## OFF

### NC – K

#### Their use of an ethical frame of “injustice” presumes a metaphysics of discrete individuals for injustice to be acted by and on – that’s both conceptually incorrect and leads us to egoistic violence

Carpenter 17 Carpenter, Amber, works in ancient Greek and classical Indian philosophy, with a topical focus on the metaphysics, epistemology and moral psychology underpinning Plato’s ethics and Indian Buddhist ethics, taught or held visiting research appointments at the University of York, St Andrews, Cornell, Oxford, the University of Melbourne and Yale University. BA (Yale), PhD (Kings College London). "Ethics without Justice." A Mirror Is for Reflection: Understanding Buddhist Ethics (2017).

This study in the Buddhist claim that we ought to eliminate anger, and the distinctively Buddhist mode of doing so, has shown that the link between injustice and anger presumes a metaphysics. The moral perspective that picks out injustice as a special and additional kind of harm requires a metaphysics of discrete individuals, doing and “being done to” in turn, with a clear distinction between the two. But such a metaphysics and its moral categories engender in turn certain typical modes of thought—in particular, obsessing about Who is to Blame. Particularly in our victim-status-claiming age, we should wonder whether this is especially fruitful—or apt.

The Buddhist cannot show that their view will confirm or conform to all our intuitions about injustice because their basic metaphysical presumptions do not support the centrality of autonomous agency as a distinctive sort of cause, nor the violation of that by such free agents as a distinctive sort of harm. This is not, however, just an oversight or a morally horrifying omission. The proposal of an alternative metaphysics is the proposal of an alternative way of conceiving the moral. For every exercise in appreciating what no-self means, and what its implications are, is simultaneously an exercise in detachment, in recognizing the impulse to blame and resent as harmful assertions of oneself over and against others. Removing the conceptual structures for righteous indignation strips our evaluations of situations and persons of its self-assertiveness. Rather than being enervating, or blinding us to what moral responsiveness demands, this outlook is resolutely practical. None of this denies the no-self anger-eliminativist the resources necessary for forensics: we can see that some sets of conditions have intentions among them, and we can recognize that under some circumstances, these are more effectively engaged with in modes that differ from how we would engage with a forest fire.30 To regard someone’s raging violence as a forest fire does not mean that we turn the fire hose on it; it means that we consider the enabling conditions and defeating conditions and seek to eliminate the one and enhance the other.31

At the same time, as no-self introduces fluidity into our practices of individuation, it presents us with the entangled mutual causation of all factors and the simultaneous suffering. To see no-self, Buddhist-wise, just is to see that everything is conditioned and conditioning. Released from the demands of indignation, we are left with the only attitude that is appropriate in the face of suffering—a practically oriented care to relieve that suffering. Karuṇā is not an additional feature of a Buddhist outlook or the next thing on the list of dogmata. Care just is the affective and practical recognition of no-self metaphysics. Without discrete individuals to appeal to in any situation—these the perpetrators, these the victims—we have only efficacy in removing suffering as the standard preventing us from nihilism. Where before there were culprits to blame, and myself to exonerate or assert in retaliation, there is now only suffering, for which care to alleviate it is simply what is left when I am no longer distracted by righteous indignation.

#### Delusional egoism collapses the biosphere and produces rampant nationalism – extinction

Loy 17 David R Loy, former Besl Professor of Ethics/Religion and Society at Xavier University, teacher in Sanbo Kyodan Buddhism. M.A. in Asian philosophy from the University of Hawaii in 1975, and Ph.D. in philosophy in 1984 from the National University of Singapore. “Are Humans Special?” Tikkun, Vol. 32, No. 1, Winter 2017, <http://www.davidloy.org/downloads/Loy%20Are%20Humans%20Special.pdf>.

One uniquely human characteristic, emphasized by Buddhism, is that we can develop the ability to “dis-identify” from anything and everything, letting go not only of the individual sense of separate self but also of collective selves: dissociating from dualisms such as patriarchy, nationalism, racism, even species-ism (“we’re human, not lower animals”). Meditation develops such nonattachment, yet the point of such letting-go is not to dissociate from everything but to realize our nonduality with everything.

That human beings are the only species (so far as we know) that can know it is a manifestation of the entire cosmos opens up a possibility that may need to be embraced if we are to survive the crises that now confront us. Instead of continuing to exploit the earth’s ecosystems for our own supposed benefit, we can choose to work for the well-being of the whole. That we are not separate from the rest of the biosphere makes the whole earth our body, in effect, which implies not only a sp cial understanding but also a special role in response to that realization. As the Metta Sutta declares: “Let one’s thoughts of boundless love pervade the whole world— above, below, and across — without any obstruction, without any hatred, without any enmity.”

To ask whether the universe itself is objectively meaningful or meaningless is to miss the point— as if the universe were outside us, or simply there without us. When we do not erase ourselves from the picture, we can see that we are meaning- makers, the beings by which the universe introduces a new scale of significance and value.

The Responsibility of Being Special

If we are special because of our potential, we must choose. We are free to derive the meaning of our lives from delusions about who we are—from dysfunctional stories about what the world is and how we fit into it—or we can derive that meaning from insight into our nonduality with the rest of the world. In either case, there are consequences.

The problem with basing one’s life on delusions is that the consequences are unlikely to be good. As well as producing poetry and cathedrals, our creativity has recently found expression in world wars, genocides, and weapons of mass destruction, to mention a few disagreeable examples. We are in the early stages of an ecological crisis that threatens the natural and cultural legacy of future generations, including a mass extinction event that may lead to the disappearance of half the earth’s plant and animal species within a century, according to E. O. Wilson—an extinction event that may include ourselves.

What needs to be done so that our extraordinary co-creative powers will promote collective well-being (collective in this case referring to all the ecosystems of the biosphere)? Must we evolve further—not biologically but culturally—in order to survive at all? From a Buddhist perspective our unethical tendencies ultimately derive from a misapprehension: the delusion of a self that is separate from others, a big mistake for a species whose well-being is not separate from the well-being of other species. Insofar as we are ignorant of our true nature, individual and collective self-preoccupation naturally motivates us to be selfish. Without the compassion that arises when we feel empathy—not only with other humans, but with the whole of the biosphere—it is likely that civilization as we know it will not survive many more generations.

In either case, we seem fated to be special. If we continue to devastate the rest of the biosphere, we are arguably the worst species on earth: a cancer of the biosphere. If, however, humanity can wake up to become its collective bodhisattva—undertaking the long-term task of repairing the rupture between us and Mother Earth—perhaps we as a species will fulfill the unique potential of precious human life.

#### Planetary interdependence uniquely extends into space – the alternative is a shift away from individuation towards a politics of care that recognizes our mutual interdependence

Gál 20 Réka Gál, PhD student at the Faculty of Information and a Fellow at the McLuhan Centre for Culture and Technology, work unites feminist media theory and postcolonial studies with the history of science and environmental studies and explores how technological tools and scientific methods are employed to purportedly solve socio-political problems. B.A American and Media Studies, Humboldt Universität zu Berlin, M.A Cultural Studies, Humboldt Universität zu Berlin. "Climate Change, COVID-19, and the Space Cabin: A Politics of Care in the Shadow of Space Colonization." mezosfera.org, Oct, 2020, mezosfera.org/climate-change-covid-19-and-the-space-cabin-a-politics-of-care-in-the-shadow-of-space-colonization.

As much as dominant cultural narratives encourage us to entertain the idea that humans stand separate from and above their environments, the planetary crises of climate change and COVID-19 are painful reminders of the ways in which human and nonhuman ecologies are perpetually entangled. It is well-known that industrialized human-nonhuman relations, based on the capitalist extraction of what are considered natural resources, stand at the root of numerous environmental problems that are contributing to climate change. Animal industries – specifically the livestock industry – are one of the largest contributors to deforestation, greenhouse gas emission, and species extinctions.17 COVID-19’s believed origins in the Huanan wild animal markets and its eventual spread to humans is further testament to the ways in which our ecologies are always inseparable, with their intertwined nature here manifesting violently towards humans. Moreover, the spread of the coronavirus lays bare how local exploitation of nature can have global repercussions: the wildlife industry in China exists to this day because wildlife is considered a natural resource owned by the state, and the breeding, domestication, and trading of wildlife is encouraged by law.18

What must be made clear to those who are entertaining the idea that space habitats could provide a solution to such crises is that leaving Earth does not render these entanglements null and void. As much as spacecraft have been positioned as examples of subordinating the rules of nature to human control, their material reality only further consolidates the reciprocity of human and nonhuman, including human-machine, relations. 19 Our dependence on our surroundings intensifies in outer space. The inhospitality of space makes even the most physically fit astronauts dependent on numerous life support systems: oxygen and food supplies, waste management, and humidity control are all technologically operated but require continuous maintenance by humans. As such, ensuring the normal operation of a spacecraft is a relevant analogy for how a relationship of care with the diverse life support systems on Earth could be established.20

However, governments and private companies have been selling people the dream of human spaceflight ever since the Cold War, and the origins of this project in a military enterprise have made a significant mark on its implications for care work. The world of the 1960-70s astronauts was extremely segregated: the popular narrative was that of the hypermasculine astronaut, able to cope with danger and pain without complaint, with a brave wife at home waiting for his return.21 This segregation has had a remarkable impact on the types of work which have been considered “worthy” of these hypermasculine astronauts. In fact, the first American to travel to space, Alan Shepard, explicitly objected to having to learn maintenance techniques. As historian David Mindell put it, “the hottest test pilots didn’t want to be repairmen in space.”22 Similarly, data collected from NASA’s Skylab and the International Space Station’s 4-8 expeditions reveal that the time needed to complete maintenance activities on the Environmental Control and Life Support Systems was vastly underestimated, and in some cases even completely left out of operations plans.23 Even as late as the 2000s, the gendered view of care activities aboard spacecraft persisted: regarding the first female commander of a Space Shuttle, Eileen Collins, NASA made sure that her public persona was level-headed but also “pleasing.” She was referred to as “nice.” She took care of her fellow astronauts on board, taking on emotional labor by “providing support in ways that ease[d] the long hours and tension of training.” Her Air Force nickname was Mom.24

When this article calls for a feminist critique of outer space colonization, the argument is not that banishing technology and returning to a “pristine” nature or some other type of utopian primitivism is going to solve our planetary crises. Nor is it the point that more women need to be hired. What is being critiqued here is what Debbie Chachra has pointed out as a masculinist-capitalist obsession with progress and technological innovation that casts all maintenance, repair, and care work as inferior to creation.25 Much as our current experience of physical isolation during COVID-19 has exhibited, only during breakdowns are such taken-for-granted services made visible anew.26 The privileging of production obscures the societal understanding of the very real relationality of living, and the ongoing care and maintenance work required to keep human life running smoothly both on Earth and in outer space.

Therefore, the problem with extraplanetary colonization is not solely that this escape reinforces an enduring gendered opposition between exit and care, privileging the former over the latter, but also that machines only give the illusion of providing humans with independence from care work. Orsolya Ferencz, the Hungarian Secretary of Space Affairs, claims that Hungarian machines in outer space do not break down27 but the truth is that machines, just like our “natural” environments, do repeatedly break down. They require maintenance. Humans whose lives are intimately intertwined with technology are all too aware of this. Social scientist Laura Forlano writes about her experience as a diabetic who uses various technologies to monitor and maintain her blood glucose levels: “With respect to my insulin pump and glucose monitor, often, I am not really sure whether I am taking care of them, or they are taking care of me.”28 This interdependence additionally applies to the care for “natural” environments which can be regularly observed, for example, in the relationship of Indigenous communities to the environment. In the Hā’ena community in Hawaii, for instance, not only do they always return some of the fish caught to the water as a way of thanking the ocean, but they also managed to impose a ten-year fishing moratorium around their island in 2019, which will both help the renewal of the ecosystem and the recovery of the immediate environment, allowing future generations to fish sustainably.29 With this moratorium, the Hā’ena are providing care-based, restorative justice: the ocean ecosystem has fallen victim to injustice (overfishing), and remedying this ought to help heal the party wounded by the injustice, which is in this case the ocean.30

The extractive industry practices deeply embedded within Western social systems clearly propel us toward unsustainable development. Escaping Earth will not solve these problems. Rather, the solution requires a fundamental onto-epistemological shift, one that will enable us to move away from the exploitative Western-colonialist worldview and towards one that prioritizes care and sustainability. The works of feminist and Indigenous thinkers can inspire us to imagine and understand such a worldview. Numerous pre-colonial Indigenous cultures were sustainability-centric: the acceptance of the reciprocity between humans and their environment and the enforcing of the ethics of care in all areas of life were essential parts of several nations’ worldviews. Indigenous epistemologies see humans and nature as members of an ecological family in which humans, the nonhuman beings around them (for example, badgers, antelopes) and materials (for example, water, clay) all form part of their kinship structures.31 In Indigenous cultures that have survived colonization, such teachings and ethical approaches are passed down to this day.32 Research by Potawatomi scholar Kyle P. Whyte and Chris Cuomo demonstrate that Indigenous conceptions of care emphasize the importance of recognizing that humans, nonhumans (animals) and collectives (e.g. forests) exist in networks of interdependence. Indigenous care ethics manifest also in the fact that mutual responsibility is seen as the moral basis of relationships.33 An important part of this mutual responsibility is that care-based justice is not punishment-centered but recovery-centered: as in the example of the fishing moratorium of the Hā’ena, it seeks to promote restorative justice for those wounded by injustice. This restoration is aimed not only at people and communities, but also at nature.34 Similarly, an ethics of care in feminist philosophy treats the state of interdependence of human and nonhuman beings as a moral foundation.35

