’s required to activate when malicious, anomalous, or abnormal activity is detected, Supply Chain Risk Program, Independent Command Logging, Physical Separation of Network Components, Crisis Communication Plans, Machine Learning that detects abnormal activity, and Collision Avoidance Procedures

#### Private entities should ban rocket propellants that produce alumina particles in the stratosphere or deposit black soot in the stratosphere.

#### Private entities should mandate all satellites be launched with active debris removal shepherd satellites, launch Active Debris Removal satellites and require all satellites be equipped with systems to enable spacecraft to deorbit themselves.

#### Private LEO constellations are economically viable in the long term, but require upfront investment – those uniquely solve disaster response because of satellite internet’s connectivity options for island countries

Garrity and Husar 21 Garrity, John, and Arndt Husar. John Garrity is an economist, policy advisor, and project manager focusing on digital inclusion, universal internet access policy, and last-mile connectivity. He has coauthored numerous reports on technology and development and has presented around the world on efforts to close the digital divide. Arndt Husar facilitates the effective use of digital technology, advising ADB clients, regional departments, as well as sector and thematic groups on digital transformation. " Digital Connectivity and Low Earth Orbit Satellite Constellations: Opportunities for Asia and the Pacific." (2021).

Satellite communication plays a necessary role in the global connectivity ecosystem, connecting rural and remote populations, providing backhaul connectivity to mobile cellular networks, and rapidly establishing communication in emergency and disaster response scenarios. This Asian Development Bank (ADB) Sustainable Development Working Paper, the first in a series reviewing emerging innovations in connectivity technologies, focuses on low Earth orbit (LEO) satellites, which have been in deployment for decades and are again a subject of intensive investment as new large constellations are in early stages of deployment. These new LEO constellations, such as those being deployed by Starlink by SpaceX, Project Kuiper by Amazon, OneWeb, Lightspeed by Telesat, among others, may prove to be transformational to the connectivity landscape based on their global coverage and their suitability for areas not served by fiber optic cable networks. ADB’s developing member countries are well placed to leverage and benefit from this expansion of internet connectivity, particularly for underserved geographies and countries with limited international internet bandwidth, such as landlocked developing countries and small island developing states. With their global reach and coverage, LEO constellations are expected to dramatically expand the availability of high-speed broadband internet access with levels of service that rival fiber optic cables in terms of speed and latency, and at significantly reduced price levels compared to traditional geostationary satellites. A proactive engagement with LEO solutions is likely to yield benefits as the relevant business models are still evolving. Well-informed early action by regulators and investors can ensure that developing member countries prepare for opportunities presented by the anticipated expansion of connectivity bandwidth. I. IntRoDUCtIon This Emerging Connectivity Innovations Case Study on SpaceX Starlink and low Earth orbit (LEO) satellite constellations is intended to provide readers, particularly in developing countries in Asia and the Pacific, with a background understanding of the role of satellite communications in global internet connectivity and an exploration of the potential impact of the next generation of LEO constellation systems. While the adoption of internet connectivity across the world has generally increased incrementally, some innovations have been transformational, dramatically expanding the geographic reach of connectivity and bandwidth capacity. For example, the introduction of basic mobile phones in the late 1990s and early 2000s led to rapid adoption of mobile telephony across low- and middle-income countries (a phenomenon known as the “mobile miracle”). Similarly, public and private investment in undersea fiber optic cables circling sub-Saharan Africa in the 2000s significantly reduced the cost of bandwidth in many countries in the region. Satellites have used low Earth orbits since the beginning of space exploration; however, private investment in LEO constellations, consisting of hundreds or thousands of satellites, has been limited because significant up-front capital expenditure is required. While it remains to be seen how the next generation of LEO satellite constellations will evolve, LEOs are forecasted to significantly increase the available internet bandwidth in remote and rural geographies not currently served by fiber optic cables. This increased bandwidth could be leveraged to increase economic and social development opportunities for individuals, organizations, businesses, and government facilities (including public schools) located in these areas, provided that the private sector satellite companies investing in LEO constellations see market opportunities to extend service to these areas. This case study is intended to introduce to Asian Development Bank developing member countries how to start preparing for the expansion of LEO satellite communication services. II. BACKGRoUnD: sAteLLIte ConneCtIVItY As A MeAns FoR BRoADBAnD InteRnet Internet connectivity has become a necessary component of every country’s critical infrastructure given the reliance of all aspects of economic activity, governance, and social development on internet communications. The coronavirus disease (COVID-19) pandemic dramatically increased the importance of internet communications infrastructure. Trade, employment, learning, leisure, and communications quickly shifted into the digital sphere and countries with robust internet infrastructure and high adoption rates of internet-enabled devices were better able to adjust and adapt to the shift to digital activity. The United Nations estimates that 1.6 billion learners were affected by school closures in 2020, affecting 94% of the world’s student population and up to 99% in low and lower middle-income countries.1 1 United Nations. 2020. Policy Brief: Education during COVID-10 and beyond. 2 ADB Sustainable Development Working Paper Series No. 76 Access to distance learning opportunities varies greatly by country and income groups, with estimates of less than half of students in low-income countries able to access distance learning.2 Internet access and adoption in the developing member countries (DMCs) of the Asian Development Bank (ADB) continues to grow, particularly as a result of public and private investment in telecommunications infrastructure, increased competition, and allocation of shared resources, such as spectrum auctions and assignment. Despite these efforts, large access gaps remain in Asia, where the most remote, difficult to reach, or sparsely populated districts remain disconnected, leaving more than half of the population without access to the internet. This lack of digital infrastructure represents a missed opportunity to accelerate economic and social development. Despite the rapid expansion of internet connectivity infrastructure across the world, significant gaps in internet adoption and infrastructure access remain. This highlights the importance of satellite communications that can bridge gaps, swiftly expand network coverage, and enhance existing infrastructure. The latest estimates from the International Telecommunication Union (ITU) show that 3.7 billion people are still not participating online (49% of the global population), and 63% of rural households are without internet access (Figure 1).3 Also, 1.5 billion people reside in areas without high-speed mobile data coverage (fourth generation long-term evolution or 4G LTE), while 607 million people reside in areas with no mobile data coverage at all (at least 4G or third generation [3G] coverage). Furthermore, 313 million people reside in areas with only basic voice and short messaging service (SMS) coverage (second generation [2G]), and 220 million people reside in areas with no cellular coverage. The ITU estimates that nearly $428 billion is required to achieve universal access to broadband globally, $251 billion of which is required for Asia, with approximately 75% coming from the private sector

and the remainder with support from the public sector.4 The majority of the world’s population, over 5 billion people, live more than 10 kilometers (km) away from any fiber optic cable infrastructure (3.6 billion reside more than 25 km away).5 Other issues, such as affordability, digital literacy, and the lack of relevant or local language content, have resulted in 2.4 billion people who live within 4G coverage not subscribing to 4G data services. [FIGURE 1 OMITTED] Satellite connectivity is predominantly used for backhaul connectivity for remote cellular base stations and as a last-mile connection for individual subscribers and enterprises. Figure 2 provides an overview of the internet infrastructure network components, from international connectivity to the last mile. Because of the higher relative cost of bandwidth transmitted via satellite versus terrestrial technologies, satellite is currently primarily used in situations where fiber optic cables and other high-capacity technologies are not financially viable due to low population densities and large distances between high-capacity networks and last-mile networks.6 However, in a few cases, satellite connectivity is relied upon for international internet gateway traffic or as part of a country’s core network. For landlocked developing countries that are dependent on terrestrial fiber connectivity, in some cases, satellite connectivity serves as a substitute to complex bilateral and multilateral negotiations to extend costly fiber connectivity to their country. [FIGURE 2 OMITTED] Satellite connectivity is predominantly used for backhaul connectivity for remote cellular base stations and as a last-mile connection for individual subscribers and enterprises. Figure 2 provides an overview of the internet infrastructure network components, from international connectivity to the last mile. Because of the higher relative cost of bandwidth transmitted via satellite versus terrestrial technologies, satellite is currently primarily used in situations where fiber optic cables and other high-capacity technologies are not financially viable due to low population densities and large distances between high-capacity networks and last-mile networks.6 However, in a few cases, satellite connectivity is relied upon for international internet gateway traffic or as part of a country’s core network. For landlocked developing countries that are dependent on terrestrial fiber connectivity, in some cases, satellite connectivity serves as a substitute to complex bilateral and multilateral negotiations to extend costly fiber connectivity to their country. Particularly in situations where a high degree of data throughput is required per site, such as satellite backhaul for broadband cellular networks, the data volumes as well as the distance to the nearest backbone node play a significant role in cost comparisons between satellite connectivity versus terrestrial network deployments (microwave backhaul, in particular). Figure 4 illustrates how higher data bandwidth requirements are more cost-effectively supplied by terrestrial ground networks; however, a crossover point occurs where satellite capacity may end up being more cost-competitive, depending on different price points of satellite bandwidth and total traffic demand per month.12 Satellite connectivity is also well- suited to deploy in emergency situations, such as in response to natural disasters or other external shocks, that require expeditious deployment of network connectivity where terrestrial infrastructure is either nonexistent or destroyed. For many rural and remote communities, satellites are the only connectivity option. For geographies without direct access to fiber optic cable infrastructure or at great distances from high- capacity bandwidth capacity, satellite connectivity is the only option available. Even where terrestrial network infrastructure that could be used for backhaul connectivity is available, satellite deployments may still be preferred because satellite terminals require only electrical power and a clear line of sight to the sky. However, an expansion of terrestrial infrastructure usually requires extensive civil works (underground fiber ducts, pole attachments, or tower construction for cellular base stations), which comes with challenges such as securing the rights-of-way, permits, and having to pay the related fees. Satellite broadband is poised to become an even more important technology for addressing the growing digital divide. As information and communication technologies play an increasingly important role in commerce, government services, health care, education, and other sectors, satellite connectivity allows communities to get connected swiftly, bypassing the infrastructure deployment challenges that come with terrestrial infrastructure deployments. The role of satellite connectivity in emergency telecommunications has also been vital where the communications satellites are heavily relied upon in disaster recovery efforts.13 Satellite technology may also be complementary with traditional wired and mobile broadband, which are better suited for densely populated areas. Satellite service could become a default solution for remote areas, allowing terrestrial services to focus on improving access in their current coverage areas. Satellite connectivity is already being used for network redundancy at national levels for international internet capacity, as well as for backup in core and backhaul networks.14 The recent $50 million loan to Kacific by ADB for the deployment of a broadband satellite, which covers large parts of Southeast Asia and the Pacific, demonstrates the relevance of satellite connectivity for unserved and underserved regions.15 By deploying new satellite technology (in the Ka-band16), Kacific’s service offering is commercially viable despite the existing presence of other major competitors in Asia and the Pacific, including global entities such as Intelsat, SES, and Eutelsat, as well as more regional players such as AsiaSat, Thaicom, MEASAT, and SKY Perfect JSAT.

