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Stalkers in Space: Defeating the Threat

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Abstract

Since 2008, China has been developing a new co-orbital antisatellite weapon (ASAT). These "space stalkers" could be placed on orbit in peacetime and maneuvered to tailgate US satellites during a crisis. At a moment's notice, they could simultaneously attack multiple critical satellites from such close proximity that the United States would not have time to prevent damage. Current national security space strategy, existing and developing space defense capabilities, and current proposals for dealing with weapons in space cannot counter this new threat. Since space stalkers cannot be reliably distinguished from ordinary satellites, these ASATs cannot be banned outright. Instead, this article proposes to ban threatening positioning of space objects, whether satellites or space stalkers. As these positions can be observed by multiple countries, the United States should declare and work with the international community to agree that any country configuring and readying space stalkers for attack demonstrates hostile intent, which justifies preemptive self-defense as the last resort. In the case of space stalkers, self-defense is a justified action rather than a pretext for aggression. The proposed scheme would be effective in deterring and defending against space stalkers.

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The United States has 554 operational satellites, the largest number of satellites among all countries and organizations in the world (see table 1).[1] While these space capabilities offer great advantages for the US military, they simultaneously create great vulnerabilities. The Department of Defense (DOD) is increasingly concerned, particularly about the space threat from China. In its annual reports to Congress, *Military*

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and Security Developments Involving the People's Republic of China for 2013,[2] 2014,[3] 2015,[4] and 2016,[5] the DOD has warned repeatedly: "PLA [People's Liberation Army] writings emphasize the necessity of 'destroying, damaging, and interfering with the enemy's reconnaissance . . . and communications satellites,' suggesting that such systems, as well as navigation and early warning satellites, could be among the targets of attacks designed to 'blind and deafen the enemy.' " Gen John Hyten, the former head of Air Force Space Command, said without space assets, the United States would be forced to revert to industrial age warfare: "It's Vietnam, Korea and World War II"—no more precision missiles and smart bombs.[6] Hyten was also quoted as saying that "China will soon be able to threaten US satellites in every orbital regime, from low Earth orbit a few hundred miles above the Earth, to geosynchronous orbit more than 20,000 miles up—where some of the military's most important satellites circle the Earth. . . . Now we have to figure out how to defend those satellites."[7]

Table 1. Operational satellites of the United States, China, Russia, and others

Country of operator/owner	GEO[a]	MEO[b]	LEO[c]	Elliptical[d]	Total
USA	176	32	327	19	554
China	44	7	125	0	176
Russia	28	29	68	5	130
USA/Others[e]	4	0	20	0	24
China/Brazil	0	0	1	0	1
Russia/others[f]	1	0	0	0	1
Russia/USA	0	0	2	0	2
ESA[g]/USA/Russia	0	0	0	1	1
Other nations	240	24	216	12	492
Total	**493**	**92**	**759**	**37**	**1,381**

Source: Derived from Union of Concerned Scientists' satellite database; includes launches through 31 December 2015 (Cambridge, MA: Union of Concerned Scientists, http://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database#.WLZauoWcFZU.)

[a]Geosynchronous Earth orbit
[b]Medium Earth orbit
[c]Low Earth orbit
[d]Elliptical Earth orbit
[e]USA and other operators/owners except China and Russia
[f]Russia and other operators/owners except USA and China
[g]European Space Agency

As threats from ground-based ASATs (such as traditional threats from ballistic missiles, lasers, and jammers and the newer cyber attacks[8]) grow, it is easy to continue focusing on these much more well-known ASATs and ignore China's developing co-orbital ASAT—hereafter what

this article refers to as space stalkers. In November 2015, the U.S.-China Economic and Security Review Commission released its annual report to Congress stating that "since 2008, China has tested increasingly complex space proximity capabilities."[9] It confirmed what it and others have been suggesting, that "China's recent space activities indicate it is developing co-orbital antisatellite systems to target US space assets. These systems consist of a satellite armed with a weapon such as an explosive charge, fragmentation device, kinetic energy weapon, laser, radio frequency weapon, jammer, or robotic arm."[10] Space objects capable of rendezvous proximity operations and particularly equipped with a robotic arm could pose a game-changing threat as these objects could be placed in orbit during peacetime. During a crisis, such as China seizing Taiwan or territorial disputes in the South China Sea, these space objects could be maneuvered to tailgate US satellites and become space stalkers. They could simultaneously attack multiple critical satellites from such a close proximity that the United States would not have time to react. The space stalkers could destroy enough critical satellites to force the United States back toward General Hyten's warning of fighting primitive "industrial age warfare" with greatly increased collateral damage. On 29 November 2016, CNN broadcast the documentary "War in Space: The Next Battlefield," based on interviews of more than 10 high-ranking military personnel of the entire chain of command for space warfare. These interviews described the concerns of senior space officials about the threat from "kamikaze and kidnapper satellites launched by Russia and China."[11]

Geosynchronous satellites have long been considered safe from attacks, especially simultaneous attacks, since direct-ascent ASAT ballistic missiles would typically take about four hours to reach geosynchronous satellites.[12] However, these satellites could soon be under serious threat. Setting up the space stalkers to be co-orbital with, and in close proximity to, their prey is the easiest way to coordinate simultaneous attacks. If China could place these highly maneuverable space stalkers in close proximity to multiple US critical satellites, simultaneous attacks would be possible with little advance warning, leaving the United States inadequate time to save the targeted satellites.

The space-stalking threat is unique and cannot be mitigated by focusing on and responding to traditional satellite threats. Even if the United States could perfectly deter and defend against all the traditional ASAT

threats and the newer cyber attacks, adversaries could still use multiple stalkers to mount a devastating first strike against critical US satellites. Thus, the United States must specifically deal with the emerging space-stalker threat. This article provides analysis and recommendations on how to develop an overarching strategy to deter and defend against space stalkers without ignoring other threats and while gaining international support for the new strategy.

One must first understand Chinese counterspace strategy to prescribe an effective US strategy and policy. The United States must also refocus its traditional space policies to address the emerging space-stalking threat—something neglected today. Additionally, the National Security Space Strategy must be updated to include a strategy to defend against and to deter space stalkers, including justified preemption as the last resort. Diplomacy alone with potential adversaries to lessen the space-stalking threat is important but not sufficient. Therefore, the new US strategy should include developing new international agreements on weapons in space and in particular space stalkers.

The space-stalker threat does not come from China alone. Russia has also been improving its close proximity operation capability, which is dual-use for non-ASAT and ASAT purposes. Its potential space-stalking capability would be more advanced than China's.[13] However, this article uses only Chinese scenarios since concerns about the threat and suggested measures for US response are essentially the same for both China and Russia.

China's Coherent Counterspace Strategy

China's counterspace development in the last decade has been a mix of traditional and new threats. This mix is coherently and asymmetrically designed to counter a far more technologically advanced US space capability. Thus far, China has been rather successful in justifying its counterspace development to the world, and many countries might accept Chinese claims when US policies and actions are in conflict with China during a crisis, war, or even peacetime. A chronological review of China's counterspace activities illustrates its win-win strategy and its effective counterspace capability.