Since all infrastructures break, they require continuous maintenance. Information scientist Steven Jackson therefore proposes that the starting point to our thinking on the human relationship to technology has to be a contemplation of “erosion, breakdown, and decay, rather than novelty, growth, and progress.”36 If we accept that our world is “always-almost-falling-apart,”37 then instead of simply focusing on technological innovation as the vessel of our salvation,38 we need to look at the ways in which the world is constantly fixed, cared for, and maintained. This, of course, does not only translate to humans’ relationship to machines, but also to our relationship to our environment –in fact, feminist scholars have already made this point about dealing with our environmental problems: historian of science Donna Haraway’s concept of “staying with the trouble”39 explicitly pleads for the foregrounding of the inherent interconnectedness and interdependence of living, and for working on restoring our broken systems. What we are looking at here is a promising paradigm shift in human-machine and human-nature relations that promotes the recognition that the processes of care and maintenance are foundational to the way humanity relates to our biotic and abiotic environments.40

Both life during the social isolation of COVID-19 and life in the space cabin highlight our perpetual interdependence with our environments. Our life support systems are in a state of continuous decay, but the solution to this is not building more and more invasive risk-mitigation machines based on individualization, isolation and an imperative of absolute, one-directional control. Instead, a better, safer, more sustainable future starts with acknowledging one’s place in a web of interdependent relationships.41 Among other steps, this means that instead of acting as though our biotic and abiotic infrastructures can endlessly care for us, we need to care for them in return. This entails not only planting new forests and cleaning up shorelines, but also policy decisions such as the fishing moratorium mentioned above. As anthropologist Gökçe Günel indicates, even the technologies used for the harvesting of renewable energies require maintenance: solar panels, for example, need to be wiped clean of dust and sand regularly.42 Thinking through the lens of maintenance and care also means providing infrastructures for effectively repairing machines as opposed to producing e-waste and continuously buying new ones which are thrown away once a smarter version is released. Additionally, it means respecting and paying theworkers who are cleaning our hospitals, nursing our sick and harvesting food – most of them immigrants, predominantly women43 – better, as they are the reason we have clean hospitals, transport, and food on our tables, even during a global pandemic.44

## OFF

### NC – T

#### Next off is topicality.

#### 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

#### Even if it seems like appropriation because they occupy space exclusively, orbital slots are temporary, forfeitable, and non-exclusive in international law

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

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

#### Military satellites, once bought/licensed, aren’t private.

US Code 6 U.S. Code § 1501 – Definitions, <https://www.law.cornell.edu/uscode/text/6/1501#15_A>, 2015 RE

(15)Private entity (A)In general Except as otherwise provided in this paragraph, the term “private entity” means any person or private group, organization, proprietorship, partnership, trust, cooperative, corporation, or other commercial or nonprofit entity, including an officer, employee, or agent thereof. (B)Inclusion The term “private entity” includes a State, tribal, or local government performing utility services, such as electric, natural gas, or water services. (C)Exclusion The term “private entity” does not include a foreign power as defined in section 1801 of title 50.

#### 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

#### 3] Independently, their interp explodes the neg prep burden – the aff is military, not private – their interpretation is a limits disaster because it opens the floodgates to all potential government-based affirmatives because the government uses private contracts for pretty much everything – that makes the topic bidirectional and turns their 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.

## OFF

### NC – CP

#### States ought to participate in State Engagement Events and abide by the recommendations set forward by the Woomera Manual.

#### The CP’s assertion of international rules solves space escalation.

Adelaide University [DS] [https://law.adelaide.edu.au/woomera/system/files/docs/Woomera%20Manual.pdf]

AIM The Woomera Manual on the International Law of Military Space Operations aims to articulate and clarify extant law applicable to military activities associated with the space domain, especially that which is relevant in periods of tension (when States and non-State actors may consider using force) or outright hostilities. The Manual will examine the circumstances in which operations associated with space infrastructure would be considered unlawful as a violation of the law on the use of force. It will also consider the responses available to States in reacting to such operations. Further, the Manual will discuss how the law of armed conflict governs operations that are conducted from, to or through outer space, should armed conflict break out. Ultimately, the Manual is meant to support a stable, rules-based global order, even in periods of tension and armed conflict. SCOPE The Woomera Manual follows in the footsteps of, inter alia, the Oxford Manual, the San Remo Manual, the Harvard Manual and the Tallinn Manuals. Importantly, in the tradition of these manuals, it will maintain a strict focus on the law as it is (lex lata), not on the law as we might wish it to be (lex ferenda). The latter is more appropriate for official, intergovernmental efforts in drafting new international instruments. Yet, it is unlikely that the diverse interests of States in the current geopolitical environment will coalesce around any new international instruments on space security. For that reason, we consider a strict focus on lex lata to be essential. EXPERTS The Woomera Manual gathers together legal experts specialised in the fields of international space law, international law on the use of force and the law of armed conflict, together with technical experts. Experts contribute in a personal capacity on the basis of their own conclusions as to the state of the law, independent of the official position or preference of any State or organisation. Core Experts draft Rules and Commentary and attend each Workshop. The number attending each Workshop will vary, but there are expected to be approximately 20 such experts. There are also Associate Experts, who do not attend Workshops, but who contribute as reviewers of all draft Rules and Commentary and contribute in niche areas, including by providing examples of State practice and State assertions of a legal position. RULE-DRAFTING PROCESS The Rules set forth in The Woomera Manual are succinct statements of international law in a military space context. A Commentary accompanying each Rule expands on its interpretation, discusses difficult issues of application, and provides examples or scenarios as a means of clarification. Experts will come together in a series of workshops over the next several years to agree upon the Rules and Commentary on the basis of non-attribution and consensus (where possible). However, most of the work will take place between workshops, when the experts draft the proposed Rules and Commentary to be considered at the workshops. STATE ENGAGEMENT Once the Rules and Commentary are consolidated into a single text, the complete draft will be shared with officials from States that participate in State engagement events. The Board of Directors will also seek other opportunities for State engagement while the Rules and Commentary are being drafted. Other international law and space operations experts around the world will carefully scrutinise the draft text in a robust ‘peer review’ process. The Board welcomes proposals by States to host and contribute to State engagement events.

#### Solves the case – ZERO 1AC authors advocate for a full ban on military satellites.

1AC Graff ’18 [The New Arms Race Threatening to Explode in Space, <https://www.wired.com/story/new-arms-race-threatening-to-explode-in-space/>, Garrett Graff, 6/26/18, Garrett M. Graff (@vermontgmg) is a contributing editor at WIRED and a director at The Aspen Institute. He is the author of the No. 1 national bestseller The Only Plane in the Sky: An Oral History of 9/11. He can be reached at [garrett.graff@gmail.com](mailto:garrett.graff@gmail.com).] [SS]

