**1NC**

**T**

**1NC – Appropriation**

**Interp and violation: Affirmatives may not defend that specific instances of outer space appropriation by private entities are unjust.**

**"The" can either indicate a definite generic or definite description**

**Ojeda 91** [Almerindo E. Ojeda, PhD linguistics from UChicago, professor of linguistics at UC Davis. "Definite Descriptions and Definite Generics", Linguistics and Philosophy, Vol. 14, No. 4, pp. 367-397, Published August 1991, https://www.harvardlds.org/wp-content/uploads/2019/04/1-s2.0-S0010027718300313-main-3.pdf] HWIC

A definite noun phrase may be taken either as a definite description or as a definite generic. Thus, a noun phrase like the origin of the ballad may denote either the origin of an individual ballad we have been discussing, or else the origin of ballads in general as a literary species. In the first case, the ballad has been taken as a definite description; in the second, it has been taken as a definite generic.2 Notice that the ambiguity between definite descriptions and definite generics can be resolved in certain con texts. Thus, the definite noun phrase the computer is taken only as a definite description in (**la**), a statement about an individual computer; it is taken only as a definite generic in (lb), a statement about computers in general. Similarly, the definite noun phrase the dodo may be taken as a definite description in (2a) while it must be taken as a definite generic in (2b).3

**(1)a. Turing repaired the computer.**

**b. Turing invented the computer.**

(2)a. The dodo is dead.

b. The dodo is extinct.

**The resolution is a definite generic – "appropriation" isn't a countable noun, you can't have "one appropriation" which means the res can only be referring to appropriation in general.**

**Negate –**

**1] Precision – They agreed to debate the topic when they came to the tournament and it’s the only stasis point we know before the round – controls the internal link to engagement and there’s no way to use ground if debaters aren’t prepared to defend it.**

**2] Limits – every combination of instances of appropriation could be an aff like individual missions, programs or satellites – unlimited topics incentivize obscure affs that negs won’t have prep on – limits are key to reciprocal prep burden**

**Drop the debater and competing interps – T is a question of norms and we indict their advocacy**

**PIC**

**1NC – REMs**

**Plan: The appropriation of outer space through asteroid mining by private entities, except those in the United States, should be banned.**

**The PIC is key to beat China and protect against Chinese REM gatekeeping**

Stavridis 21 [(James, retired US Navy admiral, chief international diplomacy and national security analyst for NBC News, senior fellow at JHU Applied Physics Library, PhD in Law and Diplomacy from Tufts) “U.S. Needs a Strong Defense Against China’s Rare-Earth Weapon,” Bloomberg Opinion, March 4, 2021, <https://www.bloomberg.com/opinion/articles/2021-03-04/u-s-needs-a-strong-defense-against-china-s-rare-earth-weapon>] TDI

You could be forgiven if you are confused about what’s going on with rare-earth elements. On the one hand, news reports indicate that China may increase production quotas of the minerals this quarter as a [goodwill gesture](https://www.scmp.com/news/china/diplomacy/article/3122501/china-raises-rare-earth-quotas-goodwill-trade-signal-us) to the Joe Biden administration. But other sources say that China may ultimately ban the export of the rare earths altogether on “[security concerns](https://www.bloomberg.com/news/articles/2021-02-19/china-may-ban-rare-earth-technology-exports-on-security-concerns?sref=QYxyklwO).” What’s really going on here?

There are 17 elements considered [rare earths](https://www.bloomberg.com/news/articles/2021-02-16/why-rare-earths-are-achilles-heal-for-europe-u-s-quicktake) — lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, scandium and yttrium — and while many aren’t actually rare in terms of global deposits, extracting them is difficult and expensive. They are used across high-tech manufacturing, including smartphones, fighter aircraft and components in virtually all advanced electronics. Of particular note, they are essential to many of the clean-energy technologies expected to come online in this decade.

I began to focus on rare-earth elements when I commanded the North Atlantic Treaty Organization’s presence in Afghanistan, known as the International Security Assistance Force. While Afghans live in an extremely poor country, [studies](https://thediplomat.com/2020/02/afghanistans-mineral-resources-are-a-lost-opportunity-and-a-threat/) have assessed that they sit atop $1 trillion to $3 trillion in a wide variety of minerals, including rare earths. Some [estimates](https://www.fraserinstitute.org/article/afghanistans-rare-earth-element-bonanza) put the rare-earth levels alone at 1.4 million metric tons.

But every time I tried to visit a mining facility, the answer I got from my security team was, “It’s too dangerous right now, admiral.” Unfortunately, despite a great deal of effort by the U.S. and NATO, those security challenges remain, deterring the large foreign-capital investments necessary to harvest the lodes. Which brings us back to Beijing.

China controls roughly 80% of the rare-earths market, between what it mines itself and processes in raw material from elsewhere. If it decided to wield the weapon of restricting the supply — something it has repeatedly [threatened](https://www.wsj.com/articles/china-trade-fight-raises-specter-of-rare-earth-shortage-11559304000) to do — it would create a significant challenge for manufacturers and a geopolitical predicament for the industrialized world.

It could happen. In 2010, Beijing threatened to cut off exports to Japan over the disputed Senkaku Islands. Two years ago, Beijing was reportedly considering restrictions on exports to the U.S. generally, as well as against specific companies (such as defense giant Lockheed Martin Corp.) that it deemed in violation of its policies against selling advanced weapons to Taiwan.

President Donald Trump’s administration issued an executive order to spur the production of rare earths domestically, and created an [Energy Resource Governance Initiative](https://www.state.gov/wp-content/uploads/2019/06/Energy-Resource-Governance-Initiative-ERGI-Fact-Sheet.pdf) to promote international mining. The European Union and Japan, among others, are also aggressively seeking newer sources of rare earths.

Given this tension, it was superficially surprising that China announced it would boost its mining quotas in the first quarter of 2021 by nearly 30%, reflecting a continuation in strong (and rising) demand. But the increase occurs under a shadow of uncertainty, as the Chinese Communist Party is undertaking a “review” of its policies concerning future sales of rare earths. In all probability, the tactics of the increase are temporary, and fit within a larger strategy.

China will go to great lengths to maintain overall control of the global rare-earths supply. This fits neatly within the geo-economic approach of the [One Belt, One Road](https://www.bloomberg.com/opinion/articles/2019-10-30/china-is-determined-to-reshape-the-globe) initiative, which seeks to use a variety of carrots and sticks — economic, trade, diplomatic and security — to create zones of influence globally. In terms of rare earths, the strategy seems to be allowing carefully calibrated access to the elements at a level that makes it economically less attractive for competitors to undertake costly exploration and mining operations. This is similar to the oil-market strategy used by Russia and the Organization of Petroleum Exporting Countries for decades.

Some free-market advocates believe that China will not take aggressive action choking off supply because that could [precipitate retaliation](https://www.bloomberg.com/opinion/articles/2021-02-22/china-weaponizing-rare-earths-technology-will-probably-backfire) or accelerate the search for alternate sources in global markets. What seems more likely is a series of targeted shutdowns directed against specific entities such as U.S. defense companies, Japanese consumer electronics makers, or European industrial concerns that have offended Beijing.