In 2007, China launched a missile that successfully destroyed one of its own satellites but generated an unacceptably large amount of debris. Merely a year after this ASAT test, two Russian scientists at the Institute for

Precision Instrument Engineering in Moscow reported that a small Russian satellite had been hit by debris from China's 2007 test. Analysis by T. S. Kelso at the Center for Space Standards & Innovation in the United States confirmed the same.[14] Since then a new component of China's counterspace program is to conduct ASAT tests with little enduring space debris. The US State Department said that on 23 July 2014, China conducted a "non-destructive" test of an antisatellite weapon.[15] Speaking at a conference in 2015, Lt Gen Jay Raymond, USAF, said, "We've known for some time that China conducted an antisatellite test July 23 last year [2014], but we learned today that that test was 'successful' even if it didn't destroy anything." [16] Thus, DOD recognized that China is able to conduct successful ASAT tests without generating space debris. For its part, China claimed that the 23 July 2014 test was for missile defense. It routinely takes advantage of the fact that many space activities, including tests, are dual-use for non-ASAT and ASAT purposes and can be used to conceal its ASAT development.

In parallel with the "non-destructive" ASAT tests, China is conducting rendezvous proximity operations (RPO). In September 2008, China deployed a miniature imaging satellite. It "passed within 45 kilometers of the International Space Station, apparently without prior notification, suggesting it may have been simulating a co-orbital antisatellite attack."[17] In June 2010, China launched the SJ-12 satellite. While maneuvering, this satellite "apparently bumped the Chinese SJ-6F satellite, causing it to drift slightly from its orbital regime. This activity suggests China also could have used the test to demonstrate the ability to move a target satellite out of its intended position by hitting it or attaching to it."[18] On 20 July 2013, "China launched a rocket carrying the CX-3, SY-7, and SJ-15 satellites, one of which was equipped with a robotic arm for grabbing or capturing items in space. Once all three were in orbit, the satellite with the robotic arm grappled one of the other satellites, which was acting as a target satellite."[19]

Based on China's "non-destructive" ASAT tests and RPOs, one can see that a robotic arm could be used to disable a satellite while producing little space debris. Space stalkers might well be a key element of China's post–2007 ASAT development strategy in threatening multiple critical satellites of a potential adversary without generating enduring space debris during testing and actual execution of the space-stalker attack.

China's ASAT developments are comprehensive. In addition to the emerging space stalkers, it continues to develop jammers against communications satellites; powerful lasers to dazzle, blind, or damage space sensors; and cyber capabilities to hack or spoof the control and functioning of satellites. China has also been expanding its space diplomacy. Its space programs have included international cooperation with countries other than Russia. China and the European Space Agency (ESA) are cooperating on a space-weather observatory. ESA personnel have visited Chinese human spaceflight training facilities, with the long-term goal of flying a European astronaut aboard a Shenzhou spacecraft to a Chinese space station.[20] These activities help project China as a peaceful and friendly space power. Thus, under the current ambiguity about whether configuring multiple space stalkers or exercising preemptive self-defense is the first act of aggression, the international community might well be on China's side in a conflict.

Russia and China have been taking the lead to ban weapons in space. Their latest version of the draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Treaty or Use of Force against Outer Space Objects (PPWT) was issued 12 June 2014. The PPWT defines the term weapon in outer space as "any outer space object or its component produced or converted to eliminate, damage or disrupt normal functioning of objects in outer space, on the Earth's surface or in the air."[21] Thus they have defined weapons in outer space both broadly and ambiguously to cover weapons that are based in space, as opposed to those based on Earth. While all space-based ASATs can be included, it is ambiguous—perhaps purposely so—whether space stalkers are included. Also included are space-based ballistic missile defense systems and space-based weapons that can damage terrestrial targets. The US analysis submitted to the Conference on Disarmament stated that "the draft PPWT (CD/1985) proposed by Russia and China, like the 2008 version, remains fundamentally flawed," including "lack of a verification regime, the risk of a Party developing and deploying a break-out capability, and the failure to address the threat of terrestrially-based antisatellite capabilities." It concluded that "the 2014 draft PPWT provides no basis for the U.S. to support establishing an ad hoc committee to negotiate any such Treaty."[22]

China's proposed space weapons ban, whether it results in a treaty or not, is a win-win strategy for China. On the one hand, the ban allows

China to project itself as a champion for keeping peace in space. On the other hand, the "peaceful" proposal does not prevent China from continuing space-stalker development. In spite of their definition of "weapon in outer space" as discussed above, China would likely insist that it is not developing a space-stalker weapon but satellites that service its other satellites. Indeed, a space object equipped with a robotic arm can serve well as a space-stalking ASAT or as a satellite that performs civil and non-ASAT military tasks. It can perform maintenance on another satellite, such as refueling to extend service life or replacing a faculty component. It can also be used to inspect another satellite. It can even be used to capture and divert a piece of space debris so as to avoid its predicted collision with a functioning satellite. These developmental activities, even if non-ASAT originally, would yield a space-stalker capability. Further, it is much easier for China than the United States to switch satellites between performing civil and military functions, including ASATs, because, according to the U.S.-China Economic and Security Review Commission, "in China, the military runs the space program, and there is no separate, distinguishable civilian program."[23] Furthermore, while China and the United States would need the capability to rendezvous with and manipulate another satellite for legitimate tasks, this dual-use capability including its manifestation as space stalkers cannot be banned.

A Neglected Focus

The most worrisome threat from space stalkers is their use for a surprise attack by simultaneously disabling critical satellites. As early as 2001, the Rumsfeld Commission worried that "the U.S. is an attractive candidate for a 'Space Pearl Harbor,' " and space stalkers could be the instrument to turn that worry into a fateful reality.[24] The commission also issued a warning: "The question is whether the U.S. will be wise enough to act responsibly and soon enough to reduce its space vulnerability. Or whether, as in the past, a disabling attack against the country and its people—a 'Space Pearl Harbor'—will be the only event able to galvanize the nation and cause the U.S. Government to act."[25] The argument here aims to spur responsible US action—and soon.

Whether by design or luck, China's ASAT developmental activities and space arms-control proposals since the 2007 test could make the United States and the international community continue to focus on

countering ground-based ASAT threats and neglect emerging space-based stalkers. For example, on 13 May 2013, China fired a ballistic missile reaching an altitude of "possibly over 20,000 miles," whereas the geosynchronous Earth orbits (GEOs) are at 22,236 miles. In a paper requested by the U.S.-China Economic and Security Review Commission, Cray Murray, senior policy analyst at the commission, stated "available data suggests it was intended to test at least the launch vehicle component of a new high-altitude ASAT capability.[26] Tests since 2007 made the United States consider the growing traditional ground-launched ASAT threats to be much more urgent than space stalkers and thus focused the US Strategic Portfolio Review,[27] space budget increase, and new programs on these traditional threats.

In congressional testimony on 15 March 2016, Douglas Loverro, deputy assistant secretary of defense for space policy, stated, "To deter space attack, would-be attackers need to understand or at least suspect that their attacks will likely be unsuccessful. . . . As we've worked through that calculus we arrive at the conclusion that of the three pathways we've outlined—reconstitution, defensive operations, and resilience—resilience is the best path for both understandable assurance and robust assurance. It's also the area where we can best offset the advantages that adversaries seek to exploit with their offensive space control ambitions."[28] Loverro provided no indication of how to deal with space stalkers or the level of resilience needed to deny the effectiveness of stalkers. His three pathways do not provide sufficient defense against space stalkers.

Reconstitution takes time, and the US fighting force cannot wait that long. Also, not knowing which types of critical satellites would be targeted and destroyed, the United States could not afford to fund a quick and adequate reconstitution on all critical types.

Defensive operations, whether passive or active, would require adequate warning time of the pending attack to initiate and execute actions to block the attack. If space stalkers are allowed to tailgate satellites closely, there would not be enough time to mount an effective defense.