For decades, America’s satellites had circled Earth at a largely safe remove from the vicissitudes of geopolitics. An informal global moratorium on the testing of anti-satellite weapons had held since 1985; the intervening decades had been a period of post–Cold War peace—and unquestioned American supremacy—high overhead. During those decades, satellites had become linchpins of the American military apparatus and the global economy. By 2007, ships at sea and warplanes in the air had grown reliant on instant satellite communications with ground stations thousands of miles away. Government forecasters relied on weather satellites; intelligence analysts relied on high-­resolution imagery to anticipate and track adversaries the world over. GPS had become perhaps the single most indispensable global system ever designed by humans—the infrastructure upon which the rest of the world’s infrastructure is based. (Fourteen of the 16 infrastructure sectors designated as critical by the Department of Homeland Security, like energy and financial services, rely on GPS for their operation.) Now, Shelton feared, all those satellites overhead had become so many huge, unarmored, billion-dollar sitting ducks. In the decade since China’s first successful anti-satellite missile test, Shelton’s premonition has largely come true: Everything has changed in space. A secretive, pitched arms race has opened up between the US, China, Russia, and, to a lesser extent, North Korea. The object of the race: to devise more and better ways to quickly ~~cripple~~ [hurt] your adversary’s satellites. After decades of uncontested US supremacy, multinational cooperation, and a diplomatic consensus on reserving space for peaceful uses, military officials have begun referring to Earth’s orbit as a new “warfighting domain.” On the ground, the military is starting to retrain pilots, ship captains, and ground troops in fail-safe forms of navigation that don’t rely on GPS—like celestial navigation. The US military must relearn how to fight “unwired” and defend itself in space. “We knew how to do that, and somehow we forgot,” General John E. Hyten, the head of US Strategic Command, said in 2015. When former director of national intelligence James Clapper left office at the end of the Obama administration, he told me that the increasing sophistication of America’s adversaries in space was one of the top three strategic threats he worried about. Clapper’s successor, Dan Coats, warned last spring that “Russia and China remain committed to developing capabilities to challenge perceived adversaries in space, especially the United States.” Since he took office, President Trump has dropped numerous hints of the warnings he’s evidently getting from military and intelligence leaders. During a spring livestream with astronauts aboard the International Space Station, he alluded, obliquely and without context, to the “tremendous military applications in space.” And he has repeatedly floated the idea of creating a new branch of the armed forces specifically for celestial combat—culminating last week with a speech out-and-out ordering the Joint Chiefs of Staff to begin developing plans for a new “Space Force.” But if space is indeed becoming a war-­fighting domain, it’s important to understand the stakes, not just for America’s strategic standing but for the species. A Russo-Sino-American space war could very well end with a ~~crippled~~ [hurt] global economy, inoperable infrastructure, and a planet shrouded by the orbiting fragments of pulverized satellites—which, by the way, could hinder us all on Earth until we figured out a way of cleaning them up. In the aftermath of such a conflict, it might be years before we could restore new constellations of satellites to orbit. Preparing for orbital war has fast become a priority of the US military, but the more urgent priority is figuring out how to prevent it. GROWING UP IN Oklahoma City, William Shelton dreamed of becoming a pilot. He got as far as the Air Force Academy before he discovered his eyes weren’t good enough. So instead he became an astronomical engineer. In 1976 he began serving as a launch facility manager at Vandenberg Air Force Base, the military’s oldest space and missile launch base, perched on the California coast north of Santa Barbara. He arrived just as the Air Force was beginning to understand how crucial space would be to its future: The nation’s first early-warning satellites had been put in orbit with the intention of tracking Soviet missile launches, and satellite imagery was becoming increasingly critical to intelligence gathering. Shelton’s poor eyesight, it turned out, had led him to the center of the Air Force’s new frontier. In August 1990, Shelton, then a young lieutenant colonel, took command of the 2nd Space Operations Squadron in Colorado. When he arrived at his post, the Air Force was busy building a new constellation of satellites—launching new ones from Cape Canaveral in Florida every few months to help fill out what he was told would ultimately be a global system aimed at helping the US improve its navigation and increase the precision of its bombs and missiles. This was the new Global Positioning System, and one of Shelton’s first duties at “2Sops” was to build support and enthusiasm for the new effort. To impress visitors (including the brass), he carried around a demo GPS unit that weighed 10 pounds, cost $3,000, and could tell America’s soldiers, sailors, airmen, and Marines exactly where they were on the surface of the planet. The power of the new system that 2Sops ran was proven faster than anyone imagined. The Gulf War caused a rush of final preparations to get GPS ready for battle. Around 2:30 am on January 17, 1991, GPS-equipped helicopters snuck into Iraq, using the technology to guide themselves through the darkened desert and knock out air defense radars. The first bombing campaign of the war had begun. Reporters marveled at precision-­guided bombs zeroing in on their targets and cruise missiles appearing to turn street corners to hit the right buildings. Shelton had a front-row seat to this transformation. As the technology has improved, so has the precision of GPS. The system originally provided accuracy to within 17 yards; with it, you could pinpoint a specific copse of pine trees. Today, if you’re using a smartphone, it can generally locate an object to within five yards—a resolution fine enough to locate a pair of pine trees within that copse. Soon it could be able to zero in on a pine cone: Research from UC Riverside has demonstrated that the latest tech is reliable to within an inch. And research has shown that 1-millimeter accuracy might be eventually possible—which means that the system could locate an individual seed inside that pine cone. Today, troops on the ground use GPS to navigate foreign streets; drone pilots can program a flight plan from thousands of miles away. And because GPS satellites also house America’s detection system for nuclear detonations, we rely on them to tell us if North Korea launches a nuclear weapon, and to tell our missiles and bombs where to find their targets. “When you look at our American way of war, the strategy is largely underpinned by space assets—navigation, early warning, timing,” Shelton says. And that’s just the military. The creators of GPS probably never intended for the system to become the backbone of daily life, but it has. I visited Colorado while reporting this story and tried to keep tabs on everything I did that relied on GPS. There were the obvious navigational moments—my Uber ride to the airport, my American Airlines flight to Denver, my own Google Maps–guided drive in a rental car to Schriever Air Force Base, outside Colorado Springs. But there were also less obvious instances, like the phone calls I made along the way (cellular networks rely on GPS data to keep their stations synchronized), my stop at the ATM (banks use GPS to track deposits and withdrawals), and the fill-up at the gas station (the credit card system also relies on GPS). Moreover, GPS is no longer the world’s sole geolocating mechanism. Russia, China, and the European Union have now all either deployed or begun working on their own full constellations of navigation satellites, ensuring that they won’t have to rely on the US system. It also means that, in the early moments of a war, it’s a fair bet that satellites—the other guy’s satellites—could be among the first targets. DURING THE COLD War, a US army mountain outpost in the Fulda Gap, the shortest route between East and West Germany, served as an early warning trip wire for a Soviet invasion of Europe. If Russian tanks ever made a surprise attack, NATO planners knew that the soldiers there would likely be the first to find out. Today, the members of 2Sops play a similar role. Deep inside the squat, beige, windowless Building 400 at Schriever Air Force Base—the destination I had plugged into Google Maps during my trip to Colorado—10 people at a time remotely operate the heavenly constellation of GPS satellites that guide Tomahawk cruise missiles to their targets, deliver Lyft passengers to their destinations, and help farmers cultivate their crops. They also watch out for any shocks or attacks on the system. The average GPS operators are in their mid-twenties. During one recent shift, the entire Global Positioning System was being operated by two 19-year-old airmen (who, the Air Force emphasizes, are rigorously trained). Their commander, US Air Force lieutenant colonel Peter Norsky, is in his mid-thirties. Together, they watch over the roughly three dozen GPS satellites, troubleshooting the geolocation system and minding the quirks of each orbiting craft—this one’s damaged solar panels, that one’s balky communications links—as if they were remotely tending a stable full of temperamental horses. As integral as GPS is to daily life, the way it actually works is little understood by most people outside of Schriever Air Force Base. Fundamentally, the function of GPS is to provide the globe with a shared clock. GPS satellites allow phone companies to keep their systems in sync, battleships to chart open waters, and ATMs to time-stamp their transactions by triangulating signals from overhead and measuring how long it takes those signals from different satellites to reach a GPS receiver. Any malfunction in the GPS system threatens to plunge the global economy into chaos. The system works by making daily calculations, employing Newtonian physics and Einsteinian relativity, to minutely tweak the time broadcast from each GPS satellite as it moves through space—the high-tech version of tuning your grandfather clock to within 100-­billionths of a second. Time is, after all, relative; as of January, the time in space was 18 seconds ahead of Earth’s “Coordinated Universal Time,” since space doesn’t recognize the leap seconds that scientists add to terrestrial time to account for the planet’s slowing rotation. Additionally, the time-keeping device on each satellite gives a subtly different reading, the result of variations in their atomic clocks, which tell time by measuring the precise oscillations of an atom. (Some GPS satellites use rubidium atoms, which are highly accurate day to day; some use cesium, which is more accurate over long stretches.) Any malfunction in the GPS system threatens to plunge the global economy into chaos. Fortunately those glitches are rare, but they’re not unheard of. On January 25, 2016, one of 2Sops’ flight commanders, Captain Aaron Blain, was awoken by a call from work in the middle of the night. User reports from around the country suggested that the system’s precision had “wobbled,” making measurements increasingly inaccurate. Blain raced to Schriever in his Ford pickup and found that the constellation’s timing was off by about 13 microseconds. It was an infinitesimal number—over 25,000 times shorter than the blink of an eye—but for the finely tuned GPS it was a yawning crevice. Left uncorrected, the glitch could have ricocheted through the global economy, corrupting not just driving directions but stock trades too. Alongside the rest of his team, Blain worked through the night, chugging Mountain Dew. It took about six hours to locate the problem—a single corrupted measurement—and then individually reset the affected satellites. (Russia’s GPS equivalent, known as Glonass, has suffered even more serious issues. In 2014 it went down for 10 hours, but many Glonass receivers can also use GPS as a backup, so the systemic chaos was limited.) 2Sops averted a benign catastrophe that night, but it seems increasingly worried about what China and Russia are doing up in the heavens, out of sight. It recently doubled the number of airmen who oversee the satellites, so one team can run the GPS constellation while another trains to face worst-case scenarios—what the Pentagon refers to as “a contested, degraded, and ­operationally limited environment.” That is, a space war. IN ONE RESPECT, space is already like a war zone: It’s increasingly shot through with flying shrapnel. By some estimates, there are more than 100 million pieces of debris zipping around in Earth’s orbit. China’s 2007 anti-satellite test is estimated to have created some 150,000 new ones, many too small to be tracked. In 2013, some of those fragments hit a Russian satellite—threatening to add still more debris to the orbital mix. And as commercial ventures like SpaceX and Blue Origin ramp up their space tourism plans, Earth’s orbit is about to get even more crowded with both junk and spacecraft. Scientists say there could be a point at which the density of objects spinning around the planet reaches a threshold—called the Kessler effect—that triggers a runaway cascade of collisions: an entire orbit, in other words, set to Blend. Another tricky thing about space debris is that sometimes it isn’t just debris. A US military program called the Space Surveillance Network carefully tracks and monitors every piece of space junk that’s larger than a softball. That currently amounts to some 20,000 objects—everything from old satellite parts to discarded rocket boosters to a pair of pliers lost during an astronaut’s spacewalk. In 2014, a piece of presumptive space junk known to the US military as Object 2014-28E began to behave strangely. The object, known to be of Russian origin, started to perform complicated maneuvers. “That’s concerning—when you see something that appears to be debris come to life,” Shelton says. Object 2014-28E was, in fact, an autonomous spacecraft capable of veering off course and sidling up to other objects, including American commercial communications satellites. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT ADVERTISEMENT In the years since, Object 2014-28E has been joined by similar space objects of Russian provenance. Analysts fear that they might mark the revival of a Russian program known as Satellite Killer, which was shut down after the Cold War. But it’s difficult, even for US government analysts, to know for certain whether that fear is warranted. The secrecy that surrounds nearly everything space-related makes it hard to assess any adversary’s capabilities. Discerning intentions is especially difficult. “If I wanted to build a satellite that looked very different from its actual mission, that’s not hard to do,” Shelton says. A satellite that maneuvers close to another could be doing a repair job or squaring up for an attack—and it might use the same tools for both. “Small satellites with small grappling arms—they have both military and nonmilitary uses,” says Dean Cheng, who studies China’s military capabilities at the Heritage Foundation. “If I manipulate a satellite’s bits and pieces, I can also rip something out.” The US has also been secretive in developing what may or may not be weapons in space. Last May, the Air Force announced that an unmanned space-shuttle-like vehicle that appears to be classified had completed 718 days orbiting Earth, doing who knows what. As of this May, another OTV was circling the globe, more than 200 days into its mostly classified mission. Todd Harrison, director of the Aerospace Security Project at the Center for Strategic and International Studies in Washington, explains that there are effectively four categories of space weapons: kinetic (aimed at destroying a satellite), nonkinetic (aimed at disabling a satellite without touching it), electromagnetic (aimed at interfering with a satellite’s signals), and cyber (aimed at corrupting the data sent to a satellite). No country can claim sovereignty in orbit. So what counts as an act of territorial aggression? What qualifies as a proportional response? The US tested its own anti-satellite missile in 2008, shooting down an errant spy satellite as it was falling out of orbit. Russia has repeatedly flight-tested a so-called direct ascent weapon, the PL-19 Nudol ballistic missile, which could strike objects in orbit, although it hasn’t conducted a live attack on an orbiting satellite. And in the decade since China shot down its weather satellite in 2007, Beijing has launched multiple ballistic missile tests that extended into orbit. In addition, a trio of Chinese satellites have practiced “close-proximity operations,” similar to those performed by the Russian Object 2014-28E. Anti-satellite weapons form just one part of what China calls shashoujian, or “assassin’s mace” systems, which can be used at the start of an attack to achieve a surprise, decisive advantage over a technologically superior foe. There’s also the growing challenge of cyberattacks on satellites: Chinese hackers have reportedly infiltrated the US weather satellite system, and a Romanian hacker announced that he had accessed the server of one of NASA’s space flight centers. In the past decade, at least two nonmilitary US satellite systems have experienced brief, unattributed glitches tied to hacking attacks. Some actors have begun to exploit the fragility not of satellites themselves, but of the signals they broadcast. By the time the radio signals from a GPS satellite reach Earth from thousands of miles up, they can be easily overridden by a stronger signal broadcast on the same frequency. Simple GPS jammers sell online for $119, but they have a short reach. Militaries appear to be acquiring much more powerful jamming technologies. In 2016, roughly 1,000 planes and 700 vessels at sea reportedly experienced problems with their GPS signals near North Korea, which is believed to have purchased Russian jammers that can be mounted on trucks. Those devices have an effective radius of 30 to 60 miles. The US seems to possess similar technology; a test that went awry near a Navy base in San Diego in 2007 knocked out GPS signals to cell phone network operators for at least two hours. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT More troubling than simple jamming, though, is the rise of “spoofing,” which overrides correct GPS data with a more powerful localized signal that delivers false information to a receiver. In 2013 a team of researchers from the University of Texas at Austin successfully led astray an $80 million yacht in the Mediterranean, overpowering its GPS receivers and sending it onto a new course. The dirty truth about spoofing is that secure channels are no defense against it. “Even our encrypted military GPS receivers can be spoofed,” Harrison says. SHELTON, WHO RETIRED in 2014 after 38 years in the Air Force, lives not far from 2Sops in Colorado; these days he chairs an educational and advocacy nonprofit called the Space Foundation. He still expends a lot of energy worrying about what is happening in the heavens. “We as a nation have been too slow to respond to this threat,” he says. He’s particularly troubled by the failure of the US to procure new space systems. Some GPS satellites are older than the people running them. “Our systems are archaic,” Shelton says. “Because space assets are so expensive, we deploy ‘just enough’; there’s no backup or excess capability.” (The Air Force noted that the GPS constellation consists of more than 30 satellites, which provides some redundancy.) China, by contrast, is investing heavily in its space program, seeing it as a symbol of its growing prominence. As soon as this year, it could land a craft on the never-before-touched far side of the moon. And China’s global navigation satellite system, known as BeiDou, has some capabilities that outmatch even the United States’ GPS. In 2015, China created a new space-­focused military service, known as the People’s Liberation Army Strategic Support Force. Meanwhile, the US relies entirely on Russian rockets to get its astronauts to the Space Station (although NASA has awarded contracts to Boeing and SpaceX to fix that). As Cheng says, “Today China is one of two countries that can put a person into space—and the other country isn’t the United States.” Many of America’s space warriors, as they call themselves, share Shelton’s sense that the US isn’t responding nearly quickly enough to the threat of orbital war. “We needed to be marching faster,” says Deborah Lee James, who served as President Obama’s secretary of the Air Force. “Why aren’t there more space and cyber officers at the top of the Air Force?” Deadly Debris In orbit, trash becomes shrapnel. When objects in space collide—whether by accident or because, say, someone down on Earth has decided to launch a missile at a satellite—it sometimes creates a hail of smaller fragments that fan out across Earth’s orbit. It’s already getting difficult to operate satellites and conduct launches amid all the junk zipping around up there. That’s why, around the world, scientists and engineers are devising ways to pull space junk out of orbit. In April, a SpaceX rocket carried a collection of experimental debris-removal technologies to the International Space Station. During its time in orbit, the satellite will test out nets, harpoons, and drag sails designed to reduce detritus. — Saraswati Rathod 20,000 Pieces of space debris larger than a softball — 500,000 Pieces of debris the size of a marble or larger — 4,300 Number of satellites in space — 72 Percent of satellites that are non­functioning — $1.4 billion Cost of degradation to commercial satellites caused by debris — 2,000 Number of trackable fragments created by the last major satellite collision in 2009 — 160 million Estimated number of pieces of space junk too small to be tracked — Sources: European Space Agency; NASA; Aerospace Corporation Addressing these issues, as James’ question suggests, is not just about throwing money at the space-industrial complex. It involves organizational changes too. The Air Force is building what it calls the nation’s first Space Mission Force, made up of airmen trained to respond to the demands of an orbital war. On the same base as the 2Sops command center, the military has established the National Space Defense Center, which puts representatives from various military and intelligence offices focused on space under a single roof. And the defense authorization bill is full of upgrades to the Air Force’s space-­fighting capabilities, including the creation of an additional Air Force unit responsible for space warfighting operations. Not content to tinker with the Air Force, a growing number of people in Washington—including the commander in chief—have to come to favor creating an entire new military branch dedicated to space operations. In May, during a ceremony honoring West Point’s football team, President Trump told his audience, “We’re getting very big in space, both militarily and for other reasons, and we are seriously thinking of the Space Force.” The comment sounded to many listeners like yet another oddball Trumpian tangent. But then, after reportedly meeting resistance from the Air Force, Trump escalated. At a mid-June meeting of the newly constituted US Space Council, he announced—much to the surprise of his own advisors and the military itself—that he was ordering the Pentagon to move forward. As he said, “I’m hereby directing the Department of Defense and Pentagon to immediately begin the process necessary to establish a Space Force as the sixth branch of the Armed Forces. That’s a big statement. We are going to have the Air Force and we are going to have the Space Force—separate but equal. It’s going to be something.” The Space Force is, of course, not a fait accompli. Any military reorganization has to be approved by Congress—which is not necessarily an easy path. (Last year, a bill that included the creation of just such a new branch of the military passed the US House of Representatives, but that provision was taken out of the Senate version.) And the establishment of a new branch of the military involves a vast set of logistical and structural questions. Yet Trump’s push may speed up a natural evolution toward an independent space branch by years, if not a decade. Space, the president said, was “going to be important monetarily and militarily. We don’t want China and Russia and other countries leading us. We’ve always led.” But where—and to what—are we leading? Part of the challenge in figuring out how to think about space conflict is the sheer complexity of the orbital environment—an arena that has long belonged to nation-states, but that is increasingly becoming a domain of commerce and tourism. How do countries protect their interests up above—and down here? Right now, countries appear to be racing to build their military capabilities—but an arms race isn’t the only answer. The last time an arms race appeared poised to overtake space, the world’s superpowers banded together to sign the 1967 Outer Space Treaty, which banned weapons of mass destruction in space and held that “the moon and other celestial bodies” should be reserved for peaceful purposes. The Outer Space Treaty is still in force, but it is by now full of holes. Legal scholars had a hard time proving that China’s 2007 anti-­satellite test, for instance, violated the agreement. That’s because the missile that China fired was not technically addressed in the 50-year-old treaty. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT Part of what makes space such volatile terrain right now is that it’s hard even to apply the existing laws of war to it. No country can claim sovereignty in orbit, and it’s impossible to occupy territory there. So what counts as an act of territorial aggression? What qualifies as a proportional response? It’s even difficult to say, with certainty, what the physics of war in space will look like. We don’t well understand, for instance, how a kinetic attack on a satellite constellation might spill over into a spiraling Kessler effect. Humans have “millennia of experience in blowing up things on land,” says Laurie Blank, a law professor at Emory University and a specialist in the laws of armed conflict. “We’re still learning the consequences of all these things in space.” Blank recently joined together with an international team of legal experts to create what they’re calling the Woomera Manual on the International Law of Military Space Operations—a kind of rule book for celestial international conflict, one that will endeavor to translate the laws of terrestrial war for space. It’s a daunting task, and the resulting document will be nonbinding. But, Blank says, it’s a necessary first step for anyone who would seek to contain a conflict that has, in some senses, already begun.

