Keep Your Friends Close, and Your Enemies Closer: Minimizing the Threat to US Space Assets

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Introduction

The space age began as a competition for security, power and prestige between two superpowers – the United States and the USSR. With the demise of the Soviet Union in 1991, the US became, and remains to this day, the dominant space power. While other states, such as China, Russia, India and Iran have begun to develop space capabilities, they are dwarfed by the "space footprint" of the US. Due to their significant space integration, it has been argued that the US has become reliant on outer space for continued military dominance[1] and economic prosperity.[2] This reliance, coupled with the difficulty inherent in defending space assets[3] or deterring enemies from attacking them, puts the US in a precarious position – one in which it is the dominant space power but is highly vulnerable to space attack, potentially nullifying its military and economic advantage.

This paper proposes a solution to this problem that challenges traditional international relations thinking. It argues that the United States, due to high costs, the unique space environment and technological difficulties, cannot move from its current dominant-vulnerable position to a dominant-invulnerable position. Therefore, it is in the best interest of the US to move to a non-dominant-mutually vulnerable position, in which the US is no longer the dominant, but remains the superior, power in outer space. In exchange for this move to non-dominance, the threat to US space assets will be minimized by the creation of mutual vulnerability – adversaries' increased penetration into outer space will increase their reliance on outer space and thus their vulnerability to US attack, creating a disincentive to attack US space assets. This shift can best be accomplished through the facilitation of potential adversaries' space capabilities by the US. By aiding the increase of adversaries' space footprints, the US is ensuring these adversaries become reliant on outer space and vulnerable to space attack, providing the motive for a space cooperation regime and, over time, minimizing the threat to US space assets.

To make this argument, this paper will be separated into three sections. The first will outline the benefits of outer space. In addition, it will illuminate the significant advantage enjoyed by the US in outer space compared to other states. The second will examine the threats faced by US space assets and the potential consequences should these threats become reality. The final section will attempt to demonstrate that, in order to minimize the threat to US space assets, it is in the best interest of the US to facilitate increases in the space footprint of potential adversaries such as China. This section will highlight the unique space conflict environment and argue that, given current technology, it is prohibitively costly and potentially impossible to achieve outer space dominance *and* invulnerability. Thus the US would be better off in a position of non-dominance but mutual-vulnerability.

Outer Space Benefits and Activity – US Dominance

The 60 years that have passed since humankind first ventured into outer space has seen significant advances in technology, some as a direct result of outer space exploitation. Overall, these advances in technology have deepened humankind's integration with outer space and provided it with significant benefits, both economic and militarily.

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[1] Benjamin S. Lambeth, *Mastering the Ultimate High Ground: Next Steps in the Military Uses of Outer Space* (Santa Monica, CA: RAND Corporation, 2003), 100-101.

[2] Michael Krepon, "Lost in Space: the Misguided Drive Toward Antisatellite Weapons," *Foreign Affairs* 80, no. 3 (May/June, 2001): 2-8.

[3] Jeffrey Lewis, "Rumsfeld Aims for the Stars: An Arms Control Alternative to the Pentagon's Plans in Space," *Georgetown Journal of International Affairs* (Winter/Spring, 2002): 114.

Economically, outer space has had an effect on numerous aspects of daily life. Communications satellites have allowed for the proliferation of cell phone technology. GPS and remote sensing satellites have revolutionized the way people travel, providing individuals with instant access to directions, travel information and information on areas of the globe that were previously ignored. These systems have also enabled such technological advancements as automatic teller machines (ATM). Space exploration and exploitation have contributed to such technologies as improved weather monitoring, improved search and rescue technology, improved firefighter breathing systems, cordless power tools, and CAT scan technology.[4] Moreover, the economic potential of outer space has only begun to be exploited, leaving ample room for future economic growth in outer space.[5]

In 2009, total civilian investment in outer space was 64.4 billion dollars, with the US accounting for 43 billion.[6] In the same year, China invested 6.1 billion and Russia 2.5 billion.[7] Global revenues from space-related products in 2009 were estimated to be between 150-165 billion dollars[8], with the US accounting for a significant amount of that revenue and activity.[9] These numbers, however, can be misleading. Numerous industries rely on space technology but are not considered to be space industries, making the assessment of the economic "value" of space extremely difficult. Nonetheless, it is safe to say that the total economic impact resulting from the loss of space-based resources would be greater than the loss of direct revenue from these assets.[10] Therefore, the total economic importance of outer space may be significantly larger than these numbers suggest. Some authors have speculated that total US investment in space technology could have reached 500 billion dollars in 2010, roughly equaling US investment in all of Europe.[11]

Given these numbers, and the technological advances brought about by the use of space, it is safe to say that outer space plays a significant role in the global economy. However, it is also apparent that the US dwarves other states in both inputs and outputs. This integration in outer space has given the US an economic advantage, but has also made its continued economic prosperity dependent on the use of outer space.[12] Were humankind unable to exploit outer space any longer, it would be the US economy that would suffer disproportionately in comparison to others. This reality may make US space assets a tempting target for attack.[13]

The military benefits of outer space are as large as, if not larger than, the economic benefits. Communications satellites provide militaries with fast and effective global communication abilities, improving overall performance. They can provide valuable links for crisis management or

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[4] Space Foundation, "Inducted Technologies/1998," Space Technology Hall of Fame, http://www.spacetechhalloffame.org/inductees.html (accessed March 30, 2012).
[5] Michael Pearson, "Historic Launch of Private Rocket Heralds New Era," CNN http://www.cnn.com/2012/05/22/tech/us-spacex/index.html?hpt=us_c2 (accessed May 22, 2012).
[6] OECD, *The Space Economy at a Glance, 2011* (OECD Publishing, 2011), 9.
[7] OECD, 53.
[8] OECD, 9.
[9] OECD, 60-69.
[10] Bruce M. Deblois, "The Advent of Space Weapons," *Astropolitics* 1 no. 1 (Spring, 2003): 33.
[11] Krepon.
[12] Krepon.
[13] Clayton K.S. Chun, "Shooting Down a 'Star': Program 437, the US Nuclear ASAT System and Present Day Copycat Killers," CADRE Paper no. 6 (Maxwell AFB, AB: Air University Press, 2000), 69-70.

