## T

#### Interpretation: Appropriation means use, exploitation, or occupation that is permanent and to the exclusion of others

Babcock 19 Professor of Law, Georgetown University Law Cente. Babcock, Hope M. "The Public Trust Doctrine, Outer Space, and the Global Commons: Time to Call Home ET." Syracuse L. Rev. 69 (2019): 191.

Article II is one of those succeeding provisions that curtails “the freedom of use outlined in Article [I] by declaring that outer space, including the [m]oon and other celestial bodies, is not subject to national appropriation.”147 It flatly prohibits national appropriation of any celestial body in outer space “by means of use or occupation, or by any other means.”148 However, “many types of ‘use’ or ‘exploitation’. . . are inconceivable without appropriation of some degree at least of any materials taken,” like ore or water.149 If this view of Article II’s prohibitory language is correct, then “it is not at all farfetched to say that the OST actually installs a blanket prohibition on many beneficial forms of development.”150 However, the OST only prohibits an appropriation that constitutes a “long-term use and permanent occupation, to the exclusion of all others.”151

#### Violation: Constellations do not appropriate – reject non-legal interpretations

Johnson 20 [Chris Johnson is the Space Law Advisor for Secure World Foundation and has nine years of professional experience in international space law and policy. He has authored and co-authored publications on international space law, national space legislation, international cooperation in space, human-robotic cooperative space exploration, and on the societal benefits of space technology for Africa. "The Legal Status of MegaLEO Constellations and Concerns About Appropriation of Large Swaths of Earth Orbit." https://swfound.org/media/206951/johnson2020\_referenceworkentry\_thelegalstatusofmegaleoconstel.pdf]

No, This Is Not Impermissible Appropriation

An opposite conclusion can also be reasonably arrived at when approached along the following lines. The counter argument would assert that the deployment and operation of these global constellations, such as SpaceX’s Starlink, OneWeb, Kepler, etc., are aligned with and in full conformity with the laws applicable to outer space. These constellations are merely the exercise and enjoyment of the freedom of exploration and use of outer space and do not constitute any impermissible appropriation of the orbits that they transit.

Freedom of Access and Use Permits Constellations

Rather than being a violation of other’s rights to access and explore outer space, the deployment of these constellations is more correctly viewed as the exercise and enjoyment of the right to access and use outer space. Article I of the Outer Space Treaty establishes a right to access and use space without discrimination.

Not allowing an actor to deploy spacecraft, regardless of their number or destination, would be infringing with the exercise of their freedom. It would be discriminatory. Additionally, actors do not need permission from any other State, or group of States, to access and explore outer space.

Aligned with the Intentions of the Outer Space Treaty

This use of outer space by constellations in LEO, while not explicitly mentioned by the drafters of the Outer Space Treaty or other space law, actually is the fulfillment of their visions for the use of outer space. The preamble to the Outer Space Treaty (which contains the subject matter and purpose of the treaty and can be used for interpreting the operative articles of the treaty) speaks of the aspirations of humanity in exploring and using outer space. It is easy to see constellations that will provide Internet access to the world as fulfilling the visions of the drafters:

The States Parties to this Treaty,

Inspired by the great prospects opening up before mankind as a result of man’s entry into outer space,

Recognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes,

Believing that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development,

Desiring to contribute to broad international cooperation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes,

Believing that such cooperation will contribute to the development of mutual understanding and to the strengthening of friendly relations between States and peoples,

As such, subsequent article of the Outer Space Treaty should be read in a permissive light, as permitting constellations, rather than a restrictive light which only sees potential negative aspects of constellations.

Due Regard and Harmful Contamination Will be Addressed

Operators in LEO are well aware of the challenges to space sustainability that their constellations will pose and will be taking efforts to mitigate the creation of debris. OneWeb is keenly focused on space sustainability and has even argued that the current norm, whereby spacecraft are not in space for longer than 25 years and are deorbited from lower orbits at the end of their lifetime (aka post mission disposal), is not sufficient to keep outer space clean and that shorter lifespan limits should be imposed on operators, especially operators in LEO, and operators of small satellites.

Additionally, these systems will be able to cooperate with emerging space safety and space traffic management plans and can operate in ways that do not restrict or impinge on other users of the space domain. Because due regard is therefore displayed for the space domain, and to the interests of others, these constellations do not prejudice or infringe upon the freedoms of use and exploration of the space domain and are therefore not occupation, or possession, much less appropriation.

This Does Not Constitute Possession, or Ownership, or Occupation

The use of LEO by satellite constellations is substantially similar to the use of GSO, and therefore permissible. In each region, individual actors are given permission - either from a national administrator or from an international governing body (the ITU) via a national administer–to use precoordinated subsections of space. In a way that is overwhelmingly similar to the use of orbital slots in GSO, the placement of spacecraft into orbits in LEO or higher orbits does not constitute possession, ownership, or occupation of those orbits. This is because States (and their companies) have been occupying orbital slots in GSO for decades, and these uses of GSO have never been accused of “appropriating” GSO. The users have never claimed to be appropriating GSO, and their exercising of rights to use GSO is respected by other actors in the space domain. This is the same situation for other orbits, including LEO and other non-Geostationary orbits.

And while GSO locations are relatively stable (subject to space weather and other perturbations, and require stationkeeping), spacecraft in LEO are actually moving through space and are not stationary, so it is even more difficult to see this use by constellations as occupation, much less appropriation. Moreover, Space Situational Awareness (SSA) and Space Traffic Management (STM) will allow other uses to use these orbits, and nothing about the use of any one user necessarily precludes others. Lastly, there is no intention by operators of constellations to exclusively occupy, must less possess or appropriate, these orbits. Would not the appropriation of outer space be an intentional, volutional act? No such intention can be found in the operators of global constellations.

#### 1] Precision – if we win definitions the aff doesn’t defend a shift from the squo or solve their advantages – so at best vote negative on presumption. The resolution is the only predictable stasis point for dividing ground—any deviation justifies the aff arbitrarily jettisoning words in the resolution at their whim which decks negative ground and preparation because the aff is no longer bounded by the resolution.