In the same testimony, Loverro described better anti-jam and anti-spoof technologies, more resilient next-generation satellites, life extension of on-orbit legacy satellites, and partnerships with allied nations and commercial partners.[29] These resilience measures are aimed at the rapidly growing traditional space threats. Against space stalkers, these measures cannot meet his aforementioned requirement for deterrence by

providing "understandable assurance and robust assurance" that "their attacks will likely be unsuccessful." There are two reasons that resilience is inadequate in countering the emerging space-stalking threat. First, passive defenses, such as anti-jamming and evasive maneuver, would be either irrelevant or ineffective against space stalkers even if the defenses were executed preemptively, because space stalkers could dedicate much of their on-board resources (such as fuel and propulsion) for the sole purpose of attack, including chasing down an escaping target satellite. Second, backups drawn from partners might have lower capability and take time to resume lost services, and partners might not be able to spare the full capacity requested by the United States.

More importantly, as stated in the 2011 *National Security Space Strategy*, the current strategy for "preventing and deterring aggression against space infrastructure"—including satellites—has been focusing on countering traditional ground-based ASAT weapons such as direct-ascent ballistic missiles, jammers, and lasers. The strategy has five elements:

1. "Support diplomatic efforts to promote norms of responsible behavior in space."
2. "Pursue international partnerships that encourage potential adversary restraint."
3. "Improve our ability to attribute attacks."
4. "Strengthen the resilience of our architectures to deny the benefits of an attack."
5. "Retain the right to respond, should deterrence fail."[30]

These five elements either have not been used to deal with the emerging space stalker threat or are far from adequate to counter it. The first two elements are important in establishing international norms to justifiably and fairly counter space stalkers, as these elements are the best way to develop mutual understanding and arrive at mutually beneficial compromise. Unfortunately, exchanges and measures developed thus far tend to focus on space activities during peacetime. As far as weapons in space and deterrence of space war are concerned, the diplomatic efforts and international partnerships have been focusing on either the unattainable goal of banning all weapons in space or the endless debate about the control of traditional Earth-based ASAT threats, but to the neglect of the emerging space-stalker threat. While the emphasis of the third

element has been on attributing traditional space attacks, it should have been stated explicitly to include the attribution of space stalkers not just after, but also before, the attack. The fourth element would provide far too little survivability to many of the critical satellites already on orbit, because they cannot be retrofitted on orbit to be resilient or reconstituted quickly and adequately enough to perform the same lost capability. Finally, after space-stalking attacks begin, the response according to the fifth element would be too late to save US-critical satellites. Retaliation would not deter Chinese space stalking, because destroying such critical satellites would benefit China far more than the cost of US punishment as a proportional response. China could deter US intervention without firing a terrestrial shot or even a shot from space stalkers, as merely being too close for comfort would suffice. This outcome may well be the ultimate goal of China's counterspace strategy. In sum, while current efforts to implement the National Security Space Strategy might protect satellites or their missions against traditional threats, these efforts alone cannot protect satellites against simultaneous space-stalker attacks, because these attacks do not provide adequate warning for defense.

As discussed in the previous section, a space weapons ban proposed by China and Russia cannot ban space stalkers. Can any other space proposal deal with the presence of space stalkers? Over the years, the most ambitious one that focused on peaceful and dangerous space activities was proposed by the Stimson Center. Michael Krepon and his colleagues posted the initial draft of "Model Code of Conduct for the Prevention of Incidents and Dangerous Military Practices in Outer Space" on the Stimson Center's website in 2004. Stimson's Code originally was intended to deal with all space activities, whether peaceful civil and military activities or dangerous military practices. The latter include ASATs and others agreed by party members as dangerous. However, this Code could not deal with space stalkers because their physical appearance and activities cannot be reliably distinguished from those of peaceful civil and military satellites.

The Stimson's Code and efforts did have a significant influence on the European Union's (EU) Space Code of Conduct. Its latest version, "Draft International Code of Conduct for Outer Space Activities," was released in 2014.[31] It focuses on accidental collisions from space, as opposed to intentional collisions from ASATs, where space stalkers belong. Both the Stimson Center and the EU decided to focus on peaceful

activities, because such a focus would be relatively far more acceptable to the major spacefaring nations as well as a more diverse group of nations. Therefore, it is unlikely the EU Space Code would now go back to including dangerous military activities or practices. Moreover, since the EU Code merely relies on public shaming, it is suitable for managing peacetime space activities but not for deterring a space war. In a crisis, China could be willing to be shamed by breaking an agreement if it could significantly degrade US space mission capability for war-fighting support or, better yet, deter US intervention in the first place without firing a shot in space or on Earth.

Similar to government officials' statements, major reports from think tanks and other research organizations focus on how to deal with the rapidly growing traditional threats, not the emerging space-stalker threat from rendezvous-and-proximity operations (RPO). In his 2010 treatise *Deterrence and First-Strike Stability in Space: A Preliminary Assessment*, Forrest Morgan did not mention China's RPOs at all. He argued generally for "a national space policy that explicitly condemns the use of force in space and declares that the United States will severely punish any attacks on its space systems and those of friendly states in ways, times, and places of its choosing."[32] His punishment or retaliation could not protect the satellites being attacked and, as discussed above, the benefits of such an attack to China could far exceed the punishment China might incur. In any case and as stated earlier, punishment does not meet Loverro's requirement for deterrence: "To deter space attack, would-be attackers need to understand or at least suspect that their attacks will likely be unsuccessful."[33] Therefore, regardless whether Morgan's policy could deter traditional space attacks, it could not induce would-be attackers to believe that "their attacks will likely be unsuccessful." On the contrary, China could be convinced that once enough critical satellites are disabled, the United States could either fight with inadequate space support or simply not intervene at all. Morgan is also a key author of the *U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power 1996–2017*, released in 2015. The focus is again exclusively on traditional threats without any mention of RPOs.[34]

In January 2016, the Center for a New American Security released the report *U.S. Defense Strategy for Space*, by Elbridge Colby.[35] He focused on traditional space threats from missiles, jammers, and lasers and did not mention RPOs, including their potential threats.

In April 2016, the National Bureau of Asian Research released a special report, which contains an article by Brian Weeden and Xiao He on US-China strategic relations in space. They did discuss RPOs and stated that, "A more promising approach is to focus on transparency and confidence-building measures [TCBM] for both direct ascent and RPO. TCBMs are a means by which governments can share information to help create mutual understanding and trust and reduce misperceptions and miscalculations."[36] They also described how space situational awareness (SSA) capability can detect and monitor close approaches.[37] However, while TCBMs and SSA are important, they are far from adequate to deter or protect satellites targeted by space stalkers and do not meet Loverro's requirement for deterrence cited above.

In June 2016, Rebeccah Heinrichs of the Hudson Institute released a report on "Space and the Right to Self Defense," which did not mention RPOs.[38] The report focused on the desirability of space-based interceptors for ballistic missile defense. Also in June 2016, the Atlantic Council released a paper, *Toward a New National Security Space Strategy: Time for a Strategic Rebalancing*, by Theresa Hitchens and Joan Johnson-Freese. They asserted that "maneuverable satellites being developed in the United States and elsewhere for rendezvous-and-proximity operations (RPO) are often considered nefarious capabilities by potential adversaries, causing finger pointing in both directions."[39] They did not offer a prescription to deal with RPOs or any other specific threat. Similar to other reports, the Hitchens–Johnson-Freese study is a high-level report and argues for a rebalancing, which "would require a continued emphasis on strategic restraint in the very near term, as well as a continued focus on diplomacy."[40]

Finally, in August 2016, the National Academies of Sciences, Engineering, and Medicine released a report titled *National Security Space Defense and Protection: Public Report*.[41] It is also a high-level report and does not mention RPOs or their use for attack.

