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**Abstract:**

The United States military's ability to gain and maintain full spectrum domination of the battlefield is predicated on its space-based systems and space domain superiority. Events over the last decade suggest that the space domain will become a contested battlespace in the near future as emerging powers and historical adversaries seek to establish a credible presence. Therefore the United States should prepare for an eventual weaponization of space despite the existence of several dated treaties regarding the sanctity of that environment. This will require adjusting the language of the National Security Strategy and National Military Strategy as well as pursuing technological capabilities that will assure the United States maintains the initiative over its competitor's space-based systems.

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Space Weaponization: A Red Line to Avoid or an Eventuality to Prepare For?

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The United States (US) military’s space domain system have enabled the US to maintain an unparalleled advantage in the realm of satellite communications, global-positioning satellite (GPS) guided munitions, navigation, and intelligence, surveillance, and reconnaissance (ISR). These abilities to gather real-time information or destroy a target with precision accuracy demonstrate that, since Operation DESERT STORM, the U.S. has enjoyed unrivaled combat capabilities on the land, sea, and air, enabled considerably by satellites. Unfortunately, recent events suggest this unparalleled space dominance will be challenged in the 21st century.

In 2007, the People’s Republic of China (PRC) successfully launched an anti-satellite (ASAT) weapon into low-earth orbit (LEO) against a derelict weather satellite. The test demonstrated just one of the developing ASAT capabilities within the PRC. They are also suspected of developing directed energy (DE) technology for the specific purpose of engaging and disabling satellites without the consequence of creating orbital debris, a current space environmental threat to all systems regardless of country of origin. This suggests that the PRC seeks credible space domain capabilities, potentially challenging U.S. space hegemony along with other space competitors.

Recently and more alarming is the December 2012 successful launch of a rocket and satellite by the Democratic People’s Republic of Korea (DPRK). Further complicating matters is the suspicion that the DPRK has been unable to control this satellite, which appears to be “tumbling out of control.” Although the DPRK has not demonstrated any surface-to-satellite intercept capability, their recent activity suggests the increased likelihood of a military presence in space within the next two decades.

What do these events indicate? In short, the U.S. ability to remain dominant in space will be threatened in the near future by existing powers as well as recognized unstable regimes whose
intentions are difficult to predict and arguably more volatile. If the U.S. wishes to remain unchallenged in the space domain, it must be prepared to defend its space assets. Therefore, future threats to U.S. space-based systems necessitate the weaponization of space and adjustments to dated international agreements and national policies.

This paper examines the challenges by way of five questions. First, what are the current threats and competitors to U.S. space domain systems? This includes not only ASAT weapons but also the dangers to space-based systems posed by the environment. Second, what international agreements and U.S. policies regarding the weaponization of space currently exist? International treaties regarding the weaponization of space date back 50 years but are far from all encompassing. Third, what threats should be anticipated to U.S. space systems over the next 10-15 years? Despite agreements and treaties, the evidence suggests the PRC and U.S. are hedging their bets. Fourth, what consequences must the U.S. consider while pursuing space weaponization? Specifically, how does the security dilemma fit into space weaponization? Finally, what conclusions should be drawn for the next two decades regarding space weaponization?

The PRC’s ambitions regarding space remain on the U.S. national security radar. The 2011 Office of the Secretary of Defense (OSD) report to Congress indicates the PRC is pursuing continued development of their space-based capabilities with an emerging role in space extending beyond the 2007 ASAT missile test. The PRC’s ability to launch and intercept a target in space will carry over to ballistic missile defense (BMD) systems, providing an additional capability tied to their nuclear weapons threat. Consequently, development of these systems indicates that the PRC’s ambition is to gain parity with U.S. BMD technology employed within the space domain.
Furthermore, the PRC revealed its intention to develop and employ a reusable space vehicle named the Shenlong, or Divine Dragon. Although the purpose and capability of this vehicle is subject to speculation, arguably China is crafting a competitor to the U.S. Air Force (USAF) X-37 Orbital Test Vehicle (OTV), which began long-endurance orbital flights in 2010. Despite the fact that both of these systems are in their infancy, the “tit-for-tat” response by the PRC to emerging U.S. space technology seems clear.

The PRC’s drive to expand its space domain capabilities also include directed energy (DE) weapons that will be capable of disrupting or disabling satellites without producing orbital debris beyond the target itself. The 2011 OSD report states the PRC is developing lasers, high and particle beam microwaves technology as a kill mechanism against satellites. Evidence suggests the PRC is experimenting with ASAT laser technology at its Jiuquan space research and launch facility in the Gobi Desert. While the full spectrum of DE potential is still unknown, this evolving technology indicates the PRC’s willingness to shift from conventional approaches of destroying or disabling space-based systems to a cleaner method.

