Strategy Research Project

SPACE POWER THEORY: CONTROLLING THE MEDIUM WITHOUT WEAPONS IN SPACE

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USAWC STRATEGY RESEARCH PROJECT

SPACE POWER THEORY: CONTROLLING THE MEDIUM WITHOUT WEAPONS IN SPACE

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ABSTRACT

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Since space operations are inherently joint, the Services have strived to normalize and operationalize space operations for military utility. Services rely heavily on space-based force enhancement capabilities as combat multipliers for on-demand communications, navigation, missile early warning, reconnaissance and surveillance. The protection of U.S. strategic space assets and the ability to negate enemy space systems is essential to U.S. space strategy in controlling the geographical environment of space, predominately in the Lower Earth Orbit (LEO). Modern theorists suggest today's military is poised to develop a space power theory, similar to Corbett's sea power theory, that is relevant in the exploitation of the space medium. The challenges associated with space power as a theory begins with the emerging threat to on-orbit assets by nation states as well as non-state actors. This paper examines whether the U.S. military should deploy weapons into space, or are emerging offensive ground-based weapon systems and conventional weapons sufficient for a space power theory today. It answers the question does the U.S. need weapons in orbit to control the space medium in order to have a recognizable DoD space power theory?

SPACE POWER THEORY: CONTROLLING THE MEDIUM WITHOUT WEAPONS IN SPACE

Some modern theorists look at the emerging environments of space and cyberspace as the new warfighting domains of the information or non-kinetic environment that can be exploited for war. Any warfighting domain requires good strategic principles, forethought and methods to minimize threats to our national security in order to assure strategic success. Space power as a theoretical concept can be defined as "combining technology, economic, industrial, military, national will, and other factors that contribute to the coercive and persuasive ability of a country to politically influence the actions of other states and other kinds of players, or to otherwise achieve national goals through space activities."[1] Space power, like sea power, relies on the ability to impact military and commercial activities in the medium without having absolute control of the medium. Additionally, since space has no sovereign boundaries and is much more vast than the land, air and sea geographical environments, it is impractical for one nation to completely control the medium or prevent an adversary or competitor from conducting limited operations in that medium.

With today's evolution in technologies supporting complex military operations, a "space power theory," although not recognized by some modern strategists, is arguably applied by the United States (U.S.) government and its military services who rely heavily on space-based products and information for national security and as a combat multiplier throughout all spectrums of conflict. In fact, space capabilities support all levels of warfare and have been employed in a combined arms approach similar to other warfighting capabilities that support terrestrial military forces. Colin Gray argues

that existing theories related to sea power and air power supports the logic for the development of a space power theory.[2] This paper supports a concept that a de facto U.S. space power theory already exists and assumes that a Department of Defense (DoD) supported space theory will be forthcoming. What weapons systems are required to effectively control the medium in order to validate a space power theory? Again, this paper examines the employment of various space and kinetic conventional capabilities necessary to achieve strategic dominance in support of national security and as means of national power.

Space Power in Doctrine and Strategy

To better understand how space capabilities support our national security and the U.S. informational and military instruments of power, one must first understand what constitutes Space Operations. Joint Publication (JP) 3-14, the Joint Doctrine for Space Operations, defines space operations into the four elements or mission areas: force enhancement, space control, space support and space application. Force enhancement operations enhance strategic and battlespace awareness through five functions: Intelligence Surveillance Reconnaissance (ISR); integrated missile warning and attack assessments; environmental monitoring; communications; and position, velocity, timing and navigation. The joint doctrine further defines space power as the "total strength of a nation's capabilities to conduct and influence activities to, in, through, and from space to achieve its objectives."[3] This mission area provides the strategic indications and warning (I&W) to reduce the Clausewitzian form of "fog or friction" inherent in combat operations to improve the lethality of air, land, sea, space and special operations forces. Space control operations provide the necessary freedom of action for friendly forces

and when required can deny that same freedom and access to space to the enemy. The space control mission area is further defined into offensive and defensive operations which specifically enables friendly forces to gain and maintain space superiority and strategic situational awareness that can impact the other mission areas of space operations. Space Support Operations are those activities that launch, deploy, augment, maintain, sustain, replenish, deorbit and recover space forces to include the command and control networks for space operations. Finally, the application of force would consist of attacks against terrestrial-based targets carried out by military weapons systems operating in or through space. Force Application by definition consists of ballistic missile defense and force projection however, there are currently no force application assets operating in space.[4] It is clear from the definition that space power is couched in terms of a nation state's ability to employ space capabilities which will influence activities, therefore one could argue that the mission areas of space are in direct support of the informational instrument of power, as well as the military instrument of power, in order to achieve strategic objectives.

The National Defense Strategy (NDS) of the United States addresses the space medium in terms of our ability to operate in and from the "Global Commons." The NDS considers the space environment as one of the "global commons," or "strategic commons," that will enable the U.S. to project power anywhere in the world and is critical to the defense of the U.S. and its friends and allies in key regions abroad. The strategy points out that the United States' ability to operate in space remains important for joint military operations. Therefore, one key goal of the NDS is to ensure our access and use of space and deny an adversary's hostile actions through the use of the space

against the U.S.[5] The NDS reinforces that a space power theory should exist and is a clear indication that the U.S. defense strategy infers that the space environment may become a new theater of operations that might someday require warfighting capabilities to maintain a strategic advantage over potential enemies.