Preemptive Defense against Space Stalkers

A successful defense against space stalkers will benefit not only the United States but also other nations. Many nations rely on US satellites such as the Global Positioning System (GPS) and communications satellites for critical services. Also, a multilateral or international agreement based on the same concept and measures to protect US satellites

would protect other nations' satellites as well, including those of China and Russia.

On 15 November 2014, Secretary of Defense Chuck Hagel announced the Defense Innovation Initiative (DII), "a broad Department-wide initiative to pursue innovative ways to sustain and advance our military superiority for the 21st Century and improve business operations throughout the Department."[42] He said that the DII is "an initiative that we expect to develop into a game-changing third 'offset' strategy." Subsequent Secretary of Defense Ashton Carter continued to pursue this third offset strategy. Hagel's pronouncements and Carter's actions provide the needed attention and resources to deal with the space-stalker threat, which calls for a new operational concept such as preemptive self-defense as the last resort.

Deterring and defending against space stalkers starts with two principles. First, once a space object is in orbit, one cannot reliably distinguish an ordinary satellite from a space stalker. Thus space stalkers cannot be banned without banning all satellites. This indistinguishability explains the difficulty in verifying violations in the joint proposal of PPWT by Russia and China for banning space weapons, which include space stalkers. An alternative to their proposal is that the international community instead bans dangerous positioning of space objects, which can be satellites and/or space stalkers. Banning dangerous configurations is observable and verifiable. Second, routine space operations could bring one or even a few space objects close to another nation's satellites at the same time. These occurrences cannot be prohibited and must be accommodated.

The above two principles are analogous to the Third United Nations Convention on the Law of the Sea (UNCLOS III), or simply the Law of the Sea, adopted in 1982. Unlike PPWT attempting to ban weapons in space, UNCLOS III does not ban warships or attack submarines at sea but, instead, allows states to exercise control over contiguous areas. Two concepts, if modified, can be applied to deal with space stalkers, with or without a space agreement.

First is contiguous zone, within which "the coastal State may exercise the control necessary to (a) prevent infringement of its customs, fiscal, immigration or sanitary laws and regulations within its territory or territorial sea; [and] (b) punish infringement of the above laws and regulations committed within its territory or territorial sea."[43]

The application to space is by having a self-defense zone around a nation's satellite and having the right to "punish infringement" as stated above.[44] Even with the self-defense zone, the owner of the satellite would continue to comply with Article II of the 1967 Outer Space Treaty that "outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[45] While the owner of the satellite does not have sovereignty over the self-defense zone, the United States can propose, according to Article IX of the 1974 Convention on Registration of Objects Launched into Outer Space, that this Convention be amended to automatically include the self-defense zone in the registration of the satellite to be launched or, retroactively, already launched into space.[46]

Second, Article 17 of UNCLOS III says "ships of all States, whether coastal or land-locked, enjoy the right of innocent passage through the territorial sea."[47] Similarly in space, satellites of all states enjoy the right of passage through the self-defense zones of others, provided it is innocent and not part of a threatening configuration to multiple satellites.

Implementing Preemptive Self-Defense against Space Stalkers

The purpose of preemption is to prohibit the positioning of space objects to tailgate (or closely lead) more than an innocuous threshold number of another country's satellites. The Space Security and Defense Program already established by the DOD and the National Intelligence Office should decide whether the threshold is three, four, five, or some other number. Once the threshold is determined, the United States can plan to use preemption as the last resort against the threat of space stalkers with a number exceeding the threshold. At the same time, the United States can plan to use traditional, postattack self-defense to protect satellites or their missions or to deter satellite attacks. Since preemption eliminates the far more damaging attacks that result from a larger number of space stalkers, it makes the job of post-attack self-defense feasible. Moreover, since there is no peaceful reason to tailgate so many satellites at the same time, simultaneously stalking a large number of another nation's satellites is justifiably treated as hostile intent requiring a last-resort preemption to neutralize such a threat. This is equally justified as the proper use of self-defense. The ultimate purpose of last-resort preemptive self-defense is that it does not actually have to be executed.

Therefore, the adversary knowing its space-stalking attack to be futile would not pose a space-stalking threat in the first place. In any case, declaring, during peacetime, the US right of self-defense to prevent an imminent space-stalking attack can garner international condemnation of anyone setting up such a threat during a crisis and international support of US defensive actions. This declaration could also reduce incentives for an aggressor to pose the space-stalking threat.

One could define a geosynchronous satellite as tailgating if its longitude of the ascending or descending node or orbital plane's inclination is less than 0.2 degree from that of another country's satellite already occupying that orbit. If the United States wants to deter and defend against simultaneous space-stalking attacks against GEO satellites, it could declare that any country that positions its space objects within 0.2 degree in longitude (148 km in minimum separation) or inclination of more than a threshold number of another country's satellites is the aggressor and the defender has the right to exercise self-defense even before any actual attacks begin. The threshold number could be between three and five. However, the actual threshold, as well as the minimum separation, should be first determined by the DOD and then brought to the international community by the State Department for discussion and negotiation. It is feasible to arrive at both useful and practical thresholds. For example, both the United States and China need not reposition any of their operational satellites to observe the above suggested rule of 0.2-degree minimum satellite separation between any pair of US-China GEO satellites.[48]

The rapidly growing number of small (less than 500 kg) satellites forces the need to observe guidelines on their orbital placements so their deployment would not appreciably enhance the space-stalking threat but would maintain much of their civil benefits. Space expert John Bradford reported 36 successful launches of microsatellites (typically defined as 10 kg to 50 kg) and nanosatellites (1 kg to 10 kg) in 2012; 92 in 2013 and 158 in 2014.[49] In January 2015, WorldVu Satellites Ltd. said it had secured Qualcomm Inc. and Virgin Group as investors in the OneWeb satellite Internet network. The network is planned to have some 650 125-kg satellites operating at 1,200-km altitude.[50] In June 2015, SpaceX filed a proposal to test a very large fleet of 4,025 small satellites for high-speed Internet service to be launched over a period of 15 years to around 1,200-km altitude.[51] Thus, thousands of small satellites will

populate low Earth orbits (LEO) in the near future. The concern is that China or Russia could make space stalkers in the form of small satellites and conceal them among other small satellites. This concern should be addressed now, not after more small satellites are planned or launched. Since all these satellites aim to be cheap for predominately communications and Earth observation, they are placed in LEOs. There should be an international understanding or agreement that they will not be placed in or travel to GEOs or medium Earth orbits (MEO). This restriction would not affect the utility of small satellites because there are few commercial reasons for them to be placed in those higher orbits.

The prohibition of positioning a space-stalking threat for simultaneous attacks can and should first be applied to GEOs as described in this article. For MEOs and elliptical Earth orbits (EEO), no country would need to change its current satellite orbits to meet the guidelines in this article to deal with the space-stalker threat, as their satellites in these orbits are already well separated from those of every other country's. As to LEO satellites, which will soon number in the thousands, close-proximity restrictions can still be established with an approach similar to that for GEOs. However, the design of the prohibition for LEOs should be discussed along with other issues including:

- how DOD's plan for disaggregating large LEO satellites for better mission survivability will work;
- how DOD's arrangements with commercial providers and other governments in using their space and other assets for backup will work;
- which types of LEO satellites DOD needs to protect against simultaneous attacks by multiple space stalkers;
- how transparent should be the function and capability of small satellites to the international community; and
- how several thousand small satellites launched into LEO can be made to avoid collisions and creating space debris.