#### The Asia-Pacific is the most disaster-prone region in the world – the next catastrophe is a question of when, not if

Thomas Bickford et al 15, Ph.D., senior research scientist in CNA Corporation’s China Studies division, “The Role of the U.S. Army in Asia,” May, https://www.cna.org/CNA\_files/PDF/CRM-2015-U-010431-Final.pdf

Natural disasters As Typhoon Haiyan amply demonstrated when it hit the Philippines in November 2013, natural disasters can represent a significant threat to human security. In 2012, the Asia-Pacific region experienced 93 natural disasters, which affected some 75 million people.206 It is one of the most disaster-prone regions in the world:207 it is prone to typhoons and cyclones; it contains some of the world’s most active faults and volcanos; and many areas experience massive flooding. As former USARPAC commander Lieutenant General Wiercinski has noted, the only questions are when and where the next big disaster will occur. Admiral Locklear, Commander, USPACOM has noted that climate change is one of the region’s most pressing security challenges.209 While the ability to respond to natural disasters varies widely among countries in the region, even advanced countries can require international assistance, as Japan did after the March 2011 earthquake and tsunami.

#### Natural disasters are an existential threat – but increased preparation solves – outweighs all other risks

Anders **Sandberg 18**. Future of Humanity Institute, University of Oxford. 02/26/2018. “Human Extinction from Natural Hazard Events.” Oxford Research Encyclopedia of Natural Hazard Science. oxfordre.com, doi:10.1093/acrefore/9780199389407.013.293.

Systemic Risks

**Localized** disasters or slow-moving risks are unlikely **on their own** to spell doom for H. sapiens. It may appear that an unlikely intense global event or confluence of disasters need to occur in order to cause extinction. **However**, many risks are potentially **systemic**: a **sequence** or **combination** of disasters may **reduce resiliency** and the ability to **recover**, especially when interacting with the **human systems**. A model of how compound risks can act is the synchronous failure model of Homer-Dixon et al. (2015). **Multiple stresses** (such as climate change, resource shortages, or conflicts) can **interact** and **accumulate** in a social-ecological system, **pushing** **it** **to**ward a state where its **coping capacity** is **diminished**. Different sub**systems** become **coupled** because they require support from each other to function in the stressed state. When a **crisis occurs** (either externally triggered or because an internal component finally fails) it **rapidly cascades through the system**, spreading between subsystems and causing the **whole to fail**. Simultaneous damage is often **multiplicative in severity**. Many **human systems** such as **food, energy, finance and comm**unication**s** are **global**, densely interconnected systems where failures can **cascade** **rapidly** (Helbing, 2013). They have **developed** in a locally rational way: the gains in efficiency and reliability have been significant. However, the probability of global failures also has **increased** compared to more local, modular and redundant systems (Goldin & Vogel, 2010). While societal collapse does not imply extinction, humans are **dependent** on complex societies and their high productivity, and **any** long-term **collapse** would **reduce the human carrying capacity significantly**. A stressor such as **climate change** may **increase** the probability and severity of global failure, and once this occurs **vulnerability to further risks increases**. Various example scenarios can be constructed where plausible events produce gradual deterioration of the human system before it can recover; see, for example, Tonn and MacGregor (2009) and other papers in the same issue. Another example is sudden geoengineering cessation. If, as a response to climate change, solar radiation management geoengineering is used to maintain temperature, this will require ongoing technological maintenance. If a global disaster disrupts civilization, besides the damage from the primary disaster there would also be a rapid temperature change to close to what the un-modified climate would have been. This will likely produce massive **disruptions of ag**riculture and other human systems at the time when **vulnerability is maximal** (Baum, Maher, & Haqq-Misra, 2013). In this case a risk mitigation effort adds to systemic risk. Systemic effects are **hard to predict** (trade can both strengthen human societies by providing an adaptive system of distribution, prosperity, and incentives for innovation as well as destabilize them due to market bubbles, dependencies, and spread of pathogens). Taking uncertainty into account is possible but tends to lead to conservative policies (Weitzman, 2009). Another approach is to engineer human systems so they are naturally redundant, modular, and otherwise resilient to systemic stresses (Helbing, 2013). Probabilities Estimating existential risks can be done in many ways, each with their own merits and drawbacks; see (Tonn & Stiefel, 2013) for a review. It is possible to place upper bounds on extinction risks due to natural disasters by considering the fossil record. This can be done in several ways; the following will be based on the work of Toby Ord (2017). The simplest bound is based on the observation that H. sapiens has existed for 200,000 years: this observation would be unlikely if the extinction risk was higher than about 1 in 3,000 per century. One can say that an extinction rate of 0.15% or higher per century is ruled out at a 95% confidence level. Another bound uses now-extinct related hominin species as a reference class, producing estimates in the range 0.001% to 0.05% per century. This is in line with survival times for mammalian species, which typically is 1–2 million years (Raup, 1978) but shorter than for the entire fossil record where lifetimes of 5–10 million years are typical (Raup, 1986; May, Lawton, & Stork, 1995). H. sapiens is an unusually populous, well-dispersed, and adaptable large mammal species. However, it also has high food requirements and a long generation time. It may then be that the most likely risk to lead to extinction would be a mass-extinction level risk. Large mass extinctions occur at a rate of about 1 in 100 million years, producing a risk estimate of 0.0001% per century. One issue is that we are still discovering new kinds of existential risks. As noted above, supernovas have been recognized as a risk since the 1950s but gamma ray bursts were recognized as a risk first in the 1990s. High-energy physics risks were suggested in 1970s and later. Recognition of supervolcanism as a risk dates to the 1990s, in turn based on the models of nuclear winter in the 1980s. “Big rip” early endings of the universe were noticed in 2003 (Caldwell, Kamionkowski, & Weinberg, 2003). Since the rate of discovery does not seem to have slacked off, it is plausible that more natural hazards exist that we are unaware of, yet could pose a threat. At the same time, the above estimates bound the total risk: we are merely refining our understanding of what hazard categories exist. It should be noted that using past geological or fossil records to estimate risks that could have influenced the emergence of the species doing the risk estimation requires some care: risks that would have precluded the emergence of the species would naturally be underrepresented (Ćirković, Sandberg, & Bostrom, 2010). It is also clear that the peculiarities of the current situation may exacerbate some risks (e.g., pandemics) while reducing others (e.g., local disasters); these estimates merely show the risk magnitude for the earlier stages of the species’ history. The current probability is dynamically changing depending on human action. Probability estimates are on their own irrelevant: the point of risk assessment is to motivate rational risk management. This includes prioritizing mitigation efforts (typically toward the largest, most urgent, and most controllable risks) and research to reduce uncertainty and find more options. Mitigation Human extinction is an unusual risk since it can only occur once. Mitigation efforts need to succeed every time. Mitigating extinction risk can be done by reducing the probability of sufficiently severe hazards occurring, improving resilience mechanisms to reduce the damage, and endurance mechanisms to ensure that survivors can rebuild and repopulate. Many astrophysical extinction risks, supervolcanism and the emergence of new diseases are likely impossible to prevent, requiring resilience strategies. Impacts from near earth objects or comets can in principle be prevented given enough lead time and the right technological level (NRC, 2010). The amount of impulse needed to avoid an earth collision scales inversely with the lead time and proportional to the impactor mass: with enough time, even a high-precision weak intervention can move large objects. Managing atmospheric emissions and possibly intervening with geoengineering can influence climate risks (Wigley, 2006; Moreno-Cruz & Keith, 2013). Human systems can be designed to be resistant to various forms of systemic risks (Helbing, 2013). Prediction of extreme events is often impossible since they are the outcome of cascades in noisy, chaotic systems with hidden variables, and past data of less extreme cases often does not constrain models of phenomena of this magnitude. This requires using robust strategies taking large uncertainty into account (Weitzman, 2009). Although exact prediction may not be possible, rapid and improved response is possible and can enhance the resiliency against many of the listed threats. This includes better risk surveillance, preparation of responses and resources, as well as intergovernmental coordination. Many ex