The other national strategy that bolsters the support for a space power theory would be the most recent National Military Strategy (NMS) in 2004. The NMS addresses space capabilities in terms of preventing conflict and surprise attacks by potential state or non-state actors. The strategy suggests that the U.S. must prevent conflict and attacks through deterring aggression and coercion by using enhancements to support non-nuclear strike capabilities acknowledging that space assets are a new deterrent capability which support targeting and precision engagements to reduce overall collateral damage during offensive operations.[6] Again, the NMS indicates that space power will play an important role by enhancing the other geographical mediums in achieving strategic objectives. Further, it is another example illustrating the need for a DoD-recognized space power theory that must be on par with other military geographical theories for policy makers and military planners in order to become an integral part of today's national security and regional military warfighting plans similar to land, sea and airpower theories for war.[7]

Modern Space Power Theory

In order to understand what constitutes a space power theory based on current capabilities and employment, you can first explore the original concept put forth by James Oberg in his book, *Space Power Theory*. Oberg does not present a codified, detailed theory for space power but a concept of what elements are important while

developing an inclusive theory that will address all facets of users, capabilities, education and geography required to exploit the medium. Oberg identifies what he calls the “elements of space power” a nation must possess to achieve dominance in the space environment. He identifies facilities, technology, industry, hardware and other products, economy, populace, education, tradition and intellectual climate, geography, and exclusivity of capabilities and knowledge. These elements also include space vehicles, as well as launch and control sites of a complete space system. Oberg also acknowledges that this list is not all inclusive and weaknesses in one area can be trounced by the strengths of any one of the individual elements.[8]

The two elements of Oberg’s space power that are applicable to the premise of this paper will be the technology and hardware necessary to establish power in the space medium. Oberg believes that the primary contributors to technological advances for space systems and weapons must come from government-funded ventures using government laboratories or laboratories within the defense industry to develop and produce the required hardware for space capabilities.[9]

Therefore, expenditures for space capabilities will require long-term investments in which many countries are not willing to fund in the near-term. On-orbit space weapon systems are currently not practical or economically feasible until the technology can support more lethal offensive techniques that can be applied in-orbit or from space to earth. Additionally, the concept of on-orbit space weapons must not only address the maintenance of on-orbit weapon systems but also responsive and cost effective spacelift. Therefore, the U.S. military should look to other conventional weapons capabilities to reinforce and support a genuine space power theory.

Oberg goes on to state that “situational awareness in space is key in the successful application of space power.” Space situational awareness along with access to space, are the foundations for the control of space that support other mission areas of space operations. He explains space situational awareness as the means of having knowledge of where all objects in space are located, where space objects are going, where they could potentially go and what they are doing while in orbit.[10]

The most important facet of a space power theory according to Oberg is the control of space and a nation’s unencumbered access to space and on-orbit assets. He states that the “control of space is the linchpin upon which a nation’s space power depends.”[11] One can surmise that in order to have assured access to space-based services and data, space control must be at the nucleus of any space power theory if the U.S. expects to continue the exploitation of the space medium. Oberg’s assertion regarding space control and space power theory leads to the principle question that must be addressed: Must a nation deploy weapons into space to control the geographical environment, and subsequently, are these weapons essential for an effective space power theory? There is a belief that weapons in space are inevitable, therefore, the U.S. should take the necessary efforts to ensure that we will be the first to field these weapons.[12]

It is difficult to support Oberg’s prognostication that weapons in space are inevitable for the U.S. in the 21st Century. The extensive cost of current space programs like Global Positioning System (GPS), Space-Based Infrared System (SIBIRS), the Rapid Attack Identification Detection Reporting System (RAIDRS) and Space Based Radar (SBR) along with numerous service military programs competing

within a limited defense budget, it is highly unlikely that the U.S. government will make more funding available for space weapons when the currently perceived threat can be mitigated using existing cost effective capabilities.

The August 2006 U.S. National Space Policy states that its primary objective is to ensure that the U.S. maintains and enables free access to and the use of space for peaceful purposes. The policy mandates that the U.S. will pursue programs and capabilities to ensure space assets are protected since they are vital to our national security and economic interests.[13]

However, the policy does not direct the development or deployment of space weapons. The official U.S. policy in space continues to support the existing Outer Space Treaty of 1967 focusing on free access to space for peaceful purposes while deterring the misuse of space by other nation states. Nevertheless, the U.S. will not disclose any technical developments or options that may be essential in defending space assets "in order to forestall a hypothetical future arms race in space. Such an approach would not be in the national security interest of the U.S."[14] One may infer that the U.S. government will not hamper or discourage technological programs and developments that may eventually produce techniques, weapon systems and operating procedures that place weapons in orbit to defend space assets.

For many years the U.S. has arguably been the world's space hegemony in terms of civil space programs and the militarization of space.[15] It has always been in the national interests for the U.S. to support any ban against weapons in space especially during the Cold War. As a result of nuclear proliferation by several nation states, the U.S. did not want to instigate an arms race in space contributing to a new strategic

deterrence potentially holding space and terrestrial targets at risk. Although this policy was challenged during the 1980s with discussions of the Strategic Defense Initiative, the U.S. continued to support the 1967 Outer Space Treaty, acknowledging the sanctuary of space for peaceful purposes should remain paramount and is well within our national interests.[16]

The recent Chinese launch of an anti-satellite (ASAT) kill vehicle to destroy one of its aging weather satellites in orbit, has again focused U.S. attention on space protection and the debate for more resources to the protect space-based assets since the U.S. has more satellites in orbit than any other nation.[17] Despite the publicity surrounding the Chinese ASAT weapon, the U.S. was probably the first nation to pursue and operate a working ASAT capability in 1963. Program 437, a Thor Missile System mounted with a Mark 49 nuclear warhead, was this country's first operational ASAT system located on Johnston Island in the Pacific from June 1964 to April 1975. This program was later highlighted by the Johnson Administration in 1964, acknowledging that Program 437 was developed to intercept satellites carrying a weapon that threatened U.S. national security.[18] The Soviets also established a coorbital ASAT program which started in the 1960's and reached operational status in 1971. The weapon system was last tested in space in 1982. Although Russia had announced a moratorium on the launching of ASAT weapons in 1983, it was believed that they still maintained operational readiness of coorbital ASAT weapons throughout the 1980s.[19]