#### 2] Predictable limits—including satellite slots offers huge explosion in the topic since they get permutations of different satellite systems – LEO MEO and HEO, plus different companies, plus sizes of constellations, et cetera. Letting temporary occupation be appropriation is a limits diaster - any aff about a single space ship, satellite, or weapon would be T because they temporarily occupy space. Limits explodes neg prep burden and draws un-reciprocal lines of debate, where the aff is always ahead, turns their pragmatics offense

#### Topicality is a voting issue that should be evaluated through competing interpretations – it tells the negative what they do and do not have to prepare for—there’s no way for the negative to know what constitutes a “reasonable interpretation” when we do prep – reasonability is arbitrary and causes a race to the bottom, proliferating abuse

#### No RVIs—it’s your burden to be topical.

## CP

#### CP: Private entities ought to

#### Increase funding for astronomy research,

#### remove debris pieces from orbit in order to maintain debris levels at the current level of debris, prioritizing the most volatile and largest debris pieces in the most congested orbits,

#### collaborate on techniques to track and display the location of objects in real time and AI to automate debris-avoidance maneuvers, and

#### inject large amounts of ice particles into the lower stratosphere in late fall, especially in Antarctica.

#### That solves satellites, miscalc, Kessler, and debris collisions

Nature 8/11 [(Nature Editorial Board, peer-reviewed, comprises experimental scientists and data-standards experts from across different fields of science) “The world must cooperate to avoid a catastrophic space collision,” Nature, 8/11/2021] JL

But there are no traffic cops in space, nor international borders with clearly delineated areas of responsibility. To avoid further damage, it’s crucial that satellite operators have an accurate and up-to-date list of where objects are in space. At present, the main global catalogue of space objects is published at Space-Track.org by the US Space Command, a branch of the military. The catalogue is the most widely used public listing available, but it lacks some satellites that countries — including the United States, China and Russia — have not acknowledged publicly. In part because of this lack of transparency, other nations also track space objects, and some private companies maintain commercially available catalogues.

Rather than this patchwork of incomplete sources, what the world needs is a unified system of space traffic management. Through this, spacefaring nations and companies could agree to share more of their tracking data and cooperate to make space safer. This might require the creation of a new global regime, such as an international convention, through which rules and technical standards could be organized. One analogy is the International Telecommunication Union, the United Nations agency that coordinates global telecommunications issues such as who can transmit in which parts of the radio spectrum.

It won’t be easy to create such a system for space traffic. For it to succeed, questions of safety (such as avoiding smashing up a satellite) will need to be disentangled from questions of security (such as whether that satellite is spying on another nation) so that countries can be assured that participating in such an effort would not compromise national security. Countries could, for instance, share information about the location of a satellite without sharing details of its capabilities or purpose for being in space.

One near-term move that would help would be for the United States to complete a planned shift of responsibility for the Space-Track.org catalogue from the military to the civilian Department of Commerce. Because this catalogue has historically been the most widely used around the world, shifting it to a civilian agency could start to defuse geopolitical tensions and so improve global efforts to manage space debris. It might one day feed into a global space-traffic agreement between nations; even the nascent space superpower China would have a big incentive to participate, despite rivalries with the United States. The transition was called for in a 2018 US presidential directive that recognizes that companies are taking over from national governments as the dominant players in space, but it has yet to occur, in part because Congress has not allocated the necessary funds.

On 25 August, the UN Committee on the Peaceful Uses of Outer Space will meet to discuss a range of topics related to international cooperation in space. The UN is the right forum through which spacefaring nations can work together to establish norms for responsible space behaviour, and that should include how the world can track objects to make space safer. It should continue recent work it has been doing emphasizing space as a secure and sustainable environment, which at least brings countries such as the United States and China into the same conversation.

Basic research has a role, too: innovations such as techniques to track and display the locations of orbiting objects in real time, and artificial intelligence to help automate debris-avoidance manoeuvres, could bolster any global effort to monitor and regulate space.

If governments and companies around the world do not take urgent action to work together to make space safer, they will one day face a catastrophic collision that knocks out one or more satellites key to their safety, economic well-being or both. Space is a global commons and a global resource. A global organization responsible for — and capable of — managing the flow of space traffic is long overdue.

#### Removing the largest debris solves

Khlystov 18 [Nikolai Khlystov](https://www.weforum.org/agenda/authors/nikolai-khlystov) Lead, Space, and lead, Global Future Council on Space, World Economic Forum. 3 April, 2018 “We have a space debris problem Here’s how to solve it” [We have a space debris problem. Here’s how to solve it | World Economic Forum (weforum.org)](https://www.weforum.org/agenda/2018/04/we-have-a-space-debris-problem-heres-how-to-solve-it/) Accessed 12-19, photos omitted // gord0

The first Chinese space station, Tiangong-1, crashed on 1 April over the Southern Pacific, after uncontrollably re-entering the Earth’s atmosphere.

In fact, the station most likely all but burned up on re-entry, ironically very close to the location called ‘spacecraft cemetery’, where space agencies purposefully guide their old spacecraft to crash as it is the most isolated location in the ocean.

The Chinese authorities lost contact with the station back in 2016 and could not guide it since then.

Tiangong-1 is one example of space debris that ended up coming back to Earth and burning up, just like most other debris that re-enters Earth’s atmosphere. That is not a bad thing.

But large quantities of space junk end up staying in various orbits around Earth, threatening satellites, the International Space Station (ISS), as well as future missions beyond Earth's vicinity – to asteroids, the Moon and Mars.

Somewhat similar to pieces of tyres that litter the highways on Earth, debris can be parts of old satellites, from paint chips, to bolts, larger sections, and entire defunct satellites; it can also include spent rocket bodies, the sections of rockets that don’t fall back to Earth after a rocket's launch. The total number of debris pieces larger than a marble counts more than half a million.