tinction risks have joint pathways. For example, supervolcanism, large meteor impacts, and nuclear winters (not discussed in this article) do most of their harm by precluding agricultural/fishing over a span of years leading to widespread starvation (Engvild, 2003). While they also cause other harms this particular shared pathway can be dealt with by emergency food stores or alternative food sources (Denkenberger & Pearce, 2014). Shielding in space against radiation sources could in principle mitigate the risk from supernovas, GRBs, superflares, and similar risks (Ćirković & Vukotić, 2016). Improved resiliency against particular damage pathways can hence improve chances against a large set of risks. Endurance mechanisms aim at ensuring survival, adaptation, and eventual recovery after a near-extinction disaster (Maher & Baum, 2013). An occasionally suggested endurance mechanism against extinction risks is the deliberate construction of refuges where people can survive (or the encouragement of natural refuges in isolated regions, nuclear submarines etc.). Ideally such refuges would be self-sufficient and independent of the earth’s surface (Baum, Denkenberger, & Haqq-Misra, 2015; Jebari, 2015). However, refuges only help against certain categories of disasters and their cost-effectiveness depends on the relative value of current and future generations (Beckstead, 2015). Undersupply of Mitigation Preventing extinction is important; **at least** as important as saving the lives of 7.2 billion people, and quite possibly **far more important** when taking future generations and their value into account (Parfit, 1984; Bostrom, 2003; Bostrom, 2013; Häggström, 2016). **Mitigating** extinction risk is an **undersupplied global public good**. For example, traditional statistical life valuations suggest that a $16–$32 billion annual investment in asteroid defense would be cost-effective yet U.S. government spending on asteroid detection (with no mitigation) is around $4 million per year, orders of magnitude smaller than funding for hazardous waste sites per unit of risk (Gerrard, 2000; Matheny, 2007). The annual cost to the world due to pandemic influenza has been estimated to $570 billion per year or 0.7% of global income, comparable to estimates of the long-term costs of climate change (Fan, Jamison, & Summers, 2016): the global influenza vaccine market has been estimated to less than $4 billion per year (Kaddar, 2013). These estimates merely take lives saved into account, not the value of future generations. Since existential risk mitigation is non-excludable and non-rivalrous there is a free-rider problem (non-participants gain the benefit without having to pay) and each producer of risk reduction would only gain a fraction of the total benefit. This is amplified by the transgenerational nature of risk reduction: most of the benefit will accrue to future generations. In principle the value to them of our present preventing extinction is near-infinite, but they cannot pay us any compensation (Matheny, 2007; Bostrom, 2013). Beside the normal logic of undersupply and lack of global coordination mechanisms there are also **cognitive** and **cultural** factors making existential risk mitigation rare. Part of the problem may be discomfort with the topic leading to willful denial or ignorance (Epstein & Zhao, 2009). Part of the problem is the difficulty to fit the topic with human **cognitive biases** (Yudkowsky, 2008; Wiener, 2016). Humans have **heuristics** that provide quick and adequate answers for many situations but lead to **systematic biases** in many situations removed from our ancestral everyday ones. For example, since extinction has not occurred in the past, the **availability heuristic** (“probabilities of events are roughly proportional to how easy examples of past events come to mind”) will underestimate likelihood. **Scope neglect** makes us relatively **insensitive** to the **number of lives** affected, making the willingness to make an effort scale sublinearly with the size of the problem. In general, without rich context information people are generally bad at judging differences between low probability events (Kunreuther, Novemsky, & Kahneman, 2001). Risks are judged not just by probability and severity but also by psychological aspects such as outrage and dread (Slovic, 1987). This can sometimes support efforts to mitigate global risks (since they tend to score highly on dread) but makes the focus strongly dependent on what is and is not discussed in public (Yudkowsky, 2008). This makes constructing risk management strategies that are resistant to behavioral biases vitally important for extreme risks (Kunreuther & Heal, 2012; Wiener, 2016). Conclusion There is **clear ev**idence that **natural events could cause** **the** **extinction** **of H. sapiens**. While astronomical risks may be the most dramatic, geophysical risks to food security and pathogenic risks appear to be more significant. It is unlikely that a **single disaster** will be severe enough to directly cause extinction, but it is plausible that it could place the species in **a vulnerable situation** for a long time, during which **other risks** could lead to **further vulnerability and** **extinction**.

#### That outweighs their impacts of nuclear winter – its junk science

Walker 18 (Robert Walker, first class honours degree in Math from York university, PhD at Wolfson College Oxford, 2018, "Debunked: Nuclear Winter and Radioactive Fallou...," https://debunkingdoomsday.quora.com/Debunked-Nuclear-Winter-and-Radioactive-Fallout-myths)

**There are many online pages and websites that seem very authoritative that say that even a limited nuclear war, say between India and Pakistan, would plunge the Earth into** a ‘Nuclear winter’ with no crops able to grow, no plants, no animals, and people soon starving to extinction. **This** is politically motivated and based on **out of date or** junk science. I am very much in favour of nuclear disarmament so I’m strongly in favour of the political views that motivate these people. I go so far as to argue that the UK should disarm unilaterally, and should never use its nuclear weapons under any circumstances. This is a similar view to the Scottish National Party and Jeremy Corbyn though he has not persuaded his party to adopt this stance, see my [Is Corbyn Right About The Bomb?- Op Ed](http://www.science20.com/robert_inventor/is_corbyn_right_about_the_bomb_op_ed-180465). But I think people need to know the truth and make decisions based on truth. I think it is important to speak up when a view is widely publicized that just about all scientists believe to be false, based on poorly supported research that they think will lead politicians to desired actions. Even if it has good political effects. In this case as well, **it is** also scaring **people** unnecessarily **who are afraid that even a small nuclear war could plunge us all into a deep freeze. No, it would not, and the** research suggesting this is **fundamentally** flawed and based on out of date ideas**. The** expert scientists **involved are sure** **that the** older nuclear winter models were incorrect, based on their failed predictions for the Kuwaiti oil fires **which they predicted would harm agriculture over much of** Asia but it only had local short term effects. There were many who were skeptical all along, but that was what persuaded nearly all of the ones who still thought it was possible that their models were wrong. There is one notable remaining nuclear winter proponent, Robok, who along with various co-authors publishes articles that are widely publicized because of their dramatic conclusions. However these predictions are not only not well received by other climate researchers, they are generally regarded as incorrect due to fundamental flaws in the assumptions his models are based on. The researchers who say this make assumptions that they can't prove and that everyone else in the field has said long ago don't work. **Carl Sagan gave up on the nuclear winter hypothesis after the Kuwaiti oil field fires and just about everyone else** except Robok **agreed with him.** SUMMARY The nuclear winter predictions date back to some predictions in the 1970s based on their limited crude models on slow computers (by modern standards) with hardly any memory, just kilobytes. They tried to model what would happen to the soot from fires in cities during a nuclear war. They concluded that it would be lofted so high into the atmosphere that it would get above all the normal weather and linger there for a decade, nearly blocking out the sun completely world wide. Their predictions were so dramatic that a 'nuclear winter' is an understatement. Average world temperature -25 C. You are talking about the ocean freezing even right to the tropics, for ten years. It's no wonder that they gave it that name. It had the support by highly respected scientist. One of the authors of the original paper was Carl Sagan. But the models were based on flawed assumptions**. Even at the time they were questioned. Nowadays just about all scientists involved, including ones that supported the hypothesis originally, are** **agreed that it would have little effect**. **It might** no effect on temperature **at all,** **except for a brief reduction of temperature** **locally during the fire itself as it turns day to night temporarily - since after all we have** large areas burnt in wildfires **every year with no effect.** The **scientists who did the nuclear winter work realized they had made a mistake in the modeling after the Kuwaiti oil fires**. **When the oil fields were left burning by the retreating troops, they predicted dire consequences for agriculture througout Asia. Instead it** **shaded out a** small part **of the gulf area** **with a** slight reduction of temperature **(similar to night time) for the duration of the fires** (several months). This showed that there was something wrong with their models. After looking into it in more detail **they decided that the** **soot** **doesn't rise nearly as high as they predicted in the atmosphere, and it** **tends to get** washed out within days **by rain.** The combined effect is that the darkening is temporary and local instead of long term and global. So, nearly all scientists agreed on this, but **Alan Robock published a paper in Physics Today in which he claimed that an all out exchange between Pakistan and India, of, say, 100 nuclear weapons would cool the Earth on average by a few degrees. The** **science in this paper** **was good except that he** started it already pre-loaded with soot **in the upper atmosphere**. Remember the very reason the early models got discredited is because soot doesn’t rise as high as expected in the Kuwaiti oil fires. Nor does it with wildfires or the fires from the Dreden bombing - and Hiroshima and Nagasaki didn’t have fire storms at all. This paper doesn’t even discuss this question. **It simply pre-loads the atmosphere with soot in the upper atmosphere, and from then on it follows the consequences.** **But that is the very point at contention** - **whether the soot would end up so high in the atmosphere.** **Everyone is agreed that there would be serious consequences if this happened but the evidence is that** it can’t get there **after the fires started in a nuclear war.**

#### solves ozone depletion

Mortillaro 21 (Nicole Mortillaro, Senior Reporter, Science, She is the editor of the Journal of the Royal Astronomical Society of Canada and the author of several books., 4/22/21, Canadian Broadcasting Corporation, “Rocket launches could be affecting our ozone layer, say experts”, <https://www.cbc.ca/news/science/rocket-launches-environment-1.5995252>, Accessed 1/27/22, HKR-RKT)

Black soot in the atmosphere The stratosphere is an important weather driver for Earth's systems, and that's where some particles from rocket launches are ending up. The ozone layer, which helps protect us from the sun's harmful ultraviolet rays, is also located in the stratosphere. In 1990, the Montreal Protocol was signed into law, banning harmful ozone-depleting substances, such as chlorofluorocarbons (CFCs), used in things like refrigerators and air conditioners, after it was revealed that the ozone layer was being stripped away by these chemicals. While the protocol touched on airlines, there was no mention of the aerospace industry. But now some industry experts are concerned that with no oversight, we could be in for a problem. There are different types of rocket propellants. Some, like liquid oxygen and liquid hydrogen, produce mainly water vapour and have little environmental impact. These were used in past shuttle launches and even in the Apollo-era Saturn V vehicles. Then there are those that produce alumina particles in the stratosphere, such as those in solid rocket boosters, which were also used in past shuttle launches, and are still being used today by some launch companies. Finally, there are those that deposit black soot in the stratosphere, such as kerosene used in SpaceX's Falcon 9 and Russia's Soyuz rockets. It's the alumina and black soot that is most concerning to experts.

#### Collision avoidance solves

Arif 17 — (Aayesha Arif, Journalist, “This Is How Satellites Avoid Colliding Into Each Other“, Wonderful Engineering, Available Online at https://wonderfulengineering.com/satellite-collision/, accessed 3-22-2022, HKR-AR)

A standard collision avoidance procedure has been established by space agencies to avoid any such accident. Every time a satellite is launched, a Collision On Launch Assessment (COLA) is performed. To make sure that the space vehicle trajectory does not take it too close to any other object in space, the launch window is set such that it has COLA blackout period, the intervals during which the spacecraft does not lift.