Incidents such as the Chinese ASAT launch might become the catalyst for the U.S. to change the "rules of the game" resulting in our withdrawal from the Space Treaty in order to pursue placing weapons in space. One recent example that illustrates this

kind of policy change regarding arms control would be the Bush Administration's withdrawal from the Anti-Ballistic Missile Treaty in 2001.[20]

Gray's contention that military technological advances and what he refers to as a "revolution in military affairs" like weapons in space, calls for new theories such as space power for the modern strategist to consider. He suggests that space power as a theory should be integrated, similar to Mahan's sea power theory, into the modern strategist thought process.[21]

Space power as a theory illustrates the importance of strategic space systems and demonstrates that space is the "ultimate high ground" in which policy makers and commanders will need to formulate actions to seize and control in support of strategic objectives. Theoretically, on-orbit offensive space capabilities would be used to find, fix, track, and destroy targets in space, air, on land and at sea. Again, if this capability existed, the employment of space weapons would be more of a combat multiplier in support of the other geographical mediums rather than providing unilateral control of all environments from space. Gray contends that space power "adds the greatest value for lethality in combat in the twentieth century."[22] However, since most of the United States' current offensive space power capabilities are ground-based and augmented with superior conventional as well as other non-kinetic weapons and forces, one could argue that we currently control the space medium without the cost, proliferation and hazards associated with placing weapon systems in orbit. Gray believes that the strategic interest in terms of space power theory "lies in the consequences of its application for deterrence and the conduct of war as a whole."[23]

The concept of space control put forth by Gray compares the control of the space medium as similar to conducting blockades and 'choke points' like Mahan's maritime strategy for sea power. Space has similar choke points such as specific launch sites attempting to launch offensive space weapons or satellites that are susceptible to attack or that can be held at risk.[24] Again, these choke points or space blockades can be affected using existing capabilities without the need for placing weapons in space. The naval theories of Sir Julian Corbett are probably more fitting when considering a space power theory based on the control of space. Corbett emphasized the "conditional nature" of sea control. He believed that the conditional nature could be positive and defined as one's ability to travel the seas freely. Corbett also believed that the conditional nature could be negative or the ability to deny this freedom to the enemy. It could either be local or global, permanent or temporary. This theory is very similar and applicable to the strategy of space control.[25]

No matter how integral and essential space operations will be during combat operations, it is doubtful that today's wars and those in the immediate future will be decided in space. Therefore, Gray's prospect of space control is less likely to be contested under that Mahanian concept of "battle fleets" clashing in space whether manned or unmanned.[26]

Weapons in Space Debate

The United States currently enjoys a strategic advantage in space with force enhancement capabilities such as space ISR, communications, navigation and missile early warning. Undoubtedly, the protection of these assets is a critical aspect of space national security and the defense of U.S. national interests. Many space proponents

and modern strategists would argue that space is the next theater for warfare. Therefore, the U.S. government should make the necessary policy changes and invest in the appropriate technologies to ensure that the U.S. has "freedom of action in space and deny, if necessary, adversaries the use of space capabilities hostile to U.S. national interests."[27]

The arguments for placing weapons in space are centered around the U.S. government and its military services' heavy reliance on space-based assets that have now become essential in how we conduct day-to-day operations. Others would argue that as access to space becomes more affordable and the technology to develop space assets become more available, the threat to our systems will undoubtedly increase. The underlying assumption is that space-based weapons are necessary if the U.S. aims to control the medium of space which is crucial to a viable space power theory.[28]

Conversely, the other side of the argument to not deploy weapons in space is probably more compelling. The proliferation of space-based weapons will allow potential adversaries to place U.S. space assets at risk without the long-term equivalent investment in technology and hardware, and potentially without placing similar space systems in orbit. If the U.S. withdraws from the Outer Space Treaty and begins pursuing weapons in space to justify the defense of vital national space systems, other countries will undoubtedly pursue these weapons as well. Once other space-faring nations deploy weapons in space, not only will on-orbit assets be in danger, but also terrestrial targets within the U.S., such as cities, conceivably may be held at risk from attack from space.

The proliferation of space weapons could become tomorrow's "nuclear arms control" issue that would be a costly venture for all involved. Countries would begin to

channel resources to develop the technology and systems to place weapons in space in order to demonstrate their power, modernity and their desire to compete with the world's most powerful countries. However, current U.S. ground-based space weapon systems and conventional warfighting systems already provide the necessary offensive capabilities and deterrence to support a space power theory without deploying weapons into space.

Weaponization of Space

As currently defined in JP 3-14, the missions for potential space-based weapons can be divided into two categories, space control and force application.[29] The space control mission consists of the ability to conduct space surveillance, protect friendly space assets, attack the adversary's space assets or deny the enemy access to space systems. One assertion would be that the principle mission for space-based weapons is to prevent space launches or to destroy or degrade enemy satellites. There are principally two space weapon concepts that can perform this mission in support of space control, Direct Energy Weapons (DEWs) and Direct Impact Weapons (DIWs).

Direct Energy Weapons (DEWs) would constitute weapon systems in orbit that utilize electromagnetic means such as laser and radio frequency (RF) technologies to deny, degrade, disrupt or destroy space targets and potentially terrestrial targets in an attempt to control the space medium.