## OFF

### NC – DA

#### The plan collapses warfighting

Graff ’18 [The New Arms Race Threatening to Explode in Space, <https://www.wired.com/story/new-arms-race-threatening-to-explode-in-space/>, Garrett Graff, 6/26/18, Garrett M. Graff (@vermontgmg) is a contributing editor at WIRED and a director at The Aspen Institute. He is the author of the No. 1 national bestseller The Only Plane in the Sky: An Oral History of 9/11. He can be reached at [garrett.graff@gmail.com](mailto:garrett.graff@gmail.com).] [SS]

For decades, America’s satellites had circled Earth at a largely safe remove from the vicissitudes of geopolitics. An informal global moratorium on the testing of anti-satellite weapons had held since 1985; the intervening decades had been a period of post–Cold War peace—and unquestioned American supremacy—high overhead. During those decades, satellites had become linchpins of the American military apparatus and the global economy. By 2007, ships at sea and warplanes in the air had grown reliant on instant satellite communications with ground stations thousands of miles away. Government forecasters relied on weather satellites; intelligence analysts relied on high-­resolution imagery to anticipate and track adversaries the world over. GPS had become perhaps the single most indispensable global system ever designed by humans—the infrastructure upon which the rest of the world’s infrastructure is based. (Fourteen of the 16 infrastructure sectors designated as critical by the Department of Homeland Security, like energy and financial services, rely on GPS for their operation.) Now, Shelton feared, all those satellites overhead had become so many huge, unarmored, billion-dollar sitting ducks. In the decade since China’s first successful anti-satellite missile test, Shelton’s premonition has largely come true: Everything has changed in space. A secretive, pitched arms race has opened up between the US, China, Russia, and, to a lesser extent, North Korea. The object of the race: to devise more and better ways to quickly ~~cripple~~ [hurt] your adversary’s satellites. After decades of uncontested US supremacy, multinational cooperation, and a diplomatic consensus on reserving space for peaceful uses, military officials have begun referring to Earth’s orbit as a new “warfighting domain.” On the ground, the military is starting to retrain pilots, ship captains, and ground troops in fail-safe forms of navigation that don’t rely on GPS—like celestial navigation. The US military must relearn how to fight “unwired” and defend itself in space. “We knew how to do that, and somehow we forgot,” General John E. Hyten, the head of US Strategic Command, said in 2015. When former director of national intelligence James Clapper left office at the end of the Obama administration, he told me that the increasing sophistication of America’s adversaries in space was one of the top three strategic threats he worried about. Clapper’s successor, Dan Coats, warned last spring that “Russia and China remain committed to developing capabilities to challenge perceived adversaries in space, especially the United States.” Since he took office, President Trump has dropped numerous hints of the warnings he’s evidently getting from military and intelligence leaders. During a spring livestream with astronauts aboard the International Space Station, he alluded, obliquely and without context, to the “tremendous military applications in space.” And he has repeatedly floated the idea of creating a new branch of the armed forces specifically for celestial combat—culminating last week with a speech out-and-out ordering the Joint Chiefs of Staff to begin developing plans for a new “Space Force.” But if space is indeed becoming a war-­fighting domain, it’s important to understand the stakes, not just for America’s strategic standing but for the species. A Russo-Sino-American space war could very well end with a ~~crippled~~ [hurt] global economy, inoperable infrastructure, and a planet shrouded by the orbiting fragments of pulverized satellites—which, by the way, could hinder us all on Earth until we figured out a way of cleaning them up. In the aftermath of such a conflict, it might be years before we could restore new constellations of satellites to orbit. Preparing for orbital war has fast become a priority of the US military, but the more urgent priority is figuring out how to prevent it. GROWING UP IN Oklahoma City, William Shelton dreamed of becoming a pilot. He got as far as the Air Force Academy before he discovered his eyes weren’t good enough. So instead he became an astronomical engineer. In 1976 he began serving as a launch facility manager at Vandenberg Air Force Base, the military’s oldest space and missile launch base, perched on the California coast north of Santa Barbara. He arrived just as the Air Force was beginning to understand how crucial space would be to its future: The nation’s first early-warning satellites had been put in orbit with the intention of tracking Soviet missile launches, and satellite imagery was becoming increasingly critical to intelligence gathering. Shelton’s poor eyesight, it turned out, had led him to the center of the Air Force’s new frontier. In August 1990, Shelton, then a young lieutenant colonel, took command of the 2nd Space Operations Squadron in Colorado. When he arrived at his post, the Air Force was busy building a new constellation of satellites—launching new ones from Cape Canaveral in Florida every few months to help fill out what he was told would ultimately be a global system aimed at helping the US improve its navigation and increase the precision of its bombs and missiles. This was the new Global Positioning System, and one of Shelton’s first duties at “2Sops” was to build support and enthusiasm for the new effort. To impress visitors (including the brass), he carried around a demo GPS unit that weighed 10 pounds, cost $3,000, and could tell America’s soldiers, sailors, airmen, and Marines exactly where they were on the surface of the planet. The power of the new system that 2Sops ran was proven faster than anyone imagined. The Gulf War caused a rush of final preparations to get GPS ready for battle. Around 2:30 am on January 17, 1991, GPS-equipped helicopters snuck into Iraq, using the technology to guide themselves through the darkened desert and knock out air defense radars. The first bombing campaign of the war had begun. Reporters marveled at precision-­guided bombs zeroing in on their targets and cruise missiles appearing to turn street corners to hit the right buildings. Shelton had a front-row seat to this transformation. As the technology has improved, so has the precision of GPS. The system originally provided accuracy to within 17 yards; with it, you could pinpoint a specific copse of pine trees. Today, if you’re using a smartphone, it can generally locate an object to within five yards—a resolution fine enough to locate a pair of pine trees within that copse. Soon it could be able to zero in on a pine cone: Research from UC Riverside has demonstrated that the latest tech is reliable to within an inch. And research has shown that 1-millimeter accuracy might be eventually possible—which means that the system could locate an individual seed inside that pine cone. Today, troops on the ground use GPS to navigate foreign streets; drone pilots can program a flight plan from thousands of miles away. 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But there were also less obvious instances, like the phone calls I made along the way (cellular networks rely on GPS data to keep their stations synchronized), my stop at the ATM (banks use GPS to track deposits and withdrawals), and the fill-up at the gas station (the credit card system also relies on GPS). Moreover, GPS is no longer the world’s sole geolocating mechanism. Russia, China, and the European Union have now all either deployed or begun working on their own full constellations of navigation satellites, ensuring that they won’t have to rely on the US system. It also means that, in the early moments of a war, it’s a fair bet that satellites—the other guy’s satellites—could be among the first targets. DURING THE COLD War, a US army mountain outpost in the Fulda Gap, the shortest route between East and West Germany, served as an early warning trip wire for a Soviet invasion of Europe. 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In 2013, some of those fragments hit a Russian satellite—threatening to add still more debris to the orbital mix. And as commercial ventures like SpaceX and Blue Origin ramp up their space tourism plans, Earth’s orbit is about to get even more crowded with both junk and spacecraft. Scientists say there could be a point at which the density of objects spinning around the planet reaches a threshold—called the Kessler effect—that triggers a runaway cascade of collisions: an entire orbit, in other words, set to Blend. Another tricky thing about space debris is that sometimes it isn’t just debris. A US military program called the Space Surveillance Network carefully tracks and monitors every piece of space junk that’s larger than a softball. That currently amounts to some 20,000 objects—everything from old satellite parts to discarded rocket boosters to a pair of pliers lost during an astronaut’s spacewalk. In 2014, a piece of presumptive space junk known to the US military as Object 2014-28E began to behave strangely. The object, known to be of Russian origin, started to perform complicated maneuvers. “That’s concerning—when you see something that appears to be debris come to life,” Shelton says. Object 2014-28E was, in fact, an autonomous spacecraft capable of veering off course and sidling up to other objects, including American commercial communications satellites. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT ADVERTISEMENT In the years since, Object 2014-28E has been joined by similar space objects of Russian provenance. Analysts fear that they might mark the revival of a Russian program known as Satellite Killer, which was shut down after the Cold War. But it’s difficult, even for US government analysts, to know for certain whether that fear is warranted. The secrecy that surrounds nearly everything space-related makes it hard to assess any adversary’s capabilities. Discerning intentions is especially difficult. “If I wanted to build a satellite that looked very different from its actual mission, that’s not hard to do,” Shelton says. A satellite that maneuvers close to another could be doing a repair job or squaring up for an attack—and it might use the same tools for both. “Small satellites with small grappling arms—they have both military and nonmilitary uses,” says Dean Cheng, who studies China’s military capabilities at the Heritage Foundation. “If I manipulate a satellite’s bits and pieces, I can also rip something out.” The US has also been secretive in developing what may or may not be weapons in space. Last May, the Air Force announced that an unmanned space-shuttle-like vehicle that appears to be classified had completed 718 days orbiting Earth, doing who knows what. As of this May, another OTV was circling the globe, more than 200 days into its mostly classified mission. Todd Harrison, director of the Aerospace Security Project at the Center for Strategic and International Studies in Washington, explains that there are effectively four categories of space weapons: kinetic (aimed at destroying a satellite), nonkinetic (aimed at disabling a satellite without touching it), electromagnetic (aimed at interfering with a satellite’s signals), and cyber (aimed at corrupting the data sent to a satellite). No country can claim sovereignty in orbit. So what counts as an act of territorial aggression? What qualifies as a proportional response? The US tested its own anti-satellite missile in 2008, shooting down an errant spy satellite as it was falling out of orbit. Russia has repeatedly flight-tested a so-called direct ascent weapon, the PL-19 Nudol ballistic missile, which could strike objects in orbit, although it hasn’t conducted a live attack on an orbiting satellite. And in the decade since China shot down its weather satellite in 2007, Beijing has launched multiple ballistic missile tests that extended into orbit. In addition, a trio of Chinese satellites have practiced “close-proximity operations,” similar to those performed by the Russian Object 2014-28E. Anti-satellite weapons form just one part of what China calls shashoujian, or “assassin’s mace” systems, which can be used at the start of an attack to achieve a surprise, decisive advantage over a technologically superior foe. There’s also the growing challenge of cyberattacks on satellites: Chinese hackers have reportedly infiltrated the US weather satellite system, and a Romanian hacker announced that he had accessed the server of one of NASA’s space flight centers. In the past decade, at least two nonmilitary US satellite systems have experienced brief, unattributed glitches tied to hacking attacks. Some actors have begun to exploit the fragility not of satellites themselves, but of the signals they broadcast. By the time the radio signals from a GPS satellite reach Earth from thousands of miles up, they can be easily overridden by a stronger signal broadcast on the same frequency. Simple GPS jammers sell online for $119, but they have a short reach. Militaries appear to be acquiring much more powerful jamming technologies. In 2016, roughly 1,000 planes and 700 vessels at sea reportedly experienced problems with their GPS signals near North Korea, which is believed to have purchased Russian jammers that can be mounted on trucks. Those devices have an effective radius of 30 to 60 miles. The US seems to possess similar technology; a test that went awry near a Navy base in San Diego in 2007 knocked out GPS signals to cell phone network operators for at least two hours. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT More troubling than simple jamming, though, is the rise of “spoofing,” which overrides correct GPS data with a more powerful localized signal that delivers false information to a receiver. In 2013 a team of researchers from the University of Texas at Austin successfully led astray an $80 million yacht in the Mediterranean, overpowering its GPS receivers and sending it onto a new course. The dirty truth about spoofing is that secure channels are no defense against it. “Even our encrypted military GPS receivers can be spoofed,” Harrison says. SHELTON, WHO RETIRED in 2014 after 38 years in the Air Force, lives not far from 2Sops in Colorado; these days he chairs an educational and advocacy nonprofit called the Space Foundation. He still expends a lot of energy worrying about what is happening in the heavens. “We as a nation have been too slow to respond to this threat,” he says. He’s particularly troubled by the failure of the US to procure new space systems. Some GPS satellites are older than the people running them. “Our systems are archaic,” Shelton says. “Because space assets are so expensive, we deploy ‘just enough’; there’s no backup or excess capability.” (The Air Force noted that the GPS constellation consists of more than 30 satellites, which provides some redundancy.) China, by contrast, is investing heavily in its space program, seeing it as a symbol of its growing prominence. As soon as this year, it could land a craft on the never-before-touched far side of the moon. And China’s global navigation satellite system, known as BeiDou, has some capabilities that outmatch even the United States’ GPS. In 2015, China created a new space-­focused military service, known as the People’s Liberation Army Strategic Support Force. Meanwhile, the US relies entirely on Russian rockets to get its astronauts to the Space Station (although NASA has awarded contracts to Boeing and SpaceX to fix that). As Cheng says, “Today China is one of two countries that can put a person into space—and the other country isn’t the United States.” Many of America’s space warriors, as they call themselves, share Shelton’s sense that the US isn’t responding nearly quickly enough to the threat of orbital war. “We needed to be marching faster,” says Deborah Lee James, who served as President Obama’s secretary of the Air Force. “Why aren’t there more space and cyber officers at the top of the Air Force?” Deadly Debris In orbit, trash becomes shrapnel. When objects in space collide—whether by accident or because, say, someone down on Earth has decided to launch a missile at a satellite—it sometimes creates a hail of smaller fragments that fan out across Earth’s orbit. It’s already getting difficult to operate satellites and conduct launches amid all the junk zipping around up there. That’s why, around the world, scientists and engineers are devising ways to pull space junk out of orbit. In April, a SpaceX rocket carried a collection of experimental debris-removal technologies to the International Space Station. During its time in orbit, the satellite will test out nets, harpoons, and drag sails designed to reduce detritus. — Saraswati Rathod 20,000 Pieces of space debris larger than a softball — 500,000 Pieces of debris the size of a marble or larger — 4,300 Number of satellites in space — 72 Percent of satellites that are non­functioning — $1.4 billion Cost of degradation to commercial satellites caused by debris — 2,000 Number of trackable fragments created by the last major satellite collision in 2009 — 160 million Estimated number of pieces of space junk too small to be tracked — Sources: European Space Agency; NASA; Aerospace Corporation Addressing these issues, as James’ question suggests, is not just about throwing money at the space-industrial complex. It involves organizational changes too. The Air Force is building what it calls the nation’s first Space Mission Force, made up of airmen trained to respond to the demands of an orbital war. On the same base as the 2Sops command center, the military has established the National Space Defense Center, which puts representatives from various military and intelligence offices focused on space under a single roof. And the defense authorization bill is full of upgrades to the Air Force’s space-­fighting capabilities, including the creation of an additional Air Force unit responsible for space warfighting operations. Not content to tinker with the Air Force, a growing number of people in Washington—including the commander in chief—have to come to favor creating an entire new military branch dedicated to space operations. In May, during a ceremony honoring West Point’s football team, President Trump told his audience, “We’re getting very big in space, both militarily and for other reasons, and we are seriously thinking of the Space Force.” The comment sounded to many listeners like yet another oddball Trumpian tangent. But then, after reportedly meeting resistance from the Air Force, Trump escalated. At a mid-June meeting of the newly constituted US Space Council, he announced—much to the surprise of his own advisors and the military itself—that he was ordering the Pentagon to move forward. As he said, “I’m hereby directing the Department of Defense and Pentagon to immediately begin the process necessary to establish a Space Force as the sixth branch of the Armed Forces. That’s a big statement. We are going to have the Air Force and we are going to have the Space Force—separate but equal. It’s going to be something.” The Space Force is, of course, not a fait accompli. Any military reorganization has to be approved by Congress—which is not necessarily an easy path. (Last year, a bill that included the creation of just such a new branch of the military passed the US House of Representatives, but that provision was taken out of the Senate version.) And the establishment of a new branch of the military involves a vast set of logistical and structural questions. Yet Trump’s push may speed up a natural evolution toward an independent space branch by years, if not a decade. Space, the president said, was “going to be important monetarily and militarily. We don’t want China and Russia and other countries leading us. We’ve always led.” But where—and to what—are we leading? Part of the challenge in figuring out how to think about space conflict is the sheer complexity of the orbital environment—an arena that has long belonged to nation-states, but that is increasingly becoming a domain of commerce and tourism. How do countries protect their interests up above—and down here? Right now, countries appear to be racing to build their military capabilities—but an arms race isn’t the only answer. The last time an arms race appeared poised to overtake space, the world’s superpowers banded together to sign the 1967 Outer Space Treaty, which banned weapons of mass destruction in space and held that “the moon and other celestial bodies” should be reserved for peaceful purposes. The Outer Space Treaty is still in force, but it is by now full of holes. Legal scholars had a hard time proving that China’s 2007 anti-­satellite test, for instance, violated the agreement. That’s because the missile that China fired was not technically addressed in the 50-year-old treaty. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT Part of what makes space such volatile terrain right now is that it’s hard even to apply the existing laws of war to it. No country can claim sovereignty in orbit, and it’s impossible to occupy territory there. So what counts as an act of territorial aggression? What qualifies as a proportional response? It’s even difficult to say, with certainty, what the physics of war in space will look like. We don’t well understand, for instance, how a kinetic attack on a satellite constellation might spill over into a spiraling Kessler effect. Humans have “millennia of experience in blowing up things on land,” says Laurie Blank, a law professor at Emory University and a specialist in the laws of armed conflict. “We’re still learning the consequences of all these things in space.” Blank recently joined together with an international team of legal experts to create what they’re calling the Woomera Manual on the International Law of Military Space Operations—a kind of rule book for celestial international conflict, one that will endeavor to translate the laws of terrestrial war for space. It’s a daunting task, and the resulting document will be nonbinding. But, Blank says, it’s a necessary first step for anyone who would seek to contain a conflict that has, in some senses, already begun.