The purpose of COLA is to avoid the collision after launch. To avoid any debris or spacecraft collision while in orbit, the satellite performs collision avoidance maneuver also called Debris Avoidance Maneuver (DAM). The collision avoidance maneuver is usually performed to raise or lower the orbit of the craft by a few kilometers. Read more about how the Hubble Space Telescope conducts it to avoid space debris hits.

#### Solves the case

Brooks 22 — (Chuck Brooks, President of Brooks Consulting International, is a globally recognized thought leader and subject matter expert Cybersecurity and Emerging Technologies. Chuck is also Adjunct Faculty at Georgetown University’s Graduate Applied Intelligence Program and the Graduate Cybersecurity Programs where he teaches courses on risk management, homeland security, and cybersecurity. LinkedIn named Chuck as one of “The Top 5 Tech People to Follow on LinkedIn.” He was named as one of the world’s “10 Best Cyber Security and Technology Experts” by Best Rated, as a “Top 50 Global Influencer in Risk, Compliance,” by Thompson Reuters, “Best of The Word in Security” by CISO Platform, and by IFSEC and Thinkers 360 as the “#2 Global Cybersecurity Influencer.” He was featured in the 2020, 2021, and 2022 Onalytica "Who's Who in Cybersecurity" – as one of the top Influencers for cybersecurity. He was also named one of the Top 5 Executives to Follow on Cybersecurity by Executive Mosaic, He is also a Cybersecurity Expert for “The Network” at the Washington Post, Visiting Editor at Homeland Security Today, Expert for Executive Mosaic/GovCon, and a Contributor to FORBES. He has an MA in International relations from the University of Chicago, a BA in Political Science from DePauw University, and a Certificate in International Law from The Hague Academy of International Law., “The Urgency To Cyber-Secure Space Assets“, Forbes, 2-27-2022, Available Online at https://www.forbes.com/sites/chuckbrooks/2022/02/27/the-urgency-to-cyber-secure-space-assets/, accessed 3-22-2022, HKR-AR)

2. Identity and access management (“IAM”) – those accessing flight control information and surfaces need to be identified and verified by an IAM solution that will pass muster on the user using machine learning identifiers to attempt to prevent authorized access to critical vehicle functions.

3. Multi check for IoT related devices – IoT devices must be able to be updated; no hard-coded passwords should be allowed.

4. The backbone of a cyber-resilient spacecraft should be a robust intrusion detection system (IDS). The IDS should consist of continuous monitoring of telemetry, command sequences, command receiver status, shared bus traffic, and flight software configuration and operating states, anticipate and adapt to mitigate evolving malicious behavior. The spacecraft IPS and the ground should **retain the ability to return critical systems** on the spacecraft to known cyber-safe mode. Logging should also be available to cross-check for anomalous behavior.

5. It is critical that spacecraft developers implement a supply chain risk management program. They must ensure that each of their vendors handles hardware and software appropriately and with an agreed-upon chain of custody. Critical units and subsystems should be identified and handled with different rigor and requirements than noncritical units and subsystems and should also be constructed with security in mind. All software on the spacecraft should be thoroughly vetted and properly handled through the configuration management and secure software development processes (DevSecOps).

6. Both the spacecraft and ground should independently perform command logging and anomaly detection of command sequences for cross validation. Commands received may be stored and sent to the ground through telemetry and automatically checked to verify consistency between commands sent and commands received.

7. Protections should be made against communications jamming and spoofing, such as signal strength monitoring and secured transmitters and receivers; links should be encrypted to provide additional security.

Security elements for defending ground-based systems and network assets include but are not limited to (also from the Homeland Security Today article):

1. Adoption of cybersecurity best practices, including those aligned with the NIST cybersecurity framework (“CSF”). As academic professors and pragmatists, we both are ardent supporters of the CSF and see no reason why the hundreds of space and satellite suppliers should not adopt the NIST framework.

2. Key network components should be logically and physically separate to prevent virus-like (ransomware) attacks from spreading throughout the network.

3. All ground-based system and network assets should be required to have the following policies in place: incident response, business continuity and crisis communications plans, patching policies, BYOD policies and backup policies.

4. All ground-based space systems and facilities should be required to hold quarterly employee training for all individuals on things like spear-phishing and socially engineered email attacks.

5. All ground-based space systems and facilities should be required to adopt a fulsome vendor supply chain risk management program that touches all primary and tertiary vendors.

6. All ground-based space systems and facilities must adopt machine learning intrusion detection systems to help guard against anomalous and potential malicious activity.

7. All ground-based space systems, facilities, and space manufacturers and vendors should be required to join the Space ISAC to be able to collaborate by sharing threats, warnings, and incident information.

#### solves adv 1

ESA 18 – [European Space Agency, “Curbing space debris in the era of mega-constellations,” 7/18/2018, https://www.esa.int/Enabling\_Support/Preparing\_for\_the\_Future/Discovery\_and\_Preparation/Curbing\_space\_debris\_in\_the\_era\_of\_mega-constellations]

Two ESA-led teams of researchers carried out investigations as part of this endeavour. The MEGACO study, consisting of representatives from Airbus, Braunschweig Technical University and École polytechnique fédérale de Lausanne, set out to understand the complexity of mega-constellations in general, including a focus on collision avoidance and dealing with satellites that have reach b ed the end of their lives. Meanwhile, a team from Thales Alenia Space explored two specific methods of removing debris, including failed satellites, from orbit.

The MEGACO team investigated three theoretical mega-constellations. For each one, they analysed the space and ground infrastructure required to operate the constellation, assessed different end-of-life strategies, looked at collision avoidance requirements, and investigated associated costs and risks.

"One aim of MEGACO was to design a set of spacecraft that can deorbit themselves, and to figure out what to do with failing spacecraft,” explains Kate Symonds, systems engineer responsible for the MEGACO study on ESA’s side.

The team selected one mega-constellation concept for further study and looked at more specific operational requirements.

“Our final investigations included exploring having spare satellites, carefully controlling launches and orbits to avoid collision, and using ‘shepherd satellites’ – in the same plane but in a lower orbit – that capture dead spacecraft and deorbit them,” Symonds continues. “This research will feed into future ESA studies on mega-constellations.”

The team from Thales Alenia Space looked more closely into actively deorbiting dead satellites. They identified two theoretical constellations (named Mega1000 and TAS3200) and produced a different Active Debris Removal (ADR) design for each.

“Without ADR, a failed spacecraft can remain in orbit for hundreds of years,” explains Robin Biesbroek, the ESA systems engineer overseeing the project. “This could affect other spacecraft in that orbit and result in lots of debris and many collisions.”

Similar to MEGACO’s shepherd satellite idea, the first ADR design includes a chaser satellite containing capture equipment that is launched with the rest of the constellation. When a spacecraft fails, the chaser captures it using a net and both spacecraft re-enter Earth’s atmosphere and burn up.

The other design puts three ADR spacecraft into space at once in a dedicated launch. Each spacecraft uses a robotic arm to capture and de-orbit at least 35 pieces of debris, one after another, before completely burning up on re-entry.

“Both techniques are viable options for Active Debris Removal, with the second being especially effective at removing a lot of debris,” Biesbroek concludes.

These two studies present exciting ideas for dealing with end-of-life mega-constellation spacecraft, and they will feed into new research by Clean Space, which continues to develop technologies required for ADR and collision avoidance.

## NC – OFF

#### CP: Private entities should significantly invest in the exclusive use of Low Earth Orbit via Large Satellite Constellations for the purposes of 6G development and research.

#### Private LEO mega constellations drive rapid SatCom 6G innovations – that’s key to pervasive communication services that solve medical data flow deficits and solve UN SGDs

Höyhtyä et al 22 Marko Höyhtyä, Senior Member, IEEE, Sandrine Boumard, Anastasia Yastrebova, Pertti Järvensivu, Markku Kiviranta, Senior Member, IEEE and Antti Anttonen, Senior Member, IEEE. "Sustainable Satellite Communications in the 6G Era: A European View for Multi-Layer Systems and Space Safety." arXiv preprint arXiv:2201.02408 (2022)

THE two main disruptions driving the development and rapid growth of satellite communications (SatCom) are increasing satellite constellations sizes and integration of satellite and terrestrial networks. The former also aims to provide broadband services to currently underserved areas with improved performance. The latter is related to the evolution of mobile networks where different wireless and wired technologies converge together. This creates vast amount of new opportunities in different application fields such as public safety, digital health, logistics and Internet services in developing countries. The annual space business related to 5th generation (5G) and 6th generation (6G) of communication systems is expected to grow to more than €500B during the next two decades [1]–[3]. This is more than the whole space business currently including scientific missions, earth observation (EO) and navigations. At the same time the whole space sector is in the transformation phase due to so called New Space Economy. Significant reduction of launch costs and easy and affordable access to space have attracted new innovative players to space business [4], [5]. Especially Low Earth Orbit (LEO) systems and small satellites are increasing rapidly. The most typical orbit heights are above 500 km but there are significant efforts to use also very low Earth orbits (vLEO) to provide sensing and communications services. The so called Karman line, defining where atmosphere ends and space begins, is above 80 km and orbiting objects can survive multiple perigees passages at altitudes around 80–90 km [6]. Small satellites in the range of 80-220 kg can be seen as a sweet spot [5] since they are large enough for payloads to support e.g. broadband communications [7]–[9] or synthetic aperture radar (SAR) imaging [10], [11]. A. Multi-Layer Networks 6G systems will be used to provide pervasive services worldwide in order to support both dense and less dense areas. To achieve this goal, 6G systems will need to integrate terrestrial, airborne (drones, high-altitude platforms (HAPs)) and satellite communications at different orbits [12], [13]. This means that in contrast to traditional research and development (R&D) work, network analysis, planning and optimization will be updated from two dimensions to three dimensions (3D), where also the heights of communications nodes are taken into consideration [12]–[15]. In this way, 6G networks will be able to provide drastically higher performance to support e.g., passengers in ships and airplanes. The initiatives spawned recently range from very high throughput geostationary orbit (GEO) systems to unmanned aerial vehicles (UAVs) [16]–[18] and small satellite systems dedicated to machine-to-machine (M2M) and Internet-of- things (IoT) services [19]–[21]. Especially interesting are mega-constellations consisting of hundreds to thousands of small and medium size satellites like those proprietary ones envisaged by OneWeb, Starlink, Orbcomm and Telesat to mention but a few. There is also ongoing active work in the 3rd Generation Partnership Project (3GPP) standardization to define non-terrestrial networks (NTN) with interoperable interfaces in order to have truly seamless connectivity in the future, described in detail in Section V.B. B. Space Safety and Sustainability There are not only technical drivers in the development of the multi-layer 6G networks. It is essential to develop services and technologies in a sustainable way in order to ensure high quality services also to coming generations. To mention a few examples: 1) According to International Telecommunication Union (ITU) only half of the world’s population has access to broadband services above 256 kbits/s currently [22]. 2) The COVID-19 pandemic has shown that video communications provide means for people and businesses, including medical professionals, and their patients to remain in virtual contact, avoiding the need for travel while remaining socially, professionally, and commercially active [23]. A comprehensive analysis to linkage between 6G and the United Nations Sustainable Development Goals (UN SDGs) from technological, business and regulation perspectives has been provided in [24], [25]. A very good overview on how European Space Agency (ESA) programs support SDGs is given in [26]. For instance, satellite communication technologies provide e-learning in Congo, tools for telemedicine and transmission of key medical data to and from remote locations, and means to gather and share data on arctic sea and climate conditions. Thus, it supports multitude of SDGs including good health and wellbeing, climate action, quality education, sustainable cities and communities, reduced inequalities, and life on land by helping to protect terrestrial ecosystems. Therefore, modern communication networks will be purposefully designed to be socially, economically and environmentally sustainable, and they will provide means to support equality globally. The main sustainability aspects are visualized in Figure 1. In the following, we list a couple of key points from the SatCom point of view.