allow communication across globally separate forces.[14] Remote sensing and reconnaissance satellites provide the national technical means to verify many arms treaties, but also provide targeting information, submarine tracking capabilities and information for the initiation of electronic warfare.[15] Weather satellites provide detailed information on appropriate times of attack based on the weather over targets, thereby improving attack effectiveness. Launch detection satellites provide indispensible warnings for possible nuclear launches, and may also be used as part of the infrastructure of a ballistic missile defense system.[16] All this says nothing of the increased intelligence collection capability provided by all of the above-mentioned satellites. Agencies such as the National Security Agency (NSA) and the National Reconnaissance Office (NRO) in the United States rely heavily on outer space satellites in order to conduct their intelligence activities.

While retrieving accurate spending figures for any national military space program can be daunting, in 2006, it was estimated that the Chinese space agency budget was 2 billion dollars annually, of which an unknown amount is defense-related. This amounts to roughly one-tenth the size of NASA's total budget[17], of which about half is suspected to be military in nature.[18] In 2010, the total estimated number of Chinese ISTAR[19] space assets was 36 while total American ISTAR space assets were estimated to be 61.[20] Beyond these budget estimates and numbers, however, is the level of integration and benefit that specific states receive from their military space activities. The US military benefits more than any other military from outer space. Outer space is crucial to the current global military dominance of the US, representing the "ultimate high ground"[21] and giving the US military an unmatched ability to "see, hear and talk" during a military conflict.[22] The US is currently the only country that is able to effectively and efficiently integrate and use its outer space assets on the battlefield. Its outer space assets are a key component of US national strength and power projection[23], and are considered to be a vital national interest.[24] This significant military advantage enjoyed by the US due to its space capabilities also makes it dependent on outer space for continued military dominance.[25] Much like its economic assets, due to its reliance on outer space, US military assets in space become a potential target for attack.

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[14] Paul Stares, "US and Soviet Military Space Programs: A Comparative Assessment," *Daedalus* 114 no. 2 (Spring, 1985): 129.
[15] Stares: 128.
[16] Stares: 129.
[17] "Chinese Annual Space Budget Exceeds Two Billion Dollars Annually," *Space Daily*, October 12, 2006.
[18] Robert Higgs, "The Trillion-Dollar Defense Budget is Already Here," The Independent Institute http://www.independent.org/newsroom/article.asp?id=1941 (accessed May 9, 2012).
[19] Intelligence, surveillance, target acquisition and reconnaissance.
[20] This includes imagery, intelligence and navigation satellites. "The Dragon's New Teeth," *The Economist*, April 7, 2012.
[21] Deblois: 38.
[22] Alan D. Campen, ed., *The First Information War: The Story of Communications, Computers and Intelligence Systems in the Persian Gulf War* (Fairfax, VA: AFCEA International Press, 1992), xi.
[23] Scott Koopman, "Space, National Characteristics, and Revolutions in Thinking," *High Frontier Journal* 2 no. 1 (September, 2005): 32.
[24] Marcia S. Smith, "Military Space Activities: Highlights of the Rumsfeld Commission Report and Key Organization and Management Issues," CRS Report for Congress (February 21, 2001): 2.
[25] Everett C. Dolman, "US Military Transformation and Weapons in Space," *SAIS Review* 26 no. 1 (Winter/Spring, 2006): 163-164.

Threats – US Vulnerability

The security challenges facing US outer space assets can be broken down into two distinct types of threat: irreversible and reversible. Irreversible threats refer to those threats that cause permanent damage to, or destroy, a satellite. Reversible threats refer to the temporary disrupting of signals to or from a satellite, or the denial of such signals to or from that satellite.

Irreversible

Irreversible threats can include space-to-space weapons (such as space-based missiles or dual-use satellites) or Earth-to-space weapons (such as Anti-Satellites Weapons (ASATs)). Though space-based weapons can indeed pose a problem, they are much more costly than Earth-to-space weapons, particularly if a state is looking to develop more than a one-time use weapons system.[26] In addition, the production, testing and deployment of ASATs is extremely difficult to detect given their resemblance to ballistic missiles. This makes predicting and responding to an attack much more difficult as there is almost no way of knowing an attack is about to occur until a launch is detected.[27] For these reasons, an Earth-based attack in the form of an ASAT would be more likely.

Assessing the likelihood of such an attack is not the purpose of this paper, but it should be noted that both Russia and China have the capability to produce, deploy and use ASATs against US satellites relatively quickly.[28] In 2007, the Chinese government successfully tested an ASAT against its own satellite.[29] The use of ASATs against US space capabilities could have a detrimental effect on US economic competiveness and military superiority. To illustrate one scenario, it is estimated that as much as 80% of US military communications go through outer space satellites.[30] The loss of these satellites through a targeted ASAT attack, in combination with the loss of intelligence and imagery satellites could leave the US drastically disadvantaged in a conflict. The potential for this problem was made clear to the US military in 1994 war games, in which the US was devastated in a simulated conflict with China.[31]

Reversible

Reversible threats can include jamming or spoofing uplink or downlink communications channels of satellites.[32] In essence, a state can use space-based or Earth-based technology to impede communication with satellites or satellite systems, rendering them useless. While this type of threat does not completely destroy a satellite, and any damage is usually reversible, the number

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[26] Deblois: 46.
[27] Phillip J. Baines and Adam Cote, "Promising Confidence- and Security-Building Measures for Space Security," *Disarmament Forum* 4 (2009): 5.
[28] Norman Friedman, "War In Space?" *U.S. Naval Institute Proceedings* 133 no. 3 (March, 2007): 90-91.
[29] "China Confirms Anti-Satellite Missile Test" *The Guardian*, January 23, 2007.
[30] Eisenhower Center for Space and Defense Studies, "Threat Assessment and the Space Domain," *2009 National Space Forum* 3 no. 2 (Fall, 2009): 4.
[31] Barbara Opall, "China Sinks U.S. in Simulated War," *Defense News*, Jan. 30-Feb. 5, 1995.
[32] Jessica West et al., *Space Security 2007* (Waterloo, ON: Project Ploughshares, 2007), 118.