Since GEOs host many critical satellites for space-faring nations, if the prohibition against threatening space stalkers were only enforced there, the chance of triggering a war in space that spreads to Earth could be reduced.

There are two ways to lighten the burden of monitoring space stalkers. First, there is no need to monitor space objects belonging to friends and

allies of the United States. Second, neither is there a need to monitor space objects from countries that do not possess a capability of carrying out multiple space-stalking attacks. Thus, Russia and China are the key countries to watch for this type of attack in the near term.

Because the Joint Space Operations Center (JSpOC) is already monitoring the movement of all operational satellites worldwide, monitoring any adversary's maneuvering and positioning of its space objects for multiple space-stalking attacks would be part of its responsibility. The sensors and process to alert satellite owners of potential collisions can also be used to alert the US military of potential space-stalking attacks, if JSpOC is provided with warning criteria for such imminent attacks. In addition to ground-based optical and radio telescopes and the space-based space surveillance constellation, the Geosynchronous Space Situational Awareness Program (GSSAP) can and should play a major role in the defense against space stalkers. Two GSSAP satellites were launched successfully into a near-geosynchronous orbit in July 2014. Gen William Shelton, former commander of Air Force Space Command, told reporters that "this neighborhood watch twosome will help protect our precious assets in GEO (high-altitude orbit), plus they will be on the lookout for nefarious capability other nations may try to place in that critical orbital regime."[52] An Air Force fact sheet states,

> GSSAP satellites will operate near the geosynchronous belt and will have the capability to perform rendezvous and proximity operations (RPO). RPO allows for the space vehicle to maneuver near a resident space object of interest, enabling characterization for anomaly resolution and enhanced surveillance, while maintaining flight safety. Data from GSSAP will uniquely contribute to timely and accurate orbital predictions, enhancing our knowledge of the geosynchronous orbit environment, and further enabling space flight safety to include satellite collision avoidance."[53]

Just as with JSpOC, the GSSAP can be used for both avoiding accidental collision and alerting DOD of potential space stalkers and helping to defend against them. Also, since a GSSAP satellite can perform RPO, it can get extremely close to a space object for an inspection. Although the GSSAP satellite might not have a very high confidence of distinguishing a space stalker from a garden-variety satellite, a close-up inspection might still identify suspicious space objects and keep a close eye on them, especially those that can maneuver and move quickly. The Air Force launched another pair of GSSAP satellites in August 2016.

Since the civil use of the RPO capability is crucial to both countries, this dual-use capability is unlikely to be banned. On the other hand, in principle an RPO capability, such as one manifested in GSSAP satellites, could be tasked to attack Chinese satellites. The United States should declare that the prohibition of space stalkers in threatening their prey is a two-way street and would not so position multiple GSSAP satellites and other space-stalking-capable satellites to threaten Chinese satellites. Thus, China would benefit from this declaration or agreement as well. Also, the United States does not need to conduct multiple RPOs at the same time and would sacrifice little in not doing so.

Adopting a policy of using preemptive self-defense against space-stalker attacks must be based on satisfactory answers to four questions:

1. Under what situations is the threat of preemptive self-defense as a deterrent justified and stabilizing?
2. How can the policy of preemptive self-defense be structured to "strike the right balance between assurance efforts measurable by the adversary, and those that must remain more ambiguous?"[54]
3. How does the United States assure that preemptive self-defense cannot be used as a pretext for aggression?
4. What development and acquisition programs are needed so preemptive self-defense is effective in deterring and defending against space stalkers?

Justification of Preemptive Self-Defense against Space Stalkers

In the 2016 Center for a New American Security report cited earlier, Colby stated that "a space defense strategy that relied excessively, let alone exclusively, on striking an adversary's counterspace assets preemptively could thus put the nation in an impossible political-military position, one in which it would be required to strike early in a crisis to ensure it could attack a potential adversary's counterspace architecture before they dispersed or readied their defenses. It seems clear that no American political leader would want to be forced into such a position, and with ample reason."[55] His statement reflects well the concerns of those in the United States and abroad who are against preemption in space. Thus, any suggestion of preemption in space needs to answer Colby's concerns. First, the use of preemption is reserved as the last

resort and only against a specific threat of space stalkers as opposed to other space threats. Second, Colby's preemption is not self-defense but first strike against "adversary's counterspace architecture before they dispersed or readied their defenses." His argument is drawn from classic nuclear deterrence theory that a first nuclear strike that can significantly, if not totally, disable an opponent's second nuclear strike capability is destabilizing and dangerous. But this is irrelevant to the case of deterring space-stalker attacks, because the US preemptive self-defense action is meant to disable space stalkers only and not to make a first strike against an adversary's counterspace architecture before it is dispersed or readied for defense. Preemptive action does not destroy adversary's counterspace capability. Most importantly, the United States' currently ambiguous self-defense posture could lead the international community to believe that the preemptive self-defense was indeed a "first strike" that Colby worried about as destabilizing. Indeed, an ambiguous self-defense is destabilizing, as it is unclear whether the country posing the stalking threat or the country firing the first shot in the course of self-defense is the aggressor. In contrast, the international community, in peacetime and well before crisis, should know that the aggressor is the nation readying the multiple space-stalking attacks and the preemption is not the first strike but part of the right of self-defense. With such an understanding well in advance of crisis, preemptive self-defense as the last resort enhances space stability.

Facing a new game-changing threat under development in China, the United States can no longer remain ambiguous about preemptive self-defense.[56] US self-defense doctrine and policies, as well as those in other nations, have long been strongly influenced by Article 51 of the United Nations Charter: "Nothing in the present Charter shall impair the inherent right of individual or collective self-defence if armed attack occurs against a Member of the United Nations."[57] Georgetown University Prof. of Government and Foreign Service Anthony Arend stated, "Although the basic contours of Article 51 seem straightforward, its effect on the customary right of anticipatory self-defense is unclear."[58] There are two interpretations: restrictive and broad. Legal scholars who are proponents of a restrictive interpretation of "armed attack occurs" allow self-defense only after attack has started. Other legal scholars take a broad view that the Charter does not "impair the inherent right" embedded in the customary international laws, which allow anticipatory

or preemptive self-defense if certain conditions are met. Typical conditions were suggested as far back as 1842 by US Secretary of State Daniel Webster in the Caroline case.[59] Subsequently, jurists like Roberto Ago in 1980 came to a similar set of conditions: necessity, proportionality, and immediacy.[60]

The attacks of 11 September 2001 confirmed the need for preemptive self-defense in specific situations and led to the 2002 *US National Security Strategy*: "For centuries, international law recognized that nations need not suffer an attack before they can lawfully take action to defend themselves against forces that present an imminent danger of attack."[61] This premise should apply to preemptive self-defense against space stalkers as well, provided that Ago's three conditions are met. First, this preemption is necessary because the United States cannot defend with, as Ago stated, "measures not involving the use of armed force."[62] For example, the Stimson's proposed Space Code Agreement recommends establishing "a system of consultation for the purpose of resolving expeditiously any incident, ambiguous development, or concern which may arise pertinent to the obligations contained in this Agreement."[63]

Unfortunately, no consultation and resolution can be expeditious enough when the space stalkers are set to attack at a moment's notice. Preemptive self-defense might be the only option. If so, the best way forward is to limit the right of preemption against space stalkers to only justified situations and as the last resort. Second, the preemption is also proportional because, as proposed here, the preemption is not allowed to go beyond what is necessary to disable this attack. Third, self-defense must take place immediately, as the attack could happen at any moment with little warning and the outcome would be devastating. It is this immediacy that distinguishes a necessary preemptive war from the optional preventive war, which rightly could be considered as a pretext for aggression and should be avoided. Some analysts might argue that China's close positioning of stalkers might not signal an imminent attack as its intent was merely to deter the United States from terrestrial intervention. Because intent is unobservable, this article proposes the use of a self-defense zone that observably determines that China had infringed into an area that justifies preemptive self-defense as the last resort, as China had gained the ability to mount successful attacks at any time of its choosing.