[photo omitted]

The key difference is that while it would be dangerous for your car to hit a piece of garbage on the highway at 100 km/h, in orbit, things are moving at the much faster speed of 28,000 km/h – the speed required by the laws of physics for objects to stay in orbit and not fall back to the ground.

At that speed, even a small bolt could destroy an entire satellite, or even endanger the entire Space Station. That is the reason why astronauts or cosmonauts on board the ISS have to huddle into the escape capsules several times a year, when a piece of debris is being tracked close to the Space Station. Currently only the Russian Soyuz offers a way of getting to and from the ISS for humans.

The most polluted orbits in general are considered to be those between 200-2000 km above Earth (Lower Earth Orbits or LEO), and the 36,000 km orbit (Geosynchronous).

This is a growing issue, which has become more widely known to the public through the movie ‘Gravity’.

Out-of-control space junk in LEO orbit – the so-called Kessler Syndrome – in real life would not be quite as dramatic as in the movie; however, it does pose a serious and an ever-growing threat, nonetheless.

There are two key elements to addressing this global risk.

First, we need to start removing the most volatile and biggest pieces from the most congested orbits.

A number of companies, such as Astroscale and Saber Astronautics, are looking at this very complicated and technical solution already. The idea is essentially to grab a piece of debris with a special satellite and de-orbit both of them, in the process burning up both objects above the aforementioned ‘spacecraft cemetery’.

Other technologies include moving objects with a powerful laser beam. It is important to start doing that soon – current scientific estimates predict that without active debris removal, certain orbits will become unusable over the coming decades.

Though it is hard to capture objects that are moving as fast as this debris, it is certainly possible. After all, spacecraft dock with the ISS all the time.

The bigger issues are financing and international cooperation. The question of who pays for these ‘garbage collection’ missions is a tricky one. Perhaps even trickier, is negotiating the international diplomatic space and persuading, for example Russia, that their old military satellite needs to be de-orbited by a technology company.

[photo omitted]

The second part of the puzzle to ensure the long-term accessibility of orbits is to adjust our current behaviour in space in order to minimize the creation of new debris. We need to be more careful with existing operational satellites and new missions.

The UN guidelines on space debris mitigation are among the key international efforts to get different actors to follow proper rules of the road, but they are voluntary.

There are over 1,500 active satellites in various orbits, but this figure is set to grow dramatically over the coming years.

Large constellations that number hundreds and thousands of satellites, such as OneWeb and SpaceX, are being developed currently (mostly for LEO orbits), and promise to provide affordable connectivity to all parts of the world.

New governments are also entering the race to get access to space. The question is, with such an increase in traffic, how do we get all the private and public actors to think more sustainably?

The [Global Future Council on Space Technologies](https://www.weforum.org/communities/the-future-of-space-technologies) is working on an industry framework to incentivize private actors to step up their act. Other efforts are needed.

Orbits are a critical part of the Earth environment, a global commons just like the oceans, and we need to protect this resource for future generations.

#### Ice particles solve ozone depletion

* Note: PSCs = polar stratospheric clouds

Nagase et al. 15 (H. Nagase, D. E. Kinnison, A. K. Petersen, F. Vitt, G. P. Brasseur, 3/30/15, American Geophysical Union, “Effects of injected ice particles in the lower stratosphere on the Antarctic ozone hole”, <https://doi.org/10.1002/2014EF000266>, Accessed 1/27/22, HKR-RKT)

In this study, it was found that the depth of the ozone hole could be significantly reduced by supplying ice to the Antarctic lower stratosphere in late fall (May) before heterogeneous reactions on the surface of natural PSC particles start to activate chlorine. If a sufficiently large amount of ice is injected under favorable conditions, it should remain during several days as ice, and could provide an uptake mechanism for HCl before the formation of PSCs and the activation of chlorine species, if the size of the particles is sufficiently large and sedimentation is sufficiently fast. Without any action, it will take about 40 years for the Antarctic ozone hole to disappear. During this period, the Antarctic region will continue to be exposed to UV-B, with potential impact on living organisms. The proposed approach, which supplies ice to the stratosphere, is designed to accelerate the recovery of ozone in the Antarctic without generating major side effects. Furthermore, because Antarctic ozone is projected to recover in the coming decades, the changes in tropospheric climate forced by ozone depletion in the last decades, specifically in the southern hemisphere, are likely to be reversed in the 21st century. The recovery of ozone may counteract on the tropospheric circulation change caused by increase of greenhouse gases [Son et al., 2008, 2010; Gillett and Son, 2012], and climate may therefore benefit from the proposed geo-engineering approach. It was also found that CFCs were transported upward by supplying ice, so that their atmospheric degradation may be accelerated under the proposed method. Thus, because CFCs are strong greenhouse gases, supplying ice may be useful for mitigation of global warming. The impact of injecting ice in the stratosphere on climate forcing and the related climate response needs to be further investigated, using comprehensive three-dimensional climate-chemistry models and investigate possible influences on the climate system over a long period.

## DA

#### Starlink funding key to colonization and a pre-requisite to communications networks in space

Crist 22 – [Ry, CNET, “Starlink explained: Everything you should know about Elon Musk's satellite internet venture,” 1/10/2022, https://www.cnet.com/home/internet/starlink-satellite-internet-explained/]

And don't forget that this is Elon Musk we're talking about. SpaceX is the only company on the planet with a landable, reusable rocket capable of delivering payload after payload into orbit. That's a mighty advantage in the commercial space race. On top of that, Musk said in 2018 that Starlink will help provide SpaceX with revenue needed to fund the company's long-held ambition to establish a base on Mars.

If that day arrives, it's also likely that SpaceX will try to establish a satellite constellation on the red planet, too. That means that Starlink customers are potentially doubling as guinea pigs for the Martian wireless networks of the future.

"If you send a million people to Mars, you better provide some way for them to communicate," Shotwell said in 2016, speaking about the company's long-term vision for Starlink. "I don't think the people who go to Mars are going to be satisfied with some terrible, old-fashioned radios. They'll want their iPhones or Androids on Mars."