of states able to engage in these types of activities is greater than those with ASAT or space-based weapon capability. These states include Iran, Cuba and pre-revolution Libya.[33]

Jamming or spoofing can have important consequences for the US. During the Cold War, both the US and USSR relied on the use of outer space capabilities to ensure strategic stability. Satellites such as those used in the US Defense Support Program (DSP) were used to detect missile launches and allowed the US to receive an early warning should any state launch a missile (of the nuclear variety or not).[34] Post-Cold War, these and other satellites are used to detect missile and satellite launches around the globe. The loss of this early warning ability through the jamming of the DSP satellites could have a significant destabilizing effect on the international system, potentially prompting escalating conflict.[35] Spoofing these in an attempt to delay or obscure the realization of an attack could diminish US confidence in these systems, also leading to escalatory behavior.

Keep Your Enemies Closer

The potential for these threats, both reversible and irreversible, to become reality puts the US in a precarious position. It enjoys a near complete dominance of outer space and receives a significant military and economic benefit from this dominance. Yet US dominance breeds US reliance and leaves US space assets vulnerable to attack, thereby rendering their dominance and its advantages unimportant should a conflict arise. Faced with the problem of being in a dominant-vulnerable position, the obvious solution is to reduce the vulnerability of US space assets – to move from a vulnerable to an invulnerable position.

A Move To Invulnerability?

This potential solution, however, begs the question: can anything ever be invulnerable? In order to answer this question, it is important to define invulnerability. At the end of World War II (WWII), the United States found itself in a dominant-invulnerable military position on Earth. As the only state in possession of nuclear weapons, it held a significant military advantage over all other states. In addition to this, its possession of nuclear weapons rendered it invulnerable. Any potential destabilizing threat could be effectively neutralized through the threat or use of its nuclear weapons. This does not mean that the US was invincible – other states could certainly threaten or attack it. It simply meant that its dominant military position was secure from rapid transformation and that its assets were perceived to be secure from attack. Therefore, invulnerability should be defined as a perceived security of assets that ensures the stability of one's current position. Stability, in this case, means that the position one currently occupies is either only changeable willingly by oneself or unwillingly through significant cost or difficulty. In this way, a state is invulnerable if it is difficult or counterproductive to attempt to affect transformation against that state against its will. This does not mean that others could not attempt to change the US' position. Indeed, by building the bomb, this is what the USSR did.

Two caveats are necessary here. First, it is important to note that, at the end of WWII, nuclear weapons acted as the source of *both* US dominance and invulnerability. This is not the case in outer space. Current US space activity and penetration makes it the dominant power. However,

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[33] West et al., 17 & 125.
[34] US Air Force, "Defense Support Program (DSP) Satellites," Los Angeles Air Force Base http://www.losangeles.af.mil/library/factsheets/factsheet.asp?id=5323 (accessed May 10, 2012).
[35] Baines and Cote: 7.

these same assets that make it dominant do not render it invulnerable. Satellites, unlike other economic and military assets, are unable to be kept under complete monitoring and control. They are, essentially, floating in space for other states to see, track and target. This makes them more vulnerable to attack than other military or economic assets, which can be placed behind borders or under constant guard. Therefore, unlike nuclear weapons, the same assets that render the US dominant also render it vulnerable. Second, it is important to separate space dominance from military dominance. While the US is currently the dominant military power, this is not due entirely to its outer space capabilities. US space dominance contributes significantly to US military dominance, particularly its global reach, but the two are not synonymous. This is important when discussing the potential mechanisms the US can employ to move to a dominant-invulnerable position as the confusion of the two can lead one to reject a key proposition of this paper – that it is impossible for the US to move to a dominant-invulnerable outer space position.

Moving from a vulnerable to invulnerable position can be done in two ways. One could choose to protect ones assets through defense, or one could seek to dissuade others from attacking vulnerable assets through deterrence. While both methods have their advantages, this paper contends that, specifically related to outer space, neither creates invulnerability.

Defense

Defense tactics fall under what the US Department of Defense calls Defensive Counter Space (DCS). DCS is designed to protect space systems from hostile or damaging activities. DCS can, and does in some instances[36], include building protective measures into satellites. When dealing with reversible threats, these measures include, but are not limited to, configuring an imagery satellite to place a cap over its lens should it receive a hostile signal, building redundant systems within a satellite or group of satellites in case one should be jammed or spoofed, dispersing satellites into many different orbits or planes to prevent "scheduling" – the tactic of mapping times and places of hostile satellites – or employing frequency hopping.[37] In addition to these defensive measures, the US can choose to employ active suppression of adversary counterspace capabilities (SACC). The most obvious example of this would be to destroy, via direct attack, the enemy ground station responsible for jamming or spoofing the satellite in question.[38]

To defend against irreversible threats, such as ASATs, the options are much more limited. The US can construct the satellite to do one (or more) of three things: avoid, withstand, or dodge an attack. Avoiding would entail placing within the satellite a means of camouflage or the ability to deceive an ASAT.[39] This would function similar to the dispensing of chaff and flares by aircraft.[40] Withstanding would mean constructing a satellite so that it could bear the brunt of an ASAT and still function. This is known as "hardening".[41] Finally, dodging an attack would entail constructing a satellite so that it has the ability to detect an ASAT attack and maneuver to avoid it.[42] Within the

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[36] David O. Meteyer, "The Art of Peace: Dissuading China from Developing Counter-Space Weapons," *US Air Force Institute for National Security Studies Occasional Paper* 60 (August, 2005): 48.
[37] Meteyer: 48 and US Air Force, "Counterspace Operations," *US Air Force Doctrine Document* 3-14.1 (August 2, 2004): 27.
[38] "Counterspace Operations": 27.
[39] "Counterspace Operations": 26.
[40] Meteyer: 48.
[41] "Counterspace Operations": 26.
[42] Meteyer: 48.

realm of active SACC, the US could employ ballistic-missile defense systems to shoot down ASATs in flight or could launch an attack against ASATs on the ground prior to their use.