The path to rare-earth independence for the U.S. must include: Ensuring supply chains of rare earths necessary for national security; promoting the exploitation of the elements domestically (and removing barriers to responsibly doing so); mandating that defense contractors and other critical-infrastructure entities wean themselves off Chinese rare earths; sponsoring research and development to find alternative materials, especially for clean energy technology; and creating a substantial stockpile of the elements in case of a Chinese boycott.

This is a bipartisan agenda. The Trump administration’s [strategic assessment](https://www.commerce.gov/news/press-releases/2019/06/department-commerce-releases-report-critical-minerals) of what needs to be done (which goes beyond just 17 rare earths to include a total of 35 critical minerals) is thoughtful, and should serve as a basis for the Biden administration and Congress.

**REM access key to military primacy and tech advancement – alternatives fail**

Trigaux 12 (David, University Honors Program University of South Florida St. Petersburg) “The US, China and Rare Earth Metals: The Future Of Green Technology, Military Tech, and a Potential Achilles‟ Heel to American Hegemony,” USF St. Petersberg, May 2, 2012, <https://digital.stpetersburg.usf.edu/cgi/viewcontent.cgi?article=1132&context=honorstheses>] TDI

The implications of a rare earth shortage aren’t strictly related to the environment, and energy dependence, but have distinct military implications as well that could threaten the position of the United States world’s strongest military. The United States place in the world was assured by powerful and decisive deployments in World War One and World War Two. Our military expansion was built upon a large, powerful industrial base that created more, better weapons of war for our soldiers. During the World Wars, a well-organized draft that sent millions of men into battle in a short amount of time proved decisive, but as the war ended, and soldiers drafted into service returned to civilian life, the U.S. technological superiority over its opponents provided it with sustained dominance over its enemies, even as the numerical size of the army declined. New technologies, such as the use of the airplane in combat, rocket launched missiles, radar systems, and later, GPS, precision guided missiles, missile defense systems, high tech tanks, lasers, and other technologies now make the difference between victory and defeat.

The United States military now serves many important functions, deterring threats across the world. The United States projects its power internationally, through a network of bases and allied nations. Thus, the United States is a powerful player in all regions of the world, and often serves as a buffer against conflict in these regions. US military presence serves as a buffer against Chinese military modernization in Eastern Asia, against an increasingly nationalist Russia in Europe, and smaller regional actors, such as Venezuela in South America and Iran in the Middle East. The U.S. Navy is deployed all over the world, as the guarantor of international maritime trade routes. The US Navy leads action against challenges to its maritime sovereignty on the other side of the globe, such as current action against Somali piracy. Presence in regions across the world prevents escalation of potential crisis. These could result in either a larger power fighting a smaller nation or nations (Russia and Georgia, Taiwan and China), religious opponents (Israel and Iran), or traditional foes (Ethiopia and Eretria, Venezuela and Colombia, India and Pakistan). US projection is also key deterring emerging threats such as terrorism and nuclear proliferation. While not direct challenges to US primacy, both terrorism and nuclear proliferation can kill thousands.

The US Air Force has a commanding lead over the rest of the world, in terms of both numbers and capabilities. American ground forces have few peers, and are unmatched in their ability to deploy to anywhere in the world at an equally unmatched pace.

The only perceived challenge to the United States militarily comes from the People’s Republic of China.76 While the United States outspends all other nations in the world put together in terms of military spending, China follows as a close second, and has begun an extensive modernization program to boot.77 The Chinese military however, is several decades behind the United States in air power and nuclear capabilities.78 To compensate, China has begun the construction of access-denial technology, preventing the US from exercising its dominance in China’s sphere of influence.79 Chinese modernization efforts have a serious long-term advantage over the United States; access to rare earth metals, and a large concentration of rare earth chemists doing research.80 This advantage, coupled with the U.S. losing access to rare earth metals, will even the odds much quicker than policymakers had previously anticipated. 81

The largest example is US airpower. With every successive generation of military aircraft, the U.S. Air Force becomes more and more dependent on Rare Earth Metals.82 As planes get faster and faster, they have to get lighter and lighter, while adding weight from extra computers and other features on board.83 To lighten the weight of the plane, scandium is used to produce lightweight aluminum alloys for the body of the plane. Rare Earth metals are also useful in fighter jet engines, and fuel cells.84 For example, rare earths are required to producing miniaturized fins, and samarium is required to build the motors for the F-35 fighter jet.85 F-35 jets are the next generation fighter jet that works together to form the dual plane combination that cements U.S. dominance in air power over the Russian PAK FA.86

Rare earth shortages don’t just affect air power, also compromising the navigation system of Abrams Tanks, which need samarium cobalt magnets. The Abrams Tank is the primary offensive mechanized vehicle in the U.S. arsenal. The Aegis Spy 1 Radar also uses samarium.87 Many naval ships require neodymium. Hell Fire missiles, satellites, night vision goggles, avionics, and precision guided munitions all require rare earth metals. 88

American military superiority is based on technological advancement that outstrips the rest of the world. Command and control technology allows the U.S. to fight multiple wars at once and maintain readiness for other issues, as well as have overwhelming force against rising challengers. This technology helps the U.S. know who, where, and what is going to attack them, and respond effectively, regardless of the source of the threat.

Rare Earth Elements make this technological superiority possible.

To make matters worse, the defense industrial base is often a single market industry, dependent on government contracts for its business. If China tightens the export quotas further, major US defense contractors will be in trouble.89 Every sector of the defense industrial base is dependent on rare earth metals. Without rare earths, these contractors can’t build anything, which collapses the industry.90

Rare Earth shortages are actually already affecting our military, with shortages of lanthanum, cerium, europium and gadolinium happening in the status quo. This prevents us not only from building the next generation of high tech weaponry, but also from constructing more of the weapons and munitions that are needed in the status quo. As current weapon systems age and they can’t be replaced, the US primacy will be undermined. Of special concern is that U.S. domestic mining doesn’t produce “heavy” rare earth metals that are needed for many advanced components of military technologies. Given the nature of many military applications, substitutions aren’t possible. 91

**Primacy and allied commitments solve arms races and great power war – unipolarity is sustainable, and prevents power vacuums and global escalation**

Brands 18 [(Hal, Henry Kissinger Distinguished Professor at Johns Hopkins University's School of Advanced International Studies and a senior fellow at the Center for Strategic and Budgetary Assessments) "American Grand Strategy in the Age of Trump," Page 129-133]

Since World War II, the United States has had a military **second to none**. Since the Cold War, America has **committed** to having **overwhelming military primacy**. The idea, as George W. Bush declared in 2002, that America must possess “strengths beyond challenge” has featured in every major U.S. strategy document for a quarter century; it has also been reflected in concrete terms.6

From the early 1990s, for example, the United **S**tates consistently accounted for around 35 to 45 percent of world defense spending and maintained **peerless global power-projection capabilities**.7 Perhaps more important, U.S. primacy was also unrivaled in key overseas **strategic regions**—**Europe, East Asia, the Middle East**. From **thrashing Saddam** Hussein’s million-man Iraqi military during Operation Desert Storm, to deploying—with impunity—two carrier strike groups off Taiwan during the China-Taiwan crisis of 1995– 96, Washington has been able to project military power **superior** to anything a **regional rival** could employ even **on its own geopolitical doorstep.**

This **military dominance** has constituted the **hard-power backbone** of an ambitious global strategy. After the Cold War, U.S. policymakers committed to averting a return to the **unstable multipolarity** of earlier eras, and to perpetuating the more favorable unipolar order. They committed to building on the successes of the postwar era by further advancing **liberal political values** and an open international **economy**, and to **suppressing** international scourges such as **rogue states**, **nuclear proliferation**, and catastrophic **terrorism**. And because they recognized that military force remained the ultima ratio regum, they understood the **centrality** of military preponderance.