As CNET's Jesse Orral noted in a recent video about Starlink, you'll even find hints of Musk's plans for Mars in the Starlink terms of service, which at one point reads:

"For services provided on Mars, or in transit to Mars via Starship or other colonization spacecraft, the parties recognize Mars as a free planet and that no Earth-based government has authority or sovereignty over Martian activities."

#### Colonization solves extinction

Drake '16 – a science journalist and contributing writer at National Geographic. She earned an A.B. in biology, psychology, and dance at Cornell University, worked in a clinical genetics lab at The Johns Hopkins University School of Medicine, then returned to Cornell for her Ph.D. in genetics and development. (Bynadia, "Elon Musk: A Million Humans Could Live on Mars By the 2060s," Science, 9-27-2016, https://www.nationalgeographic.com/science/article/elon-musk-spacex-exploring-mars-planets-space-science, Accessed 6-22-2021)

In perhaps the most eagerly anticipated aerospace announcement of the year, SpaceX founder Elon Musk has revealed his grand plan for establishing a human settlement on Mars. In short, Musk thinks it’s possible to begin shuttling thousands of people between Earth and our smaller, redder neighbor sometime within the next decade or so. And not too long after that—perhaps 40 or a hundred years later, Mars could be home to a self-sustaining colony of a million people. “This is not about everyone moving to Mars, this is about becoming multiplanetary,” he said on September 27 at the International Astronautical Congress in Guadalajara, Mexico. “This is really about minimizing existential risk and having a tremendous sense of adventure.” Musk’s timeline sounds ambitious, and that's something he readily acknowledges. “I think the technical outline of the plan is about right. He also didn’t pretend that it was going to be easy and that they were going to do it in ten years,” says Bobby Braun, NASA’s former chief technologist who’s now at Georgia Tech University. “I mean, who’s to say what’s possible in a hundred years?” And for those wondering whether we should go at all, the reason for Musk making Mars an imperative is simple. “The future of humanity is fundamentally going to bifurcate along one of two directions: Either we’re going to become a multiplanet species and a spacefaring civilization, or we’re going be stuck on one planet until some eventual extinction event,” Musk told Ron Howard during an interview for National Geographic Channel’s MARS, a global event series that premieres worldwide on November 14. “For me to be excited and inspired about the future, it’s got to be the first option. It’s got to be: We’re going to be a spacefaring civilization.” Mars Fleet Though he admitted his exact timeline is fuzzy, Musk thinks it’s possible humans could begin flying to Mars by the mid-2020s. And he thinks the plan for getting there will go something like this: It starts with a really big rocket, something at least 200 feet tall when fully assembled. In a simulation of what SpaceX calls its Interplanetary Transport System, a spacecraft loaded with astronauts will launch on top of a 39-foot-wide booster that produces a whopping 28 million pounds of thrust. Using 42 Raptor engines, the booster will accelerate the assemblage to 5,374 miles an hour. Overall, the whole thing is 3.5 times more powerful than NASA’s Saturn V, the biggest rocket built to date, which carried the Apollo missions to the moon. Perhaps not coincidentally, the SpaceX rocket would launch from the same pad, 39A, at Kennedy Space Center in Cape Canaveral, Florida. The rocket would deliver the crew capsule to orbit around Earth, then the booster would steer itself toward a soft landing back at the launch pad, a feat that SpaceX rocket boosters have been doing for almost a year now. Next, the booster would pick up a fuel tanker and carry that into orbit, where it would fuel the spaceship for its journey to Mars. Once en route, that spaceship would deploy solar panels to harvest energy from the sun and conserve valuable propellant for what promises to be an exciting landing on the Red Planet. As Musk envisions it, fleets of these crew-carrying capsules will remain in Earth orbit until a favorable planetary alignment brings the two planets close together—something that happens every 26 months. “We’d ultimately have upward of a thousand or more spaceships waiting in orbit. And so the Mars colonial fleet would depart en masse,” Musk says. The key to his plan is reusing the various spaceships as much as possible. “I just don’t think there’s any way to have a self-sustaining Mars base without reusability. I think this is really fundamental,” Musk says. “If wooden sailing ships in the old days were not reusable, I don’t think the United States would exist.” Musk anticipates being able to use each rocket booster a thousand times, each tanker a hundred times, and each spaceship 12 times. At the beginning, he imagines that maybe a hundred humans would be hitching a ride on each ship, with that number gradually increasing to more than 200. By his calculations, then, putting a million people on Mars could take anywhere from 40 to a hundred years after the first ship launches. And, no, it would not necessarily be a one-way trip: “I think it’s very important to give people the option of returning,” Musk says. Colonizing Mars After landing a few cargo-carrying spacecraft without people on Mars, starting with the Red Dragon capsule in 2018, Musk says the human phase of colonization could begin. For sure, landing a heavy craft on a planet with a thin atmosphere will be difficult. It was tough enough to gently lower NASA’s Curiosity rover to the surface, and at 2,000 pounds, that payload weighed just a fraction of Musk’s proposed vessels. For now, Musk plans to continue developing supersonic retrorockets that can gradually and gently lower a much heavier spacecraft to the Martian surface, using his reusable Falcon 9 boosters as a model. And that’s not all these spacecraft will need: Hurtling through the Martian atmosphere at supersonic speeds will test even the most heat-tolerant materials on Earth, so it’s no small task to design a spacecraft that can withstand a heated entry and propulsive landing—and then be refueled and sent back to Earth so it can start over again. The first journeys would primarily serve the purpose of delivering supplies and establishing a propellant depot on the Martian surface, a fuel reservoir that could be tapped into for return trips to Earth. After that depot is set up and cargo delivered to the surface, the fun can (sort of) begin. Early human settlers will need to be good at digging beneath the surface and dredging up buried ice, which will supply precious water and be used to make the cryo-methane propellant that will power the whole enterprise. As such, the earliest interplanetary spaceships would probably stay on Mars, and they would be carrying mostly cargo, fuel, and a small crew: “builders and fixers” who are “the hearty explorer type,” Musk said to Howard. “Are you prepared to die? If that’s OK, then you’re a candidate for going.” While there will undoubtedly be intense competition and lots of fanfare over the first few seats on a Mars-bound mission, Musk worries that too much emphasis will be placed on those early bootprints. “In the sort of grander historical context, what really matters is being able to send a large number of people, like tens of thousands if not hundreds of thousands of people, and ultimately millions of tons of cargo,” he says.