Along similar lines of DE disabling satellites is the disruptive ability of electromagnetic pulse (EMP) which is one side effect of a nuclear detonation (NUDET). While one may debate the probability of either the PRC or the U.S. to use its current nuclear arsenal in an ASAT capacity, the U.S. and Soviet Union both experimented with this option. Tests estimating the effect of a NUDET at high altitude began in 1958 as the U.S. military explored countering space-based systems with nuclear weapons. Much of the inspiration behind this line of thinking can be attributed to the “psychological and political impact of Sputnik.” Nonetheless, the U.S. began an extensive series of tests involving ballistic missiles and nuclear detonations to intercept and destroy satellites. The “Starfish Prime” shot in July, 1962, demonstrated the collateral...
damage effect of detonating a nuclear weapon at high altitude. The 1.4 megaton explosion 248 miles above Johnson Island in the Pacific caused a communication blackout within the immediate region as well as noticeable effects as far away as Hawaii. Additionally, the NUDET resulted in inadvertent damage to three satellites in orbit. This result, combined with similar tests of the decade, led the U.S. military to conclude that using a NUDET as an ASAT weapon was unrealistic. However, that decision occurred when only two legitimate competitors for space superiority existed in the world, the U.S. and the Soviet Union. But with the successful launch of a missile in 2012, the DPRK regime led by Kim Jong-un may enter the fray. Considering the observed intent of the DPRK to develop its own nuclear weapon the idea of NUDET as an ASAT tactic may once again be in play.

Aside from the kinetic and non-kinetic threats, the space environment itself presents an immediate threat to U.S. space systems. The National Aeronautics and Space Administration (NASA) currently estimates over 24,000 pieces of space debris larger than ten centimeters are in orbit around the Earth with most of it in low Earth orbit (LEO). As commercial satellites are increasingly sent into space, the threat will grow due to debris created by the launch vehicles. Despite the U.S. and other nations signaling their intent to reduce the amount of space debris, the threat remains. The 2007 PRC ASAT test and a collision between U.S. and Russian satellites in 2009 demonstrate that space debris can be created unintentionally. Therefore, the DPRK may only need to bounce its satellite into another creating an orbital debris threat to U.S. satellites in LEO.

Russia is another challenger to U.S. space superiority and like the PRC has experimented with DE. Despite agreements outlined in the Strategic Arms Limitation Treaty (SALT) regarding the use of satellites to verify treaty compliance, Russia experimented with lasers to
"dazzle" U.S. satellites providing a non-destructive yet disrupting effect in 1975. The U.S. demonstrated its own DE potential for BMD with high-powered lasers (HPL) aboard the Boeing 747-400 Airborne Laser Testbed (ALTB). Although budgetary constraints have placed the ALTB on the shelf, the demonstrated potential of this BMD platform leads one to speculate on its ability as an ASAT weapon. What may be more alarming to the U.S. beyond the demonstrated PRC and Russian ASAT capabilities is the entry of the DPRK into the space domain. Despite international condemnation and continued economic sanctions, the DRPK successfully launched a satellite into orbit. Although their overall intent in space is unclear, an early hypothesis is that they are also exploring options to challenge U.S. space superiority. Intentional or not, the inability of the DPRK to control their satellite after launch makes it an unpredictable threat to U.S. and other satellites in space. An open question is whether the DPRK intends to offer its space technology to other U.S. adversaries like Iran. Thus, the existing treaty framework must be resolved to account for new players in the space domain.

Preventing the weaponization of space currently rests on several aged treaties of which the 1967 Outer Space Treaty serves as the cornerstone. Beyond the rhetoric of "recognizing the common interest of the exploration and use of outer space for peaceful purposes" the treaty leaves a very large loophole regarding the types of weapons. Specifically, Article IV states that only nuclear and other weapons of mass destruction (WMD) are forbidden in Earth's orbit. In short, there is no prohibition regarding the use of DE weapons, ASAT countermeasures, or non-nuclear kinetic weapons in space. This leaves the U.S., Russia, PRC, and DPRK free to explore conventional space-weapon development.
In 2008, China and Russia brought forth a proposed update to the 1967 treaty which included language specifically banning any object in space carrying any type of weapon.\textsuperscript{22} The U.S. has not signed this draft treaty nor pursued a counterproposal.\textsuperscript{23} One argument for this reticence is that the 1967 Outer Space Treaty is sufficient. However, the more likely explanation is that the U.S. prefers to keep its options open.