Unfortunately, while DCS tactics are numerous, a closer examination reveals their failings. Concerning reversible threats, DCS tactics suffer from two flaws. First, they are extremely costly and technically challenging. According to the Union of Concerned Scientists, the US has a total of 441 satellites in outer space – 117 are government satellites, 122 are military and 194 are commercial.[43] Retroactively equipping even a fraction of these satellites with defensive mechanisms would be tremendously costly. In addition, it may simply not be possible to retroactively equip particular satellites with defensive mechanisms, leaving them vulnerable. Fitting new satellites with defensive mechanisms will be costly due to launch-weight considerations. As the weight of the satellite increases, the cost of launching it increases, by an average of $20,000 per kilogram.[44] Other DCS tactics, such as the use of redundant systems, dispersal or frequency hopping also increase the cost of the satellite itself or the costs of the maintenance and operation of the satellite.

Second, employing DCS tactics aimed at making jamming or spoofing difficult or impossible may encourage potential adversaries to use ASATs. In this way, DCS tactics aimed at reversible threats may increase the potential for irreversible threats to become reality. Unfortunately, DCS tactics aimed at jamming and spoofing offer no protection against ASATs.[45] Therefore, any DCS tactics must focus on both reversible and irreversible threats, again increasing costs.

Regrettably, the effectiveness of DCS tactics aimed at irreversible threats are no better than those aimed at reversible threats. As already noted, ASATs are nearly impossible to distinguish from other missiles, making a preemptive strike against them unfeasible. Employing ballistic-missile defense systems suffers from significant problems, including being highly susceptible to countermeasures.[46] Avoiding an attack, while possible, is extremely costly. Defensive mechanisms must be built into the satellite, increasing cost and weight. In addition, unlike aircraft, a satellite cannot deploy chaff or flares and land to restock their supply. Therefore, any avoidance mechanism must be either unlimited or self-replenishing, both a technical and monetary challenge. Withstanding an attack using hardening techniques is plausible, but can be easily overcome by increasing the size or payload of an ASAT. ASATs can feasibly get numerous shots at a satellite, allowing the attacking state to adjust the amount of force employed. The defending state, however, only has one chance to harden its satellite – pre-launch. Finally, dodging an attack may not even be possible. While movement in reaction to an attack is theoretically feasible, it is far too slow to avoid a collision with an ASAT.[47] In summary, while numerous defensive techniques exist, due to technological, engineering and economic challenges, offense is clearly at an advantage in outer space.

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[43] Union of Concerned Scientists, "UCS Satellite Database," Union of Concerned Scientists http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons/technical_issues/ucs-satellite-database.html (accessed May 12, 2012).

[44] Lewis: 115.

[45] Meteyer: 48.

[46] Andrew M. Sesslet et al., *Countermeasures: A Technical Evaluation of the Operational Effectiveness of the Planned US National Missile Defense System* (Cambridge, MA: Union of Concerned Scientists Publications, 2000), xx.

[47] Meteyer: 48.

Deterrence

Deterrence, as observed by Thomas Schelling, "is concerned with influencing the choices another party will make, and doing it by influencing his expectations of how we will behave."[48] Deterrence "refers to the effect when a person, institution or policy decides not to take action that otherwise would have been taken, because of the belief or strong suspicion that intolerable consequences would ensue for such action."[49] Unlike defense, which focuses on securing ones assets against attack by another party, deterrence focuses on dissuading the other party from attacking at all. During the Cold War, nuclear deterrence was the key strategic policy of the United States.[50] Since vital assets (namely American citizens and American territory) could not be adequately defended against a Soviet nuclear attack due to the weapons destructive power and delivery technology[51], the US sought to deter the Soviets from attacking in the first place. This was done through signaling that any nuclear attack would be met in kind, meaning the end of both societies. Given the offensive advantage in outer space, deterrence seems like an effective course to pursue to minimize the threat to US space assets and place the US in a dominant-invulnerable position. The US has two deterrence options – space-based and Earth-based.

A space-based deterrence strategy would be based on the idea that the US would respond to attacks against its space assets with retaliation against an aggressor's space assets. This deterrence strategy could involve the placement of weapons in outer space, with space-to-space destructive capability or the use of ASATs. The US remains able to use ASAT technology, as was demonstrated in 2008 when it shot down a failed satellite, presumably in response to the 2007 Chinese ASAT test.[52] In essence, then, space-based deterrence would involve signaling, by the US, that attacks against its space assets will be responded to in kind, with retaliation coming against space assets.

Space-based deterrence suffers from two significant flaws. The first concerns the nature of the outer space environment itself. Outer space, unlike any other medium – air, land and sea – possesses properties such that any attack against an adversary's satellite increases the threat to one's own satellites and future use of space *even without retaliatory attack*. Space debris – leftover pieces of rockets, destroyed satellites and other space junk – can travel at very high speeds (upwards of 7.8km/s in certain orbits), turning pieces of satellites, as small as 10cm in diameter, into destructive forces capable of delivering the same amount of energy to an object as a 35,000kg truck traveling at 190km/hour.[53] Furthermore, once space debris is created, it will remain in orbit – sometimes indefinitely. This can lead to a cascade effect, where old debris hits new satellites, creating more debris.[54] The destruction of numerous satellites could lead to a situation where entire areas of space could become unusable for hundreds, or thousands, of years, thus negating the benefits that the exploitation of outer space provides. Therefore, the outer space environment adds a unique challenge to space-based deterrence: by retaliating against an aggressor, the US would be undermining its own potential future use of outer space and further endangering their