# Case

## Solvency

#### 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

## Collisions

#### Collisions are far off, so assume intervening actors solve and live to fight another day

#### No miscalc - Lack attribution means they have no one to retaliate against

Schwarzer et al ’19 [Daniela, Eva-Marie McCormack, and Torben Schutz; Director, Editor, and Associate Fellow in the Security, Defense, and Armaments Program at the German Council of Foreign Relations; Deutsche Gesellschaft fur Auswartige Politik, “Technology and Strategy: The Changing Security Environment in Space Demands New Diplomatic and Military Answers,” [https://www.ssoar.info/ssoar/bitstream/handle/document/63288/ssoar-2019-schutz-Technology\_and\_Strategy\_the\_Changing.pdf](https://www.ssoar.info/ssoar/bitstream/handle/document/63288/ssoar-2019-schutz-Technology_and_Strategy_the_Changing.pdf?sequence=1&isAllowed=y&lnkname=ssoar-2019-schutz-Technology_and_Strategy_the_Changing.pdf);]

However, even a (misinterpreted) threat to space assets could start a chain reaction and quickly escalate an incident in space to a wider war. Successful deterrence, therefore, requires situational awareness, attribution capabilities and resilient assets. Especially the latter two are notoriously difficult to achieve in space. While it might be easy to attribute a kinetic attack executed with a missile, the same is not true for ASAT attacks by other satellites, and, especially, not for cyberattacks and electronic warfare measures. Without clear attribution, however, it is difficult to deter any adversary, since he could speculate that an attack cannot be traced back to him – making deterrence and retaliation more difficult. Although cross-domain deterrence, i.e. threatening an actor through potential retaliation attacks on or by other-than-space assets, is always possible, it also amplifies the problems involved in traditional deterrence: A response has to be timely and proportionate, and it should not further expand of the conflict.

#### Even if there is miscalc, no one would escalate – official statements prove

Colby 16 (Elbridge, Senior Fellow at the Center for a New American Security, “From Sanctuary to Battlefield: A Framework for a U.S. Defense and Deterrence Strategy for Space”)SLAIR

But such a threat is of substantially decreasing credibility. In today’s much different context, no one really believes that a limited space attack would necessarily or even plausibly be a prelude to total nuclear war. Would the United States respond with a major strategic strike if China or Russia, in the context of a regional conflict with the United States, struck discriminately at implicated U.S. space assets in the attempt to defang U.S. power projection, all while leaving the broader U.S. space architecture alone? Not only does such a massive response seem unlikely – it would be positively foolish and irresponsible. Furthermore, would other nations regard attacks on assets the United States was actively employing for a local war as off limits to attack? Indeed, any reasonable observer would have to judge that such discriminate attacks on U.S. space assets would not necessarily be illegitimate, as, by the United States’ own admission, it relies greatly on its space architecture for conventional power projection. Moreover, official U.S. statements on how the United States would respond to attacks on its space assets – to the limited extent such statements exist and the degree to which those given are clear – offer no indication it would respond massively to such strikes.53 Perhaps more to the point, senior responsible U.S. officials have telegraphed that the United States would indeed not necessarily respond massively to attacks against its space assets.54 In light of these factors, any U.S. space deterrence strategy that is predicated on an all-or-nothing retaliation to space attacks will become increasingly incredible and thus decreasingly effective – and indeed might even invite an adversary’s challenge in order to puncture or degrade U.S. credibility. In other words, since space assets can increasingly be attacked segmentally and discriminately rather than totally, this means that credibly and effectively deterring such attacks requires a less than total response. Since the threat is more like a rapier than a broadsword, the United States needs rapier-like ripostes of its own. Accordingly, the United States Any U.S. space deterrence strategy that is predicated on an all-or-nothing retaliation to space attacks will become increasingly incredible and thus decreasingly effective. needs a more discriminate deterrent for space. In particular, it needs a flexible deterrent capable of meeting the intensifying challenge of deterring an adversary – and particularly a highly capable potential opponent like China or Russia – from attacking (or attacking to a sufficient degree) those U.S. space assets needed for the United States to effectively and decisively project power and ultimately prevail in a conflict in a distant theater. At the same time, this flexible deterrent must contribute to dissuading such an enemy from striking at the nation’s broader military and civilian space architecture, and in particular those core strategic space assets needed for central deterrence.

#### No card says cyber escalates – Falco is powertagged and just says China and Russia could attack satellites, but no ev that ever goes beyond small-scale attacks

#### Cyberattacks can’t scale up and the grids are resilient – their authors are hacks

* Threat can’t be scaled up because of sheer complexity
* US power plants have been resilient to attacks and have become more effectively resilient over time
* Threat is overblown- tons of news articles rely on misinformation and hype to sell to readers
* Power plants are isolated from the internet and extremely decentralized
* Russia is only attempting reconnaissance and has no incentive to attack
* Attacks only last a few hours because of backup generators

Wagenseil 3/11/19[Paul Wagenseil, Senior Editor of security and privacy @ Tom’s Guide, Citing Selena Larson, intelligence analyst @ Dragos Cybersecurity Firm, “Hackers Can't Cause Crippling Blackouts, Expert Says”, https://www.tomsguide.com/us/blackout-hack-threat-rsa2019,news-29594.html]

SAN FRANCISCO — Don't believe the hype. Hackers cannot easily take down the North American electrical grid to cause massive blackouts, despite numerous news stories, magazine articles and books claiming that they can, a cybersecurity expert told the last week's RSA Conference.