#### Alternatives are impossible – plan destroys GPS

Hambling ’20 [By David Hambling 4th October 2020, What would the world do without GPS?, <https://www.bbc.com/future/article/20201002-would-the-world-cope-without-gps-satellite-navigation>,] [SS]

We really would be lost without satellite navigation. But is there anything out there that could replace it? And how might we cope without this ubiquitous system? A loss of satellite navigation for five days would cost the UK alone more than £5.1bn ($6.5bn) , according to an assessment by the London School of Economics for the British Government. A failure of the GPS system would also cost the US economy an estimated $1bn (£760m) a day, and up to $1.5bn (£1.1bn) a day if it occurred during planting season for farmers in April and May. But GPS outages are surprisingly common – the military regularly jams it in certain areas while testing equipment or during military exercises. The US Government also regularly performs tests and exercises that lead to disruption of the satellite signal, but also some technical problems lead to worldwide issues. There are, of course, other global navigation satellite systems available – the Russian Glonass, Europe’s Galileo and China’s BeiDou all work on a similar basis to GPS. But increasingly, interference or deliberate jamming can also lead to interruptions in the signals from satellite positioning systems. You might also like: The clocks that rule our world Why it’s not surprising that ships collide Why north is always at the top of maps “The military are coming up against jamming quite frequently now,” says Charley Curry, fellow of the Royal Institute of Navigation and founder of Chronos Technology, which works in this field. The military has especially good reason to be worried. Satellite navigation was originally developed by the Pentagon, and now guides everything from strategic drones and warships down to individual smart bombs and foot soldiers. And it is under threat. A massive solar storm, one like the Carrington Event of 1859, could bring down the entire GPS satellite network Criminals also use GPS jammers, easily bought online, to foil the systems used to track stolen cars, not caring who else is affected in the surrounding area. And there are bigger dangers. “There is also the remote threat that the whole GPS constellation could be rendered inoperable in the initial salvo of a war targeting the US economy by attacking critical infrastructure,” says Humphreys. Natural forces could be similarly disastrous. A massive solar storm, one like the Carrington Event of 1859, could bring down the entire GPS satellite network as surely as a military strike. But if GPS and its international cousins were to suddenly disappear – what alternatives could we turn to in an attempt to keep all our world moving? One possible backup for GPS is a new version of Long Range Navigation (Loran), which was developed during World War Two to guide allied ships while they were crossing the Atlantic. Instead of satellites, however, it consisted of ground-based transmitters with 200-metre (660-feet) tall aerial masts broadcasting radio navigation signals. While good old fashioned maps can help us find our way, many aspects of our modern lives would cease to function without GPS (Credit: Alamy) While good old fashioned maps can help us find our way, many aspects of our modern lives would cease to function without GPS (Credit: Alamy) At first Loran was only accurate to within a few miles, but by the 1970s it could give a location within a few hundred metres. The UK and other countries decommissioned their Loran transmitters in the 2000s when GPS made them redundant, but a modern, enhanced version, known as eLoran could be as accurate as GPS. It uses more advanced transmitters and receivers than the original version, along with a technique known as differential correction – where the signal is monitored by reference stations and corrected – to improve its accuracy. This enhanced version is reportedly capable of pinpointing locations to an accuracy of less than 10m (32 feet). Unlike GPS, it is also able to penetrate buildings and tunnels – primarily because it uses a lower frequency and higher power than satellite signals. The powerful eLoran signals are much harder to jam and there are no vulnerable satellites. But someone would have to fund it. “eLoran is a great technology that could fill nationwide gaps,” says Humphreys, adding “**if there were a commitment** to setting it up and maintaining it”. Other approaches do not require additional infrastructure. Long before radio, sailors navigated with the aid of the sun and stars, using a sextant to measure the angles between them. Celestial navigation continued into the modern age. And surprisingly enough, ballistic missiles like Trident still use astro-navigation during flight. By using fixes from stars it is possible to pinpoint a location on Earth to within a thousand metres or so. Having large numbers of fast-moving objects to get bearings on means that Skymark can achieve greater accuracy than was possible with slow-moving stars But US company Draper Laboratory has developed a new generation of celestial navigation known as Skymark which uses a small, automated telescope to track satellites, the International Space Station and other objects orbiting the Earth along with the stars. Having large numbers of fast-moving objects to get bearings on means that Skymark can achieve greater accuracy than was possible with slow-moving stars. Skymark uses a database of visible satellites – both working satellites and space junk – and has a claimed accuracy of 15m (49ft), making it almost as good as GPS. At times it is capable of greater accuracy, but this depends on how many of these satellites can be seen at once, says Benjamin Lane, group leader of advanced position, navigation and timing instrumentation at Draper. “The best accuracy for celestial navigation with certainty is within a couple of meters,” he says. “One limitation is the size of the satellite references.” Another drawback is that it only works with a clear view of the sky. Using infrared light rather than visible light, which can pass more easily through haze and light cloud, helps a little, but in parts of the northern and southern hemisphere where thick cloud and grey-skies are more common, it is likely to be less useful. Tracking fast moving satellites like the International Space Station has helped to improve the accuracy of celestial navigation (Credit: Alamy) Tracking fast moving satellites like the International Space Station has helped to improve the accuracy of celestial navigation (Credit: Alamy) Perhaps a more day-to-day option might be inertial navigation, which uses a set of accelerometers to work out the exact speed and direction that a vehicle is travelling in to calculate its position. Basic versions are already in common use. “When your car goes into a tunnel and you lose the GPS signal, it’s inertial navigation that keeps your position updated,” says Curry. The problem with inertial navigation is “drift” – the calculated position gets less accurate over time as errors build up, so the inertial navigator in your car is only useful for short GPS interruptions. Drift could be overcome with quantum sensors thousands of times more sensitive than existing devices. In the quantum world, atoms and particles start to behave as both matter and waves, and acceleration alters the properties of this behaviour. French company iXBlue is using this technique to build a device to rival GPS precision, and a team from Imperial College London, working with laser specialists M Squared, demonstrated a prototype portable quantum accelerometer in 2018. The US Department of Transport is now holding a competition to select possible backups for GPS Such quantum sensors are still confined to laboratories and are years away from a usable end product. Optical navigation, in which automated systems with cameras use landmarks like buildings and road junctions, may be with us much sooner. An early version, known as Digital Scene Matching, was developed for cruise missiles. ImageNav, developed by Scientific Systems for the US Air Force, is a modern optical navigation system for aircraft. It has a terrain database of the area being navigated and matches it with input from video cameras to work out its location. ImageNav has been successfully tested on a number of aircraft, but could also find uses in self-driving vehicles. Swedish company Everdrone also recently carried out the first drone delivery between hospitals without using GPS. Their system uses a combination of optical flow – measuring speed by the rate of which scenery passes below – and landmark identification to find its way from point to point with GPS-like precision. Of course, this method relies on have a complete and accurate image database of the area you are navigating, which is likely to require a lot of memory and frequent updates. Inertial navigation is what takes over when in-car navigation devices lose the GPS signal inside tunnels (Credit: Alamy) Inertial navigation is what takes over when in-car navigation devices lose the GPS signal inside tunnels (Credit: Alamy) The UK is developing a backup system for the timing synchronisation services that GPS provides in the form of The National Timing Centre program, the first such national service in the world. When it becomes operational in 2025, it will involve sets of precise atomic clocks at distributed, secure locations across the UK, providing timing signals via cable and radio services. The idea is that if satellite signals go down, there is no single vulnerable centre that could be brought down by an accident, technical glitch or cyberattack. Ultimately no single system may be able to replace the power of satellite navigation systems such as GPS, and we may end up with a mix-and-match of different solutions for ships, planes and cars. The US Department of Transport is now holding a competition to select possible backups for GPS. There is a real question though over whether any alternative will be in place soon enough. “There’s now an awareness of the problem, but things are still moving at glacial speed,” says Curry. We are becoming ever more reliant on accurate navigation. Self-driving cars, delivery drones, and flying taxis are expected to appear on and above our roads over the next decade. All of them will be dependent on GPS. As Curry notes, one person with a powerful jammer in a could knock out GPS across an area the size of London from the right place. Unless adequate backup systems are developed, in the future whole cities might grind to a halt at the flick of a switch. When satellite navigation was jammed at Israel’s Ben Gurion airport last year, only the skill of the air traffic controllers prevented serious accidents. The jamming was apparently accidental, originating with Russian forces fighting in Syria, but it highlighted just how dangerous interruptions to the global positioning system – better known as GPS – can be. “There is a growing recognition of the need to protect, toughen, and augment GPS,” says Todd Humphreys, a communications engineer at the University of Texas, Austin. GPS now underpins a surprising amount of our everyday lives. In its simplest form it tells us where on Earth at any time a GPS receiver is. We have them in our mobile phones and cars. They enable boats to navigate their way through difficult channels and reefs, like a modern-day lighthouse. Emergency services now rely upon GPS to locate those in distress. Less obviously, ports would cease to operate, as their cranes need GPS to find the right container to move, and they play a crucial role in logistics operations, allowing car manufacturers and supermarkets to take advantage of just-in-time delivery systems. Without it, our supermarket shelves would be emptier and prices would be higher. The construction industry uses GPS when surveying and fishermen use it to comply with strict regulations, But GPS is not only about identifying locations, it is also about time. The constellation of 30 satellites held in orbit around the Earth all use multiple, extremely precise atomic clocks to synchronise their signals. They allow users to determine the time to within 100 billionths of a second. Mobile phone networks all use GPS time to synchronise their base stations, while financial and banking institutions rely upon it to ensure trades and transfers occur correctly.