#### 6G uniquely solves emerging biodisasters – extinction

**Su ’21** [Zhaohui; 2021; Center on Smart and Connected Health Technologies, Mays Cancer Center, School of Nursing, UT Health San Antonio; The Hong Kong Polytechnic University, “Addressing Biodisaster X Threats with Artificial Intelligence and 6G Technologies: Literature Review and Critical Insights,” https://arxiv.org/pdf/2105.08870.pdf]

A disaster can be defined as “a serious disruption of the functioning of a community or society involving widespread human, material, economic, or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources” [47]. Based on the contributing causes, disasters are usually categorized as **natural** (eg, **earthquakes**, infectious disease-inducing epidemics, or **pandemics** of natural origin) and **anthropogenic** (eg, armed **conflicts**, **nuclear accidents**, or the release of **pathogenic genetically modified organisms** from laboratory settings). In the context of this study, **biodisasters** are defined as disasters that occur as a result of **infectious** **pathogens** **with bioweapon potential**, which are unleashed by state or nonstate actors **accidentally** and **intentionally** (eg, the Japanese government’s controversial decision to dump Fukushima’s contaminated water into the boundless and borderless ocean shared by all life forms on earth, including humans and sharks [48]). In the context of biodisasters, a state actor often takes the form of a nation that deliberately and systematically designs and develops infectious pathogens with its national interest in mind. In contrast, a nonstate actor is an individual or group acting independently to obtain or manufacture a pathogen either owing to misguidance or malice. Of note, although existing multilateral agreements prohibit the production and use of bioweapons by state actors (termed biowarfare) [49], the presence of signed agreements **does not imply** that accidental or intentional development and release of pathogens by state actors **will not occur**. The concept of “bioterrorism,” defined as the deliberate release of pathogens that could cause illnesses and deaths in society, is not the focus of this study because “**bioterrorism**” entails both deliberation and malice (eg, to elicit terror to the public) [50]; antecedents **may not necessarily apply** to Biodisaster X threats. Insights from behavioral science [51-53] and evidence regarding individual-caused mass casualty events (eg, indiscriminate mass shootings) [54-56] suggest that individual actors’ behaviors, potentially leading to the onset of Biodisaster X, may or may not include conscious deliberation to harm. In other words, while it is possible that individual actors’ malicious actions might cause **some** biodisasters, it is also possible that some individual-caused biodisasters are **accidental**. Furthermore, the term bioterrorism is **limited**, in that “**terror**” is the main outcome. We believe that for Biodisaster X, which could **upend lives**, **livelihoods**, and **economies**, “**disaster**” is a more appropriate description that sheds light on the **scale** and **severity** of its consequences and is more diverse than “terror.” Drawing insight from real-world examples, similar to the prevalent ransomware hacks, it is possible that state or individual actors could develop and utilize infectious pathogens as “ransomgens” for financial gain rather than merely aiming to generate terror in society. Therefore, under the current research context, we adopted the term “biodisaster” instead of “bioterrorism.” Furthermore, considering that various studies have discussed approaches to address state actor–initiated biodisasters [57-61], this study focuses on biodisasters that are infectious in nature, caused by individual actors, and can result in catastrophic human and economic consequences. Biodisaster X vs Disease X The risk of biodisasters, such as Biodisaster X, is **increasing** **in likelihood**: advances in technology, particularly the **availability** and **maturity** of **biotech**nology, have grown **considerably** in recent years. Inadvertently, these advances may resemble those of **Oppenheimer** [62] in facilitating the release of destructive factors. One example of the misuse of biotechnology is a microbiologist, vaccinologist, and senior biodefense researcher who worked at the United States Army Medical Research Institute of Infectious Diseases, who allegedly engineered the 2001 anthrax attacks [63-65]. While the scale of the 2001 **anthrax** attacks was minor, it demonstrated how **easily** biodisasters can occur and how **unprepared** society was for these events. As seen in the lack of **adequate preparation** and **coherent responses** to infectious disease–induced **pandemics**, including **COVID**-19 [66-69], Biodisaster X’s effects may be **compounded** to the same, if not greater, degree by **incompetence** across international, national, and regional agencies and organizations. The concept of Biodisaster X can be best understood in contrast with Disease X. In terms of similarities, both Biodisaster X and Disease X are driven by pathogens unknown to humans and have the potential to cause crippling effects on society. Furthermore, based on previous inadequacies in response to emergency events including pandemics [66-74], the world at large may be ill-prepared for both Biodisaster X and Disease X. In terms of unique attributes, compared to Disease X, Biodisaster X is more likely to have the following characteristics: (1) having a pathogen directly affiliated to a laboratory; (2) having distinctive and engineered attributes tailored by the capabilities and intentions of the developer; and (3) the origin, development, and history can be definitively ascertained upon identification of the developer, which is not possible for naturally occurring pathogens (eg, the 1918 influenza pandemic), where there is always uncertainty regarding the origin and evolutionary history of the disaster [75-77]. The Imperative of Preparing for Biodisaster X Some of the **deadliest** **pandemics**—the most recent ones ranging from AIDS, severe acute respiratory syndrome, Middle East respiratory syndrome, Ebola, and COVID-19—all have zoonotic origins [78]. Studies have further shown that for viruses that can transmit from animals to humans, especially those that can infect a diverse range of host species, the transmission speeds are **substantially amplified** once human-to-human transmission is established, and the diseases can **quickly evolve** into **global pandemics** [79]. Consequently, once a pathogen is transmissible within a population, there is a **low access threshold**: an individual actor can “obtain” these deadly pathogens **without** the need for **advanced laboratory skills** or **extensive financial resources**. However, costs to physical and mental health may reveal a counternarrative. Based on available evidence, it is difficult to determine whether an individual can be a malicious “patient zero”; an individual who intentionally contracts a novel virus intending to cause infectious disease outbreaks in a society [80]. It is not impossible to purposely study and capture known or unknown deadly pathogens that can trigger infectious diseases; microbial surveys are commonly conducted to identify novel pathogens before they pose a threat to public health [81-84]. In theory, there could be individual actors, with adequate knowledge or experience (similar to the microbiologist allegedly behind the 2011 anthrax attacks [63-65]), who may take the same actions but with different motives, ranging from scientific curiosity to ill-guided intentions. Considering the **rich biodiversity** of wildlife, along with the large number of “**missing viruses**” and “missing **zoonoses**” that remain unidentified [85], close contacts with latent deadly pathogens are **nearly impossible** to control, which in turn, renders it challenging to locate or identify individual actors who might utilize them. Advances in **synthetic biology** may further compound the situation, especially considering the scholarly endeavors using pathogens in laboratory settings, which could amount to the level of real-world pandemics (eg, laboratory-cultured viruses such as smallpox [86-88]). The likelihood of Biodisaster X increases in proportion to these factors. Overall, considering the species diversity of wildlife, the unknown factors related to the scale and severity of viruses in animals, which have the latent potential to infect humans, and the varying degrees of competency of community health centers in detecting infectious disease outbreaks in a bottom-up manner, it could be tremendously difficult for health experts and government officials to monitor potentially emerging Biodisaster X threats. However, not all hope is lost. Technology-based solutions, especially those utilizing AI and 6G technologies, can help address these issues. The Need for Advanced Technology Solutions for Monitoring and Managing Biodisaster X The Need for Technology-Based Solutions Once Biodisaster X becomes a reality, human contact will drive transmission and become the primary fuel for exacerbating infections and deaths caused by the disaster. As seen during the COVID-19 pandemic, owing to virus spread and subsequent public health policies (eg, lockdowns), many **critical** **societal** **functions** could be **substantially** **disrupted**. The potential to **control** and **contain** human and economic **consequences** of Biodisaster X, such as the functionality of the health care systems (eg, infected health care professionals) [89-91], may also become **critically undermined**. In these circumstances, **tech**nology-based solutions could be the **key** to addressing these crises, as they are different from conventional solutions; they are **not** **highly** **dependent** on physical interactions and transportation. Overall, technology-based solutions require **limited** human resources (eg, with the ability to operate without human input), can be delivered **independent** of physical human contact (eg, web-based and remote deployment), and are **immune** to infectious diseases (eg, can function in contaminated environments). Furthermore, technology-based solutions are **less vulnerable** to issues ranging from physical fatigue to mental health burdens, which are health challenges that frontline workers often face amid emergency events. The Need for Advanced Technologies To effectively predict, control, and manage Biodisaster X, which is an event with a low probability (ie, difficult to detect preemptively) and a high impact (ie, difficult to control and contain), advanced technologies are needed. While many emerging technologies can address the dangers and damages associated with Biodisaster X [92,93], 2 families of advanced technology-based solutions show particular promise, namely AI techniques and 6G technologies. Unique Capabilities of AI AI is generally considered synonymous with “thinking machines” [94], or techniques that can facilitate “a computer to do things which, when done by people, are said to involve intelligence” [95]. With AI technologies, machines can identify patterns too intricate for humans to identify and process quickly. AI techniques are widely used in areas such as natural language processing, speech recognition, machine vision, targeted marketing, and health care, including efforts to combat COVID-19 [96-99]. While technologies such as virtual reality, smart sensors, drones, and robotics could play a positive role in supporting health care professionals to cope with the pandemic [100-102], AI technologies are arguably most instrumental in addressing some of the most prominent issues health experts and government officials are faced with, ranging from pandemic surveillance to COVID-19 drug and vaccine development [103-106]. AI and machine learning techniques are particularly valuable in their ability to identify trends and patterns across large amounts of data promptly and cost-effectively; for example, in identifying or searching for specific patterns. With natural language processing, for instance, data can be extracted retrospectively from clinical records or prospectively in real time and statistically processed for insights, which, in turn, can supplement existing structured data to enrich actionable information [86]. During the COVID-19 pandemic, natural language processing models have been used to analyze publicly available information such as tweets, tweet timestamps, and geolocation data, to identify and map potential COVID-19 cases cost-effectively, without utilizing testing devices or other medical resources that involve health care professional [107]. Overall, most, if not all, AI techniques are irreplaceable in regard to administering complex tasks such as extracting useful information from large data sets. Moreover, with the continuously increasing speed of its technological advancements and applications, AI technologies are often utilized as core components in other emerging technologies [108]. Smart sensors that perform advanced tasks, such as effectively identifying and recognizing captured motions and images, often need to integrate deep learning technologies (a subgroup of AI) [109-111]. These combined insights suggest that AI techniques have great potential in monitoring and managing Biodisaster X threats. Unique Capabilities of 6G Networks 6G technologies are the next generation of wireless communication systems following 5G networks [112]. While 6G is still under development, it is envisioned as the most capable communication network currently available [112-119]. The advantages of 6G networks derive from their high data transmission speed (up to 1 terabyte per second), wireless hyper-connectivity (100 million connections per km2), low end-to-end latency (< 1 ms), reliability (1-10-9) (reliability in terms of the frame error rate, which is defined as the ratio of the number of incorrectly decoded frames to that of total transmitted frames), and high-accuracy positioning capabilities (indoor: <10 cm in 3D; outdoor: <1 m in 3D) [112-119]. Adding the fact that 6G networks also excel in their energy efficiency and spectrum efficiency, these networks can provide fast and efficient wireless reporting and access to remote computational facilities, facilitating mobile biomonitoring and disaster management. For instance, the high reliability and data transmission speed of 6G technologies will be of critical importance amid global emergency events with the scale of Biodisaster X. At the onset of the COVID-19 pandemic, many internet companies and service providers experienced outrage and were forced to reduce the amount of data individuals and organizations could utilize to ensure continuous communication for all [120]. This limitation of existing communication networks could compromise the ability of health experts and government officials to monitor and manage COVID-19–related threats and other disasters promptly and properly. Of note, in the face of an extremely deadly, contagious, and fast-developing Biodisaster X, information will be predominantly updated and exchanged remotely and over the internet. The speed and success of updating and exchanging information are highly dependent on the reliability of communication networks, in which 6G technologies excel, especially when spatial big data have been introduced for disease control and prevention since the COVID-19 pandemic [27,108,121]. Figure 1 lists visual comparisons in communication capabilities between 6G and 5G networks.