Dissecting U.S. national security and space strategy offers no detailed guidance on how to respond should a satellite be attacked. The 2010 National Security Strategy (NSS) recognizes the vulnerability of U.S. space domain assets to attack by asymmetric threats but offers no suggestions on how those threats should be mitigated.\textsuperscript{24} The 2011 National Security Strategy (NSSS) acknowledges the dependence of the U.S. defense strategy on space-based capabilities and the increasingly congested space environment threats due to debris and the 2007 PRC ASAT test.\textsuperscript{25} However, the NSSS only states that the U.S. will “use force in a manner that is consistent with longstanding principles of international law ... and the inherent right of self-defense.”\textsuperscript{26} Neither policy makes mention of a course of action should the U.S. be forced to defend itself in space, and external guidance and treaties leave a considerable gap in what could be accomplished regarding space weaponization in the future.

The most likely weapons developed by space-faring nations will be improvements on existing systems and concepts. The next 10 to 15 years will see the improvement of current ASAT surface launched missiles like the DF-21 which was used during the PRC 2007 ASAT test.\textsuperscript{27} Described as a medium-range ballistic missile (MRBM), the DF-21 is thought to have a vertical reach of up to 600 miles, or one-half its horizontal range.\textsuperscript{28} Therefore, only satellites in LEO would be threatened by the DF-21 variant used in 2007. That said, of the approximate
1,000 active satellites orbiting the Earth, nearly one half operate in LEO.\textsuperscript{29} In sum, LEO presents a target rich environment for an aggressor with MRBM capability.

The potential to incorporate intermediate range ballistic missiles (IRBM) and intercontinental ballistic missile (ICBM) technology into ASAT roles is a very real responsibility. For example, India has entered the ICBM club with the successful launch of its Agni-V missile.\textsuperscript{30} Considering the potential for international competition within the region, the Agni-V provides India with a platform for not only nuclear ICBM capability but also the technology to develop its own ASAT missile challenging the PRC as a regional space power.

The Boeing X-37B orbital test vehicle (OTV), or spaceplane, is another indicator of emerging space technology for the near future. Although the details of its intended missions for outer space remain undisclosed, the space plane has already demonstrated its reusable and long-endurance capabilities.\textsuperscript{31} The X-37B’s ability to carry a limited payload combined with its design as an unmanned spacecraft indicates that it could be designed to support missions similar to U.S. military remotely piloted aircraft (RPA) like the RQ-4 Global Hawk or MQ-9 Reaper.

The X-37B and follow-on spaceplane designs could be outfitted with either kinetic or DE weapons. If these ideas come to fruition, the spaceplane could play a role in ISR and direct attack missions, only the fight will occur in LEO as opposed to the air domain. The spaceplane will provide constant vigilance due to its ability to remain in LEO for extended periods. Similar to a RPA, its primary mission is probably ISR; but could be configured for more “active” mission profiles including ASAT missions. Based on the PRC’s intent to field a spaceplane of its own, future spaceplane designs or X-37 modifications will no doubt include capabilities to not only engage satellites, but defeat other spaceplanes.
While DE weapons have already demonstrated their potential, based on the initial success of the ALTB, competitors to U.S. space superiority will explore this capability. Certainly the U.S. will continue researching the potential of high energy lasers (HEL) and high powered microwave (HPM) systems. Low and medium powered lasers have already demonstrated their tactical ability to dazzle or disrupt infrared and night vision technologies.\textsuperscript{32} HEL, which was the backbone of the 747 ALTB provided a “speed of light response” with “precision effects”.\textsuperscript{33} As technology improves over the next decade and weapon systems are reduced in size and weight, it will become feasible to integrate spaceplane and HEL technology to create an extremely long endurance spaceborne vehicle capable of employing precision DE weapons creating effects ranging from temporary disruption to functional kills.

The above said, the most dangerous ASAT capability that will be pursued by newcomers to the space domain will be a NUDET at high altitude. The incredibly destructive force of a NUDET may be the only counterspace weapon available to lesser space faring states and possibly non-state actors who have neither the economic nor the technological ability to field HEL, HPM, or space-based vehicles. Despite international condemnation, the DPRK accomplished underground nuclear tests in 2006 and 2009.\textsuperscript{34} While the destructive capability of these tests pale in comparison to the destructive power of U.S. and Russian nuclear weapons, merely the potential for the DPRK to launch nuclear-tipped missiles into space is a fearsome prospect.\textsuperscript{35} And despite being a signatory on the 1967 Outer Space Treaty, the DPRK already possesses the ability to create a nuclear device and launch a satellite into orbit.