Lasers in the form of a DEW system in space would be one of several space-based weapon technologies the U.S. might explore as a potential space weapon. Lasers can strike at the speed of light providing near simultaneous line-of-sight engagement with an object without being constrained by orbital dynamics. However, the

basic components of a space based laser such as the laser device, large output optics, acquisition, pointing and tracking (APT) and battle management software still face monumental engineering challenges. Space based lasers are quite expensive and may require an operational network of up to 20 on-orbit systems to provide global coverage.[30]

Most lasers have various degrees of limitations based on power levels associated with multiple pulse wave lasers versus continuous pulse wave lasers. The primary limitation to overcome with developing lasers as weapons would be the ability to generate a high power beam lethal enough to degrade or destroy on-orbit space systems and especially potential terrestrial targets.[31] Since the most efficient lasers are chemical lasers, the large quantity of chemicals necessary to employ a space-based laser would not be feasible or suitable with a current launch cost of $10,000 per pound to place the system in orbit.[32]

Employing space-based lasers as a force application method to attack terrestrial targets from space could be another illustration of space weaponization. Assuming that a space laser weapon was powerful enough to destroy airborne or ground targets, the limiting factor would be developing optical or IR tracking sensors capable to detect a small target with a relatively cool signature compared to ballistic missiles in flight against the background of the earth. Furthermore, the ability to engage stationary or moving ground targets with an orbital laser would be even more of a challenge. Therefore, the practicality of space-based weapons in the form of lasers requires high efficiency in terms of targeting and tracking, high power, and a robust space vehicle constellation. It would also require considerable funding and the ability to withstand the harsh space

environment making orbital laser platforms unfeasible and cost prohibitive in the near term.[33]

The other technology in the family of DEWs capable of supporting the space control mission area would be RF weapon technologies. Some RF weapons use very large antennas that would be directly proportional to the size of the power beam necessary to reach the earth's surface. The beam's footprint power would need to be approximately 10 watts per square meter (w/m^2) and could destroy unprotected electronics and disrupt shielded space systems. Again, the RF space weapon system would need to maintain position relative to the target which would require large amounts of spacecraft propellant for maneuverability. Such systems would not be fielded until launch costs for heavy payloads are reduced and the capability to provide routine access to space in terms of responsive spacelift is also available. In order for RF space weapons to become a reality, considerable testing and experimentation must occur to validate this complex weapon system.[34]

Based on the complexities of DEWs, one can assert that the technology and cost limitations surrounding DEWs clearly makes any near-term employment of these weapons unlikely. Although these weapon concepts could arguably introduce the next evolution for non-kinetic weapons for the space domain, it is conjecture that DIWs show the most potential in support of an existing space power theory and space control using current technologies that exist today.

Direct Impact Weapons such as Kinetic Energy (KE) Anti-satellite (ASAT) weapons technology, has been tested and validated in support of the Ground-Based Midcourse Defense concept and already considered a force application method.[35] Using

this technology as a space-based weapon system has been proposed as a means for attacking surface and airborne targets. A space-based KE ASAT would rely on large velocity differences found in orbital dynamics in order to destroy a target in space. If a satellite traveling at a velocity of approximately 7.8 km/s in a LEO orbit collides with a one pound mass of a solid object moving at 9 km/s in space, it would be catastrophic for any space asset causing considerable destruction and debris.[36] However, the limitations associated with space-based KE weapons are similar to problems of DEWs. KE weapon systems in space must have the ability to maneuver, locate and track objects in order to destroy potential targets.

Intercepting satellites is not an easy task due to the combination high velocity of the KE ASAT weapon closing in on what can be a relatively small target. Since the orbital altitude of the satellite determines the speed at which the space vehicle travels, at the point of interception the velocities of the KE weapon and its target may be similar but traveling in different directions. The KE weapon relies heavily on its high velocity for its destructive energy complicating the interception process even more. Although promising, the combination of an on-orbit KE ASAT weapon being able to see the target at great distances coupled with the challenge for differential velocities and the ability for the weapon to make timely last minute adjustments yields a very complex weapon system in orbit. (See Table 1.)

Another DIW concept discussed as a potential force application capability would be orbital bombardment using projectiles such as long thin metallic rods or ultra dense penetrating warheads against terrestrial targets. Orbital bombardment is the ability to destroy terrestrial targets by converting the kinetic energy from the weapon's high

velocity into work (joule) and heat (joule). This DIW concept also known as “Rods from God” would require weapons made from a durable material like tungsten traveling at speeds of more than 10,000 ft/s, entering the earth’s atmosphere and penetrating deep into the earth surface destroying surface and deeply buried terrestrial targets.[37]

Additionally, problems with orbital timing and responsiveness as well as the ability to precisely hit stationary terrestrial targets, let alone surface moving targets, make this a difficult task. Furthermore, scientists argue that the rods’ velocity would be so high that they could vaporize on impact, before they could penetrate the surface.[38] Again, the size, altitude, timing and responsiveness of this weapon as a concept as illustrated in Table 1, are currently not feasible or cost effective as a method for force application in support of the space control mission area.

Many of these space weapons concepts and the low probability that they can be fielded within the next decade provide no strategic value to the argument that weapons in space are essential to a space power theory. Modern theorists, space professionals and U.S. military services should appreciate that there exists alternatives and weapons that provide offensive and defensive capabilities suitable and feasible enough to effectively control and exploit the medium of space, such as ground-based space weapons or active defense and passive defense measures.

Ground-Based Space Weapons and Alternatives

The various components that make up the space system consist of the spacecraft or satellite in orbit, and the ground stations that allow for the tracking, telemetry and commanding of the spacecraft. The communication links between the satellite and other satellites or the links between satellites and the ground stations also make up the key

segments of the space system.[39] Protecting all segments of this system is a critical task described as Defensive Counterspace (DCS), or the defensive methods for space control.

The most vulnerable segment of any space system is the ground node or ground stations that control the on-orbit assets or receive the data downlinks from the satellites. Since ground stations are typically considered “soft” targets and many locations can be easily identified through good intelligence, they are probably the most susceptible to attack from conventional weapons. Equally vulnerable would be the launch facilities used to place satellites into orbit. Therefore, substantial investments to place weapons in space would be counter-intuitive if ground stations are more susceptible to attack and can be easily neutralized. Perhaps discretionary funding should be allocated to hardening critical space nodes, ground nodes and communication links making them less susceptible to intentional electronic jamming, blinding, spoofing and conventional strikes. The author contends that these passive and active defense measures help make on-orbit and ground space systems more resistant to attack and are more economically feasible than placing weapons in space.