Preemption against space stalkers would comply with the broad view of Article 51, as it satisfies Ago's three conditions. However, for those insisting on its restrictive interpretation, the United States should respond that such an interpretation drafted in October 1945 understandably could not anticipate and counter the space-stalker threat seven decades later. Article 51 was designed against armed attack that takes time to prepare and gives warning by the massing of soldiers and weapon systems for an attack. The defender would have alternative responses, including the referral of the threat to the United Nations for peaceful resolution. However, in the case of space stalkers, there is no time for referral and no means other than preemption to neutralize the imminent threat.

Balancing Assurance and Ambiguity

How can the United States strike a balance between revealing capabilities and concealing capabilities, as both Loverro and Deputy Secretary of Defense Bob Work insisted,[64] in the application of self-defense to deter and defend against space stalkers? The analysis thus far indicates that preemptive self-defense can be effective to defend against and deter space-stalker attacks. Unfortunately, preemption is loaded with stigmas in the minds of many officials, experts, and the public domestically and internationally. Indeed, a policy of preemption against all space threats or even a specific threat under other than absolutely necessary situations is inadvisable and, fortunately, not needed. On the other hand, the space-stalker threat is so dangerous, and the technological and political environment has changed so much, that preemption as a last resort against space stalkers calls for an open-minded examination by all parties. Thus the United States should make its potential adversaries understand that configuring space stalkers for multiple attacks is an aggression that will draw self-defensive measures, including preemption as last resort. The United States should also demonstrate that it has the capability to defeat the space-stalking threat. On the other hand, the United States need not detail which and how specific self-defense measures would be used under various space-stalking situations.

Preemptive self-defense performed during a crisis without any forewarning in peacetime would surprise allies, friends, and others and limit their full understanding and support for US actions. It could even lead many of them to treat the United States as the instigator of a space war. Further, if the United States ruled out the use of preemptive self-defense

for any situation now, it would prevent developing and acquiring the best types of capabilities or even adequate capabilities for preemptive self-defense against space stalkers.

Allaying the Danger of Using Preemption as a Pretext for Aggression

Many governmental officials and space experts alike would not endorse preemptive self-defense for two reasons. First, they argue that if one needs to resort to self-defense, it is far better to exercise it after the attack, because it fits the transparent norm that the first mover is the attacker and the second mover is the defender and, thus, self-defense after an attack is far more justifiable. Second, they are concerned that preemptive self-defense can be used as a cover for aggression. Some are even concerned about self-defense whether before or after the attack. For example, it has been reported that countries across Latin America and a few African countries object to even the reference in the Space Code of Conduct to the right to self-defense under Article 51 of the UN Charter, because these countries fear accelerating "the process of space weaponization" and want to avoid "resorting to military solutions in space rather than diplomatic means."[65]

Indeed, exercising self-defense after an attack is far better than before an attack, provided the former is so effective that it can deter the attack in the first place. Unfortunately, self-defense after an attack cannot save many of the satellites attacked by space stalkers. Instead of deterring the space-stalker attack, ineffective self-defense after an attack emboldens the use of space stalkers as a threat that can deter US intervention. While the fear of using preemptive self-defense as a pretext for aggression is real, the restrictions outlined in this article should eliminate this fear. Simply put, once the threshold on the number of space stalkers is known and justified during peacetime, preemption against space stalkers exceeding the threshold should be considered self-defense and those not exceeding the threshold, an aggression. Since the number of space stalkers next to another nation's satellites is observable at the time of preemption and verifiable afterward, there is little ambiguity whether the preemption is self-defense or aggression. In contrast, there would be far more ambiguity and instability under the current situation when the international community cannot even tell who is the aggressor or defender. The country positioning its space objects next to another

nation's satellites would say these space objects are ordinary satellites and not space stalkers, as no one can reliably distinguish one from the other. It would further claim that another nation's act is not preemptive self-defense but an attack to destroy its innocent satellites that just happen to be very near US satellites and flying in the same orbit. This country could point out that currently there is no agreement against any number of such nearby satellites. Thus, a well-designed policy of preemptive self-defense is far more stabilizing for space peace than the current situation full of ambiguity and instability.

Preemptive self-defense against space stalkers could be favored by proponents of an ASAT ban because preemption as a last resort would still be needed as insurance to guard against space objects that appeared as satellites but actually were ASATs. The sensitive issue of preemption in space should be deliberated and resolved, as it is a prerequisite for agreements, whether banning or allowing ASATs. The Committee on National Security Space Defense and Protection agreed with an earlier observation in a study by the Center for International and Security Studies that "a national discussion updating public awareness of the changing character of the space domain simply has not yet occurred."[66] Such a discussion would help the public better support US policy and programs for self-defense, when it is necessary—as in the case of space stalkers—and how preemptive self-defense as the last resort can be conducted without being construed as a pretext for aggression.

Developing Preemptive Self-Defense Capability against Space Stalkers

On 12 April 2016, Deputy Secretary of Defense Work said, "an advanced U.S. satellite can cost upwards of $1 billion—even more when you factor in launch and operating costs."[67] Loverro said something similar: "An advanced U.S. satellite might cost upwards of $1 billion; missiles that could destroy such a satellite cost a few percent of that sum; co-orbital microsatellites cost even less."[68] Space systems are expensive to develop and acquire. The cost to defend space systems or their backup systems is also high, especially when the United States is facing both growing traditional threats such as direct-ascent ballistic missiles, jammers, and lasers and emerging new threats such as cyber attacks and space stalkers. Fundamentally, a defender has to defend all critical space systems, but an attacker can focus its resources to attack only a few.

Therefore, the cost of defense is much higher than that of attack. This asymmetric penalty could be so high that the United States could not afford to protect the needed space missions against Chinese attack. On the other hand, preemptive self-defense makes effective defense much cheaper and more feasible. If positioning space stalkers for attack is considered by the international community as an aggression, the defender could now gain back some of the initiative by eliminating the threat before the attack.

The Defense Innovation Initiative discussed earlier can help develop a preemptive self-defense capability.[69] Clear goals will facilitate talented people from inside and outside government to assemble the right technologies to attain each goal most efficiently. Having specific, big goals can guide commercial innovation and technologies in dealing with current and future threats under tight defense budgets. Deterring a space Pearl Harbor can serve as such a goal. At the same time, DII can provide access to the commercial disruptive innovation and technologies that the defensive capability required for this deterrence needs. Therefore, connecting DII and space Pearl Harbor deterrence is mutually beneficial. Mounting attacks from close proximity provides only a short time for the United States to detect and defeat the attacks. The United States needs to monitor space objects and detect space stalkers in near real-time. Performing this monitoring task successfully would require the orchestration of advanced sensor technologies, visualization, advanced computing, big-data analytics, and artificial intelligence. The commercial sector excels in these technologies. After detection, the United States still needs to disable the space stalker quickly and without generating space debris. The disabling could be reversible so that the space stalkers are not harmed permanently. This disabling task would require the aforementioned technologies. Also, it would require robotics, autonomous operating guidance and control systems, and miniaturization. Some of these technologies, which Work has highlighted for defending against traditional space threats, would be useful against space stalkers as well.[70]

A defensive capability is a prerequisite for a credible deterrence. The concept of self-defense zones and other ideas discussed in this article can turn the practically impossible job of protection into simply a difficult one. The following four development and acquisition programs for a stabilizing preemptive self-defense capability need the best efforts from DOD, including attracting commercial talents through DII and other venues.[71]

Real-time Awareness

Space situational-awareness programs should include the development of real-time monitoring of space objects in, or quickly maneuverable into, close proximity to important US satellites. This real-time awareness program would also be useful against other space-based ASATs as well as traditional ground-launched ASAT missiles.