#### China will launch public megaconstellations no matter what which thumps the aff BUT the US needs the private sector to stay in the game

Hallex and Cottom 20 — (Matthew A. Hallex, Research Staff Member at the Institute for Defense Analyses, Travis S. Cottom, a Research Associate at the Institute for Defense Analyses, “Proliferated Commercial Satellite Constellations: Implications for National Security”, JFQ 97, 2nd Quarter 2020, Available Online at <https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-97/jfq-97_20-29_Hallex-Cottom.pdf?ver=2020-03-31-130614-940>, accessed 1-30-22, HKR-AR)

Interest in proliferated constellations is not confined to the United States and Western commercial space actors—both China and Russia are pursuing their own proliferated constellation projects. The development of foreign proliferated constellations will allow not only their owners to access these capabilities, but potentially access also to a wider range of actors. Given China’s willingness to allow for commercial dealings with countries hostile to the United States, these systems could pose a significant threat to U.S. interests. The state-owned China Aerospace Science and Technology Corporation (CASC) is planning the 300-satellite Hongyan LEO broadband communications proliferated constellation, and the state-owned China Aerospace Science and Industry Corporation plans its own 156-satellite Xingyun communications constellation. The first Hongyan satellite was launched in late 2018, and CASC has established a factory in Tianjin capable of producing 130 satellites a year. In 2015, China launched the first of its Jilin commercial imagery satellites to complement the Gaofen civil imagery constellation. The Jilin constellation is planned to reach 60 satellites by 2020 in order to provide global, 30-minute revisit rates, and then 138 satellites by 2030 to obtain 10-minute revisit rates worldwide.15

## 1NC – Debris

#### Their plan has private entities as the actor – there’s no term of art definition of Large Satellite Constellations – proves circumvention because private entities will classify whatever they want as large or not

#### squo debris thumps –

Orwig 16 [(Jessica, MS in science and tech journalism from Texas A&M, BS in astronomy and physics from Ohio State) “Russia says a growing problem in space could be enough to spark a war,” Insider,’ January 26, 2016, <https://www.businessinsider.com/russia-says-space-junk-could-spark-war-2016-1>] TDI

NASA has already [warned that](https://www.businessinsider.com/space-junk-at-critical-density-2015-9) the large amount of space junk around our planet is growing beyond our control, but now a team of Russian scientists has cited another potentially unforeseen consequence of that debris: War.

Scientists estimate that anywhere from 500,000 to 600,000 pieces of human-made space debris between 0.4 and 4 inches in size are currently orbiting the Earth and traveling at speeds over [17,000 miles per hour](https://www.nasa.gov/mission_pages/station/news/orbital_debris.html).

If one of those pieces smashed into a military satellite it "may provoke political or even armed conflict between space-faring nations," Vitaly Adushkin, a researcher for the Institute of Geosphere Dynamics at the Russian Academy of Sciences, reported in a paper set to be published in the peer-reviewed journal [Acta Astronautica](https://www.sciencedirect.com/science/article/pii/S0094576515303416), which is sponsored by the International Academy of Astronautics.

#### It takes centuries and adaptation solves

Ted Muelhaupt 19, Associate Principal Director of the Systems Analysis and Simulation Subdivision (SASS) and Manager of the Center for Orbital and Reentry Debris Studies at The Aerospace Corporation, M.S., B.S. Aerospace and Aeronautical Engineering & Mechanics, University of Minnesota - Twin Cities, Senior Member of the American Institute of Aeronautics and Astronautics, “How Quickly Would It Take For the Kessler Syndrome To Destroy All The Satellites In LEO? And Could You See This Happening From Earth?”, Quora, 2/28/2019, https://www.quora.com/How-quickly-would-it-take-for-the-Kessler-Syndrome-to-destroy-all-the-satellites-in-LEO-And-could-you-see-this-happening-from-Earth

The dynamics of the Kessler Syndrome are real, and most people studying it agree on the concept: if there is sufficient density of objects and mass, a chain reaction of debris breaking up objects and creating more debris can occur. But the timescale of this process takes decades and centuries. There are many assumptions that go into these models. Though there is still argument about this, many people in the field think that the process is already underway in low earth orbit. But others, including myself, think we can stop it if we take action. This is a slow motion disaster that we can prevent.

But in spite of hype to the contrary, we will never “lose access to space”. Certain missions may become impractical or too expensive, and we may decide that some orbits are too risky for humans. Even that depends on the tolerance for the risk. But robots don’t have mothers, and if we feel it is worthwhile we will take the risk and fly the satellites where we need to.

To the specifics of the question, it will take many decades. It will not destroy all satellites in LEO. You won’t be able to see it from the ground unless you were extraordinarily lucky, and you happened to see a flash from a collision in the instant you were looking, with just the right lighting.

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#### Collision risk is infinitesimally small

Fange 17 Daniel Von Fange 17, Web Application Engineer, Founder and Owner of LeanCoder, Full Stack, Polyglot Web Developer, “Kessler Syndrome is Over Hyped”, 5/21/2017, http://braino.org/essays/kessler\_syndrome\_is\_over\_hyped/

The orbital area around earth can be broken down into four regions. Low LEO - Up to about 400km. Things that orbit here burn up in the earth’s atmosphere quickly - between a few months to two years. The space station operates at the high end of this range. It loses about a kilometer of altitude a month and if not pushed higher every few months, would soon burn up. For all practical purposes, Low LEO doesn’t matter for Kessler Syndrome. If Low LEO was ever full of space junk, we’d just wait a year and a half, and the problem would be over. High LEO - 400km to 2000km. This where most heavy satellites and most space junk orbits. The air is thin enough here that satellites only go down slowly, and they have a much farther distance to fall. It can take 50 years for stuff here to get down. This is where Kessler Syndrome could be an issue. Mid Orbit - GPS satellites and other navigation satellites travel here in lonely, long lives. The volume of space is so huge, and the number of satellites so few, that we don’t need to worry about Kessler here. GEO - If you put a satellite far enough out from earth, the speed that the satellite travels around the earth will match the speed of the surface of the earth rotating under it. From the ground, the satellite will appear to hang motionless. Usually the geostationary orbit is used by big weather satellites and big TV broadcasting satellites. (This apparent motionlessness is why satellite TV dishes can be mounted pointing in a fixed direction. You can find approximate south just by looking around at the dishes in your northern hemisphere neighborhood.) For Kessler purposes, GEO orbit is roughly a ring 384,400 km around. However, all the satellites here are moving the same direction at the same speed - debris doesn’t get free velocity from the speed of the satellites. Also, it’s quite expensive to get a satellite here, and so there aren’t many, only about one satellite per 1000km of the ring. Kessler is not a problem here. How bad could Kessler Syndrome in High LEO be? Let’s imagine a worst case scenario. An evil alien intelligence chops up everything in High LEO, turning it into 1cm cubes of death orbiting at 1000km, spread as evenly across the surface of this sphere as orbital mechanics would allow. Is humanity cut off from space? I’m guessing the world has launched about 10,000 tons of satellites total. For guessing purposes, I’ll assume 2,500 tons of satellites and junk currently in High LEO. If satellites are made of aluminum, with a density of 2.70 g/cm3, then that’s 839,985,870 1cm cubes. A sphere for an orbit of 1,000km has a surface area of 682,752,000 square KM. So there would be one cube of junk per .81 square KM. If a rocket traveled through that, its odds of hitting that cube are tiny - less than 1 in 10,000.