Another critical component of DCS is a rapid reconstitution or responsive spacelift capability. Launching cheaper and smaller satellites to replace aging legacy platforms or replacing satellites that have been neutralized by enemy attack, one can surmise that more on-orbit capabilities for a “strategic surge” will preserve space superiority and is much more feasible and achievable today than in recent history.

Since strategic satellites are expensive, limited in number, and currently designed to meet strategic requirements more so than tactical needs, Tactical Satellites (TacSats)

also known as microsatellites can be built for under $20 million dollars providing ISR and communications capability in support of military contingencies offsetting operational requirements placed on national systems.[40] More importantly, it provides on-orbit space systems redundancy as an element of DCS that would deter adversaries from attacking U.S. space-based assets. In other words, it is not plausible that a nation state would expend the effort and resources to compete in space with a space hegemony that already has a numerical advantage and the ability to reconstitute assets on demand. Therefore, the ground segment of the space systems is more likely to suffer attacks from nation states and non-state actors than U.S. satellites orbiting in space.

Ground-based space weapons as an Offensive Counter Space (OCS) capability of space control can be quite effective against enemy strategic space assets. They provide maneuverability and are technologically feasible and less costly than placing offensive weapon platforms or space vehicles in orbit (See Tables 1 and 2). More importantly, the technology to produce and employ ground based space weapons already exists. This is evident by the Air Force's fielding of the Counter Communications System (CCS) as a mobile SATCOM jamming capability.[41]

One mission for OCS ground-based weapons is to deny, disrupt or degrade enemy satellites by jamming their communication links between the satellites and their ground stations. Ground-based weapons or RF systems would prevent satellites from receiving commands from ground stations by jamming antenna frequencies at the satellite which is much more vulnerable than antennas at the ground stations. Jamming enemy strategic space assets could result in degradation of orbits, disruption of satellite

communications or limit the ability to task reconnaissance satellites to collect imagery or downlink their data.[42]

Another potential method for ground-based weapons would be to take command of an adversary satellite by breaking the codes or “spoofing” the commands, preventing the satellite from performing its intended mission. Again, the advantage of using these techniques in support of space control is that their affects can be temporary and reversible which is an alternative to actually destroying an enemy’s space-based system.[43]

Lasers as a ground-based weapon system are equally as promising as ground-based RF systems. Low power lasers have shown promise to temporarily blind reconnaissance and surveillance satellites sensors by denying or disrupting their ability to perform collection missions. Again, one advantage of ground-based chemical gas lasers over space weapons as a means to assist in controlling space would be their resident storage of large amounts fuel and the convenience of continuous resupply unlike space laser weapons in orbit.[44]

Conventional Weapons in Support of Controlling Space

A more definitive alternative for OCS would be the destruction of satellite communication ground stations or an ASAT threat on the launch pad. There are a considerable number of conventional weapons raging from long-range artillery, strategic bombers, ICBMs, cruise missiles, navy sea-based ballistic missile systems or even special operations forces that can be used as offensive space control capabilities to destroy enemy targets that make-up the critical components of an adversary’s space network. When intelligence provides the prerequisite I&W that a potential enemy ASAT

threat exists, U.S. military services under the control of U.S. Strategic Command (USSTRATCOM) or the appropriate Geographical Combatant Command (GCC) could initiate time sensitive planning options to conduct a conventional strike against the threat. The simple fact is that enemy launch sites, satellite control stations and potential mobile ground space weapon systems remain vulnerable to a myriad of current and enhanced conventional weapons. These existing “means” in the U.S. military arsenal remain more cost effective in lieu of developing and fielding space-based weapons. Current conventional weapons in support of space control are sufficient and essential to integrating space power theory into the mainstream of the joint military community.

The recent military intercept of an inoperable National Reconnaissance Office (NRO) satellite by a U.S. Navy AEGIS cruiser warship is a great example of employing a conventional weapon platform to control the space medium at the LEO altitude. The SM-3 missile system was originally designed to track and destroy short and medium range inbound ballistic missiles in their terminal phase of flight.[45] General James Cartwright, the Vice Chairman to the Joint Chiefs of Staff and former USSTRATCOM Commander, acknowledged that the AEGIS platform and SM-3 missile system required only minor software modifications in order to engage the malfunctioning satellite at approximately 153 miles in space.[46]

Political Implications for Space Weapons

The international political implications of placing weapons in space would generate opposition internationally and domestically. It is intuitive that once a nation state deploys weapons into space, other space-faring countries will attempt to do the same undoubtedly creating the next arms race in space. David Zeigler, a former mission

specialist with NASA, (the author of the article “Safe Havens: Military Strategy and Space Sanctuary”) argues that placing weapons in space actually detracts from the security of states that pursue protection of space based assets. He also asserts that the weaponization of space may be more consistent with Cold War strategies but not necessarily appropriate for a post Cold War environment. Zeigler contends that the need for space sanctuary is greater now than ever with space weapons being economically unfeasible based on limited military funding and the fact that their operational need and capability concepts are grossly overrated.[47]

Since the U.S. has withdrawn from the bilateral Anti-Ballistic Missile Systems Treaty of 1972 with Russia, there are now three remaining treaties that deal with the deployment of orbital weapons:

- Agreement Governing the Activities of States on the Moon and other Celestial Bodies (1979)
- Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (1977) and the
- Treaty on the Principle of the Activity of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies (1967)

The Outer Space Treaty (OST) of 1967 was unanimously declared by the United Nations General Assembly in 1966 and implemented by signatory nations in October of 1967. Unfortunately, the Treaty did not address specific details regarding weapons in orbit but created general guidelines for future negotiations of space activities by the signatory states. Its focus was on weapons of mass destruction in space and the exploration of the Moon and other celestial bodies. It prohibits placing military

installations or weapons on celestial bodies in our solar system. However, the primary agreement of the Treaty, as indicated in the preamble, states that its purpose is to ensure the "exploration and peaceful use of outer space is in the 'common interest of all mankind.' "[48]

The original intent of the U.S. and other signatories of the Treaty was that space should remain as a sanctuary free of weapons which has outlasted the Cold War illustrating the relevance of the Treaty and its significance as a space governance tool. Given that the U.S. is a leading space-faring nation due to the number of civil, commercial and military space systems in orbit, a space environment free of space-based weapons is a strategy that would benefit the U.S. now more than ever. Now is the time for the U.S. to take the lead for global cooperation banning weapons in space to ensure that the applications sited in the OST, after forty years, does not become stagnant.