Defensive Devices

The United States should coordinate the design of self-defense zones and that of defensive devices so space stalkers can be disabled in a timely manner and with minimal debris in the useful orbits. For example, the kill mechanism could paint a space stalker's sensors or bend or severely degrade its antennae and solar panels. As discussed above, commercial innovators are in a good position to combine advanced technologies in sensing, robotics, and miniaturization to physically protect satellites.

Defensive Cyber Measures

The United States also should develop capabilities such as jamming or spoofing the communications links used to command and/or control space stalkers' maneuvers and kill mechanism. Again, cyber capability in the private sector can play a key role in denying space stalkers' ability to navigate, target, or reach their prey. Using such temporary and reversible techniques, as opposed to physical destruction, could further reduce stigma against preemptive self-defense even if it is used as last resort. Reversibility could attract support from undecided nations, because they could better see that the purpose of these capabilities is to deny attacks as opposed to permanently damaging the space assets of other countries. The temporary disabling measures would be discontinued once the aggressor disassembled its threatening space-stalking configuration. A reversible capability is stabilizing as the prospect of escalation by either party is much reduced.

Combined Operations Center

A new Joint Interagency Combined Space Operations Center was created in October 2015 and renamed the National Space Defense Center (NSDC) in April 2017. With the center "meant to protect satellites from potential attack," the DOD has pointed to space systems as the first fruits of the

third offset strategy.[72] The center "will have the capability to develop, test, validate and integrate new space system tactics, techniques and procedures in support of both DOD and Intelligence Community space operations. The increasing threat to space capabilities necessitates better operational integration of these two space communities, as well as civil, commercial, allied and international partners. The [NSDC] experimentation and test effort will boost the ability to detect, characterize, and attribute irresponsible or threatening space activity in a timely manner."[73] The center can and should play an important role in developing effective concepts of operation and tactics to deal with the space-stalker threat and act as a key operator to direct defenses against this threat.

In sum, the United States as well as other nations should forewarn any party that positioning space stalkers for surprise attack would be treated as an aggressive act and the perpetrator considered an aggressor. Once this position is clearly defined in peacetime, existing and developing defense measures then will have the necessary warning time to defeat the space stalkers and protect the threatened satellites. On the other hand, specifically which actions and measures to undertake and in what sequence depend on the deliberation of the DOD in coordination with other departments.

Developing New Agreements on Weapons in Space

There is a silver lining in the emerging space-stalker threat if this threat finally convinces the international community that current proposals such as PPWT or no first placement of weapons in space have fundamental flaws. Many space weapons cannot be banned since they cannot be reliably distinguished from garden-variety satellites. Not resolving this flaw is a key reason no treaty on weapons in space exists in spite of repeated attempts since the dawn of the space age in 1957. Not only is the United States finding that the currently active proposals about weapons in space do not meet its national interests, but also it is losing international support on this matter. On 7 December 2015, the United Nations General Assembly adopted a Russian-led resolution, which initially was coauthored by Brazil and China, calling for a nonbinding restriction against the first placement of weapons in outer space. Only the United States, Ukraine, and Georgia voted against the resolution, while the states of the European Union, Australia, Japan, South Korea, and others totaled to 47 abstentions; 129 nations voted in

favor. The United States must now take the initiative to introduce the countering of space-stalking threats as an added focus into UN disarmament fora. For example, the United States should pursue agreements in space transparency and confidence-building measures and agreements on a principle declaring the party that configures and readies the space-stalker attack as the aggressor and the defending state has the right of self-defense, including preemption even before the imminent attack, to reversibly or irreversibly negate the space-stalker threat.[74] Against the emerging space-stalker threat, the United States must develop a policy concerning the conditions and timing under which self-defense could be used against a tailgating configuration threatening multiple satellites of another country. This new approach in dealing with weapons in space can address the US concerns about the draft PPWT and the proposal on no first placement of weapons in space without condemning the ideas. However, any proposal must explicitly resolve the concerns about space stalkers raised here. Specifically, the new approach should include these items:

- The definition of an aggressor must explicitly include one that poses a threatening configuration, and the defender must explicitly have the right of self-defense even before an imminent attack as the last resort.
- Because the word preemptive has the stigma of being used as a pretext for aggression, a new term should be developed and agreed upon to reflect the right to use self-defense before attack under necessary conditions as the last resort.
- The concept of self-defense zones against certain types of space weapons such as space stalkers is needed in conjunction with the outright ban of some other types of weapons in space. Self-defense zones can be used to prevent attacks from close quarters. The zonal concept and banning need not be mutually exclusive and can be used complementarily. For example, the United States can participate in both international efforts to develop a self-defense zone against some weapons and ban other weapons that can be distinguished from ordinary satellite even when they are in space. Someday, countries including the United States might even agree to intrusive inspection by a UN-sanctioned team on satellites before launch so as to assure they cannot be effectively used as ASATs.

- The United States should develop a new proposal or a modification to PPWT for effectively dealing with weapons in space as opposed to the current passive strategy of opposing others' proposals while losing international support.
- The US proposal must be able to deal with specific threats under specific situations. Being a defender, the United States cannot be satisfied with a general strategy and capability that deals with most of the threats but leaves holes for space stalkers.
- The United States should take advantage of the mechanism and offices already dealing actively with disarmament. For example, the definition of aggressor and the concept of a self-defense zone should be introduced into the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities under the United Nations. It should explicitly argue that effective defense is a prerequisite for effective deterrence. Also important are the international cooperation and coordination in space surveillance and agreement monitoring and verification.
- The US-proposed space measures and agreements, in conjunction with current US space defense capability, must be able to deal with contemporaneous threats, not just threats of the future. Even if future satellites could be equipped to be perfectly resilient, existing satellites will remain still critical and vulnerable.

The State Department should work closely with the DOD to propose, consult, and negotiate transparency and confidence-building measures and space agreements with the international community that account for the threat of space stalkers. Realistically, potential adversaries are far more likely to want the United Nations to adopt alternative space proposals, which ignore the space-stalking threat. If this occurs, the United States must be prepared to unilaterally declare a policy of preemptive defense and implement capabilities to deal with the space-stalker threat, supported by as many allies and friends as possible. Once potential adversaries recognize that the United States possesses an effective space deterrence and defense strategy including countering space stalkers, they may well reevaluate their own proposals and find themselves better off by joining the realistic approach of the United States and other nations in keeping the peace in space.