## 1NC – Hacking

#### Hacking of SATs by the government nonuniques this advantage– we’ve inserted in blue

Akoto 20 “Hackers could shut down satellites -- or turn them into weapons” February 13, 2020 William Akoto [a postdoctoral research fellow at the University of Denver.] <https://www.upi.com/Top_News/Voices/2020/02/13/Hackers-could-shut-down-satellites-or-turn-them-into-weapons/4091581597502/> SM

This scenario played out in 1998 when hackers took control of the U.S.-German ROSAT X-Ray satellite. They did it by hacking into computers at the Goddard Space Flight Center in Maryland. The hackers then instructed the satellite to aim its solar panels directly at the sun. This effectively fried its batteries and rendered the satellite useless. The defunct satellite eventually crashed back to Earth in 2011. Hackers could also hold satellites for ransom, as happened in 1999 when hackers took control of the U.K.'s SkyNet satellites.

Over the years, the threat of cyberattacks on satellites has gotten more dire. In 2008, hackers, possibly from China, reportedly took full control of two NASA satellites, one for about two minutes and the other for about nine minutes. In 2018, another group of Chinese state-backed hackers reportedly launched a sophisticated hacking campaign aimed at satellite operators and defense contractors. Iranian hacking groups have also attempted similar attacks.

#### No one’s going to war over a downed satellite

Bowen 18 [Bleddyn Bowen, Lecturer in International Relations at the University of Leicester. The Art of Space Deterrence. February 20, 2018. https://www.europeanleadershipnetwork.org/commentary/the-art-of-space-deterrence/]

Space is often an afterthought or a miscellaneous ancillary in the grand strategic views of top-level decision-makers. A president may not care that one satellite may be lost or go dark; it may cause panic and Twitter-based hysteria for the space community, of course. But the terrestrial context and consequences, as well as the political stakes and symbolism of any exchange of hostilities in space matters more. The political and media dimension can magnify or minimise the perceived consequences of losing specific satellites out of all proportion to their actual strategic effect.

#### No Terrorist groups have ever shown motive in space terrorism, they stick to easy, less sophisticated, conventional, and traceable methods of conflict – 1AC cross-ex proves they haven’t shown motive

## 1NC – Ozone

Only about the sheer number of Starlink satellite constellations – planks 1 and 3 of counterplan both solve

#### **Also thumped by rocket launches, ASATS, non-mega constellations, autonomous space movers, etc**

#### No impact

**Ridley 14** -- Matthew White Ridley, 5th Viscount Ridley DL FRSL FMedSci, known commonly as Matt Ridley, is a British journalist, businessman and author of popular science books. Since 2013 Ridley has been a Conservative hereditary peer in the House of Lords. “THE OZONE HOLE WAS EXAGGERATED AS A PROBLEM” http://www.rationaloptimist.com/blog/the-ozone-hole-was-exaggerated-as-a-problem.aspx

Serial hyperbole does the environmental movement no favours My recent [Times column](http://www.thetimes.co.uk/tto/opinion/columnists/article4206440.ece) argued that the alleged healing of the ozone layer is exaggerated, but so was the impact of the ozone hole over Antarctica: The ozone layer is healing. Or so said the news last week. Thanks to a treaty signed in Montreal in 1989 to get rid of refrigerant chemicals called chlorofluorocarbons (CFCs), the planet’s stratospheric sunscreen has at last begun thickening again. Planetary disaster has been averted by politics. For reasons I will explain, this news deserves to be taken with a large pinch of salt. You do not have to dig far to find evidence that the ozone hole was never nearly as dangerous as some people said, that it is not necessarily healing yet and that it might not have been caused mainly by CFCs anyway. The timing of the announcement was plainly political: it came on the 25th anniversary of the treaty, and just before a big United Nations climate conference in New York, the aim of which is to push for a climate treaty modelled on the ozone one. Here’s what was actually announced last week, in the words of a Nasa scientist, Paul Newman: “From 2000 to 2013, ozone levels climbed 4 per cent in the key mid-northern latitudes.” That’s a pretty small change and it is in the wrong place. The ozone thinning that worried everybody in the 1980s was over Antarctica. Over northern latitudes, ozone concentration has been falling by about 4 per cent each March before recovering. Over Antarctica, since 1980, the ozone concentration has fallen by [40 or 50 per cent each September](http://bigstory.ap.org/article/scientists-say-ozone-layer-recovering) before the sun rebuilds it. So what’s happening to the Antarctic ozone hole? Thanks to a diligent blogger named Anthony Watts, I came across a press release also from Nasa about nine months ago, which said: “ Two new studies show that signs of recovery are not yet present, and that temperature and winds are still driving any annual changes in ozone hole size.” As recently as 2006, Nasa announced, quoting Paul Newman again, that the Antarctic ozone hole that year was “the largest ever recorded”. The following year a paper in Nature magazine from Markus Rex, a German scientist, presented new evidence that suggested CFCs may be responsible for less than 40 per cent of ozone destruction anyway. Besides, nobody knows for sure how big the ozone hole was each spring before CFCs were invented. All we know is that it varies from year to year. How much damage did the ozone hole ever threaten to do anyway? It is fascinating to go back and read what the usual hyperventilating eco-exaggerators said about ozone thinning in the 1980s. As a result of the extra ultraviolet light coming through the Antarctic ozone hole, southernmost parts of Patagonia and New Zealand see about 12 per cent more UV light than expected. This means that the weak September sunshine, though it feels much the same, has the power to cause sunburn more like that of latitudes a few hundred miles north. Hardly Armageddon. The New York Times reported “an increase in Twilight Zone-type reports of sheep and rabbits with cataracts” in southern Chile. Not to be outdone, Al Gore wrote that “hunters now report finding blind rabbits; fisherman catch blind salmon”. Zoologists briefly blamed the near extinction of many amphibian species on thin ozone. Melanoma in people was also said to be on the rise as a result. This was nonsense. Frogs were dying out because of a fungal disease spread from Africa — nothing to do with ozone. Rabbits and fish blinded by a little extra sunlight proved to be as mythical as unicorns. An eye disease in Chilean sheep was happening outside the ozone-depleted zone and was caused by an infection called pinkeye — nothing to do with UV light. And melanoma incidence in people actually levelled out during the period when the ozone got thinner. Then remember that the ozone hole appears when the sky is dark all day, and over an uninhabited continent. Even if it persists into the Antarctic spring and spills north briefly, the hole allows 50 times less ultraviolet light through than would hit your skin at the equator at sea level (let alone at a high altitude) in the tropics. So it would be bonkers to worry about UV as you sailed round Cape Horn in spring, say, but not when you stopped at the Galapagos: the skin cancer risk is 50 times higher in the latter place. This kind of eco-exaggeration has been going on for 50 years. In the 1960s Rachel Carson said there was an epidemic of childhood cancer caused by DDT; it was not true — DDT had environmental effects but did not cause human cancers. In the 1970s the Sahara desert was said be advancing a mile a year; it was not true — the region south of the Sahara has grown markedly greener and more thickly vegetated in recent decades. In the 1980s acid rain was said to be devastating European forests; not true — any local declines in woodland were caused by pests or local pollution, not by the sulphates and nitrates in rain, which may have contributed to an actual increase in the overall growth rate of European forests during the decade. In the 1990s sperm counts were said to be plummeting thanks to pollution with man-made “endocrine disruptor” chemicals; not true — there was no fall in sperm counts. In the 2000s the Gulf Stream was said to be failing and hurricanes were said to be getting more numerous and worse, thanks to global warming; neither was true, except in a Hollywood studio. The motive for last week’s announcement was to nudge world leaders towards a treaty on climate change by reminding them of how well the ozone treaty worked. But getting the world to agree to cease production of one rare class of chemical, for which substitutes existed, and which only a few companies mainly in rich countries manufactured, was a very different proposition from setting out to decarbonise the whole economy, when each of us depends on burning carbon (and hydrogen) for almost every product, service, meal, comfort and journey in our lives. The true lesson of the ozone story is that taking precautionary action on the basis of dubious evidence and exaggerated claims might be all right if the action does relatively little economic harm. However, loading the entire world economy with costly energy, and new environmental risks based on exaggerated claims about what might in future happen to the climate makes less sense.

## 1NC – Asteroids

Only about the sheer number of SpaceX satellites – planks 1 and 3 of counterplan both solve

#### Their “coming now” cards shows that asteroids are…not coming now – inserted blue

1AC Spencer ’18 - senior editor for Salon. He manages Salon's science, tech, economy and health coverage Keith Spencer, “The Asteroids Most Likely to Hit Earth,” Salon, January 14, 2018, <https://www.salon.com/2018/01/14/the-asteroids-most-likely-to-hit-earth/>.

Like earthquakes and volcanoes, the most frightening thing about asteroid strikes is their inevitability. Our solar system formed from a planetary nebula of dust and gas that slowly coalesced into rocks, planets, moons, and the Sun. And there are plenty of rocks still floating around. Astronomers estimate that between 37,000 and 78,000 tons of solar system debris hit Earth every year, though luckily these usually rain down in tiny pieces that burn up in the atmosphere — rather than large chunks that explode on the ground. (Although those hit us too.)