China's successful ASAT test in January of 2007 is one case in point demonstrating the need for the U.S. to engage with the international community in a review, update and enforcement of the 1967 agreement. Additionally, the United States should leverage the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) to take on issues related to space-faring countries considering placing weapons in space. In addition to the U.S., China and Russia, other nation states like North Korea, Iran and Pakistan are also attempting to develop ASAT weapons capable of launching into space.[49]

On the domestic political front, the American public and Congress must be convinced that the need for weapons in space is vital to U.S. national security. National

security space activities currently support U.S. national security by assisting in the right of self-defense and our defense of friends and allies. They also provide deterrence, warning and if necessary counter space systems and services used for hostile purposes.[50] Until national security space activities are incorporated into the nation's Grand Strategy within the National Security Strategy, they will be nothing more than guidance for policy and military strategies, easily ignored by the American public and Congress.

Conclusion

The U.S. currently enjoys a significant advantage in the areas of space-based ISR, communications and navigation systems. These systems, along with existing conventional weapons, give the U.S. strategic dominance in support of national security and national power unmatched by any other nation state in the world. Today's U.S. military relies heavily on space systems, and our current ability to conduct unencumbered access and freedom of action in space combined with the ability to negate enemy space systems, demonstrate that we presently operate under a "space power theory" akin to Corbett's theory on sea power. George Freidman, an American political scientist, argues that a space control strategy "does not require that control be exercised over all 900 trillion cubic miles of space, any more than sea control requires domination of every inch of the ocean's surface."[51]

The space environment is vastly different from the other geographical environments associated with military operations. There are no sovereign boundaries in space unlike airspace or territorial seas. Moreover, the physical environment in space is

not stable or constant due to the rotation of the Earth making the deployment and employment of space weapons more problematic.[52]

This paper presents evidence through the analysis of various space weapon concepts and techniques that are more feasible, acceptable, and suitable in supporting an existing space power theory. It is evident from this research that the U.S. government should continue to invest more heavily in ground-based space weapons vice pursuing on-orbit weapon systems as a means to jam or disable enemy satellites in the Low Earth Orbit. Additionally, conventional weapons already provide sufficient technology and lethality to neutralize kinetic or non-kinetic enemy mobile or stationary offensive ground-based space weapons and ground control facilities that support enemy space assets. Finally, the nature of the space environment, the limitations of on-orbit weapon's technologies and the considerable cost to field these systems, make space-based weapons implausible and unnecessary in order to practice a sensible strategic theory for space power.

Therefore, a U.S. space power theory should not be contingent upon weapons in space since current technology, weapons systems and techniques already allow the U.S. military to control the space domain.

	Response Time	Technical Viability	Vulnerable to Attack	Cost to Deploy	Feasibility
Space Control					
Space-Based Lasers (DEW)	Good	Low	High	Very High	Low
Radio Frequency (DEW)	Good	Low	High	Very High	Low
Kinetic Energy (ASAT) (DIW)	Good	Low	High	High	Low
Force Application					
Space-Based Lasers (DEW)	Good	Low	High	Very High	Low
Kinetic Energy (DIW)	Fair	Low	High	High	Low

Table 1: Space-Based Weapons for Space Control and Force Application[53]

	Response Time	Technical Viability	Vulnerable to Attack	Cost to Deploy	Feasibility
Ground-Based Space Weapons					
RF (Jamming)	Good	High	Low	Low	High
Lasers (Blinding)	Good	High	Low	Low	High
Kinetic Energy (ASAT)	Good	High	Low	Low	High
Conventional Weapons					
Conventional Missiles	Good	High	Low	Low	High
Strategic Bombers	Good	High	Low	Low	High
Airborne Jammers	Good	High	Low	Low	High
Special Operations Forces	Good	N/A	Moderate	Low	High

Table 2: Ground-Based Space and Conventional Weapons for Space Control[54]

Endnotes

[1] James E. Oberg, *Space Power Theory,* (Colorado Springs, C.O.: US Air Force Academy, 1999), 10.

[2] Colin S. Gray, *Modern Strategy*, (Oxford, NY: Oxford University Press, 1999), 257-258. Colin Gray provides one of the finest theories and critical thinking on space power that reflects the nature of war and its conduct in the twenty-first century. Colin Gray uses Clausewitzian ideas to discuss future conflicts that exploit space as an additional geographical medium.

[3] U.S. Joint Chiefs of Staff, *Joint Doctrine for Space Operations*, Joint Publication 3-14 (Washington, D.C.: U.S. Joint Chiefs of Staff, 9 August 2002), X; available from http://www.dtic.mil/doctrine/jel/new_pubs/jp3_14.pdf; Internet; accessed 15 December 2007. The current revision of the JP 3-14 dated 25 January 2008 is underway. The draft version was reviewed during the development of this paper. There were no significant changes found that would contradict or change any sections referenced in the August 2002 version of the joint publication. Hereafter cited as JP 3-14.

[4] Ibid.

[5] U.S. Department of Defense, *National Defense Strategy of the United States of America* (Washington, D.C.: U.S. Department of Defense, March 2005), 13.

[6] U.S. Joint Chiefs of Staff*, National Military Strategy of the United States of America* (Washington, D.C.: U.S. Joint Chiefs of Staff, 2004), 11.