"There are lots of misunderstandings about threats to the electric grid," said Selena Larson, an intelligence analyst at Maryland cybersecurity firm Dragos and a former CNN reporter. "The reality is that a destructive incident at one site would require highly tailored [malware] tools and operations, and would not effectively scale."

That's because U.S. power plants use different makes and models of hardware and software, are often at least partly isolated from the internet and from each other, and have already undergone a fair degree of hardening against cyberattacks. There's very little chance that a single hacker or group of hackers could knock out the power

across a large swath of North America at once.

Scary headlines

Those inconvenient facts haven't prevented journalists and writers from penning what Larson deemed needlessly alarming stories. One July 2018 opinion piece in The New York Times entitled "To Hackers, We're Bambi in the Woods" began with a nightmare scenario of an America thrown back to the Stone Age by a cyberattack that kills the power, stops the trains, empties bank accounts and opens literal floodgates.

Later that same month, The Wall Street Journal ran a story called "Russian Hackers Reach U.S. Utility Control Rooms, Homeland Security Officials Say," lending credence to the nightmare scenario. But it was incorrectly reported — it was based on old information that had been revisited in a DHS presentation.

Larson didn't mention "Lights Out: A Cyberattack, A Nation Unprepared, Surviving the Aftermath," a best-selling 2015 book by former ABC News anchor Ted Koppel.

"A well-designed attack on just one of the nation's three electric power grids could cripple much of our infrastructure — and in the age of cyberwarfare, a laptop has become the only necessary weapon," reads the jacket blurb following another apocalyptic scenario of a months-long blackout leading to societal collapse.

State-sponsored attacks

The truth is that Russian hackers do try to get into American power plants, but so far they've only seemed to be performing reconnaissance, Larson said. Destructive malware has infected the office networks of some power companies, but the companies weren't specifically targeted, and the malware didn't cross over into plant operations.

"A ransomware infection at the financial-services division of an electric utility doesn't automatically translate to a blackout," Larson said.

While most state-sponsored hacker groups targeting power plants and other industrial-control systems only gather information, two other have gone further, Larson said. Those were the Electrum group, which used malware dubbed CrashOverride to take down a Ukrainian power plant in 2016, and the Trisis group, which infected the safety systems at a Saudi petrochemical plant in 2017.

Both attacks have been attributed to Russian state-sponsored hackers, and the Saudi-plant attack led another presenter at RSA 2019 to conclude that cyberattacks would soon kill people, either deliberately or accidentally.

But as Dragos founder and CEO Robert M. Lee stated in a 2017 blog posting describing the CrashOverride malware, "the public must understand that the outages could be in hours or days, not weeks or months."

Lee said that Dragos had "high confidence" that the CrashOverride hackers were the same who had in fact targeted U.S. and European infrastructure companies in 2014. And CrashOverride contained modules to "delete files and processes off of the running systems" to sabotage computer systems.

Larson said, however, that the CrashOverride creators had spent months or years planning the attack, and that the malware was specifically designed for that power plant. The attacks couldn't easily scale across the world, or even across Ukraine.

Outlook

There are true cyberattack threats out there, Larson added. For example, the Russian NotPetya ransomware worm in June 2017 cost the Maersk shipping line an estimated $200 million, and FedEx an estimated $300 million. The North Korean WannaCry attack the previous month crippled hospital computer systems in Europe and North America.

But in terms of the North American power grid, small animals such as squirrels, cats and raccoons are a much larger threat than hackers, and have caused hundreds of localized blackouts, Larson said. That mundane detail doesn't sell books.

The public should be reassured, she added, that the North American power grid (there are in fact three grids) has always been engineered to limit both the duration and the geographic reach of blackouts, and that there's no single power switch that can turn it all off.

"The truth is that the North American electric grid is resilient and segmented," Larson said.

#### Commercial megaconstellations solve communication deserts and intel shortages – that’s key to military dominance and forward deployment in the Arctic, East Asia, and Eastern Europe. Independently, it solves missile threats to precision strike systems. That solves the advantage and broader readiness

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-AM)

The emergence of proliferated constellations will lead to easier access to satellite communications, space imagery, and other capabilities that can support U.S. and adversary military operations in the ground, maritime, and air domains. Adapting to these changes will likely require the development of new joint operational concepts to better exploit space systems in support of the joint fight as well as address new force protection challenges when fighting space-enabled state and nonstate actors. Proliferated constellations will substantially increase the availability of communications bandwidth for military operations. These satellites would provide high bandwidth to forces with less latency than existing GEO satellites,32 which, in turn, would improve access to reachback communications to forward-deployed military forces, and would also help meet the growing demand for transfer capacity for data collected by unmanned systems and other forward sensors. Proliferated LEO communications constellations would also offer coverage in theaters that are poorly served by commercial satellite communications today. Satellites in GEO do not sufficiently support operations in the Arctic and other high-latitude regions that are growing in economic and national security importance.33 Similarly, naval and air forces operating in the Pacific theater have less access to commercial communications than other theaters due to the lack of commercial customers in the open ocean. Proliferated commercial LEO constellations would provide greater communications handling in both regions because of their global coverage. While unable to provide the high-resolution imagery and other specialized capabilities of existing national security satellites, proliferated LEO constellations could help to address some of the intelligence challenges the U.S. military faces. During the first Gulf War, the United States was unable to track and target Iraq’s Scud missile systems despite enjoying almost total air superiority. Since then, mobile missiles and other elusive targets have multiplied as potential adversaries seek to defeat U.S. conventional precision and nuclear strike systems. Imagery proliferated constellations could provide continuous or near-continuous coverage of missile operating areas to better enable the United States to find and eliminate these threat systems. The near continuous imagery coverage proliferated constellations offers—particularly if they include radar satellites that can see through clouds— combined with ground processing capabilities that can automatically detect changes in imagery would also make adversary deception operations less effective.34 Because the United States is likely to be on the defensive in the most worrying scenarios for conflict—such as defending allies in Eastern Europe or East Asia—these new capabilities will support U.S. efforts to detect adversary mobilization and to avoid operational surprise.