Conclusion

The emerging space-stalker threat being developed by China and Russia under the cover of dual-use technologies cannot be addressed by traditional measures including reconstitution, defensive operations after attack, or resilience. These nations could find space stalkers to be the perfect space system to present the United States with two bad choices. First, the United States could preemptively destroy the space stalkers to save the targeted satellites. However, without discussing the sensitive issue of preemption with its allies and friends in peacetime, the United States could be treated as the aggressor that started a war in space. Second, it could fight without the support of satellites. Facing these two bad choices might prevent US intervention. To avoid these poor choices, the United States should evaluate the emerging space-stalker threat and the defense and deterrence against it, including a reexamination of preemptive self-defense as the last resort. With the popular argument and sentiment against preemption, preemptive self-defense as a last resort must be clearly restricted to space stalkers under situations that are justified for its use and cannot be used as a pretext for aggression. It is time to go beyond the concerns of the space stalkers into ways to defeat and deter them. Avoiding a space Pearl Harbor is a critical issue for the Trump administration and requires thoughtful and open-minded deliberation among all interested parties domestically and internationally. SSQ

Notes

1. While many more satellites have been launched into Earth orbit, there are currently only 1,381 satellites still operational. These satellites are owned or operated by 82 countries and organizations. NASA defines three classes of Earth orbits: high, mid, and low. Holly Riebeek, "Catalog of Earth Satellite Orbits," NASA Earth Observatory, 4 September 2009, http://earthobservatory.nasa.gov/Features/OrbitsCatalog/. Those at or above the altitude of 35,780 km are called high Earth orbits. They include geosynchronous Earth orbits (GEO) at around 35,780 km. A GEO satellite has the same rotation period as that of the Earth in about 23 hours 56 minutes and 4 seconds or a sidereal day. Further, if a GEO satellite travels in the same orbital plane as that of the Earth's equator, it is stationary in the sky from an Earth observer and is in a geostationary Earth orbit (GSO). More typically, an Earth observer sees a typical GEO satellite tracing out a figure 8 in the sky over a sidereal day. Satellite orbits between altitudes of 2,000 km and 35,780 km are called mid Earth orbits, which include medium Earth orbits (MEO) and elliptical Earth orbits (EEO). While MEOs are more common as shown in table 1, EEOs such as the Molniya orbit have much higher eccentricity. Low Earth orbits (LEO) are those at altitudes between 180 km and 2,000 km. In GEOs, the United States has 176 satellites. It has 32 satellites in MEOs; 327 satellites in LEOs; and 19

satellites in EEOs. China has 176 operational satellites and has overtaken Russia as having the second largest number of operational satellites. The total number of 1,381 satellites worldwide from the Union of Concerned Scientists satellite database matches well with "roughly 1,300 of those are active satellites. The rest are debris," as stated by Lt Gen John W. Raymond at the Air Force Space Command symposium. *See* "The Battle Above," CBS's *60 Minutes*, 26 April 2015, http://www.cbsnews.com/news/rare-look-at-space-command-satellite-defense-60-minutes-2/.

2. Office of the Secretary of Defense (OSD), "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2013," 2013, 33, http://www.defense.gov/Portals/1/Documents/pubs/2013_China_Report_FINAL.pdf.

3. OSD, "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2014," 24 April 2014, 32, http://www.defense.gov/Portals/1/Documents/pubs/2014_DOD_China_Report.pdf.

4. OSD, "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015," 7 April 2015, 14–15, http://www.defense.gov/Portals/1/Documents/pubs/2015_China_Military_Power_Report.pdf.

5. OSD, "Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2016," 26 April 2016, 37, http://www.defense.gov/Portals/1/Documents/pubs/2016%20China%20Military%20Power%20Report.pdf.

6. Christian Davenport, "A Fight to Protect 'the Most Valuable Real Estate in Space,'" *Washington Post*, 9 May 2016, 4–5, https://www.washingtonpost.com/business/economy/a-fight-to-protect-the-most-valuable-real-estate-in-space/2016/05/09/df590af2-1144-11e6-8967-7ac733c56f12_story.html.

7. CBS, "The Battle Above."

8. Department of Defense (DOD), *The Department of Defense Cyber Strategy*, April 2015, 2, https://www.defense.gov/Portals/1/features/2015/0415_cyber-strategy/Final_2015_DoD_CYBER_STRATEGY_for_web.pdf. "During a conflict, the Defense Department assumes that a potential adversary will seek to target U.S. or allied critical infrastructure and military networks to gain a strategic advantage." *See* also Jana Robinson, "Governance Challenges at the Intersection of Space and Cyber Security, *The Space Review*, 15 February 2016, 2, http://www.thespacereview.com/article/2923/1. Robinson, space security program director at the Prague Security Studies Institute, provided a treatise on how "space operations are entirely cyberspace dependent."

9. U.S.-China Economic and Security Review Commission (USCC), "2015 Report to Congress of the U.S.-China Economic and Security Review Commission," November 2015, 295, https://www.uscc.gov/Annual_Reports/2015-annual-report-congress.

10. Ibid., 294.

11. Jim Sciutto, "War in Space: The Next Battlefield," CNN Special Report, 29 November 2016, https://www.youtube.com/watch?v=j-ZBLFhb_lg. Also, the highlight of kamikaze and kidnapper satellites is available from Jim Sciutto and Jennifer Rizzo, "War in Space: Kamikazes, Kidnapper Satellites and Lasers," CNN, 29 November 2016, http://www.cnn.com/2016/11/29/politics/space-war-lasers-satellites-russia-china/.

12. David Wright, "How High Did China's May 2013 Launch Go?," Union of Concerned Scientists (website), 13 March 2014, http://allthingsnuclear.org/dwright/how-high-did-chinas-may-2013-launch-go. Wright used computer modeling to show that "a trajectory with an apogee at GEO would have a total flight time of about 7.9 hours." The time to reach apogee is somewhat more than half of the flight time due to the extra time for acceleration to reach the highest initial speed. China's direct ascent ballistic missile, which was launched in

May 2013 and interpreted by some US reports as a test of a rocket that could carry ASAT to GEO, would take about four hours to reach apogee or GEO. Of course, using a larger, more powerful and expensive rocket could reduce this time.

13. The Russian Luch satellite was launched 28 September 2014. A *SpaceNews* article stated that, "The satellite's movements were observed months after the Air Force said it was watching two other Russian military satellites, each with maneuvering capabilities that are consistent with, but not necessarily indicative of, an on-orbit antisatellite weapon." The article stated, "In a response to questions from *SpaceNews*, Air Force Capt. Nicholas Mercurio, a spokesman for U.S. Strategic Command's Joint Functional Component Command (JFCC) for Space, said in an Oct. 8 email that the Luch satellite has come within 5 kilometers of another satellite on three occasions since its launch. He did not identify the satellite," and that "five kilometers is extremely close for geosynchronous satellites and usually requires satellite operators to closely work together to minimize the chance of a collision. The Russian satellite was so close, Kay Sears, president of Intelsat General, said she believed 'the safety of flight' of the Intelsat satellites was at risk." Mike Gruss, "Russian Satellite Maneuvers, Silence Worry Intelsat," *SpaceNews*, 9 October 2015, http://spacenews.com/russian-satellite-maneuvers-silence-worry-intelsat/. It is reasonable to conclude that Russia's maneuvering and positioning capability applicable to space stalkers is more advanced than China's.

14. Leonard David, "Russian Satellite Hit by Debris from Chinese Anti-Satellite Test," Space.com, 8 March 2013, 1, http://www.space.com/20138-russian-satellite-chinese-space-junk.html.

15. Mike Gruss, "U.S. State Department: China Tested Anti-satellite Weapon," *SpaceNews*, 28 July 2014, http://spacenews.com/41413us-state-department-china-tested-anti-satellite-weapon/.

16. Colin Clark, "Chinese ASAT Was 'Successful:' Lt. Gen. Raymond," BreakingDefense (website), 14 April 2015, http://breakingdefense.com/2015/04/chinese-asat-test-was-successful-lt-gen-raymond/.

17. USCC, "2015 Report to Congress," 295.

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