#### The aff guts heg – squo GPS is lagging behind and vulnerable – GPS 3 solves the impact – better precision, new algorithms prevent hackig

Arroyo 20 – innovation and technology researcher at sacyr [Isabel, “THE NEW GENERATION OF SATELLITES TO OUTPERFORM GPS “https://www.sacyr.com/en/-/la-nueva-generacion-de-satelites-para-superar-al-gps

The most universal geopositioning system, the GPS (Global Positioning System), is beginning to show signs of wear and tear. Designed in the 1960s by the United States Department of Defence, it has become practically omnipresent in our daily lives. Since it began directing our routes through the first portable navigators available for cars, GPS has become a fundamental tool for air, land and sea navigation, but also for crop planning, natural disaster relief missions and even for playing Pokémon Go. Its functionalities, however, are no longer so precise and current requirements have exposed its limitations, opening the way to solutions that seek t=o improve and even replace the system.

The first operational GPS satellite was launched in 1978 after years of testing and the efforts of scientists from MIT (Massachusetts Institute of Technology), by means of which it was possible to track objects on the planet’s surface using satellites. The system is composed of three elements: the satellites in orbit around the Earth, the terrestrial monitoring and control stations, and the GPS receivers that users have. In total, a constellation of 24 satellites—plus some reserve satellites—orbiting the Earth at an approximate altitude of 20,200 kilometres providing precise time and location signals at any time and place in the world.

A new generation of satellites

But this precision is often far from accurate. For safety reasons, GPS microwave signals that are generated for civilian use are deliberately degraded, while their broadcast is restricted to a certain frequency. These small errors, however, have been corrected to some extent by the incorporation of differential techniques (DGPS), which provide GPS receivers with corrections to data received from satellites, for greater accuracy in the calculated position.

Another of the deficiencies inherent in this geopositioning system has been its vulnerability. Its signals can be interfered with, making it impossible for the receiver to hear them, and can even be replaced by false ones. For example, North Korea has tried on several occasions to block the GPS system in South Korea, according to The New York Times. Also the elements of the system (satellites, ground control stations and receivers) are exposed to cyberattacks, and there is even specific equipment designed to block GPS transmissions, which could cause a major security problem for governments and countries.

With these limitations, the need to improve and perhaps even replace the system has become essential. The U.S. government, which owns the technology, has already launched a coordinated initiative to improve it that incorporates three elements: the GPS OCX control system, the new GPS III satellites and the MGUE (Military Gps User Equipment) receivers.

With the GPS OCX program, Raytheon, the company in charge of the development, seeks to make the ground control system more robust and less vulnerable. To this end, it is implementing new software based on a mathematical algorithm to improve reception in noisy environments. Together with the new generation of satellites, this will make it possible to increase coverage in areas of difficult access, such as urban canyons and mountainous terrain. In addition, new encryption is being used to prevent signals from being interfered with. The amount invested in the project amounts to 4.2 billion dollars, according to the Defense One portal.

To improve the accuracy of its navigation system, the United States has also launched the GPS III satellites. Aerospace company Lockheed Martin, which is developing this new generation of satellites, states that they will be three times more accurate than their predecessors and are designed to avoid possible interference. In addition, their life will be extended to 15 years, "25% longer than the newest GPS satellites in orbit today." Three such satellites have already been launched. The last one was launched this year by the company Space X.

#### Readiness solves every threat – decline emboldens rivals and causes miscalc with Russia and China which goes nuclear.

Hal Brands 18. Henry A. Kissinger Distinguished Professor of Global Affairs at the Johns Hopkins University School of Advanced International Studies, Senior Fellow at the Center for Strategic and Budgetary Assessments and the Foreign Policy Research Institute, Ph.D. in history from Yale University. “Chapter 6: Does America Have Enough Hard Power?” American Grand Strategy in the Age of Trump; pp. 129-133.

Much contemporary commentary favors the first option—reducing commitments—and denounces the third as financially ruinous and perhaps impossible.5 Yet significantly expanding American capabilities would not be nearly as economically onerous as it may seem. Compared to the alternatives, in fact, this approach represents the best option for sustaining American primacy and preventing a slide into strategic bankruptcy that will eventually be punished. 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 States 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. Second, the international outlaws are no longer so weak. North Korea’s conventional forces have atrophied, but it has amassed a growing nuclear arsenal and is developing an intercontinental delivery capability that will soon allow it to threaten not just America’s regional allies but also the continental United States.12 Iran remains a nuclear threshold state, one that continues to develop ballistic missiles and A2/AD capabilities while employing sectarian and proxy forces across the Middle East. The Islamic State, for its part, is headed for defeat, but has displayed military capabilities unprecedented for any terrorist group, and shown that counterterrorism will continue to place significant operational demands on U.S. forces whether in this context or in others. Rogue actors have long preoccupied American planners, but the rogues are now more capable than at any time in decades. Third, the democratization of technology has allowed more actors to contest American superiority in dangerous ways. The spread of antisatellite and cyberwarfare capabilities; the proliferation of man-portable air defense systems and ballistic missiles; the increasing availability of key elements of the precision-strike complex— these phenomena have had a military leveling effect by giving weaker actors capabilities which were formerly unique to technologically advanced states. As such technologies “proliferate worldwide,” Air Force Chief of Staff General David Goldfein commented in 2016, “the technology and capability gaps between America and our adversaries are closing dangerously fast.”13 Indeed, as these capabilities spread, fourth-generation systems (such as F-15s and F-16s) may provide decreasing utility against even non-great-power competitors, and far more fifth-generation capabilities may be needed to perpetuate American overmatch. Finally, the number of challenges has multiplied. During the 1990s and early 2000s, Washington faced rogue states and jihadist extremism—but not intense great-power rivalry. America faced conflicts in the Middle East—but East Asia and Europe were comparatively secure. Now, the old threats still exist—but the more permissive conditions have vanished. The United States confronts rogue states, lethal jihadist organizations, and great-power competition; there are severe challenges in all three Eurasian theaters. “I don’t recall a time when we have been confronted with a more diverse array of threats, whether it’s the nation state threats posed by Russia and China and particularly their substantial nuclear capabilities, or non-nation states of the likes of ISIL, Al Qaida, etc.,” Director of National Intelligence James Clapper commented in 2016. Trends in the strategic landscape constituted a veritable “litany of doom.”14 The United States thus faces not just more significant, but also more numerous, challenges to its military dominance than it has for at least a quarter century.

#### Unipolarity is sustainable but transition risks extinction

Michael Beckley 18. Professor of political science at Tufts. *Unrivaled: Why America Will Remain the World’s Sole Superpower*. Cornell University Press. 1-2.

Yet in terms of wealth and military capabilities—the pillars of global power—the United States is in a league of its own. With only 5 percent of the world’s population, the United States accounts for 25 percent of global wealth, 35 percent of world innovation, and 40 percent of global military spending. 4 It is home to nearly 600 of the world’s 2,000 most proﬁ table companies and 50 of the top 100 universities. 5 And it is the only country that can ﬁght major wars beyond its home region and strike targets anywhere on earth within an hour, with 587 bases scattered across 42 countries and a navy and air force stronger than that of the next ten nations combined. 6 According to Yale historian Paul Kennedy, “Nothing has ever existed like this disparity of power; nothing.” The United States is, quite simply, “the greatest superpower ever.” 7 Why is the United States so dominant? And how long will this imbalance of power last? In the following pages, I argue that the United States will remain the world’s sole superpower for many decades, and probably throughout this century. We are not living in a transitional post–Cold War era. Instead, we are in the midst of what could be called the unipolar era—a period as profound as any epoch in modern history. This conclusion challenges the conventional wisdom among pundits, policymakers, and the public. 8 Since the end of the Cold War, scholars have dismissed unipolarity as a ﬂeeting “moment” that would soon be swept away by the rise of new powers. 9 Bookstores feature bestsellers such as The Post-American World and Easternization: Asia’s Rise and America’s Decline ; 10 the U.S. National Intelligence Council has issued multiple reports advising the president to prepare the country for multipolarity by 2030; 11 and the “rise of China” has been the most read-about news story of the twenty-ﬁ rst century. 12 These writings, in turn, have shaped public opinion: polls show that most people in most countries think that China is overtaking the United States as the world’s leading power. 13 How can all of these people be wrong? I argue that the current literature suffers from two shortcomings that distort peoples’ perceptions of the balance of power. First, the literature mismeasures power. Most studies size up countries using gross indicators of economic and military resources, such as gross domestic product (GDP) and military spending. 14 These indicators tally countries’ resources without deducting the costs countries pay to police, protect, and provide services for their people. As a result, standard indicators exaggerate the wealth and military power of poor, populous countries like China and India—these countries produce vast output and ﬁeld large armies, but they also bear massive welfare and security burdens that drain their resources. To account for these costs, I measure power in net rather than gross terms. In essence, I create a balance sheet for each country: assets go on one side of the ledger, liabilities go on the other, and net resources are calculated by subtracting the latter from the former. When this is done, it becomes clear that America’s economic and military lead over other countries is much larger than typically assumed—and the trends are mostly in its favor. Second, many projections of U.S. power are based on ﬂawed notions about why great powers rise and fall. Much of the literature assumes that great powers have predictable life spans and that the more powerful a country becomes the more it suffers from crippling ailments that doom it to decline. 15 The Habsburg, French, and British empires all collapsed. It is therefore natural to assume that the American empire is also destined for the dustbin of history. I argue, however, that the laws of history do not apply today. The United States is not like other great powers. Rather, it enjoys a unique set of geographic, demographic, and institutional advantages that translate into a commanding geopolitical position. The United States does not rank ﬁrst in all sources of national strength, but it scores highly across the board, whereas all of its potential rivals suffer from critical weaknesses. The United States thus has the best prospects of any nation to amass wealth and military power in the decades ahead. For the foreseeable future, therefore, no country is likely to acquire the means to challenge the United States for global primacy. This is an extraordinary development, because the world has been plagued by great power rivalry for millennia. In the past ﬁve hundred years alone, there have been sixteen hegemonic rivalries between a ruling power and a rising power, and twelve of them ended in catastrophic wars. 16 In the ﬁrst half of the twentieth century, for example, when the world was multipolar, Germany twice challenged Britain for European primacy. The result was two world wars. In the second half of the twentieth century, under bipolarity, the Soviet Union challenged the United States for global primacy. The result was the Cold War, a conﬂict in which the superpowers spent between 6 and 25 percent of their GDPs on defense every year, waged proxy wars that killed millions of people, and brought the world to the brink of nuclear Armageddon.

## Case

### NC – Top

#### Frame – the aff links to every single 1AC card about the benefits of satellites because they ELIMINATE them. The aff takes down all satellites and is indistinguishable from an EMP that renders our satellites useless.

#### If anything, miscalc would be 20 times worse during the process of taking down the satellites. This is magnified by the fact that ZERO 1AC cards conclude aff / advocate for a ban.