#### Readiness solves nuclear war

Binnendijk 16 (Hans Binnendijk, Ph.D. in international affairs, Tufts University, senior fellow at the Center for Transatlantic Relations at SAIS, “Friends, Foes, and Future Directions: U.S. Partnerships in a Turbulent World Strategic Rethink,” Santa Monica, CA: RAND Corporation, 2016)

Today, the most important external challenge faced by the United States is the reemergence of potential confrontation between great powers and with rogue states. The United States now faces a risk of conflict with several potential adversaries: Four are nation-states with nuclear weapons or nuclear ambitions (Russia, China, North Korea, and Iran) and one is a diverse group of Salafi jihadists. Currently, the United States is engaged in military action against a wannabe state, the Islamic State of Iraq and Syria (ISIS).1 Most of these potential adversaries also cooperate with at least one other hostile nation, compounding the challenge for the United States. This is a fundamental change from the previous decade, when the focus of U.S. national security policy was on two stability operations in the greater Middle East, nonstate actors, and transnational threats. Those threats still exist, but a new set of challenges from nuclear states and nuclear aspirants is of greater concern. There are dramatic differences among these potential adversaries in terms of their ability to threaten vital U.S. interests and the extent to which their goals overlap with Washington’s. As a result, the United States must design a set of flexible and differentiated policies to deal with each potential foe. The overall goal should be to reduce these threats and the prospect of close cooperation among adversaries to challenge U.S. interests. To do this, the United States needs to quickly defeat ISIS, deter North Korea, dissuade Russia, constrain Iran, and engage China. These potential adversaries have created situations in which a large number of U.S. allies and partner nations are more vulnerable today than they were a decade ago. Many U.S. friends are in more danger than the United States is itself, and if the United States should be drawn into conflict with any of these adversaries (as it has already been drawn into conflict with ISIS), it will probably be to defend its partners more than itself. The principal risk to the United States is that conflicts with any of these adversaries could escalate. Involvement by the three nuclear powers (Russia, China, or—to a lesser degree— North Korea) could pose existential risks. While its partners remain a major U.S. asset that its adversaries do not enjoy to the same degree, many of those partnerships do present problems. Many partners are only slowly waking up to these changing international circumstances and have not yet taken up an adequate share of the global defense burden. Some partners do not fully share many of the United States’ values or interests and require flexibility in the relationship. And the most-vulnerable partners will need to work more closely with the United States to coordinate policies and crisis management plans in advance so that the United States will not be drawn into unforeseen conflict against its will. As the United States prepares to deal with adversaries and to help defend partners, it is at risk of becoming overextended. U.S. national security resources are shrinking as its challenges are expanding. U.S. engagement with friends and foes alike, therefore, must reconcile this potential mismatch between resources and requirements, and between means and ends.

## Ozone

#### 1] Ozone shot now, Chemicals take Decades to dissipate, and the major problem is agricultural copper not space

Sanders 1-14 [Robert Sanders,, 1-14-2022, "Copper-based chemicals may be contributing to ozone depletion," phys.org, https://phys.org/news/2022-01-copper-based-chemicals-contributing-ozone-depletion.html]

Earth's ozone layer is critical to protecting us from cancer-causing ultraviolet light from the sun, but chemicals containing chlorine and bromine—such as CFCs and halons—were found in the 1980s to destroy the ozone, creating thinner layers in the stratosphere that let in more of the dangerous radiation. Despite a ban on production of CFCs and halons, the major sources of halogens, the ozone layer has yet to repair itself. Last year, the hole in the ozone over Antarctica was about as bad as it's ever been, Rhew said.

Ozone-destroying chemicals take decades to dissipate

The persistence of the ozone hole is, for the most part, due to the persistence of banned ozone-depleting compounds, which take decades to dissipate in the stratosphere. But some ozone-depleting chemicals are still being emitted. Even some replacements for banned refrigerants are coming under scrutiny.

Among the major contributors today are methyl chloride and methyl bromide. One atom of bromine is 50 times more destructive to ozone than one atom of chlorine.

Though methyl bromide is banned for use as an agricultural soil fumigant, it is still used as a pesticide for quarantine and pre-shipment of agricultural products. And methyl chloride is used as a chemical feedstock, although most of its emissions are believed to be from biomass burning or natural in origin. But the total amount of these methyl halides produced each year still do not add up to the observed yearly addition of these chemicals to the atmosphere, a fact that has puzzled scientists for more than 20 years.

About one-third of the methyl bromide and methyl chloride in the atmosphere comes from unknown sources, Rhew said. The new findings suggest that copper is an important, if not the major, source of the missing methyl bromide and methyl chloride.

"We've banned methyl bromide, but are other changes that we're making in the environment causing large emissions of this compound into the atmosphere? With the increase in the use of copper, it appears that copper-catalyzed production is an increasing source, as well," Rhew said.

First author and former UC Berkeley doctoral student Yi Jiao, now a postdoctoral fellow at the University of Copenhagen in Denmark, noted that copper compounds are allowed on organic crops, a legacy of its use in farming since the 1700s, including as a major antifungal agent in the Bourdeax mixture used since the 1880s in France to prevent downy mildew on grapes. Copper contamination of soils is a major issue today in Europe because of this history. The ozone-depleting power of copper is another cause for concern, the authors said.

"Please note that organic agriculture is not a major cause for ozone depletion. However, copper-based fungicides appear to have atmospheric side effects that might be considered in terms of overall environmental impact," Jiao tweeted this week. "With widespread use of copper in the environment, this potentially growing impact should be considered when predicting future halogen load and ozone recovery."