Washington would **need** the **military power** necessary to **underwrite** worldwide **alliance commitments**. It would have to preserve **substantial overmatch** versus any potential **great-power rival.** It must be able to answer the sharpest challenges to the international system, such as Saddam’s invasion of Kuwait in 1990 or jihadist extremism after 9/11. Finally, because prevailing global **norms** generally reflect **hard-power realities**, America would need the superiority to assure that its own **values remained ascendant**. It was impolitic to say that U.S. strategy and the international order required “**strengths beyond challenge**,” but it was not at all inaccurate.

American primacy, moreover, was eminently affordable. At the height of the Cold War, the United States spent over 12 percent of GDP on defense. Since the mid-1990s, the number has usually been between 3 and 4 percent.8 In a historically favorable international environment, Washington could enjoy primacy—and its geopolitical fruits—on the cheap.

Yet U.S. strategy also heeded, at least until recently, the fact that there was a limit to how cheaply that primacy could be had. The American military did shrink significantly during the 1990s, but U.S. officials understood that if Washington cut back too far, its primacy would erode to a point where it ceased to deliver its geopolitical benefits. **Alliances** would **lose credibility**; the stability of key **regions** would be **eroded**; **rivals would be emboldened**; **international crises would go unaddressed**. American primacy was thus like a **reasonably priced insurance policy**. It required nontrivial expenditures, but protected against far costlier outcomes.9 Washington paid its insurance premiums for two decades after the Cold War. But more recently American primacy and strategic solvency have been imperiled.

THE DARKENING HORIZON For most of the post–Cold War era, the international system was— by historical standards—remarkably benign. Dangers existed, and as the terrorist attacks of September 11, 2001, demonstrated, they could manifest with horrific effect. But for two decades after the Soviet collapse, the world was characterized by **remarkably low levels of great-power competition,** high levels of **security** in key theaters such as **Europe** and **East Asia**, and the **comparative weakness** of those “**rogue” actors**—Iran, Iraq, North Korea, al-Qaeda—who most aggressively challenged American power. During the 1990s, some observers even spoke of a “strategic pause,” the idea being that the end of the Cold War had afforded the United States a respite from normal levels of geopolitical danger and competition. Now, however, **the strategic horizon is darkening**, due to four factors.

First, **great-power military competition is back**. The world’s two leading authoritarian powers—**China** and **Russia**—are seeking **regional hegemony**, contesting global norms such as nonaggression and freedom of navigation, and developing the **military punch** to underwrite these ambitions. Notwithstanding severe economic and demographic problems, Russia has conducted a major military **modernization** emphasizing **nuclear weapons**, high-end conventional capabilities, and rapid-deployment and special operations forces— and utilized many of these capabilities in conflicts in Ukraine and Syria.10 China, meanwhile, has carried out a **buildup of historic proportions,** with constant-dollar defense outlays rising from US$26 billion in 1995 to US$226 billion in 2016.11 Ominously, these expenditures have funded development of **power-projection** and antiaccess/area denial (A2/**AD) tools** necessary to threaten China’s neighbors and complicate U.S. intervention on their behalf. Washington has grown accustomed to having a generational military lead; Russian and Chinese modernization efforts are now creating a **far more competitive environment.**

**Pursuit inevitable---decline causes global war**

**Beckley 15** (Michael Beckley is a research fellow in the International Security Program at Harvard Kennedy School’s Belfer Center for Science and International Affairs., “The Myth of Entangling Alliances Michael Beckley Reassessing the Security Risks of U.S. Defense Pacts”, <http://live.belfercenter.org/files/IS3904_pp007-048.pdf>)

The finding that U.S. entanglement is rare **has important implications for international relations scholarship** and U.S. foreign policy. For scholars, **it casts doubt on classic theories of imperial overstretch** in which great powers exhaust their resources by accumulating allies that free ride on their protection and embroil them in military quagmires.22 The U.S. experience instead suggests that **great powers can dictate the terms of their security commitments and that allies often help their great power protectors avoid strategic overextension.**

For policy, the rarity of U.S. entanglement suggests that the United States’ current grand strategy of deep engagement, which is centered on a network of standing alliances, does not preclude, and may even facilitate, U.S. **military restraint**. Since 1945 the United States has been, by some measures, the most militarily active state in the world. The most egregious cases of U.S. overreach, however, **have stemmed not from entangling** alliances, but from the penchant of American leaders **to define national interests expansively**, to overestimate the magnitude of foreign threats, and to underestimate the costs of military intervention. Scrapping alliances will not correct these bad habits. In fact, disengaging from alliances may unleash the **U**nited **S**tates **to intervene recklessly** abroad while **leaving it without partners** to share the burden **when those interventions go awry**.

**Case**

**Solvency**

**Presume neg – "Optional Protocol" means states have to opt in – they have zero evidence that states will do that – they said add, not opt in or ratify**

**UNICEF ND** ["Strengthening the Convention on the Rights of the Child: Optional Protocols." Accessed 1-28-2022, https://www.unicef.org/child-rights-convention/strengthening-convention-optional-protocols] HWIC

Optional Protocols complement and add to existing treaties. A protocol may be on any topic relevant to the original treaty and is used either to further address something in the original treaty, address a new or emerging concern or add a procedure for the operation and enforcement of the treaty.

They are ‘optional’ because the obligations may be more demanding than those in the original convention, so States must independently choose whether or not to be bound by them. Optional Protocols are treaties in their own right, and are open to signature, ratification or accession.

**Even though the OST doesn’t bind private entities, governments are already responsible for NGO actions in space – proves they don't care**

**Eijk 20** [Cristian van Eijk is finishing an accelerated BA in Law at the University of Cambridge. He holds a BA cum laude in International Justice and an LLM in Public International Law from Leiden University, and has previously worked at the T.M.C. Asser Institute and the International Commission on Missing Persons. “Sorry, Elon: Mars is not a legal vacuum – and it’s not yours, either.” Voelkerrechtsblog. May 11, 2020. <https://voelkerrechtsblog.org/sorry-elon-mars-is-not-a-legal-vacuum-and-its-not-yours-either/>] HW AL

Two provisions of the Outer Space Treaty (OST), both also customary, are particularly relevant here. OST article II: “Outer 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.” OST article III: “States… shall carry on activities in the exploration and use of outer space, including (…) celestial bodies, in accordance with international law”. SpaceX is a private entity, and is not bound by the Outer Space Treaty – but that does not mean it can opt out. Its actions in space could have consequences for the United States in three ways. First, the US, as SpaceX’s launch state, bears fault-based liability for injury or damage SpaceX’s space objects cause to other states’ persons or property (OST article VII, Liability Convention articles I, III). Second, the US, as SpaceX’s state of registry, is the sole state that retains jurisdiction and control over SpaceX objects (OST article VIII, Registration Convention article II). Both refer to objects in space and are irrelevant. According to article VI OST, States “bear international responsibility for national activities in outer space”, including Mars, including those by “non-governmental entities”. The US, as SpaceX’s state of incorporation, must authorise and continuously supervise SpaceX’s actions in space to ensure compliance with the OST (OST article VI) and international law (OST article III). In practice, this task is done by the US Federal Communications Commission, which licenses and regulates SpaceX. Article VI OST sets a specific rule of attribution, supplementing the customary rules of state responsibility (Stubbe 2017, pp. 85-104). SpaceX acts with US authorisation, and its conduct in space within and beyond that authorisation is attributable to the US (ARSIWA articles 5, 7). In the absence of circumstances precluding wrongfulness, the result is straightforward. If SpaceX breaches a US obligation under international law, the US bears responsibility for an internationally wrongful act.