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[48] Thomas C. Schelling, *The Strategy of Conflict* (Cambridge, MA: Harvard University Press, 1960), 13.
[49] Colin S. Gray, "Deterrence and the Nature of Strategy," in *Deterrence in the 21st Century,* Max G. Manwaring, ed. (Portland, OR: Frank Cass, 2001), 18.
[50] Robert S. McNamara, *The Essence of Security* (New York: Harper and Row, 1968): 52-53.
[51] Bernard Brodie, *Strategy in the Missile Age* (Princeton, NJ: Princeton University Press, 1959).
[52] "China Accuses US of Double Standards Over Satellite Strike," *The Guardian*, February 21, 2008.
[53] West et al., 21.
[54] David Wright et al., *The Physics of Space Security: A Reference Manual* (Cambridge, MA: American Academy of Arts and Sciences, 2005), 22.

current space assets. This is not only counterproductive to the overall goal of space-based deterrence – minimizing the threat to US space assets – but significantly undermines the credibility of the US deterrent threat. It seems difficult to credibly threaten space-based retaliation if that retaliation also entails potentially destroying your own assets in the process.

Fortunately, this unique characteristic of the outer space environment contains within it a silver lining. While it is true that US retaliation would be counterproductive, it is also true that any attack on US satellites would endanger the aggressor's space assets and future use of outer space. In this way, the outer space environment is self-deterring. Just as it seems difficult for the US to threaten retaliation, it may be just as difficult for a potential adversary to threaten attack against US assets if it means potential damage to their own space assets. The crux of this silver lining, however, is that the aggressor needs to have enough invested in space for self-deterrence to operate – it needs something to lose.

The second flaw of space-based deterrence concerns the mismatch of space assets between the US and potential adversaries. As noted above, approximately half of the satellites currently in orbit are US satellites. Russia has about one quarter the number of satellites as the US, while China has less still. Therefore, the threat of a space-based retaliation may not be much of a threat at all, particularly when weighed against the potential benefits of attacking US space assets. Given the potential to inflict significant damage on the US economy and military, and the relatively small impact of US retaliation in space, potential aggressors may easily calculate that the benefits of attack outweigh the costs. This, combined with the credibility problem, makes space-based deterrence a risky and potentially ineffective strategy.

Earth-based deterrence would move out of the realm of outer space and extend the threat of retaliation to Earth assets. An Earth-based deterrent strategy would remedy the debris and asset mismatch problems that plague space-based deterrence. Broadly, the US would signal to potential aggressors that an attack against its space assets would be considered an attack against its vital interests and that it would retaliate against an aggressor's vital interests on Earth. This could be done through conventional methods - land, sea or air attacks – or by space-based weapons that have the ability to hit targets on Earth. Unfortunately, while an Earth-based deterrence strategy alleviates the challenges posed by a space-based strategy, it presents problems of its own.

The biggest concern of an Earth-based deterrence strategy is that it risks escalation to a much larger conflict. Of course, this is dependent on the nature of the conflict. If attacks against US space assets were part of a larger conflict, then no escalation would be apparent. However, if attacks against US space assets are made in the context of a battle for space superiority or out of a perceived threat posed by US space assets, retaliation against ground targets risks escalating the conflict, with potentially dangerous consequences. In addition to the escalation risk, a US Earth-based deterrence strategy, paradoxically, depends heavily on outer space. The ability of the US military to deter attacks against its space assets through the threat of retaliation is based on the benefits it receives from those same space assets. The US depends on satellites to conduct military tasks, including communication, targeting, planning etc. Therefore, were its space assets attacked and destroyed, it may not be able to retaliate with significant force. At the very least, it is fair to say that, given the potential destruction of satellites essential for military operations, the ability of the US to retaliate post-strike would be diminished compared to its ability to launch a pre-emptive strike. It is for this reason that many have speculated that, should China decide it needs to militarily intervene in Taiwan and assumes US military involvement on behalf of Taiwan, China would attempt to disrupt US space assets in order to create an "asymmetric advantage."[55]

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[55] Joan Johnson-Freese, "China's Space Ambitions," *Proliferation Papers* (Summer, 2007): 18.

Attempting to bolster US response capability through the addition of space-to-Earth weapons would do little to increase the usefulness of an Earth-based deterrence strategy. First, it is prohibitively costly, with some estimating that an adequate space weapons system would cost around $1 trillion, on the low end.[56] Second, space weapons are just as vulnerable to attack as other satellites, making their usefulness in the case of an attack on space assets questionable. One would assume they would simply be the first assets targeted.

In summary, deterring an attack against US space assets given current conditions is a difficult, if not impossible, task. Large problems surrounding cost, credibility and effectiveness exist that mitigate the chances of success. Taken in combination with the significant advantage given to offensive tactics in outer space and the near futility of defending space assets from attack, it is safe to say that rendering US space assets, and by extension US space dominance, invulnerable is not a feasible solution to the problem of US space vulnerability.

Mutual Space Vulnerability

Fortunately, defense and deterrence are not the only possible solutions. It is safe to say that it is in the best interest of the US to attempt to dissuade adversaries from attacking their space assets. The question becomes: how? This paper argues dissuasion is best accomplished not through non-credible threats, escalatory behavior or costly and often ineffective defense mechanisms, but through cooperation. Achieving cooperation from adversaries in outer space, in the form of a ban of space weapons of all types (space-based and Earth-based) or a security guarantee concerning US space assets, would protect US security interests in outer space and reduce their vulnerability to attack. The obvious criticism of this notion is that, while cooperation may be desirable, it is difficult, risky and uncertain. It is uncertain because one state can never be sure of another's future intentions and thus must always be worried about defection from cooperation. It is risky in that you are essentially placing your security, to a certain extent, in the hands of a potential adversary, limiting your ability to prevent future action.[57] And finally, it is difficult because adversaries often want different things, thus giving them no motive for cooperation.