## Astronomy

#### They have not read an internal link –

#### they have 0 evidence that astronomy solves asteroids or is key to detection – warning systems and telescopes solve, and no reason more innovation is key

#### Independently, even if its key to detection, no card says that causes deflection

#### Crucially, there’s also no card deflection is even possible! Or that it solves!

#### No card says constellations ruin astronomy, just that they make it harder – but Grush says the effects are contained and small adaptations in telescope design solve – Harker inserts blue – that’s good to check against irresponsible ev pratices

Grush 20 “The true impact of SpaceX’s Starlink constellation on astronomy is coming into focus” Loren Grush [science reporter for The Verge] Mar 24, 2020 <https://www.theverge.com/2020/3/24/21190273/spacex-starlink-satellite-internet-constellation-astronomy-coating> SM

As for what that means for these astronomy fields, one obvious concern is that a potentially hazardous asteroid could go unnoticed until it’s too late to act appropriately. It’s also possible observers will have to take expensive countermeasures to get the kinds of images they want. “It may mean you have to observe twice as long, if you have to throw away half your data,” says McDowell. “So that’s expensive. Or you may need to make changes to your telescope design, to stop reflections from a satellite.”

The silver lining here, at least, is that McDowell’s study found that Starlink may not really have a big effect on a lot of other astronomers’ work, especially those who only look at small slices of the night sky for certain periods of time. But his work does fly in the face of what SpaceX CEO Elon Musk has said about Starlink and its astronomy repercussions. “I am confident that we will not cause any impact whatsoever in astronomical discoveries. Zero,” Musk said during a space conference at the beginning of March. “That’s my prediction. And we’ll take corrective action if it’s above zero.”

#### James Webb proves non-uq – can still observe and gather data with constellations

#### Nuclear plants are resilient

* New reactor technology is resilient
* NERC concluded shut downs for power plants are possible during a major EMP event

Conca 19 [James Conca, pHd, expert on energy, nuclear and dirty bombs, a planetary geologist, and a professional speaker, “Can Nuclear Power Plants Resist Attacks Of Electromagnetic Pulse (EMP)?”, 1/3/19, <https://www.forbes.com/sites/jamesconca/2019/01/03/can-nuclear-power-plants-resist-attacks-of-electromagnetic-pulse-emp/#689dec8270cb>]

Yes. Specifically, the small modular nuclear reactor company, NuScale, out of Oregon, has made their reactor resistant to electromagnetic pulses (EMP) and most other reactor designs should follow.

EMPs are one of those things that many people think is fake, or over-blown, or a conspiracy theorist’s dream. But they are real. EMPs can be either natural, from things like extreme solar geomagnetic disturbances, or man-made like a large thermonuclear detonation or a cyberattack. If they are coordinated with physical attacks then things can get real dicey real fast.

As the U.S. Commission to Assess the Threat to the United States from EMP Attack points out, “the physical and social fabric of the United States is sustained by a system of systems - a complex and dynamic network of interlocking and interdependent infrastructures whose harmonious functioning enables the myriad actions, transactions, and information flow that undergird the orderly conduct of civil society.”

According to the Commission, EMP effects represent arguably the largest-scale common-cause failure events that could affect our electric power grid and undermine our society, leaving it vulnerable on many fronts. High-voltage control cables and large transformers that control the grid are particularly vulnerable. Transformers weigh 400 tons, take two years to build, and cost $7 million apiece. We are already way behind in having backup transformers ready, so if many go out at once, we have a big problem powering our country.

So can we do anything about it?

The phenomenon of a large electromagnetic pulse is not new. The first human-caused EMP occurred in 1962 when the 1.4 megaton Starfish Prime thermonuclear weapon detonated 400 km above the Pacific Ocean.

One hundred times bigger than what we dropped on Hiroshima, Starfish Prime resulted in an EMP which caused electrical damage nearly 900 miles away in Hawaii. It knocked out about 300 streetlights, set off numerous burglar alarms, and damaged a telephone company microwave link that shut down telephone calls from Kauai to the other Hawaiian islands.

And that was from 900 miles away.

On the natural side, in 1989, an unexpected geomagnetic storm triggered an event on the Hydro-Québec power system that resulted in its complete collapse within 92 seconds, leaving six million customers without power. The storm resulted from the Sun ejecting a trillion-cubic-mile plume of superheated plasma, or ionized gas.

It took two days for this cloud to smash into the Earth’s magnetosphere overwhelming its normal ability to throw off charged cosmic particles, triggering hundreds of incidents across the globe and causing undulating, multicolored auroras to spread as far south as Texas and Cuba.

Such storms occur every 60 years or so, and in 1989, we weren't anywhere near as electrified and electronically interconnected as we are today, or as we will be in 30 years.

This is the most likely EMP to occur.

A new 2018 study by the U.S. Air Force Electromagnetic Defense Task Force addresses direct EMP threats to the United States and its allies. While some issues have existed for decades, the window of opportunity to mitigate some of these threats is closing. Meanwhile, many existing threats have gained prominence because of the almost universal integration of vulnerable silica-based technologies into all aspects of modern technology and society.

In 2008, the Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack made a compelling case for protecting critical infrastructures against EMP and solar geomagnetic disturbances. To avert long term outages, the U.S. must assure the availability of survivable power sources with long-term, readily accessible and continuous fuel supplies to blackstart the grid, sustain emergency life-support services, and reconstitute local, state, and national infrastructures. Long term outages are defined as the interruption of electricity for months to years over large geographic regions.

An eye-level point-of-view rendering from inside the NuScale plant visitor’s center looking toward the plant facilities. The plant design guards against EMPs, meltdowns and cyberattacks, and can provide energy continuously through any disaster.NUSCALE

The Nuclear Regulatory Commission tracks this issue closely, and has been examining these issues for more than 30 years, starting in the late 1970s when the agency studied how EMP could affect nuclear power plant safe-shutdown systems. The agency concluded as recently as two years ago that nuclear power plants can safely shut down following an EMP event. NRC drafted a rule last year on maintaining key plant safety functions after a severe event, particularly on how to keep spent fuel pools cool.

#### 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.