### NC – AT: Cyberattacks

#### GPS 3F solves jamming

1AC Strout 1/9 [What will the US Space Force be able to do with its new GPS III variant? By Nathan Strout , January 9 2022, Nathan Strout is the staff editor at C4ISRNET where he covers the intelligence community., <https://www.defensenews.com/battlefield-tech/space/2022/01/09/what-will-the-us-space-force-be-able-to-do-with-its-new-gps-iii-variant/>] [SS]

WASHINGTON — The U.S. Space Force has yet to launch all of the GPS III satellites at its disposal, but work on new, more powerful versions is already underway. New GPS III Follow-on satellites — or GPS IIIF for short — will continue to improve the constellation’s accuracy and protection against jamming. GPS III satellites are already a substantial upgrade to the current constellation, providing three times greater accuracy and eight times better anti-jamming capability than their predecessors. In addition to introducing a new civil signal that is compatible with other navigation satellite systems, the five GPS III satellites on orbit completed the space component of M-code — an even more secure and accurate signal for military use. The Space Force has launched five of the planned GPS III satellites, and three more have been declared “available for launch” but are waiting in storage with prime contractor Lockheed Martin. The remaining two are undergoing testing. The Space Force has a contract with Lockheed for up to 22 GPS IIIF satellites. The service already exercised contract options for seven GPS IIIF satellites, with the most recent award taking place in October 2021, when Space Systems Command issued $737 million to the company for three more satellites. GPS IIIF satellites will be more advanced than their predecessors. Most notably, the new space systems will prove a new Regional Military Protection capability, a steerable M-code signal that can concentrate the effect in a specified region. RMP can provide up to 60 times greater anti-jamming measures, helping ensure soldiers can access critical position, navigation and timing data in contested environments. Other new features include a laser retroreflector array to increase accuracy; an upgraded nuclear detection detonation system payload; and a search and rescue payload. Starting with the third GPS IIIF space vehicle, the satellites will be built with Lockheed’s LM2100 Combat Bus, specifically designed for military use. The company claims its new bus, which will also be used for the Space Force’s next missile warning satellites, will have greater resiliency and cyber protections, more power, and better propulsion. And thanks to a new port option on the LM2100 bus, it could be possible to upgrade GPS IIIF satellites on orbit. The company’s Augmentation System Port Interface essentially works as a USB port for the satellite, allowing the Space Force to launch new payloads into space that can be plugged into the system.

#### GPS III is the gold standard – solves jamming and accuracy – third party testing and verification proves safety via extensive research – turns the whole case

Lye 20 – [Harry, “GPS III is the ‘gold-standard’ for US military: Draper,” https://www.airforce-technology.com/features/gps-iii-is-the-gold-standard-for-us-military-draper/]

GPS III satellites are on the way, with regular launches inching the constellation closer to service satellite by satellite and promising a dramatic increase in accuracy for the US military, its allies and civilian users across the globe.

The newest satellites, built by Lockheed Martin, are three times as accurate and feature increased hardening against jamming and interference from the environment or adversaries. On top of this GPS III is designed with a new civilian signal built in.

The future constellation is set to be made up of 32 satellites; ten GPS III, and 22 GPS IIIF follow-on satellites designed to expand the capabilities of the system.

A key process from development to launch is testing and validation. Non-profit Draper forms a key role in this chain assessing the function of each satellite from the ground to orbit and assuring it meets the operational requirements.

Pathway to launch

A crucial step in the development, launch, and operation of GPS III is the testing and validation process, which begins on the ground with simulators and follow through till post-launch checks, and handover to the newly formed US Space Force.

Draper programme manager Jan Anszperger explained to Air Force Technology how the process of testing and validating GPS III satellites works as part of a testing team with SRI International and MITRE.

Anszperger says that Draper monitors the satellites 24/7, providing testing and validation capabilities for both satellites and ground systems across both a software and hardware perspective to ensure all aspects of the satellite function as they should.

Work on testing a satellite requires years of work beforehand. Draper filled a similar role with the testing and validation of the first GPS III completed in 2019, but work began years before.

Anszperger explains: “We completed the testing of the first GPS III satellite; that was completed in 2019. But the work for that started about eight years prior, testing some of the algorithms. We test the software, using simulators prior to that, all the way up to a pre-launch test at Cape Canaveral in which we validate that the satellite still meets all requirements and didn’t, to use the term loosely, ‘break’ in transport from the factory to Cape Canaveral.”

Once launched and activated, Draper then supported a six-month validation test to assure that the satellite meets the operation requirements, established initially by the US Air Force, and now by the US Space Force.

A key part of testing is done through satellite simulators, which mirror how the satellite is designed to operate and function on the ground.

Anszperger says: “Lockheed Martin, which is the prime for GPS III, in addition to building the satellites, they do build satellite simulators which are the functional equivalent of a satellite but it sits in a room.

“It’s plugged in the wall; it does not have any fuel in it. It may in fact, and usually does, look like a rack of equipment rather than looking like a satellite. All of the software that runs on the satellite is tested in the satellite simulators. We have an extremely high level of confidence that the simulator is, in fact, an extremely accurate rendition of the satellite itself.”

#### Space militarization and GPS replacement are inevitable post plan – and the card is equivocal at best about militarization

Atherton ’18 [GPS III and the demands of a dangerous new space age, <https://www.c4isrnet.com/c2-comms/satellites/2018/12/24/gps-iii-and-the-demands-of-a-dangerous-new-space-age/>, Kelsey Atherton, 12/24/18] [SS]

CAPE CANAVERAL — After an aborted launch Tues., Dec. 18, SpaceX’s Falcon 9 rocket successfully carried its payload into orbit Sun., Dec. 23. With the launch begins the installation of a new constellation of GPS satellites and a looming question over the entire enterprise: Can communications in space be secured by good satellite design alone? “Launch is always a monumental event, and especially so since this is the first GPS satellite of its generation launched on SpaceX’s first national security space mission. As more GPS III satellites join the constellation, it will bring better service at a lower cost to a technology that is now fully woven into the fabric of any modern civilization,” Lt. Gen. John F. Thompson, commander of the Space and Missile Systems Center and Air Force program executive officer for space, said in a released statement. “It keeps GPS the gold standard for positioning, navigation and timing information, giving assured access when and where it matters. This event was a capstone, but it doesn’t mean we’re done. We’re going to run a series of procedures for checkout and test to ensure everything on Vespucci functions as it was designed.” The day the launch was aborted, Vice President Mike Pence announced that the president had signed an order to create U.S. Space Command, a sign that maybe design alone is insufficient for stability in orbit. The memorandum assigns to Space Command, among other responsibilities, “the space‑related responsibilities previously assigned to the Commander, United States Strategic Command.” A Space Command previously existed from 1985 through 2002, when it was reorganized and its responsibilities were folded into Strategic Command. Worth noting, too, is that this is a distinct move from the possible creation of a distinct Space Force as an independent branch. In the meantime, as the administration **debates** how and if it wants to transfer from a subtle to an explicit militarization of space, the satellites are going into orbit. GPS III satellites, made by Lockheed Martin, cost $577 million apiece for the first 10. The program’s costs continue to rise, so that unit price may inch upward. Each satellite is over half-a-billion dollars of vital asset, as expense as a half-dozen F-35As. When the Air Force talks about the alternatives it’s developing to GPS constellations, the conversation is often about finding ways to achieve the same effect without the singularly large expensive vulnerable targets. If there is a Plan B for GPS, it might be in clouds of smaller satellites. But GPS III remains Plan A and, for Plan A to work, it has to survive in an increasingly hostile orbit. Here is the threat environment faced by satellites: The United States and China have both destroyed deorbiting satellites of their own with missiles and other nations are developing missiles that might be capable of shooting down satellites. To the extent that a vulnerability to missiles is managed, it is managed by deterrence, the threat of retaliation and the uncontrolled danger that debris in orbit poses to all satellites. Yet it’s the nonkinetic attacks that remain the likely vulnerability and pathway into disrupting the functions of a satellite network. To that end, Lockheed Martin and the Air Force boast that the GPS III satellite has up to eight times improved anti-jamming capabilities, a metric that reveals the threat environment far more than it describes the measures taken against it. Reached for comment, Lockheed Martin decline to comment on what, exactly, was eight-times improved. Adversaries who want to degrade the usefulness of GPS can do so in a variety of ways, and most of them involve obscuring or interfering with the signal. Nations such as Iran and North Korea, as well as expected players China and Russia, have **electronic warfare capabilities** that can interfere with the signals from commercial satellites, though their capability against existing and future military satellites is unknown. Cyber means of satellite interference were demonstrated by the Tamil Tigers in 2007, and other **nonstate actors** may also be able to interfere in a similar way, though one hopes cybersecurity for satellites has improved in the decade since. **Spoofing** signals can also fool GPS receivers into following false and deliberately malicious coordinates. What GPS III’s anti-jamming capabilities acknowledge is that electronic warfare is hardly a terrestrial-only affair. The moves toward a Space Force, a unified Space Command and, even more ominously, an Air Force that declares space a “war-fighting domain” acknowledge the vulnerability of satellites to a variety of means of interference, disruption or destruction poses real security risks to the military narrowly and the functioning of the modern world broadly. What is yet to be determined is if space, like cyber before it, will remain primarily a domain of espionage, surveillance, reconnaissance and electronic warfare, with the satellites regarded as physically inviolate nodes. The alternative is the space becomes a domain for kinetic war fighting, with massive, powerful, **jamming resistant satellites a target for destructive missiles** or other physical means. However it plays out, from the unified Space Command to the launch of GPS III, 2018 marks a change in how the United States views the role of the military in space. What remains to be seen is if the change is durable and how the rest of the world adapts.

#### Chung takes out the aff – proves cyberattacks are inevitable and don’t escalate.

### 1NC – AT: Space War

#### No space war – it’s hype and systems are redundant

Johnson-Freese and Hitchens 16 [Dr. Joan Johnson-Freese is a member of the Breaking Defense Board of Contributors, a Professor of National Security Affairs at the Naval War College and author of Space Warfare in the 21st Century: Arming the Heavens. Views expressed are those of the author alone. Theresa Hitchens is a Senior Research Scholar at the Center for International and Security Studies at Maryland (CISSM), and the former Director of the United Nations Institute for Disarmament Research (UNIDIR) in Geneva, Switzerland. Stop The Fearmongering Over War In Space: The Sky’s Not Falling, Part 1. December 27, 2016. https://breakingdefense.com/2016/12/stop-the-fearmongering-over-war-in-space-the-skys-not-falling-part-1/]

In the last two years, we’ve seen rising hysteria over a future war in space. Fanning the flames are not only dire assessments from the US military, but also breathless coverage from a cooperative and credulous press. This reporting doesn’t only muddy public debate over whether we really need expensive systems. It could also become a self-fulfilling prophecy. The irony is that nothing makes the currently slim possibility of war in space more likely than fearmongering over the threat of war in space.

Two television programs in the past two years show how egregious this fearmongering can get. In April 2015, the CBS show 60 Minutes ran a segment called “The Battle Above.” In an interview with General John Hyten, the then-chief of U.S. Air Force Space Command, it came across loud and clear that the United States was being forced to prepare for a battle in space — specifically against China — that it really didn’t want.

It was explained by Hyten and other guests that China is building a considerable amount of hardware and accumulating significant know-how regarding space, all threatening to space assets Americans depend on every day. If viewers weren’t frightened after watching the segment, it wasn’t for lack of trying on the part of CBS.

Using terms like “offensive counterspace” as a 1984 NewSpeak euphemism for “weapons,” it was made clear that the United States had no choice but to spend billions of dollars on offensive counterspace technology to not just thwart the Chinese threat, but control and dominate space. While it didn’t actually distort facts — just omit facts about current U.S. space capabilities — the segment was basically a cost-free commercial for the military-industrial complex.

In retrospect though, “The Battle Above” was pretty good compared to CNN’s recent special, War in Space: The Next Battlefield. The latter might as well have been called Sharknado in Space – because the only far-out weapons technology our potential adversaries don’t have, according to the broadcast, seems to be “sharks with frickin’ laser beams attached to their heads!”

First, CNN needs to hire some fact checkers. Saying “unlike its adversaries, the U.S. has not yet weaponized space” is deeply misleading, like saying “unlike his political opponents, President-Elect Donald Trump has not sprouted wings and flown away”: A few (admittedly alarming) weapons tests aside, no country in the world has yet weaponized space. Contrary to CNN, stock market transactions are not timed nor synchronized through GPS, but a closed system. Cruise missiles can find their targets even without GPS, because they have both GPS and precision inertial measurement units onboard, and IMUs don’t rely on satellite data. Oh, and the British rock group Pink Floyd holds the only claim to the Dark Side of the Moon: There is a “far side” of the Moon — the side always turned away from the Earth — but not a “dark side” — which would be a side always turned away from the Sun.

More nefariously, the segment sensationalized nuggets of truth within a barrage of half-truths, backed by a heavy bass, dramatic soundtrack (and gravelly-voiced reporter Jim Sciutto) and accompanied by sexy and scary visuals.

Make no mistake there are dangers in space, and the United States has the most to lose if space assets are lost. The question is how best to protect them. Here are a few facts CNN omitted.

The Reality

The U.S. has all of the technologies described on the CNN segment and deemed potentially offensive: maneuverable satellites, nano-satellites, lasers, jamming capabilities, robotic arms, ballistic missiles that can be used as anti-satellite weapons, etc. In fact, the United States is more technologically advanced than other countries in both military and commercial space.

That technological superiority scares other countries; just as the U.S. military space community is scared of other countries obtaining those technologies in the future. The U.S. military space budget is more than 10 times greater than that of all the countries in the world combined. That also causes other countries concern.

