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DEFENDING AMERICA'S INTERESTS IN SPACE

by

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Biography

Prior to his attendance at Air War College, Colonel Charles H. Cynamon served as the Deputy Program Director, Space and Nuclear Network Group, 653d Electronic Systems Wing, Electronic Systems Center, Hanscom AFB, Massachusetts. In this role, Colonel Cynamon was the Program Manager for the Family of Advanced Beyond the Line-of-Sight Terminals (FAB-T), a $13.4 billion program to provide assured nuclear and tactical communications for worldwide ground fixed and airborne deployed combat forces. Commissioned through the Reserve Officer Training Corps in 1987, he has held a variety of assignments at squadron, major command, and HQ USAF levels. Colonel Cynamon has a variety of operational and program management experiences in military satellite communications, satellite control, ground-based missile warning, active and passive space surveillance, and airborne warning and control.

Chapter 1 – Introduction

"The greater the threat, the greater is the risk of inaction – and the more compelling the case for taking anticipatory action to defend ourselves."
- National Security Strategy, 2006

Without a doubt the United States uniquely relies on space capabilities to integrate and project all instruments of its national power.[1] With this reliance come tremendous risks and vulnerabilities that must be mitigated to sustain American pursuit of a world order based upon "freedom, justice, and human dignity."[2] As the 44th President of the United States entered office in January 2009, the stakes for space security in the 21st century may be of lesser consequence in comparison to issues such as the nation's flagging economy and the on-going Global War on Terrorism. Nonetheless, failure to resolutely address space security could pose severe repercussions for American power projection in the coming decades. The purpose of this research paper is to frame the anticipated space policy debates for the next Administration.

The Bush Administration boldly professed the need to maintain space freedom of action (i.e., space control) in the 2006 National Space Policy.[3] With the United States dependent on space power more than any other nation, the need for space control as unambiguously stated in this policy has led to significant domestic and international debate whether such a strategy will truly enhance US security or will be globally destabilizing, instigating a space arms race. During the 2008 election campaign, the President articulated specific views about America's interests in space and a revised National Space Policy should be expected.[4]

This paper will develop a strategy for defending America's space interests. As an initial premise, the United States should implement a mix of active, passive, and deterrent measures to protect its vital national interests in space. Active measures could include dual-purpose assets with inherently offensive capabilities, although employed in defense of US interests. In addition to defining the expected future strategic environment, chapter two will assess the need for space weapons or whether the United States should secure space interests through passive and deterrent means only. A position on space weapons will be synthesized through dialectic reasoning.[5] In chapter three, this paper will explain the potential material and non-material solutions (e.g., anti-satellite space weapons capabilities, on-board sensors, deterrent mechanisms, etc.) needed to achieve the strategy. Chapter four will present a roadmap with specific near-term and general long-term recommendations based upon a 2030 scenario in which the United States has successfully implemented the proposed strategy, thereby securing its space interests.[6]

Prior to developing a space defense strategy, overarching US space interests and "space weapons" must first be defined. With respect to space interests, the National Space Policy represents an authoritative source for identifying such interests. While some critics contend the Bush Administration has been predisposed toward the national security aspect, the space policy end goals are fairly consistent when compared to the Clinton Administration's policy ten years prior.[7] At a very broad level, US space policy consistently promotes: 1) bolstering national security, 2) advancing scientific knowledge, and 3) reaping economic benefits from space activities.[8] Independent of one's own perspectives regarding weapons in space, opponents and proponents generally agree on the validity of these broad interests. However, the parties diverge when considering the priority order and the means to achieve these interests. Chapter two will further integrate US interests with the overall strategic environment discussion.

The dilemma in debating weaponizing space is, first and foremost, agreeing on the definition for the term "space weapons." While Article IV of the Outer Space Treaty of 1967 prohibits weapons of mass destruction in space and testing or basing of any weapons on celestial bodies, the US Government has rejected any further conventions or limitations on other capabilities vital to defending our freedom of action in space.[9] For simplicity, if one defines a space weapon as "any weapon transiting the space domain or any weapon that attacks a space system," then we're far too late in waging this debate. Intercontinental ballistic missiles (ICBMs), electronic jammers, and conventional munitions targeting space ground systems have existed for decades. Thus, for the purpose of this paper, a space weapon is defined by its purposeful intent to impede freedom of action in space or to project power against terrestrial targets from space. Attacks on space links and space ground stations by terrestrially-based capabilities have been omitted from this paper because these are not "space weapons" when performing that purpose. For those desiring a technical definition, space weapons are *radio frequency (RF), directed energy (DE) or kinetic weapons either in space or terrestrial weapons directed at the space-borne targets*. This definition includes direct ascent and co-orbital, anti-satellite weapons (ASATs) as well as orbiting space-to-earth weapons, the essence of the immense anxiety for those fearing a space arms race.