Though these criticisms are important, they are far from detrimental to the prospects of outer space cooperation. Cooperation can help minimize the risks of defection and the uncertainty of intention. Cooperative arrangements help to structure transaction costs and, as such, can impose high exit costs, making defection less likely by increasing costs relative to benefits. In addition, cooperative arrangements reduce uncertainty of intention through the provision of information and, in some instances, can modify states' expectations, further reducing uncertainty. Though cases in which adversaries want mutually exclusive outcomes and have no motive to cooperate do exist, it is important to note that cooperation need not require harmony. States do not have to be in lock step on issues in order to cooperate. There merely need be an overlapping interest in which cooperation can prove to be beneficial.[58] To put it in game-theoretical terms, states need to be in a game of chicken in order for minimal cooperation to be likely. In iterated

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[56] DeBlois: 46.

[57] For a good summary of the perceived limits of cooperation in international relations see Joseph M. Grieco, "Anarchy and the Limits of Cooperation," *International Organization* 42 no. 3 (Summer, 1988): 485-507.

[58] These elements of cooperation are summarized in Robert O. Keohane, *After Hegemony: Cooperation and Discord in the World Political Economy* (Princeton: Princeton University Press, 1984), ch. 1.

chicken situations, defection becomes less and less likely through the use of credible reciprocity strategies.[59] Aggressors are deterred from defecting by the belief that any benefits it receives from defection would be negated by reciprocal action from other parties.

John Lewis Gaddis, in 1986, suggested that the lack of conflict between the US and USSR during the Cold War was a result of, among other things, the existence of nuclear weapons.[60] Drawing on conflict scholar, Geoffrey Blainey[61], Gaddis argued that nuclear weapons had "given his generation a painfully vivid awareness of the realities of war" and that this awareness had removed any optimistic notions states have about war, in effect adding a permanent pessimism "to our thinking about war and [permanent pessimism], as Blainey reminds us, is a cause of peace."[62] This permanent pessimism concerning the prospects of war led each side to calculate that going to war would be a fruitless endeavor. Nuclear weapons did this in two ways. First, they dulled the conflict itself, making each side less optimistic about its prospects for victory given the other side's ability to inflict massive damage. Second, they made the calculation of perceived power much easier. Once both sides had, and could use, nuclear weapons, differences in other capabilities became less important. Nuclear weapons moved the USSR and US to relative power equality and alleviated the problem of miscalculation.[63]

Important, but seemingly often forgotten in the discussion concerning the peaceful effects of nuclear weapons is the concept of vulnerability. As noted earlier, the destructive power of nuclear weapons combined with the difficulty in defending against their delivery systems left those without a nuclear deterrent vulnerable. This was the case for the USSR immediately after WWII – its lack of nuclear deterrent left it vulnerable to US attack. However, it is important to note that, at this same time, the US was *invulnerable* to attack by the USSR – they had an effective nuclear deterrent. The development of nuclear weapons by the USSR, however, did not render the USSR invulnerable. Instead, it made the US vulnerable. The development of nuclear weapons by the USSR shifted the US position from dominant-invulnerable to non-dominant-mutually-vulnerable. Only then did the peaceful effects discussed by Gaddis take effect. Mutual vulnerability to attack was key to the peaceful effects of nuclear weapons – it provided strong disincentives for attack, removed a first-move advantage, shifted the usefulness of nuclear weapons from destabilizing offensive weapon to stabilizing defensive threats and placed the US and USSR in a chicken game in which a credible strategy of reciprocity (2nd strike capability) prevented defection (1st strike). Mutual-vulnerability bred a semblance of cooperation and tolerance between the two superpowers and was the driving force behind the peaceful effects that nuclear weapons had on the Cold War.

Replicating this situation of mutual vulnerability and its effects – mutual deterrence and cooperation – in outer space is the best plausible solution to reduce the threat to US space assets. Mutual vulnerability provides the motive for cooperation – it shifts the current outer space situation to a game of chicken, in which each side would be better off cooperating than mutually defecting. Defection would mean the destruction of each side's respective space assets whereas cooperation would mean that both sides continue to enjoy the military and economic benefits of

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[59] Kenneth A. Oye, "Explaining Cooperation Under Anarchy: Hypotheses and Strategies," *World Politics* 38 no. 1 (October, 1985): 15.
[60] John Lewis Gaddis, "The Long Peace: Elements of Stability in the Postwar International System," *International Security* 10 no. 4 (Spring, 1986): 120-123.
[61] Geoffrey Blainey, *The Causes of War* (New York: The Free Press, 1988).
[62] Gaddis: 123.
[63] John Mearsheimer, "Why We Will Soon Miss the Cold War," The Atlantic Monthly Online http://www.theatlantic.com/past/politics/foreign/mearsh.htm (accessed May 26, 2012).

outer space. This proposition raises two important questions. The first concerns the similarity between space mutual vulnerability and nuclear mutual vulnerability. The second, and more crucial, question concerns policy. How can mutual vulnerability occur when the US is much more vulnerable in space than its adversaries, notably China? I will address both these questions.

There are two important differences between the nuclear mutual vulnerability of post-WWII and the proposed space mutual vulnerability. The biggest is the asymmetric nature of the positions of the US and USSR prior to the development of nuclear weapons by both sides. The US was in a dominant-invulnerable position and, as such, had no incentive to move from this position – it was the ideal. The USSR, on the other hand, was in a non-dominant-vulnerable position and had every incentive to better its security position. Therefore, there is little surprise that the USSR pursued nuclear weapons. Outer space is different. The asymmetric nature that was present with nuclear weapons is no longer there. The US is vulnerable while its adversaries (Russia, China, etc.) are non-dominant. Therefore, *both* sides have an incentive to shift their position. This may make shifting easier. A second difference concerns the effects of conflict. As Gaddis and others have argued, nuclear weapons affected the entirety of the relationship between the US and the USSR. Other elements became less important in measuring relative power and the conflict itself became dulled. This is not case with outer space. While nuclear weapons restricted total military conflict, outer space assets do not have that kind of effect. Therefore, any peaceful effects of mutual vulnerability should only relate to the outer space domain, though the potential for externalities certainly exists. Fortunately, these differences do not preclude a replication of mutual vulnerability and its effects in outer space. The critical question concerns how mutual vulnerability becomes reality in outer space.