Unlike conventional weapon systems, satellites are fragile. They cannot be designed with considerable armor as total weight is limited by the payload capacity of launch vehicles. Moreover, the ability to maneuver in orbit is limited as satellites contain a finite supply of
thruster propellant. Passive defensive systems like electromagnetic pulse (EMP) shielding, radio frequency (RF) filters, and shuttered optics will not discourage an attack by a challenger to U.S. space superiority, especially considering the reliance of the U.S. military on its space capabilities. Therefore, the best method to actively defend a satellite will be deterrence, achieved through a credible offensive capability. But this will come at a price.

Returning to the broad guidance outlined in the NSS and NSSS, the U.S. must adjust the language in the NSSS to identify the type of threats posed to its space based systems to guide the military and industry in terms of what space technologies should be acquired. The current NSSS states that a strategic objective is to “[s]eek a secure space environment in which responsible nations have access to space . . . without need to exercise their inherent right of self-defense.”

Now that the DPRK has a proven capability in space, the NSSS must include language as to how the U.S. will respond towards irresponsible nations actively pursuing space ambitions. An updated NSSS must also include a statement indicating the intent to pursue an active defense and deterrence measures to discourage potential aggressors in space. While specific weapons systems should not be mentioned, the new NSSS guidance must make clear the U.S. intention to outfit future satellites with weapons designed for self-protection.

The development of weapons systems for the X-37 or later spaceplane designs may signal to others an intent to gain first-strike capability in space. However, the reward of maintaining the technological edge in space outweighs the consequences of losing the initiative to another challenger to U.S. space superiority. This leads to the same security dilemma faced during the Cold War with regard to nuclear arms. That said, history suggests that the U.S. will not be discouraged for fear of the security dilemma. The atomic bomb, stealth technology, and
the F-22 serve as proof that the U.S. prefers to maintain a technological edge over its competitors and will not allow an adversary to gain the initiative.

For its part, the PRC believes that the U.S. will seek to maintain its space advantage. In 2007, one PRC military strategist argued that U.S. "space policy pursues hegemony in space and poses a significant-security risk to China that cannot be left unaddressed." This reaction was based on interpretation of the 2006 National Space Policy (NSP) which stated that the U.S. would "deny, if necessary, adversaries the use of space capabilities hostile to U.S. national interests." This language was interpreted as more aggressive than the 2010 NSP, which emphasized international cooperation in the pursuit of space-based capabilities. Nevertheless, the PRC's 2007 ASAT indicates that they believe the U.S. still seeks to maintain space hegemony. Whether future U.S. policy will follow the 2006 language or that of 2010, the PRC expects to challenge U.S. space superiority.

The DPRK made clear its intent to become a space power despite international pressure to cease developing its ballistic missile technology. They will build upon their December 2012 achievement in space throughout the next two decades and beyond. Claims of developing space capability for purely peaceful purposes will be met with skepticism thereby increasing U.S. and DPRK tensions with space becoming another location for confrontation. Although the U.S. will maintain a technological advantage in space, the DPRK may conclude the need to use or lose any ASAT capability they develop. Furthermore, the DPRK could become a gun-for-hire in the space domain for a lesser state or even non-state actors wishing to gain space-based capabilities.

Although the Soviet Union demonstrated its intent to create a viable ASAT capability during the Cold War, recent U.S. and Russia collaboration regarding the International Space Station (ISS) may limit the potential for a confrontation in space between the two powers.
However, the desire to maintain goodwill and cooperation in space will not discourage the U.S. from preparing for the threats posed by the PRC and DPRK. As the U.S. develops weaponization programs to counter those threats, prudence demands that Russia do the same to maintain the balance of power in space.

For the United States, the space weaponization adds to the argument that DoD should pursue an independent space force. Advocates for an independent space force need only reflect on the arguments by airpower theorists of the 1920s like Giulio Douhet. Reliance on space-based capabilities is already acknowledged in the NSS; therefore one may postulate that Douhet’s declaration that “to conquer the air means victory; to be beaten in the air means defeat” now applies to the space domain. Considering U.S. dependence on satellites for navigation, communications, and ISR, it is conceivable that the loss of space superiority would be disastrous for U.S. military operations. If applying Douhet’s theory of airpower is true when applied to space, then the space domain should be controlled by an independent space force. Continuing to relegate space power to land, sea, and air forces only allows space to serve as auxiliary support to those domains as opposed to truly exploring its potential. If Douhet were alive today, probably would agree.