Chapter 2 – Developing a Space Defense Strategy

"Being unconquerable lies with yourself; being conquerable lies with the enemy."
- Sun Tzu [10]

On a periodic basis, the US President publishes a National Space Policy in which broad interests, goals and responsibilities are described. The Department of Defense (DoD) translates this *policy* into operational requirements, capabilities roadmaps, planning and programming guidance, and legal interpretations. However, a comprehensive space defense *strategy* is sorely needed to document an integrated interagency plan, thereby accomplishing the defense of America's vital space interests.[11] The culmination of the strategy development process is a plan linking objectives (ends) with concepts (ways) and resources (means) based upon a thorough analysis of the strategic environment.[12]

This chapter will assess the strategic environment with emphasis on the nature of future conflicts and define the potential adversaries. Each type of adversary will be analyzed to determine the appropriate concepts to apply within the space defense strategy. While there seems to be consensus that space assets require protection against would-be aggressors, employing space weapons to defeat potential attacks on US space assets remains a matter of debate.[13] Thus, dialectic reasoning will address whether space weapons are a necessary means to protect American space interests. Chapter three will expand upon the integrated strategy, specifying the means to implement the concepts in pursuit of the objective.

Strategic Environment

Depending on one's outlook, there are a range of projected futures regarding interactions among nations as well as their propensity to wage war. Within the spectrum of international relations, idealism lies on one end and realism on the other, with many variations existing in between. Idealists contend that discourse between nation-states through soft power (e.g., diplomatic and economic means) more effectively stabilizes the international order than hard military power. Conversely, realists adhere to hard power and the pursuit of self-interests by nation-states as the main determinant of international order. While the intent of this paper is not to be a dissertation on international relations, the polarity of idealism and realism permits extrapolation for the future strategic environment. Because a major conflict between spacefaring nations could lead to catastrophic damage to space assets and the space environment itself, the key question for the purposes of this research is, "What is the potential for future conflict among great powers?" Prudently preparing America to defend her space interests is vitally dependent on this answer.

Immense disparity exists between idealism and realism when predicting the potential for great power wars in the future. Idealists advocate the democratic peace theory when prognosticating the future international order. That is, democratic nations are less likely to wage war against each other than with totalitarian or authoritarian regimes. Conversely, realists perceive an anarchical international order based upon balance of power or spheres of influence. They adhere to national interests as the key motivator in the behavior of states in international politics without regard for types of government. Through the lens of idealism, authors such as

Thomas P. M. Barnett conclude that globalization has significantly reduced the likelihood of war among the great powers (aka peer competitors) citing the economic interdependence of the democratic nations with free markets as adequate deterrence for major conflict.[14] Realists, such as James Forsyth and Colonel Thomas Griffith, are not so quick to declare the demise of great power war in the future. Recognizing there are many factors leading to conflict, realists believe conflict among great powers is not only possible but likely as nations pursuing their own interests and greater power will eventually clash.[15]

The United States will clearly continue to promote open markets for globalization and democratization as the key national interests. However, recent world events confirm the likelihood that volatility, uncertainty, complexity, and ambiguity (VUCA) will dominate the strategic landscape for the foreseeable future. In 2008, the world witnessed the Russian invasion of Georgia, heightened tensions with Iran over nuclear proliferation, global economic melt-down, continued US counter-insurgency style conflicts in Iraq and Afghanistan, and growing anti-American resentment within the Western Hemisphere. Therefore, prudence dictates charting a future course with inherent flexibility to deter and fight, if necessary, either major wars among great powers or smaller conflicts such as those in Iraq and Afghanistan.