Creating the conditions for cooperation in outer space – mutual vulnerability – and minimizing the threat to US space assets through cooperation is best achieved by increasing the vulnerability of US adversaries to outer space attack and leveraging the self-deterring effects of the outer space environment. For the sake of illustrating how this would work, this section will focus on China. Currently, China has little to lose in outer space whereas its potential relative gains are enormous. Closing this gap is essential to creating the motive for cooperation and forcing the self-deterring elements of the outer space environment to enter Chinese strategic thinking. Fortunately, both the US and China have an incentive for this to occur. China is currently a rising global power, both militarily and economically. Inevitably, and as evidenced by their increased spending, China is going to require space assets in the future to further its global reach.[64] In addition to this, China tends to view its space program as a matter of national prestige, meaning that it would, in all likelihood, want to continue it.[65] While becoming more integrated in outer space may produce vulnerability similar to that of the US, it can be argued that the benefits outweigh the cost. Indeed, when looking at the US space program up until now, it seems difficult to argue that the benefits do not outweigh the costs. US global dominance in military and economic affairs is based heavily on its space capability. Its ability to be almost anywhere and everywhere around the globe would be extremely costly and difficult without its outer space capability. It is easy to see why China would desire similar capability as well. Unfortunately, Chinese long-term interest in outer space does not minimize the current threat to US space capability. While China, in the future, may be reliant on outer space and vulnerable to space attack, this does not preclude an attack on US space assets in order to further short-term goals or level the outer space playing field.

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[64] OECD, 53.

[65] William S. Murray III and Robert Antonellis, "China's Space Program: The Dragon Eyes the Mood (and Us)," *Orbis* 47 no. 4 (Fall, 2003): 645.

Speeding up the process of Chinese space vulnerability is required. US policy can further this acceleration.

Thus far, US policy towards China concerning outer space matters has stuck to the familiar international relations policy of ignorance. Outer space cooperation has been minimal and, when suggested, has been obstructed. In 2011, a provision in the US budget resolution bars the use of federal funds to conduct bilateral science exchanges with China, with some in the US Congress arguing that "The United States has no business cooperating with the People's Liberation Army to help develop its space program."[66] Policies of this type not only prevent potentially vital intelligence from being acquired by the US through collaboration, but also continue to put US space assets at risk. Both the long-term and short-term interests of the US are best served through accelerating China's growth in space and thus its vulnerability to space attack. In the short-term, the threats to US space assets are minimized while the US continues to maintain a high level of space superiority. In the long-term, the US can gain valuable knowledge about the Chinese space program and, at the same time, expand its outer space capability with the knowledge that its vulnerability to attack is relatively low. The US needs to shift its policy from ignorance to engagement. Doing so will cost the US some immediate relative power – the loss of its space dominance – but it will secure its space superiority from neutralization. This is a better tradeoff than the current one – a dominance that may be easily neutralized when it matters most. For this reason, the US should pursue cooperative engagement policies with China on outer space matters. Some examples of this engagement may include certain types of technology transfer, joint launches, potential integration in the international space station and the creation of joint data exchange centers. By engaging in these types of policies, the US can accelerate the growth of China in space, increasing China's space dependency and reliance, thus creating a situation of mutual vulnerability that is ripe for cooperation. Failing to do so keeps US space assets at risk.

Conclusion

This paper has argued that US outer space assets are a potentially tempting target for attack. The US is currently the dominant space power and receives significant economic and military benefits from this position. However, its reliance on these assets for global reach, economic competitiveness and military dominance has left it vulnerable to space attack. Traditional strategies, such as defense and deterrence are inappropriate to minimize this threat. Defending outer space assets is costly and often impossible while attempting to deter attack against these assets is either non-credible or potentially counterproductive. Therefore, it is in the US' best interest to engage with potential adversaries in an effort to accelerate their outer space integration. Aiding the increase of an adversary's outer space integration will create important benefits for that adversary but will also increase their reliance on outer space benefits and, as such, their vulnerability to attack, creating a situation of mutual vulnerability. Much like the role of nuclear weapons during the Cold War, the construction of mutual vulnerability in outer space can create incentives for cooperation, dull outer space tensions and minimize the threat to both the outer space environment and the assets that reside there.

While this conclusion may seem counterintuitive to traditional understandings of international relations, it is important to recognize that the outer space domain is vastly different than previous mediums of potential conflict. The problem posed by debris eliminates the

[66] Mike Wall, "NASA Chief Says US Could Cooperate with China in Space," Space.com (November 3, 2011) http://www.space.com/13492-china-united-states-space-cooperation-nasa.html (accessed May 16, 2012).

effectiveness of unilateral deterrence strategies by the dominant power and creates a situation where cooperation, even in spite of a relative loss in the short term, is the best course of action. While the US could attempt to maintain the status quo and remain dominant-vulnerable, given concerns about uncertainty of intention, it seems counterintuitive to leave such a gaping hole in ones security apparatus. Moreover, the US does not have complete control over any other state, friend or foe. Therefore, it would be impossible to sustain its dominant-vulnerable position in the face of adversary determined to change it.

Unfortunately, there are still many unanswered questions concerning the prospects of mutual vulnerability as the precursor for outer space cooperation that this paper has been unable to answer. It has been unable to speculate on the best paths to the creation of mutual vulnerability and how the US might steer adversaries towards this path. In addition, it has been unable to shed light on specific policies that may achieve US goals. The crux of this paper, however, has been to argue that the US should take heed of the saying, "Keep your friends close, and your enemies closer," when deciding how to best secure its outer space assets.

References

Baines, Phillip J. and Adam Cote. "Promising Confidence- and Security-Building Measures for Space Security." *Disarmament Forum* 4 (2009): 5-16.

Blainey, Geoffrey. *The Causes of War*. New York: The Free Press, 1988.

Brodie, Bernard. *Strategy in the Missile Age*. Princeton, NJ: Princeton University Press, 1959.

Campen, Alan D., ed. *The First Information War: The Story of Communications, Computers and Intelligence Systems in the Persian Gulf War.* Fairfax, VA: AFCEA International Press, 1992.