**Turns**

**Loss of satellites shuts down drones**

Daniel **Ventre 11**, Engineer for CNRS and Researcher for CESDIP, Cyberwar and Information Warfare, p. 198-199

The introduction of cyberspace operations is part of a specific context; a major evolution in the operation environment and the nature of the conflicts, which make irregular wars the rule, and make regular actors the exception to the rule. But the battle against unconventional, non-state governed, irregular actors raises specific problems: there are multiple actors, unpredictable at that, who do not abide by the same rules. New orders in conflicts are imposing the implementation of an ever more important need for information, and information collection and processing. Networks now have an **incredible importance**. The document refers to the growing threats against American heritage: the USA is a target and the increasing amount of attacks against their networks is indeed the proof of this. There are many obstacles which need to be removed before they can achieve real superiority and freedom to act, especially as vulnerable points may originate within the very operations of the armed forces. An example of this is the vulnerability of using products (software and hardware), commercial products (off-the-shelf), and sometimes even foreign products123. This brings to mind the fact that the US Air Force uses commercial, even foreign, applications for its cyberspace operations.

Information space extends to space124, particularly via communication and observation satellites125. Satellites are the keystone to the cyberspace and communication systems, but also the security system: monitoring (Echelon network is the symbol), observation, communication. These are at the heart of the C4ISR systems, without which a concept such as network-centric warfare could not exist. **There would be no drones without satellites**. It is even a question of extending the Internet to extra-atmospheric space. Projects in this vein (Interplanetary Networks) were being formed in the 1990s, but ran into several technical difficulties (delays in important transmissions due to high distances and costs) [GEL 06]. NASA dedicates a few pages on its website to this project126. The development of communication systems based on the infrastructures in extra-atmospheric space will also raise questions for legal, geopolitical and geostrategic domains: questions of seizing this space, questions of regulation of human activity in this space, of sovereignty, new territoriality and independence.

**Otherwise drone prolif causes global nuclear war**

Dr. Michael C. **Horowitz 19**, Professor of Political Science at University of Pennsylvania, NDT Champion from Emory University, PhD in Government from Harvard University, Adjunct Senior Fellow at the Center for a New American Security, “When Speed Kills: Autonomous Weapon Systems, Deterrence, and Stability”, 5/2/2019, https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=3348356

Thus, the reason to deploy autonomous systems would have to be their reliability and effectiveness rather than signaling. And giving up human control to algorithms in a crisis that could end with **global nuclear war** would require an extremely high level of perceived reliability and effectiveness. Few things are more important to militaries in crisis situations than informational awareness and control over decisions, and there might be fear that autonomous systems are prone to **accidents**.

This counterfactual illustrates that the development and deployment of lethal autonomous weapon systems by national militaries, if it occurs, is unlikely to have simple, easy, and linear consequences. Instead, human factors, including the psychological desire for control and organizational politics, will strongly shape how militaries think about developing and using LAWS. This will not just influence the potential for arms races in peacetime, but deterrence and wartime stability due to the organizational processes militaries implement for the deployment and use of autonomous systems on the battlefield.

This paper draws on research in strategic studies and examples from military history to assess how LAWS could influence the development and deployment of military systems, including **arms races**, **crisis stability**, and wartime stability, especially the risk of **escalation**. It also discusses the potential for arms control. It focuses on these questions through the lens of key characteristics of LAWS, especially the potential for increased operational speed and, simultaneously, less human control over battlefield choices. One of the primary attractions of autonomous systems, even compared to remotely piloted systems, is the potential to operate at machine speed. Another potential benefit is the possibility of machine-like accuracy in following programming, but that comes with a potential downside: the loss of control and the accompanying risk of **accidents**, adversarial **spoofing**, and **miscalculation**. Even if LAWS malfunction at the same rate as humans in a given scenario, the ability of operators to control the impact of those malfunctions may be lower, which could make LAWS less predictable on the battlefield. The paper then examines how these issues interact with the large uncertainty parameter associated with AI-based military capabilities at present, both in terms of the range of the possible and the opacity of their programming.

The results highlight several critical issues surrounding the development and deployment of LAWS.1 First, the desire to fight at machine speed with autonomous systems, while making a military more effective in a conflict, could increase **crisis instability**. As countries fear losing conflicts faster, it will generate **escalation pressure**, including an increased incentive for **first strikes**. Second, in addition to the actual risk of accidents and miscalculation from LAWS, the fear of accidents and losing control of autonomous systems could limit the willingness of militaries to deploy them, particularly since many militaries are conservative when it comes to emerging technologies and have high standards for system reliability. Third, the dual-use, or even general purpose, character of the basic science underlying many autonomous systems will make the technology hard to control, giving many countries and actors access to basic algorithms, though whether this is described as diffusion, proliferation, or an arms race will depend on political dynamics as much as anything.

Finally, multiple uncertainty parameters concerning lethal autonomous weapon systems could exacerbate **security dilemmas**.

Uncertainty over the range of the possible concerning the programming of lethal autonomous weapon systems will increase fear of those systems in the near term, making restraint less likely for competitive reasons. Moreover, the inherent differences between remotely piloted systems and LAWS at the platform level come from software, not hardware. There is arguably an inherent opacity to lethal autonomous weapon systems. If an arms race over lethal autonomous weapon systems occurs, it will likely be because of worse-case assumptions about capability development by potential adversaries.

What is Autonomy or Artificial Intelligence?

Artificial intelligence is the use of computing power, in the form of algorithms, to conduct tasks that previously required human intelligence.2 Artificial intelligence in this context is best thought of as an umbrella technology or enabler, like the combustion engine or electricity. Military applications of artificial intelligence are potentially broad – from image recognition for surveillance to more efficient logistics to battle management.3 These include both non-kinetic applications, including in the cyber realm, as well as kinetic applications.4 One potential application of artificial intelligence is through armed autonomous systems that could be deployed on the battlefield, or what are most popularly called lethal autonomous weapon systems or lethal autonomous weapon systems. This differs from remotely-piloted systems where a human, though at a distance, still operates a given vehicle or system.