More unsettling still, the United States has long been leery of treaty-based efforts to constrain a potential arms race in outer space, as supported by nearly every other country in the world for decades. Indeed, under the administration of George W. Bush, the U.S. talking points centered on the mantra “there is no arms race in outer space,” so there is no need for diplomat instruments to constrain one. Now, a decade later, the U.S. military – backed by the Intelligence Community which operates the nation’s spy satellites – seems to be shouting to the rooftops that the United States is in danger of losing the space arms race already begun by its potential adversaries. The underlying assumption — a convenient one for advocates of more military spending — is that now there is nothing that diplomacy can do.

However, it must be remembered that most space-related technologies – with the exception of ballistic missiles and dedicated jammers – have both military and civil/commercial uses; both benign — indeed, helpful — and nefarious uses. For example, giving satellites the ability to maneuver on orbit can allow useful inspections of ailing satellites and possibly even repairs.

Further, the United States is not unable to protect its satellites, as repeated during the CNN broadcast by various interviewees and the host. Many U.S. government-owned satellites, including precious spy satellites, have capabilities to maneuver. Many are hardened against electro-magnetic pulse, sport “shutters” to protect optical “eyes” from solar flares and lasers, and use radio frequency hopping to resist jamming.

Offensive weapons, deployed on the ground to attack satellites, or in space, are not a silver bullet. To the contrary, U.S. deployment of such weapons may actually be detrimental to U.S. and international security in space (as we argued in a recent Atlantic Council publication, Towards a New National Security Space Strategy). Further, there are benefits to efforts started by the Obama Administration to find diplomatic tools to restrain and constrain dangerous military activities in space.

These diplomatic efforts, however, would be undercut by a full-out U.S. pursuit of “space dominance.” This includes dialogue with China, the lack of which Gen. William Shelton, retired commander of Air Force Space Command, lamented in the CNN report.

Given CNN’s “cast,” the spin was not surprising. Starting with Ghost Fleet author Peter Singer set the sensationalist tone, which never altered. The apocalyptic opening, inspired by Ghost Fleet, posited a scenario where all U.S. satellites are taken off-line in nearly one fell swoop. Unless we are talking about an alien invasion, that scenario is nigh on impossible. No potential adversary has such capabilities, nor will they ever likely do so. There is just too much redundancy in the system.

### 1NC – AT: US Sat Miscalc

#### No miscalc from satellite disruptions or ASAT attacks – empirically denied

Mazur 12 [Jonathan Mazur, Manager Engineering at Northrop Grumman, writing in Space & Defense, from the Eisenhower Center for Space and Defense Studies. Past U.S. Actions: Redlines in Space. Space & Defense, Volume 6, Number 1, Fall 2012. https://inss.ndu.edu/Portals/97/Space\_and\_Defense\_6\_1.pdf?ver=2018-09-06-135424-147]

U.S. Reactions To Foreign Disruption Of U.S. Capabilities

In the 1970s, it was suspected that a U.S. maritime communications satellite was turned off by the Soviets when it was outside of the range of U.S. tracking stations.25 There does not appear to be any documented U.S. reaction, and I suspect there was none. In the mid-1990s, satellite hackers in Brazil began hijacking U.S. military communication satellite signals to broadcast their own information, though it took until 2009 for Brazil to crack down on the illegal activity with the support of the DoD.26 In 1998, a U.S.-German satellite known as ROSAT was rendered useless after it turned suddenly toward the sun. NASA investigators later determined the accident was possibly linked to a cyber-intrusion by Russia.

The fallout? Though there was an ongoing criminal investigation as of 2008; NASA security officials have seemed dete

rmined to publicly minimize the seriousness of the threat.27 In 2003, a signal originating from Cuba—later determined to be coming from Iranian embassy property— was jamming a U.S. communications satellite that was transmitting Voice of America programming over Iran, which was publicly referred to as an “act of war” by a U.S. official. 28 Press reporting indicates the U.S. administration was [frozen]“paralyzed” about how to cope with the jamming that continued for at least a month, even after U.S. diplomatic protests to Cuba.29 In 2005, U.S. diplomats protested to the Libyan government after two international satellites were illegally jammed disrupting American diplomatic, military, and FBI communications.30 In 2006, press reporting indicates that China hit a U.S. spy satellite with a ground-based laser. This action was acknowledged by the then director of the NRO, though the DoD remained tight lipped about the incident.31

“We’re at a point where the technology’s out there, and the capability for people to do things to our satellites is there. I’m focused on it beyond any single event.” – Air Force Space Command Commander, General Chilton, 2006 32

In 2009, a U.S. commercial Iridium communications satellite—extensively used by the DoD—was accidently destroyed by a collision with a dead Russian satellite.33 The U.S. company, Iridium, was able to minimize any loss of service by implementing a network solution within a few days.34 As of early 2011, no legal action had been taken by the company either because it is not clear who was at fault or because it might be politically problematic for the United States, which is trying to enter into bi-lateral transparency and confidence-building measures (TCBM) with Russia regarding space activities.35 Since August of 2010, North Korea has been intermittently using GPS jamming equipment, which reportedly has been interfering with U.S. and South Korean military operations and civilian use south of the North Korean border.36 Reportedly, only South Korea and the United Nations International Telecommunications Union—at the request of South Korea—have issued letters to Pyongyang demanding the cessation of disruptive communications signals in South Korea.37

It appears that the only time the U.S. military has responded with force to a disruption in U.S. space capabilities was in 2003, a few days after the start of the Iraq war.38 According to U.S. officials, Iraq was using multiple GPS jammers—which supposedly did not affect military GPS functionality. However, the U.S. military bombed the jammers anyway after a diplomatic complaint to Russia.39 The use of military force against the GPS jamming threat was possibly because the United States was already intervening in Iraq, and the bombing probably would not have occurred if the United States was not at war.

### Debris Defense---1NC

#### No debris cascades, but even a worst case is confined to low LEO with no impact

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

Kessler Syndrome is overhyped. A chorus of online commenters great any news of upcoming low earth orbit satellites with worry that humanity will to lose access to space. I now think they are wrong.

What is Kessler Syndrome?

Here’s the popular view on Kessler Syndrome. Every once in a while, a piece of junk in space hits a satellite. This single impact destroys the satellite, and breaks off several thousand additional pieces. These new pieces now fly around space looking for other satellites to hit, and so exponentially multiply themselves over time, like a nuclear reaction, until a sphere of man-made debris surrounds the earth, and humanity no longer has access to space nor the benefits of satellites.

It is a dark picture.

Is Kessler Syndrome likely to happen?

I had to stop everything and spend an afternoon doing back-of-the-napkin math to know how big the threat is. To estimate, we need to know where the stuff in space is, how much mass is there, and how long it would take to deorbit.

The orbital area around earth can be broken down into four regions.

Low LEO - Up to about 400km. Things that orbit here burn up in the earth’s atmosphere quickly - between a few months to two years. The space station operates at the high end of this range. It loses about a kilometer of altitude a month and if not pushed higher every few months, would soon burn up. For all practical purposes, Low LEO doesn’t matter for Kessler Syndrome. If Low LEO was ever full of space junk, we’d just wait a year and a half, and the problem would be over.

High LEO - 400km to 2000km. This where most heavy satellites and most space junk orbits. The air is thin enough here that satellites only go down slowly, and they have a much farther distance to fall. It can take 50 years for stuff here to get down. This is where Kessler Syndrome could be an issue.

Mid Orbit - GPS satellites and other navigation satellites travel here in lonely, long lives. The volume of space is so huge, and the number of satellites so few, that we don’t need to worry about Kessler here.

GEO - If you put a satellite far enough out from earth, the speed that the satellite travels around the earth will match the speed of the surface of the earth rotating under it. From the ground, the satellite will appear to hang motionless. Usually the geostationary orbit is used by big weather satellites and big TV broadcasting satellites. (This apparent motionlessness is why satellite TV dishes can be mounted pointing in a fixed direction. You can find approximate south just by looking around at the dishes in your northern hemisphere neighborhood.) For Kessler purposes, GEO orbit is roughly a ring 384,400 km around. However, all the satellites here are moving the same direction at the same speed - debris doesn’t get free velocity from the speed of the satellites. Also, it’s quite expensive to get a satellite here, and so there aren’t many, only about one satellite per 1000km of the ring. Kessler is not a problem here.

How bad could Kessler Syndrome in High LEO be?

Let’s imagine a worst case scenario.

An evil alien intelligence chops up everything in High LEO, turning it into 1cm cubes of death orbiting at 1000km, spread as evenly across the surface of this sphere as orbital mechanics would allow. Is humanity cut off from space?

I’m guessing the world has launched about 10,000 tons of satellites total. For guessing purposes, I’ll assume 2,500 tons of satellites and junk currently in High LEO. If satellites are made of aluminum, with a density of 2.70 g/cm3, then that’s 839,985,870 1cm cubes. A sphere for an orbit of 1,000km has a surface area of 682,752,000 square KM. So there would be one cube of junk per .81 square KM. If a rocket traveled through that, its odds of hitting that cube are tiny - less than 1 in 10,000.

So even in the worst case, we don’t lose access to space.

Now though you can travel through the debris, you couldn’t keep a satellite alive for long in this orbit of death. Kessler Syndrome at its worst just prevents us from putting satellites in certain orbits.

In real life, there’s a lot of factors that make Kessler syndrome even less of a problem than our worst case though experiment.

* Debris would be spread over a volume of space, not a single orbital surface, making collisions orders of magnitudes less likely.
* Most impact debris will have a slower orbital velocity than either of its original pieces - this makes it deorbit much sooner.
* Any collision will create large and small objects. Small objects are much more affected by atmospheric drag and deorbit faster, even in a few months from high LEO. Larger objects can be tracked by earth based radar and avoided.
* The planned big new constellations are not in High LEO, but in Low LEO for faster communications with the earth. They aren’t an issue for Kessler.
* Most importantly, all new satellite launches since the 1990’s are required to include a plan to get rid of the satellite at the end of its useful life (usually by deorbiting)

So the realistic worst case is that insurance premiums on satellites go up a bit. Given the current trend toward much smaller, cheaper micro satellites, this wouldn’t even have a huge effect.

I’m removing Kessler Syndrome from my list of things to worry about.

#### Satellite monitoring fails and alternatives fill-in

Dr. Balázs M. Fekete 15, Professor in the Graduate School of Engineering at the City College of New York, PhD from the University of New Hampshire, MSc from the Budapest University of Technology and Economics, et al., “Time For In Situ Renaissance”, Science, August 2015, p. 686

FIDELITY, RESOLUTION, CONSISTENCY. Only in situ sensors, typically in close contact with the monitored medium, can measure a host of water-related quantity and quality parameters and processes ( 6) with reliable accuracy and sufficient frequency. Remote sensing provides indirect measurements normally limited to the near surface of the monitored object and affected by the media between the sensors and the monitored object. Remote-sensing observations are often the result of complex retrieval algorithms. In extreme cases, like satellite-derived evapotranspiration ( 7– 9), the algorithm is almost indistinguishable from land surface hydrology models, such that it is questionable that this qualifies as “observation.”

In situ observations are better suited for gradually changing observational targets, when strategically placed point measurement sensors are representative for larger areas. River discharge in particular is an ideal target for point monitoring because discharge only changes gradually along a river channel (except for confluences) and represents an integrated signal of the hydrological processes from a larger area upstream (1). Unless measurement requires laboratory processing of samples, in situ monitoring can provide observations at high temporal frequency. Many in situ observational records cover multiple decades of continuous data at high temporal resolution. Observation consistency depends on continuous instrument maintenance and recalibration that is often the most expensive part of the monitoring program. Remote sensing that only replaces relatively inexpensive measurements without comparably rigorous calibration will compromise monitoring ( 5).

Satellites are placed either in geostationary orbit, where they can provide continuous observations at low spatial resolution, or in low Earth orbits, which results in low repeat frequencies flying over the same area unless a constellation of satellites is deployed at added expense. It can be difficult to derive continuous (multidecadal) time series from satellite records, because technology changes and space agencies do not pay adequate attention to the homogeneity of observational records. Many satellite platforms (with the exception of meteorological satellites in geostationary orbits) are still in an “experimental” phase without long-term commitment for continued operations. Satellite sensors without adequate backup present a single point of failure leading to abrupt termination of observations.

COST, INNOVATION, ACCESS. Cost comparison of satellite remote sensing versus in situ monitoring is difficult because the final products are rarely comparable. Satellite remote sensing only competes in large-scale or global applications, because it cannot replace in situ monitoring in most cases. Cost comparison should be posed as the additional expense of extending existing in situ monitoring, including incentives for data sharing and aggregating observations, versus operating an independent satellite monitoring infrastructure. A recent World Bank report ( 10) estimated that $1.5 to $2 billion would be necessary to modernize developing countries’ hydrometeorological monitoring infrastructure and an additional $0.4 to $0.5 billion annually for maintenance. These are comparable to the typical $0.3 to $0.6 billion price tag of medium-sized satellite missions.

Telecommunication breakthroughs and their widespread use lower barriers to data transmission. New sensor and deployment technologies are improving performance and cost. Autonomous drone vehicles (aircraft, boats, or submarines) could operate as monitoring platforms, which would blur the distinction between remote sensing and in situ observations. Solar unmanned aerial vehicles may offer cost-effective alternatives to satellites.