[7] For the purpose of this paper, space power theory, like the other military power theories, is based on the weapon systems and employment techniques that operate in that medium, what they control and how they control that medium. Land power theory as described in U.S. Department of the Army, *The Army,* Field Manual 1.0 (Washington, D.C.: U.S. Department of the Army, 2005), 3-8, requires the employment land forces to occupy, control and protect vital areas of real estate that can only be accomplished using land forces. Sea power theorist like Mahan in Alfred T. Mahan, *The Influence of Sea Power Upon History 1660-1783* (New York: Dover Publications, 1987), 287, and Julian Corbett's theory as described in Julian Corbett, *Some Principles of Maritime Strategy (1911),* (Annapolis, MD: Naval Institute Press, 1988), 316-318, both refer to sea power in terms of naval capabilities and techniques controlling sea lines of communications that can be temporary or permanent in nature. Finally, air power theorists Giulio Douhet and William "Billy" Mitchell believed that in order to control the air medium, the military must have the ability to attain air superiority. Douhet's theory of achieving air superiority was contingent upon destroying enemy air assets on the ground as described in Giulio Douhet, *Command of the Air*, trans. Dino Ferrari (Washington, D.C.: Office of Air Force History, 1983). Mitchell's theory in William Mitchell, *Winged Defense* (New York: Dover Publications, 1988) also asserts that controlling the air medium is achieved by superior air combat to ensure that bombers could attack critical military and industrial centers of gravity.

[8] Oberg, 44-47. It is important to note that James Oberg was contracted by USSPACECOM to publish *Space Power Theory* in an attempt to create a debate regarding the need for a space power theory to help the space community better understand the criticality of space in future civilian and military applications.

[9] Ibid., 45.

[10] Ibid., 130.

[11] Ibid.

[12] There are many within the space community who believe that the U.S. has already "weaponized" space by the number of military and national satellite systems currently in orbit providing critical ISR, communications and navigation information in support of military applications. In this paper, references to "weapons in space" refer to weapon system platforms

in orbit with the ability to attack other space platforms such as satellites or the ability to engage terrestrial targets from space.

[13] U.S. Department of State, *Remarks on the President's National Space Policy – Assuring America's Vital Interests*, (Washington, D.C.: U.S. Department of State, 2007); available from http://www.state.gov/t/us/rm/78679.htm; Internet; accessed 15 December 2007.

[14] Ibid.

[15] Although the U.S. is considered one of the lead space-faring nations when it comes to civil and military space operations, in recent years the U.S. has had to rely on Russia for civil space support to the International Space Station (ISS) and the U.S. space shuttle program. The Space Shuttle Columbia tragedy and the subsequent grounding the Shuttle fleet made the U.S. human space program completely reliant on Russia's Soyuz space vehicle for crew transport and rescue. Therefore, referring to the U.S. as the world's space hegemony is arguably debatable by many space professionals.

[16] U.S. Department of State, *Remarks on the President's National Space Policy – Assuring America's Vital Interests*.

[17] Congressman Terry Everett, "Near-term Strategic Imperatives," 1 February 2007, linked from *The Second District of Alabama Home Page* at "New and Views," available from http://www.everett.house.gov/index.php?option=com; Internet; accessed 13 December 2007.

[18] Clayton K.S. Chun, "Shooting Down a 'Star' - Program 437, The U.S. Nuclear ASAT System and Present-Day Copycat Killers," in *Air University College of Aerospace Doctrine, Research, and Education, CADRE Paper* (Maxwell, AL: Air University Press, 2000), 9-23.

[19] "Soviet Military Power Prospects for Change 1989: Space Forces," linked from *The Defense Intelligence Agency Homepage* at *"Soviet Military Power,"* available from http://www.fas.org/ irp/dia/product/smp_89.htm; Internet; accessed 8 March 2008.

[20] Jim Garamone, "Bush Announces ABM Treaty Withdrawal," 13 December 2001, linked from *The Department of Defense Home Page* at "News, " available from http://www.defenselink.mil/news/newarticle.aspx ?id=44365 ; Internet; accessed 15 December 2007.

[21] Gray, *Modern Strategy*, 256. Most space proponents and strategists would agree with Colin S. Gray who states in his book *Modern Strategy* that "the character of war changes with technology, social and political conditions, so any general theory keyed to particular forms of military power must be limited by them." One can understand that changes in technology alone have not and probably will never be solely responsible for the success of a strategy or determine the outcome of war. Gray asserts that technology, in the form of weapons or as military offensive capability provides a very important dimension to warfare. However, he goes on to caution that new and innovative weapons will be of limited use if human operators and decision makers lack the training to properly employ or the will to use such weapons at all levels of conflict.

[22] Ibid., 257.

[23] Colin S. Gray, "The Influence of Space Power Upon History," *Comparative Strategy* 15 (October 1996): 304.

[24] Colin S. Gray, *Modern Strategy* (Oxford, NY: Oxford University Press, 1999), 258.

[25] John G. Fox, "Some Principles of Space Strategy (or 'Corbett in Orbit')," *Space Policy* 17 (19 February 2001): 8.

[26] Ibid.

[27] George W. Bush, *U.S. National Space Policy* (Washington, D.C.: The White House, 31 August 2006), available from http://www.ostp.gov/html/US%20National%20 Space%20Policy.pdf; Internet; accessed 7 December 2007.

[28] William L. Spacy, "Does the United States Need Space Based Weapons?," in *Air University College of Aerospace Doctrine, Research, and Education, CADRE Paper* (Maxwell, AL: Air University Press, 1999), 4. William L. Spacy discusses that every geographical environment accessible to man has eventually become a domain for warfare. The argument by many space professionals and modern strategists is that the evolution of warfare will inevitably extend into the realm of space requiring the need to place weapons in space to order to achieve national and military strategic objectives. This has been a continuous argument for more than a decade instigated by space professionals like Maj Gen Robert Dickman, the DoD Space Architect at that time who believed that as space access becomes routine and as national security becomes a matter of information dominance critical to military strength, the risk-benefit assessment for interfering with space capabilities will change. In the future, space won't provide a sanctuary for systems that can provide a decisive edge in combat, any more than the air or the ocean depths do today. He believed that industry and commercial endeavors will look to the government for protection similar to land and sea geographical environments.