What is a lethal autonomous weapon system? While simple to describe on first glance, and easy to understand in the extreme – an armed humanoid robot with extremely broad programming making decisions about engaging in warfare – drawing the line between a lethal autonomous weapon system and other weapon systems is complex. In Directive 3000.09, published in 2012, the US Department of Defense defines an autonomous weapon as “A weapon system that, once activated, can select and engage targets without further intervention by a human operator.”5 What it means to select and engage a target is not entirely clear, however. For example, homing munitions, which have existed since World War II, select and engage targets, according to a common sense understanding of the terms.6

Exactly what functions are autonomous also matters. A system could have automatic piloting, for example, that flies or drives a platform to a target, but still have complete human control over the use of the weapon. That would be a system with a high level of automation, though not a lethal autonomous weapon system according to most perspectives. Heather Roff measures the level of autonomy in a weapon system based on three subcomponents: self-mobility, self-direction, and self-determination. This helps distinguish systems where there might be autonomy concerning the best way a missile should get to a target, but the target itself is designated by a person fromsystems where an algorithm might be making higher-level engagement decisions.7 There are already some applications of limited machine autonomy in military systems, with the most prominent example being the automatic mode present on many Close-In Weapon Systems (CIWS), such as the Phalanx, used to defend ships and incoming missiles from attack.8

This article will not resolve the definitional debate surrounding lethal autonomous weapon systems, which is still ongoing in meetings of the Group of Governmental Experts focused on lethal autonomous weapon systems in the United Nations Convention on Certain Conventional Weapons. Provisionally, this article adopts the Scharre and Horowitz definition that a lethal autonomous weapon system is “[A] weapon system that, once activated, is intended to select and engage targets where a human has not decided those specific targets are to be engaged.”9 However, moving beyond the close cases (e.g. particular types of missile guidance systems) and considering those weapon systems that clearly use machine intelligence to search for, select, and/or engage targets can help clarify what is at stake in this debate in the first place.10 After all, if most militaries most of the time would not have any need for lethal autonomous weapon systems, or those systems have significant disadvantages relative to remotely-piloted military robotics or soldiers on the battlefield, the stakes are lower. In contrast, if the integration of machine intelligence with military systems could give countries or violent non-state actors a significant advantage in how they employ force, it becomes even more crucial to engage the topic.

It is important to note that this article does not address concerns about existential risk related to artificial general intelligence – the fear that a superintelligence could decide to destroy the human race, either because it decides humans are malign or because humans program it to achieve a goal it can only accomplish by destroying humans.11 The existential risk issue associated with artificial intelligence is not necessarily closely coupled to military applications of artificial intelligence. If a super-intelligent machine learning system has the ability to take over human society in the interest of a goal – any goal – whether autonomous systems at much smaller orders of magnitude already exist in military systems will likely be unimportant. The super-intelligent system would simply create what it needed.

Why Invest in Autonomous Systems?

Militaries are already increasing their investments in remotely-piloted robotic systems. From UAVs such as the MQ-9 Reaper (**U**nited **S**tates) to uninhabited surface vehicles (USVs) such as the Guardium (**Israel**) to uninhabited ground vehicles (UGV) such as Platform-M (**Russia**), militaries **around the world** are investing in remotely piloted platforms, some of which can carry weapons. In these systems, human control over the use of force is not fundamentally different from the use of force with inhabited systems. In some cases, such as the MQ-9 Reaper, the sensor system a drone pilot uses to launch a weapon might even be the same sensor system a pilot in the cockpit of an inhabited fighter uses. Using remotely piloted systems gives militaries the ability to reduce the risk to their own soldiers while still projecting power in similar ways to how they used force previously.12 The first places militaries are likely to use kinetic lethal autonomous weapon systems include relatively “clear” environments such as air-to-air combat or naval combat, especially in geographic arenas where civilians are extremely unlikely to be present.13

**Climate solutions rely on REMs**

Arrobas et al 17 [(Daniele La Porta Arrobas is a senior mining specialist with the World Bank based in Washington DC and has degrees in Geoscience and Environmental Management, Kirsten Hund is a senior mining specialist with the Energy and Extractives Global Practice of the World Bank and holds a Master’s in IR from the University of Groningen in the Netherlands, Michael Stephen McCormick, Jagabanta Ningthoujam has an MA in international economics and international development from JHU and a BS in MechE from Natl University of Singapore, John Drexhage also works at the Intl Institute for Sustainable Development) “The Growing Role of Minerals and Metals for a Low Carbon Future,” World Bank, June 30, 2017, <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/207371500386458722/the-growing-role-of-minerals-and-metals-for-a-low-carbon-future>] TDI

* Full report - https://documents1.worldbank.org/curated/en/207371500386458722/pdf/117581-WP-P159838-PUBLIC-ClimateSmartMiningJuly.pdf

Climate and greenhouse gas (GHG) scenarios have typically paid scant attention to the metal implications necessary to realize a low/zero carbon future. The 2015 Paris Agreement on Climate Change indicates a global resolve to embark on development patterns that would significantly be less GHG intensive. One might assume that nonrenewable resource development and use will also need to decline in a carbon-constrained future. This report tests that assumption, identifies those commodities implicated in such a scenario and explores ramifications for relevant resource-rich developing countries. Using wind, solar, and energy storage batteries as proxies, the study examines which metals will likely rise in demand to be able to deliver on a carbon-constrained future. Metals which could see a growing market include aluminum (including its key constituent, bauxite), cobalt, copper, iron ore, lead, lithium, nickel, manganese, the platinum group of metals, rare earth metals including cadmium, molybdenum, neodymium, and indium—silver, steel, titanium and zinc. The report then maps production and reserve levels of relevant metals globally, focusing on implications for resource-rich developing countries. It concludes by identifying critical research gaps and suggestions for future work.

**Warming causes extinction – a confluence of nonlinear and unpredictable effects will make human and natural systems inhospitable while increasing escalatory conflicts – even if the impacts are far off, only drastic action now solves**

**Melton 19** [Michelle Melton is a 3L at Harvard Law School. Before law school, she was an associate fellow in the Energy and National Security Program at the Center for Strategic and International Studies, where she focused on climate policy. Climate Change and National Security, Part II: How Big a Threat is the Climate? January 7, 2019. https://www.lawfareblog.com/climate-change-and-national-security-part-ii-how-big-threat-climate]