As a result, our planet is littered with little geologic memento mori that foreshadow what is to come. The Chesapeake Bay looks the way it does because of a massive impact of a three- to five-kilometer-wide asteroid that hit about 35 million years ago; even today, the region’s freshwater aquifer is at risk of being contaminated by an adjacent salty underground reservoir that was created in the wake of the impact. Oil drillers and water management agencies in the region must mitigate for a 35-million-year-old natural disaster.

Unsurprisingly given how often we get hit with space debris, meteors rank high on the list of existential horrors; some of our civilization’s most popular books and films are about the fear of a meteor impact–related disaster. Likewise, scientists periodically sound the alarm bells over the lack of resources being devoted to hazardous asteroid detection and — perhaps someday — diversion. Luckily, NASA, the California Institute of Technology and other agencies have done a fair bit of sky-scouring to track and monitor nearby hazardous space rocks of varying sizes.

The trick with estimating likely impact candidates is knowing that while many of the things on this list have a low probability of hitting us in the next century, they have higher — but more difficult to estimate accurately — probabilities of striking Earth in coming centuries. So why do most lists of potentially hazardous asteroids only estimate their orbits as far as a hundred years in advance? Partly because we are trapped in our own human perspectives — 100 years is about as long as our children will live — and partly because any orbital uncertainty is compounded year to year.

In estimating the precise location of an asteroid and extrapolating its future path, precision is key; being off by, say, 40 kilometers today will equate to an orbital uncertainty thousands of times greater many years in the future. That could easily mean the difference between a strike and a miss. (Incidentally, 40 kilometers of uncertainty is the approximate uncertainty of 3200 Phaethon, a near-miss that grazed Earth last month.)

All of this is to say that the asteroids on this list move in and out of our planet’s orbit — on a long enough timescale, we’re either going to have a close encounter or an impact, provided ours or another planet doesn’t gravitationally slingshot these space rocks into a less hazardous orbit. In picking and choosing asteroids for inclusion here, I tried to pick ones that were A) big enough to at least cause a nuclear winter, and B) that have a decent likelihood of eventual collision. The way that near-Earth objects are ranked by astronomers takes into account the number of opportunities for the orbit to intercept Earth; most of these have elliptical orbits that will swing past our planet many times.

3200 Phaethon

The aforementioned asteroid, which I wrote about last month when it had a close encounter with Earth, is rumored to be the source of the Geminid meteor shower. An asteroid creating meteor showers on Earth is unusual; but 3200 Phaethon is a weird asteroid. The atmosphere-free, 3.6 mile-wide rock swings very close to the Sun, rapidly heating the asteroid's surface, and — scientists believe — creating fractures in its surface as its temperature changes, thus releasing dust. That dust then creates the Geminid meteors, tiny particles that rain down periodically on Earth.

3200 Phaethon has a very elliptical orbit, meaning it passes close to the Sun before swinging far out again. Its motion moves it in and out of Earth’s near-circular orbit, which is how it ended up grazing us by 6.2 million miles back in December, at which point it was visible from Earth with a small telescope.

A 3.6 mile-wide asteroid like 3200 Phaethon probably wouldn’t end most life on Earth, but it would certainly muck things up for a bit. This size is just slightly bigger than the asteroid implicated in the aforementioned Chesapeake Bay asteroid impact. That asteroid created a crater over 50 miles wide and almost a mile deep, according to the US Geological Survey. Even outside that 50-mile-wide diameter, earthquakes, dust clouds and heat levels made a large swath of North America uninhabitable for a while.

Accordingly, NASA lists 3200 Phaethon as “potentially hazardous.”

2017 XO2

Despite being only 330 feet wide, 2017 XO2 merits inclusion on this list solely because this 2-million-ton rock keeps crossing Earth’s path. Like the bee that won’t stop buzzing you at the picnic, 2017 XO2 will take many passes at Earth, each with their own small probability of collision. Notably: April 28, 2041, April 29, 2047, April 28, 2053, April 29, 2059, and April 28, 2065, all have impact probabilities greater than 0.00001 percent. The Center for Near-Earth Object Studies (CNEOS) only calculates trajectories up to 2111 — uncertainties rise after that point — but it seems to swing near us around the end of April every few years, up to April 30, 2111. CNEOS calculates a **cumulative** impact probability of 0.002 percent between now and 2111. Threateningly, it may keep swinging by Earth for thousands more years.

2017 YZ1

Some asteroids on this list are going to cross Earth’s path again and again and keep scaring us, but 2017 YZ1 has one shot before it loses it. If it were overtime in the NBA championship game and the score were tied, 2017 YZ1 is trying desperately to dunk — by which I mean, violently collide with Earth. This 1,000-foot-wide asteroid has a non-zero chance (0.00015 percent) of hitting Earth on June 30, 2047. **Those aren’t great odds,** but still a much better chance than you have of winning the lottery. I suspect some actuary at Lloyd’s of London is selling 2017 YZ1 insurance by now.

Fortunately, 2017 YZ1 **is only about a thousand feet in diameter, which isn’t big enough to cause an extinction event**. Yet if it struck land it might create a cataclysmic explosion that would mess up our weather for a few years.

Jot down June 30, 2047, in your calendar, and then pull out your telescope, watch it sail by and toast your good fortune.

2018 AE2

As its “2018” designation hints, 2018 AE2 is hot off the observational data tables. Between 2094 and 2112, 2018 AE2 will have a number of low-probability chances to hit Earth. At 50 million tons with an impact velocity of 53,000 miles per hour, 2018 AE2 would have a destructive capacity (3,200 megatons) equal to about half the world’s nuclear arsenal. If the theory of nuclear winter is true — that the amount of smoke and ash sent into the troposphere from such a large explosion could temporarily dim the Sun’s flux on Earth, resulting in crop loss, colder days, and the probable deaths of millions or billions — we would indeed be in for trouble.

#### Chance of asteroids is tiny and no extinction

Robert **Walker 16**. Software Developer of Tune Smithy, Wolfson College, Oxford. 12-14-2016. "Why Resilient Humans Would Survive Giant Asteroid Impact." Science 2.0. https://www.science20.com/robert\_inventor/we\_wont\_go\_extinct\_after\_a\_major\_asteroid\_impact\_even\_96\_of\_species\_extinct\_0\_chance\_of\_humans\_extinct-187383

This is something you hear said so often - that we risk being hit by an asteroid that could make humans extinct. But do we really? This is the article I’m commenting on, a recently breaking news story: Earth woefully unprepared for surprise comet or asteroid, Nasa scientist warns. Some are already worrying that it means that we are all due to die in the near future from an asteroid impact. Well, no, it doesn't mean that. So, what is the truth behind it? The source of all this is a comment by Dr Joseph Nuth who warns: “But on the other hand they are the extinction-level events, things like dinosaur killers, they’re 50 to 60 million years apart, essentially. You could say, of course, we’re due, but it’s a random course at that point.” Photograph of comet Siding Spring by Hubble - right hand image is more processed. This comet did a close flyby of Mars and at one point was predicted to have a tiny chance of hitting Mars. In the end it missed Mars by more than a quarter of the distance from Earth to the Moon If you read the rest of the article, it’s a worthy goal, to prepare us for asteroid impacts of all sizes from the small Chelyabinsk one up to really large 10 km ones. There are a number of things potentially confusing about this statement however, if you read it as a non scientist. Although there is a risk of “mass extinction” if a large asteroid hit Earth, “mass extinction” there doesn’t mean “extinction of humans”, we are such a resilient species that we would certainly survive a giant asteroid impact. We are not “due” an extinction at all. Next giant impact is most likely to happen many millions of years into the future. As we'll see, there is almost zero chance of a giant impact in the next century. There is however much we can do to protect ourselves from smaller asteroids. As a result of extensive asteroid surveys over the last couple of decades: We can be pretty sure (as in perhaps 99.999999% sure) that there isn’t an extinction level asteroid headed our way in the next century. We know the orbits of all the Near Earth Asteroids that could do this and none will hit Earth over that timescale. That leaves comets, and the chance of that is something like 1 in 100 million per century, as a very rough guess (since 99% of the impacts are thought to be from asteroids). This risk has been pretty much retired due to the automated asteroid searches by the likes of Pan STARRS. But the chance of a smaller asteroid impact is still high enough to make it worth working on it, especially since this is the one natural hazard we can not only predict to the minute, decades in advance, with enough information but also prevent also, given a long enough timeline. We are already close to completing the survey of 1 km asteroids (90% done). With a bit more funding we could also find most of the asteroids down to 45 meters in diameter. As a result of new developments in the science of asteroid detection, this could be done for a cost of only $50 million to protect the entire Earth. We would then be able to deflect asteroids decades before they are due to hit, which is a far easier task than a last minute deflection. First when he said "You could say, of course, we’re due, but it’s a random course at that point.”" - that is a scientist speaking as a scientist. But of course people sharing this on social media, retweeting, writing new stories about it, pick up the “we are due” and omit the scientific qualification “but it’s a random course at that point”. To say that we are “due” a mass extinction is a bit like saying that after you throw nine heads, you are due to throw a tail. Not true. The chance that the next coin toss is a tail is always going to be 50/50 for a fair coin no matter how many heads you throw. It's the same with extinctions. So long as it is a random process, then an extinction that happens every 60 million years could happen tomorrow or it could be 60 million years or 120 million years before it happens. On average we would still expect to wait 60 million years for the next such mass extinction even if the last one happened hundreds of millions of years ago. It’s just as for the coin toss. Same for an extinction event of a size that happens every 100 million years. If you look at the diagram the big five are irregularly spaced. The last one happened 66 million years ago. But they are irregularly spaced so we can't conclude either that we need to wait 44 million years for the next big extinction either. Some scientists have tried to discern a periodicity in the extinctions of perhaps 26 to 30 million years. If they are right then we are due the next extinction perhaps 15 million years or so from now. But that is very controversial and if true, it wouldn’t cover all mass extinctions. At any rate that's so far into the future it makes no difference to us now, if they are right or wrong. We could get a mass extinction in the next few millions of years. But it is nearly impossibly unlikely in the next century.