"China Accuses US of Double Standards Over Satellite Strike." *The Guardian*, February 21, 2008.

"China Confirms Anti-Satellite Missile Test." *The Guardian*, January 23, 2007.

"Chinese Annual Space Budget Exceeds Two Billion Dollars Annually." *Space Daily*, October 12, 2006.

Chun, Clayton K.S. "Shooting Down a 'Star': Program 437, the US Nuclear ASAT System and Present Day Copycat Killers." CADRE Paper no. 6 Maxwell AFB, AB: Air University Press, 2000.

Deblois, Bruce M. "The Advent of Space Weapons." *Astropolitics* 1 no. 1 (Spring, 2003): 29-53.

Dolman, Everett C. "US Military Transformation and Weapons in Space." *SAIS Review* 26 no. 1 (Winter/Spring, 2006): 163-175.

Eisenhower Center for Space and Defense Studies. "Threat Assessment and the Space Domain." *2009 National Space Forum* 3 no. 2 (Fall, 2009): 4-5.

Friedman, Norman. "War In Space?" *U.S. Naval Institute Proceedings* 133 no. 3 (March, 2007): 90-91.

Gaddis, John Lewis. “The Long Peace: Elements of Stability in the Postwar International System.” *International Security* 10 no. 4 (Spring, 1986): 99-142.

Gray, Colin S. “Deterrence and the Nature of Strategy.” in *Deterrence in the 21st Century*, edited by Max G. Manwaring. Portland, OR: Frank Cass, 2001.

Grieco, Joseph M. “Anarchy and the Limits of Cooperation.” *International Organization* 42 no. 3 (Summer, 1988): 485-507.

Higgs, Robert. “The Trillion-Dollar Defense Budget is Already Here.” The Independent Institute http://www.independent.org/newsroom/article.asp?id=1941 (accessed May 9, 2012).

Johnson-Freese, Joan. “China’s Space Ambitions.” *Proliferation Papers* (Summer, 2007).

Keohane, Robert O. *After Hegemony: Cooperation and Discord in the World Political Economy*. Princeton: Princeton University Press, 1984.

Koopman, Scott. “Space, National Characteristics, and Revolutions in Thinking.” *High Frontier Journal* 2 no. 1 (September, 2005): 32-34.

Krepon, Michael. “Lost in Space: the Misguided Drive Toward Antisatellite Weapons.” *Foreign Affairs* 80, no. 3 (May/June, 2001): 2-8.

Lambeth Benjamin S. *Mastering the Ultimate High Ground: Next Steps in the Military Uses of Outer Space*. Santa Monica, CA: RAND Corporation, 2003.

Lewis, Jeffrey. “Rumsfeld Aims for the Stars: An Arms Control Alternative to the Pentagon’s Plans in Space.” *Georgetown Journal of International Affairs* (Winter/Spring, 2002): 111-119.

McNamara, Robert S. *The Essence of Security*. New York: Harper and Row, 1968.

Mearsheimer, John. “Why We Will Soon Miss the Cold War.” The Atlantic Monthly Online http://www.theatlantic.com/past/politics/foreign/mearsh.htm (accessed May 26, 2012).

Meteyer, David O. “The Art of Peace: Dissuading China from Developing Counter-Space Weapons.” *US Air Force Institute for National Security Studies Occasional Paper* 60 (August, 2005).

Murray III, William S. and Robert Antonellis. “China’s Space Program: The Dragon Eyes the Mood (and Us).” *Orbis* 47 no. 4 (Fall, 2003): 645-652.

OECD. *The Space Economy at a Glance, 2011*. OECD Publishing, 2011.

Opall, Barbara. "China Sinks U.S. in Simulated War." *Defense News*, Jan. 30-Feb. 5, 1995.

Oye, Kenneth A. “Explaining Cooperation Under Anarchy: Hypotheses and Strategies.” *World Politics* 38 no. 1 (October, 1985): 1-24.

Pearson, Michael. “Historic Launch of Private Rocket Heralds New Era.” CNN http://www.cnn.com/2012/05/22/tech/us-spacex/index.html?hpt=us_c2 (accessed May 22, 2012).

Schelling, Thomas C. *The Strategy of Conflict*. Cambridge, MA: Harvard University Press, 1960.

Sesslet, Andrew M. et al. *Countermeasures: A Technical Evaluation of the Operational Effectiveness of the Planned US National Missile Defense System*. Cambridge, MA: Union of Concerned Scientists Publications, 2000.

Smith, Marcia S. “Military Space Activities: Highlights of the Rumsfeld Commission Report and Key Organization and Management Issues.” CRS Report for Congress, February 21, 2001.

Space Foundation. “Inducted Technologies/1998.” Space Technology Hall of Fame http://www.spacetechhalloffame.org/inductees.html (accessed March 30, 2011).

Stares, Paul. “US and Soviet Military Space Programs: A Comparative Assessment.” *Daedalus* 114 no. 2 (Spring, 1985): 127-145.

“The Dragon’s New Teeth.” *The Economist*, April 7, 2012.

Union of Concerned Scientists. “UCS Satellite Database.” Union of Concerned Scientists, http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons/technical_issues/ucs-satellite-database.html (accessed May 12, 2012).

US Air Force. “Counterspace Operations.” *US Air Force Doctrine Document* 3-14.1 (August 2, 2004).

US Air Force. “Defense Support Program (DSP) Satellites.” Los Angeles Air Force Base http://www.losangeles.af.mil/library/factsheets/factsheet.asp?id=5323 (accessed May 10, 2012).

Wall, Mike. “NASA Chief Says US Could Cooperate with China in Space.” Space.com http://www.space.com/13492-china-united-states-space-cooperation-nasa.html (accessed May 16, 2012).

West, Jessica et al. *Space Security 2007*. Waterloo, ON: Project Ploughshares, 2007.

Wright, David et al. *The Physics of Space Security: A Reference Manual*. Cambridge, MA: American Academy of Arts and Sciences, 2005.