At least until 2050, and possibly for decades after, climate change will remain a **creeping threat** that will **exacerbate and amplify** existing, **structural** global **inequalities**. While the developed world will be negatively affected by climate change through 2050, the consequences of climate change will be felt most acutely in the developing world. The national security threats posed by climate change to 2050 are likely to differ in degree, not kind, from the kinds of threats already posed by climate change. For the next few decades, climate change will **exacerbate humanitarian crises**—some of which will result in the deployment of **military personnel**, as well as material and financial assistance. It will also **aggravate** natural **resource constraints**, potentially contributing to political and economic **conflict** over **water**, **food** and **energy**. The question for the next 30 years is not “can humanity survive as a species with 1.5°C or 2°C of warming,” but, “how much will the existing disparities between the developed and developing world widen, and how long (and how successfully) can these widening political/economic disparities be sustained?” The urgency of the climate threat in the next few decades will depend, to a large degree, on whether and how much the U.S. government perceives a widening of these global inequities as a threat to U.S. national security. By contrast, if emissions continue to **creep upward** (or if they do not decline rapidly), by 2100 climate-related national security threats could be **existential**. The question for the next hundred years is not, “are disparities politically and economically manageable?” but, “can the **global order**, premised on the **nation-state system**, itself based on territorial sovereignty, **survive** in a world in which **substantial swathes of territory** are potentially **uninhabitable**?” National Security Consequences of Climate Change to 2050 Scientists can predict the consequences of climate change to 2050 with some measure of certainty. (Beyond that date, the pace and magnitude of climate change—and therefore, the national security threat posed by it—depend heavily on the level of emissions in the coming years, as I have explained.) There is relative agreement across modeled climate scenarios that the world will likely warm, on average, at least 1.5°C above pre-industrial levels by about 2050—but perhaps as soon as 2030. This level of warming is likely to occur even if the world succeeds in dramatically reducing greenhouse gas emissions, as even the recent Intergovernmental Panel on Climate Change (IPCC) report implicitly admits. In other words, a certain amount of additional warming—at least 1.5°C, and probably more than that—is presumptively unavoidable. Looking ahead to 2050, it can be said with relative confidence that the national security consequences of climate change will vary in degree, not in kind, from the national security threats already facing the United States. This is hardly good news. Even **small differences** in global average **temperatures** result in **significant environmental changes**, with attendant **social**, **economic** and **political consequences**. By 2050, climate change will **wreak increasing havoc** on **human** and **natural systems**—predominantly, but not exclusively, in the developing world—with attenuated but **profound consequences** for **national security**. In particular, changes in **temperature**, the **hydrological cycle** and the **ranges of insects** will impact **food availability** and food access in much of the world, increasing food insecurity. **Storms**, **flooding**, **changes in ocean pH** and other climate-linked changes will damage **infrastructure** and negatively impact **labor productivity** and economic **growth** in much of the world. Vector-borne **diseases** will also become **more prevalent**, as climate change will expand the geographic **range** and **intensity** of **transmission** of diseases like malaria, West Nile, Zika and dengue fever, and cholera. Rising **public health challenges**, **economic devastation** and **food insecurity** will translate into an increased **demand** for **humanitarian assistance** provided by the **military**, increased **migration**—especially from tropical and subtropical regions—and **geopolitical conflict**. Long-term trends such as declining food security, coupled with short-term events like hurricanes, could sustain unprecedented levels of migration. The 2015 refugee crisis in Europe portends the kinds of population movements that will only accelerate in the coming decades: people from Africa, Southwest and South Asia and elsewhere crossing land and water to reach Europe. For the United States, this likely means greater numbers of people seeking entry from both Central America and the Caribbean. Such influxes are not unprecedented, but they are unlikely to abate and could increase in volume over the next few decades, driven in part by climate change-related food insecurity, climate change-related storms and also by economic and political instability. Food insecurity, economic losses and loss of human life are also likely to exacerbate existing political tensions in the developing world, especially in regions with poor governance and/or where the climate is particularly vulnerable to warming (e.g., the Mediterranean basin). While the Arab Spring had many underlying causes, it also coincided with a period of high food prices, which arguably contributed to the protests. In some situations, **food insecurity**, **economic losses** and **public health crises**, combined with **weak** and ineffectual **governance**, could **precipitate future conflicts** of this kind—although it will be difficult to know where and when without more precise local studies of both underlying political dynamics and the regionally-specific impacts of climate change. 2100 and Beyond While the national security impacts of climate change to 2050 are likely to be costly and disruptive for the U.S. military—and devastating for many people around the world—at some point after 2050, if warming continues at its current pace, changes to the climate could **fundamentally reshape geopolitics** and possibly even the current nation-state basis of the current global order. To be clear, both the ultimate level of warming and its attendant political consequences is highly speculative, for the reasons I explained in my last post. Nonetheless, we do know that the planet is currently on track for at least 3-4°C of warming by 2100. The “known knowns” of higher levels of warming—say, 3°C—are frightening. At that 3°C of warming, for example, scientists project that there will be a nearly **70 percent decline** in **wheat** production in **Central America** and the Caribbean, **75 percent** of the **land area** in the **Mid**dle **East** and more than 50 percent in South Asia will be affected by highly unusual heat, and **sea level rise** could **displace** and imperil the lives **hundreds of millions** of people, among other consequences. But even higher levels of warming are physically possible within this century. At these levels of warming, some **regions of the world** would be **literally uninhabitable**, likely resulting in the depopulation of the tropics, to say nothing of the consequences of **sea-level rise** for **economically important cities** such as Amsterdam and New York. Even if newly warmed regions of the far north could **theoretically accommodate** the resulting **migrants**, this **presumes** that the **political response** to this unprecedented **global displacement** would be **orderly** and **conflict-free** **borders on fantasy**. The geopolitical consequences of significant levels of warming are severe, but if these changes occur in a linear way, at least there will be time for human systems to adjust. Perhaps more challenging for national security is the possibility that the until-now **linear changes give way** to **abrupt** and **irreversible ones**. Scientists forecast that, at higher levels of warming—precisely what level is speculative—humanity could trigger **catastrophic**, **abrupt** and **unavoidable consequences** to the **ecosystem**. The IPCC has considered **nine** such abrupt changes; one example is the potential **shutting down** of the **Indian summer monsoon**. Over a **billion** people are **dependent** upon the Indian monsoon, which provides parts of South Asia with about 80 percent of its annual rainfall; relatively minor changes in the monsoon in either direction can cause disasters. In 2010, a wetter monsoon led to the catastrophic flooding in Pakistan, which directly affected 20 million people; a drier monsoon in 2002 led to devastating drought. Studies suggest that the Indian summer monsoon has two stable states: wet (i.e., the current state) and dry (characterized by low precipitation over the subcontinent). At some point, if warming continues, the monsoon could abruptly shift into the second, “dry” state, with catastrophic consequences for over a billion people dependent on monsoon-fed agriculture. The IPCC suggests that such a state-shift is “unlikely”—that is, there is a 10 to 33 percent chance that a state-shift will happen in the 21st century—but scientists also have relatively low confidence in their understanding of the underlying mechanisms in this and other large-scale natural systems. The consequences of abrupt, severe warming for national security are obvious in general, if unclear in the specifics. In 2003, the Defense Department asked a contractor to explore such a scenario. The resulting report outlined the offensive and defensive national security strategies countries may adopt if faced with abrupt climate change, and highlighted the **increased risk** of inter- and intra-state **conflict** over natural **resources** and **immigration**. Although the report may be off in its imagined timeframe (positing abrupt climate change by 2020), the world it conjures is improbable but not outlandish. If the Indian monsoon were to switch to dry state, and a billion people were suddenly without reliable food sources, for example, it is not clear how the Indian government would react, assuming it would survive in its current form. Major wars or low-intensity proxy conflicts seem likely, if not inevitable, in such a scenario. This is not to say that a parade of climate horribles is certain—or even likely—to come to pass. Scientific understanding of the sensitivities in the climate system are far from perfect. It is also possible that emissions will decline more rapidly than anticipated, averting the worst consequences of climate change. But this outcome is far from guaranteed. And even if global emissions decline precipitously, humanity cannot be sure when or whether the planet has crossed a climate tipping point beyond which the incremental nature of the current changes shifts from the current linear, gradual progression to a non-linear and abrupt process. Within the next few decades, the most likely scenario involves manageable, but costly, consequences on infrastructure, food security and natural disasters, which will be borne primarily by the world’s most impoverished citizens and the members of the military who provide them with humanitarian assistance and disaster relief. But **while** the head-turning national security **impacts** of climate change are **probably** several **decades away**, the **nature of the threat** is such that **waiting until** these **changes manifest** is **not a viable option**. By the time the climate consequences are severe enough to compel action, there is likely to be little that can be done on human timescales to undo the changes to **environmental systems** and the **human societies dependent upon them**.