[29] JP 3-14, IV- 6 - IV-10.

[30] Mark E. Rogers, *Lasers in Space Technological Options for Enhancing U.S. Military Capabilities* (Maxwell Air Force Base, AL.: Center for Strategy and Technology Air War College, 1997); available from http://www.au.af.mil/au/awc/awcgate/cst/ occppr02.htm; Internet; accessed 4 March 2008.

[31] Spacy, 12. Another challenge in using lasers as space-based weapons would the amount of chemical fuel required to power them. A continuous wave laser would consume approximately 375-750 kilograms (kg) of chemicals per second requiring over 100,000 pounds of chemicals in order to engage 10 ballistic warheads 7 seconds each to destroy them.

[32] Col Jeffrey Caton, "Space Power – An Overview of Key Concepts and Issues," briefing slides with scripted commentary, Carlisle Barracks, U.S. Army War College, 20 September 2007.

[33] Elihu Zimet, "High-Energy Lasers: Technical, Operational, and Policy Issues," *Defense Horizons,* October 2002 [journal on-line]; available from http://www.ndu.edu/ inss/DefHor/DH18/DH_18.htm; Internet; accessed 2 December 2007.

[34] Spacy, 19-22.

[35] JP 3-14, IV-10.

[36] U.S. Government Accountability Office, *Space Program: Space Debris a Potential Threat to Space Station and Shuttle* (Washington, D.C.: U.S. Government Accounting Office, April 1990), 10. A 1cm sphere of space debris moving a 10km/s is probably a good relative comparison of the effects that a one pound mass traveling at 9km/s might have on a moving satellite in orbit. A 1cm aluminum sphere traveling at 10 km/s would be equivalent to a 400 lbs. cast iron safe hitting a space vehicle at 60 miles per hour.

[37] Jonathan Shainin, "Rods From God," *The New York Times,* 10 December 2006 [newspaper on-line]; available from http://www.nytimes.com/2006/12/10/ magazine/ 10section3a.t-9.html; Internet; accessed 13 March 2008.

[38] Eric Adams, "Rods From God," *Popular Science,* June 2004 [journal on-line]; available from http://www.popsci.com/scitech/article/2004-06/rods-god; Internet; accessed 13 March 2008.

[39] JP 3-14, GL-11.

[40] Jeremy Singer, "Responsive Space – Making Space Launch Faster, Easier, and Cheaper Sounds Simple, "*Air Force Magazine,* March 2006 [journal on-line]; available from http://www.afa.org/magazine/march2006/0306space.asp; Internet; accessed 4 December 2007.

[41] Adam J. Hebert, "Toward Supremacy in Space," *Air Force Magazine,* January 2005 [journal on-line]; available from http://www.afa.org/magazine/jan2005/ 0105space.asp; Internet; accessed 2 December 2007.

[42] Spacy, 57.

[43] Mark Goracke, "Information Operations and the Joint Force," *Army Space Journal* 1 (Summer 2002): 9.

[44] Mark Scott, "Progress In Directed Energy Weapons Part I: High Energy Lasers," *Weapon Systems Technology Information Analysis Center Newsletter* 4 (Spring 2003): 6.

[45] Gerry J. Gilmore, "Navy Missile Likely Hit Fuel Tank on Disabled Satellite," 21 February 2008, linked from *The U.S. Department of Defense Home Page* at "News," available from http://www.defenselink.mil/news/newsarticle.aspx?id=49030; Internet; accessed 13 March 2008.

[46] Joe Pappalardo, "Satellite Shot Offers Navy Key Space Defense Trial: How It Works," *Online Journal of Popular Mechanics,* February 2008 [journal on-line]; available from http://www.popularmechanics.com/science/air_space/4249458.html; Internet; accessed 6 March 2008.

[47] Everett C. Dolman, *Astropolitik – Classical Geopolitics in the Space Age* (London: Frank Cass Publishers, 2002), 150-151.

[48] U.S. Department of State, *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies* (Washington, D.C.: U.S. Department of State, 2007); available from http://www.state.gov/t/ ac/trt/5181.htm; Internet; accessed 3 March 2008.

[49] Jessica West, "Back to the Future: The Outer Space Treaty Turns 40," *The Space Review,* 15 October 2007 [journal on-line]; available from http://www.thespacereview.com/article/982/1; Internet; accessed 20 December 2007.

[50] Dolman, 152.

[51] George Friedman and Meredith Friedman, *The Future of War: Power Technology and American World Dominance in the Twenty-First Century* (New York: St. Martin's Griffin Press, 1998), 350.

[52] Dolman, 116.

[53] Spacy, 90. The tables were modified from the Spacy reference. They are a subjective assessment of the feasibility and the technical viability of various space weapon concepts and existing ground-based space weapons and conventional weapons in the space control mission area. The intent is to graphically summarize basic characteristics of the weapon systems to demonstrate their viability for controlling the medium of space under a de-facto space power theory. The criteria used to make the qualitative and subjective assessment of the weapon systems have been defined as follows: Response Time – Time for weapon system to impact intended target: Good, Fair, Poor; Technical Viability – Weapon systems where the technology exists or under development: High, Med, Low; Vulnerable to Attack – Vulnerability of friendly capabilities to enemy attack: High, Moderate, Low; Cost to Deploy – Relative cost order of magnitude to field and employ weapon systems: Very High, High, Med, Low ; Feasibility – Weapon systems can be developed using military means historically allocated by Congress: High, Med, Low

[54] Ibid.