In conclusion, the weaponization of space will have consequences. Consider that the 1957 launch of Sputnik triggered fears of the Soviets gaining space hegemony, which ignited U.S. and eventually PRC space ambitions. The result was the U.S. space programs of the 1960s. As technology advanced, ASAT programs emerged in both the Soviet Union and U.S., consisting of both kinetic and DE weapons. Despite the present spirit of cooperation between the U.S. and Russia, the Cold War opened up space as the next frontline between superpowers. No doubt the weaponization will trigger similar initiatives.
The PRC demonstrated its intention to defend its space interests with the 2007 ASAT test. China already suspects the U.S. of seeking “unilateralist intentions in space.”\textsuperscript{43} The advent of the ALTB and X-37 supports the theory that the will U.S. seek to maintain a technological edge in ASAT technology. It is unlikely that the spirit of international cooperation projected by the 2010 NSP would dissuade China from assuming that a strategic objective of the U.S. for future decades will be unchallenged space supremacy. At a minimum China will seek parity with the U.S. Space is only the next step in an already competitive relationship.

The DPRK’s refusal to refrain from pursuing its own space ambitions is provocative. Although the DPRK lost control of its satellite shortly after it achieved LEO, that does not mean the DPRK does not already pose a legitimate threat to U.S. satellites. The only ability in space the DPRK needs to achieve to threaten U.S. satellites is creating more debris.

Does the risk of weaponizing space outweigh the reward? Based on the evidence presented, it appears clear that the weaponization of space is inevitable whether the U.S. actively takes the lead or not. The 1967 Outer Space treaty has not prevented the U.S., Russia, or PRC from developing ASAT weapons. The PRC already assumes the U.S. will weaponize space based on its interpretation of the NSP. Consequently, they are actively pursuing methods to counter that perceived threat to their interests. If the U.S. chooses to remain passive in the development of a space weapons capability, even for purely defensive purposes, then it will have lost the initiative to its competitors. In that event, it is probable that the U.S. would succumb to the same panic that was experienced in 1957 with the launch of Sputnik. Only this time, the U.S. will be operating in a multi-polar context where our adversaries will seek to maintain an advantage not only over the U.S., but over each other. This will undoubtedly accelerate technological advancement in the weaponization of space. The U.S. cannot afford the risk of
falling behind. Thus, the U.S. must lead space weaponization in a responsible manner by proposing new treaties and articulating new policies clearly defining interest and intent.

2 Ibid.


7 Ibid., 1.


12 Ibid., 1.

13 Ibid., 108.

14 Ibid.


19 Miklaszewski and Boyle.


23 Ibid.


26 Ibid. 10.
28 Ibid.
29 Brian Weeden, "The economics of space sustainability," The Space Review, June 4, 2012, http://www.thespacereview.com/article/2093/1 (accessed December 27, 2012). Approximately 470 active satellites operate in LEO between 200 and 2,000 kilometers above the Earth's surface. 419 active satellites are in geosynchronous Earth orbit (GEO), which is approximately 36,000 kilometers above the Equator.
31 Erickson and Collins, 1. The X-37 OTV was first launched on April 22, 2012 and remained in orbit for 225 days. The second OTV flight began on March 5, 2011 and remained in Leo for 649 days. The third test flight launched on the same day the DPRK accomplished its first successful missile launch into space.
33 Ibid., 5.
34 "North Korea's nuclear tests," BBC News Asia, April 24, 2012 http://www.bbc.co.uk/news/world-asia-17823706 (accessed December 27, 2012). Pyongyang declared a successful underground nuclear test in October 2006. The device was plutonium based versus enriched uranium with an estimated destructive force of less than one kiloton. The DPRK's second underground nuclear test occurred in May 2009 with an estimated blast of 20 kilotons which is similar in strength to the bombs used on Hiroshima and Nagasaki, Japan in World War II. The U.S. Geological Survey detected a 4.7 magnitude earthquake underground indicating a nuclear detonation had occurred.
35 Shixiu, 112, 117, 123. The U.S. Satellite (SAINT) program was first proposed in 1959 in to research and test the ability of co-orbital vehicle to rendezvous with and inspect other satellites in orbit. In 1957, project MUDFLAP was the U.S. Army attempt to use a Nike-Zeus missile in an ASAT role. The USAF THOR program in the early 1960s explored nuclear detonations at high altitude to disable satellites.
38 Office of the President of the United States, National Space Policy of the United States of America (Washington DC: Office of the President of the United States, August 2006), 2.
42 Morgan, 293.
43 Shixiu, 3.
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