**Space War**

**No private key warrant, drive for resource extraction / interstate tensions inev – 1ac ev cites things like space force, artemis accords (which were signed by 10 states to encourage private space mining) and russia/china joint lunar base which prove govts also have interest in space appropriation**

**Risk/reward stuff doesn't make sense –**

**No space war – attributability checks escalation**

**Pavur 19** [James, DPhil Researcher at the Cybersecurity Centre for Doctoral Training at Oxford University, and Ivan Martinovic, Professor of Computer Science in the Department of Computer Science at Oxford University, “The Cyber-ASAT: On the Impact of Cyber Weapons in Outer Space”, 2019 11th International Conference on Cyber Conflict: Silent Battle, <https://ccdcoe.org/uploads/2019/06/Art_12_The-Cyber-ASAT.pdf>]

A. Limited Accessibility Space is difficult. Over 60 years have passed since the first Sputnik launch and only nine countries (ten including the EU) have orbital launch capabilities. Moreover, a launch programme alone does not guarantee the **resources** and **precision required** to **operate a meaningful ASAT capability**. Given this, one possible reason why **space wars have not broken out** is simply because only the US has ever had the ability to fight one [21, p. 402], [22, pp. 419–420]. Although launch technology may become cheaper and easier, it is unclear to what extent these advances will be distributed among presently non-spacefaring nations. **Limited access to orbit** necessarily reduces the scenarios which could plausibly escalate to ASAT usage. Only major conflicts between the handful of states with ‘space club’ membership could be considered possible flashpoints. Even then, the **fragility of an attacker’s own space assets** creates **de-escalatory pressures** due to the **deterrent effect of retaliation**. Since the earliest days of the space race, dominant powers have recognized this dynamic and demonstrated an inclination **towards de-escalatory space strategies** [23]. B. Attributable Norms There also exists a **long-standing normative framework** favouring the **peaceful use of space**. The effectiveness of this regime, centred around the Outer Space Treaty (**OST**), is highly contentious and many have pointed out its serious legal and political shortcomings [24]–[26]. Nevertheless, this status quo framework has somehow supported over **six decades of relative peace** in orbit. Over these six decades, **norms have become deeply ingrained** into the way states describe and perceive space weaponization. This de facto codification was dramatically demonstrated in 2005 when the US found itself on the short end of a 160-1 UN vote after opposing a non-binding resolution on space weaponization. Although states have occasionally pushed the boundaries of these norms, this has typically occurred through incremental legal re-interpretation rather than outright opposition [27]. Even the most notable incidents, such as the 2007-2008 US and Chinese ASAT demonstrations, were couched in rhetoric from both the norm violators and defenders, depicting space as a peaceful global commons [27, p. 56]. Altogether, this suggests that **states perceive real costs** to breaking this normative tradition and may even **moderate their behaviours** accordingly. One further factor supporting this norms regime is the **high degree of attributability** surrounding ASAT weapons. For kinetic ASAT technology, **plausible deniability** and **stealth** are essentially **impossible**. The literally explosive act of launching a rocket cannot evade detection and, if used offensively, retaliation. This imposes **high diplomatic costs** on ASAT usage and testing, particularly during peacetime. C. Environmental Interdependence A third stabilizing force relates to the **orbital debris consequences** of ASATs. China’s 2007 ASAT demonstration was the largest debris-generating event in history, as the targeted satellite dissipated into thousands of dangerous debris particles [28, p. 4]. Since debris particles are indiscriminate and unpredictable, they often threaten the attacker’s own space assets [22, p. 420]. This is compounded by Kessler syndrome, a phenomenon whereby orbital debris ‘breeds’ as large pieces of debris collide and disintegrate. As space debris remains in orbit for hundreds of years, the **cascade effect** of an ASAT attack can constrain the attacker’s long-term use of space [29, pp. 295– 296]. Any state with kinetic ASAT capabilities will likely also operate satellites of its own, and they are necessarily exposed to this collateral damage threat. Space debris thus acts as a strong strategic deterrent to ASAT usage.

**Collisions**

**Space debris creates existential deterrence and a taboo**

Bowen 18 [(Bleddyn, lecturer in International Relations at the University of Leicester) “The Art of Space Deterrence,” European Leadership Network, February 20, 2018, https://www.europeanleadershipnetwork.org/commentary/the-art-of-space-deterrence/] TDI

Fourth, the ubiquity of space infrastructure and the fragility of the space environment may create a degree of existential deterrence. As space is so useful to modern economies and military forces, a large-scale disruption of space infrastructure may be so intuitively escalatory to decision-makers that there may be a natural caution against a wholesale assault on a state’s entire space capabilities because the consequences of doing so approach the mentalities of total war, or nuclear responses if a society begins tearing itself apart because of the collapse of optimised energy grids and just-in-time supply chains. In addition, the problem of space debris and the political-legal hurdles to conducting debris clean-up operations mean that even a handful of explosive events in space can render a region of Earth orbit unusable for everyone. This could caution a country like China from excessive kinetic intercept missions because its own military and economy is increasingly reliant on outer space, but perhaps not a country like North Korea which does not rely on space. The usefulness, sensitivity, and fragility of space may have some existential deterrent effect. China’s catastrophic anti-satellite weapons test in 2007 is a valuable lesson for all on the potentially devastating effect of kinetic warfare in orbit.

**Alt cause – broad space privatization and existing debris.**

**Muelhapt et al 19** [(Theodore J., Center for Orbital and Reentry Debris Studies, Center for Space Policy and Strategy, The Aerospace Corporation, 30 year Space Systems Analyst and Operator, Marlon E. Sorge, Jamie Morin, Robert S. Wilson), “Space traffic management in the new space era,” Journal of Space Safety Engineering, 6/18/19, https://doi.org/10.1016/j.jsse.2019.05.007] TDI

The last decade has seen rapid growth and change in the space industry, and an explosion of commercial and private activity. Terms like NewSpace or democratized space are often used to describe this global trend to develop faster and cheaper access to space, **distinct from more traditional government-driven activities** focused on security, political, or scientific activities. The easier access to space has opened participation to many more participants than was historically possible. This new activity could profoundly worsen the space debris environment, particularly in low Earth orbit (**LEO**), but there are also signs of progress and the outlook is encouraging. Many NewSpace operators are actively working to mitigate their impact. Nevertheless, NewSpace represents a significant break with past experience and business as usual will not work in this changed environment. New standards, space policy, and licensing approaches are powerful levers that can shape the future of operations and the debris environment.

2. Characterizing NewSpace: a step change in the space environment

In just the last few years, commercial companies have proposed, funded, and in a few cases begun deployment of very large constellations of small to medium-sized satellites. These constellations will add much more complexity to space operations. Table 1 shows some of the constellations that have been announced for launch in the next decade. Two dozen companies, when taken together, have proposed placing well over ~~20,000~~ [twenty thousand] satellites in orbit in the next ~~10~~ [10]years. For perspective, fewer than ~~8100~~[eight thousand one hundred] payloads have been placed in Earth orbit in the entire history of the space age, only 4800 [1] remain in orbit and approximately 1950 [2] of those are still active. And it isn't simply numbers – the mass in orbit will increase substantially, and long-term debris generation is strongly correlated with mass.

[Table 1 Omitted]

This table is in constant flux. It is based largely on U.S. filings with the Federal Communications Commission (FCC) and various press releases, but many of the companies here have already altered or abandoned their original plans, and new systems are no doubt in work. Although many of these large constellations may never be launched as listed, the **traffic created if just half are successful would be more than double the number of payloads launched in the last 60 years and more than 6 times the number of currently active satellites.**

Current space safety, space surveillance, collision avoidance (COLA) and debris mitigation processes have been designed for and have evolved with the current population profile, launch rates and density of LEO space.

By almost **any metric** used to measure activity in space, whether it is payloads in orbit, the size of constellations, the rate of launches, the economic stakes, the potential for debris creation, the number of conjunctions, NewSpace represents a **fundamental change.**

3. Compounding effects of better SSA, more satellites, and new operational concepts

The changes in the space environment can be seen on this figurative map of low Earth orbit. Fig. 1 shows the LEO environment as a function of altitude. The number of objects found in each 10 km “bin” is plotted on the horizontal axis, while the altitude is plotted vertically. Objects in elliptical orbits are distributed between bins as partial objects proportional to the time spent in each bin. Some notable resident systems are indicated in blue text on the right to provide an altitude reference. The (dotted) red line shows the number of objects in the current catalog tracked by the U.S. Space Surveillance Network (SSN). All the COLA alerts and actions that must be taken by the residents are due to their neighbors in the nearby bins, so the currently visible risk is proportional to the red line.

The red line of the current catalog does not represent the complete risk; it indicates the risk we can track and perhaps avoid. A rule of thumb is that the current SSN LEO catalog contains objects about 10 cm or larger. It is generally accepted that an impact in LEO with an object 1 cm or larger will cause damage likely to be fatal to a satellite's mission. Therefore, there is a large latent risk from unobserved debris. While we cannot currently track and catalog much smaller than 10 cm, experiments have been performed to detect and sample much smaller objects and statistically model the population at this size [3]. The (solid) blue line represents the model of the 1 cm and larger debris that is likely mission-ending, usually called lethal but not trackable. If LEO operators avoid collisions with all the objects in the red line, they are nonetheless inherently accepting the risk from the blue line. This risk is already present.

The (dashed) orange line is an estimate of the population at 5 cm and larger and is thus an estimate of what the catalog might conservatively be a few years after the Space Fence, a new radar system being built by the Air Force, comes on line (currently planned for 2019) [4]. Commercial companies offering space surveillance services, such as LeoLabs, ExoAnalytics, Analytic Graphics Inc., Lockheed, and Boeing, might also add to the number of objects currently tracked. Space Policy Directive 3 (SPD-3) [13] specifically seeks to expand the use of commercial SSA services.

Existing operators can expect a sharp increase in the number of warnings and alerts they will receive because of the increase in the cataloged population. Almost all the increase will come from newly detected debris [5].

The pace of safety operations for each satellite on orbit will significantly change because of the increase in the catalog from the Space Fence. This effect is compounded because the NewSpace constellations described in Table 1 will drastically change the profile of satellites in LEO. The green bars in Fig. 1 represent the number of objects that will be added to the catalog (red or orange lines) from only the NewSpace large LEO constellations at their operational altitudes. This does not include the rocket stages that launch them, or satellites in the process of being phased into or removed from the operational orbits. Neighbors of one of these new constellations may face a radically different operations environment than their current practices were designed to address.

Satellites in these large LEO constellations typically have planned operational lifetimes of 5–10 years. Some companies have proposed to dispose of their satellites using low thrust electric propulsion systems, which would spiral satellites down over a period of months or years from operating altitudes as high as 1500 km through lower orbits where the Hubble Space Telescope, the International Space Station, and other critical LEO satellites operate [6]. Similar propulsive techniques would raise replacement satellites from lower launch injection orbits to higher operational orbits. These disposal and replenishment activities will add thousands of satellites each year transiting through lower altitudes and posing a risk to all resident satellites in those lower orbits. More importantly, failures will occur both among transiting satellites and operational constellations, potentially leaving hundreds more stranded along the transit path.

**No launch – multi-stage confirmation process**

**Tertrais, 17** – Deputy Director at the Paris-based Fondation pour la Recherche Stratégique (Foundation for Strategic Research) and a member of the editorial board of The Washington Quarterly (Bruno, On The Brink” – Really? Revisiting Nuclear Close Calls Since 1945, The Washington Quarterly, 40:2, 51-66)

**The System Worked** Based on the above examples, one must wonder: is luck a necessary hypothesis to explain why none of these events led to nuclear war? Is it not at least equally possible that since 1945, people in charge of nuclear weapons “have taken greater care [of them] than is taken in any other situation involving human agents and complex mechanical systems”?23 Nuclear-armed countries have set up mechanisms designed to ensure that nuclear weapons will not be used by mistake. **This includes fail-safe procedures (where non-use remains the default condition up until the last possible moment) as well as dual phenomenology (the need to confirm the attack by two independent means relying on different physical principles).** When The Man Who Saved The World was shown in New York City, the Russian mission to the United Nations issued a communiqué that stated: “Under no circumstances a decision to use nuclear weapons could be made or even considered in the Soviet Union (Russia) or in the United States on the basis of data from a single source or a system. For this to happen, **a confirmation is necessary from several systems: ground-based radars, early-warning satellites, intelligence reports,** etc.”24 In all the incidents mentioned above, safety mechanisms worked, even in the early 1960s when they were still rudimentary. Furthermore, is it credible to imagine that the head of a State or government would order a nuclear strike without being certain that a major military attack was underway? U.S. nuclear expert Jeffrey G. Lewis rightly argues that he cannot imagine that an American president would embark in nuclear reprisals if there was the slightest doubt on the reality of the attack.25 Retired Russian General Vladimir Dvorkin thinks similarly, claiming that “No president, no matter what president it is, will ever make a decision about launch-onwarning based on information about one rocket or missile or even…two or three missiles.”26 From the point of view of logic and complex systems analysis, it remains possible that a combination of incidents can lead to the failure of all safety mechanisms designed to prevent **accidental nuclear war**. Such a thesis is embodied by the classic work of Scott D. Sagan, The Limits of Safety. It would thus only be “a matter of time” due to cumulative probabilities.27 In a recent documentary about nuclear risks, author Eric Schlosser reiterates the point: “it’s also due to In all the incidents, safety mechanisms worked, even in the early 1960s when they were rudimentary. luck, pure luck, and the problem with luck is that eventually it runs out…Every machine ever invented eventually goes wrong.”28 **But the probability of failure increases markedly with time only if conditions do not change—and conditions do change**. Safety mechanisms have been perfected (without necessarily becoming more complex) and lessons of past incidents are being learned. Sagan claimed in 1993 that the Yom Kippur war (see below), as well as the 1979 and 1980 incidents (see above), are proof that organizations fail to learn from experience. But if that was the case, why would the number of known incidents have significantly declined since 1983? We only know of one significant incident in nearly 35 years: the Black Brant XII episode. Charles Perrow, the father of “normal accidents” theory (those resulting from the complexity and interconnection of systems), wrote: “with regard to firing [nuclear weapons] after a false warning we reach a surprising conclusion, one I was not prepared for: because of the safety systems involved in a launchon- warning scenario, it is virtually impossible for well-intended actions to bring about an accidental attack.”29