The United States maintains hegemonic military strength with global reach that's unlikely to be matched anytime soon. However, the degree that space will be a contested environment in a future conflict greatly depends on the adversaries encountered. This paper will consider near-peer nations, non-peer nations, and non-state actors as the types of possible adversaries. Additionally, spacefaring actors with indigenous access to space represent another critical factor in considering future adversaries' ability to contest US interests in space.[16]

However, an adversary need not have access to space in order to harm US space assets. Thus, for completeness, the following taxonomy categorizes possible adversaries as:

1) near-peer, spacefaring nations;

2) non-peer, spacefaring nations;

3) non-peer, non-spacefaring nations; and non-state actors.[17]

A comprehensive strategy to defend US space interests must address the right mix of measures for **assuring** actors about US peaceful intentions, **dissuading** acquisition and use of space weapons, and **deterring** or **defeating** use of space weapons. These concepts represent the ways in which the strategy could attain the space defense strategy objective. There is no "one-size fits all" approach against the potential adversary types defined above. A tailored approach is needed and is thus described in the following paragraphs.

Tailoring the Strategy Concepts

The near-peer nation represents the most complex adversary the United States could potentially encounter. Major spacefaring nations, such as China and Russia, pursue space for economic prosperity in the globalized world, national security, and the prestige associated with scientific research.[18] These nations have vested interests in unfettered access to and viability of a space environment free of purposeful interference as well as harmful debris. It's debatable whether these nations will militarize[19] space to the degree of the United States. If they do choose to compete with extra-regional, expeditionary militaries, China and Russia are likely to become as dependent on space as the United States, consequently accepting many of the same vulnerabilities. In a limited war with a near-peer, nuclear weapons would still figure prominently in the calculus for either side to engage in space attacks, especially those assets used for indications and early warning. The complexity in devising a space defense strategy against a near-peer nation resides in the need to simultaneously synchronize all instruments of national power toward a common objective. In concert, all elements of power need to assure these near-peer nations that US intentions are peaceful, dissuade them from deploying anti-satellite capabilities, deter the use of space weapons, and defeat use of space weapons.

While near-peers are the most complex possible adversary, some non-peer spacefaring nations (aka rogue nations) present perhaps the most dangerous adversary. Nations such as Iran and North Korea have access to space by virtue of their ballistic missile programs, giving them launch capability for kinetic, direct ascent anti-satellite or electromagnetic pulse (EMP) weapons. Furthermore, ground-based radio frequency and directed energy capabilities could impair or damage US satellites. These nations are less likely to be deterred from using such capabilities should conflict erupt. For the United States, a conflict with a rogue nation will likely be a limited war. If the US objective is regime change, our adversary would likely view the conflict as unlimited--providing the incentive needed to escalate the hostilities against the United States' decisive advantage derived from space assets. For this reason, a space defense strategy against non-peer spacefaring nations must focus on a means to dissuade acquisition of space weapons as well as to defeat an attack on US space assets.

Finally, both non-spacefaring nations and non-state actors represent the lowest risk to US interests in space. Whereas, neither actor has indigenous ballistic missile or space launch capabilities to kinetically attack US space assets, the major danger to US satellites would likely be from either RF or DE weapons likely acquired from third parties. In this case, the space defense strategy should primarily seek to dissuade space weapons acquisition where possible. Failing dissuasion, the United States must deter the use of space weapons through asymmetric means and defeat any use of space weapons, if necessary.

In summary, Table 1 indicates the appropriate concepts within a space defense strategy required to protect US space interests against potential adversaries. Prior to the chapter three analysis linking proposed means with the concepts to accomplish the objectives, the controversial space weapons debate warrants analysis. In employing these strategy concepts, one should logically ask, "Are space weapons required as a means to counter threats to US satellites despite the likely international perception they present an inherently offensive capability?"

	Assure	Dissuade	Deter	Defeat
Near-peers nations	X	X	X	X
Non-peer, spacefaring nations		X		X
Non-peer, non-spacefaring nations & non-state actors		X	X	X

Table 1 - Space Defense Strategy Concepts Summary

Space Weapons Debate

Technologically, the United States has demonstrated great prowess and ingenuity in developing military capability. No one should doubt that given the resources of time, money, and the will to succeed, the US industrial complex could design, develop and deploy a broad ground and space-based architecture to defend US space assets. Furthermore, a purely realist view of international relations might un-complicate the decision to proceed along the path to space weapons development. Unlike capabilities in other domains, satellites are governed by laws of physics and once deployed cannot be ubiquitously sheltered from harmful interference by would-be adversaries, given current capabilities. With American economic prosperity and military power at stake, US interests would be best served if any potential adversary knows these space systems are defended guaranteed by the United States' ability to achieve space dominance.

This is the crux of the "high ground" perspective of space power theory currently codified in US military doctrine, both Joint and Air Force.

At the opposite end of the spectrum, space weapons opponents fear US steps to deploy such capabilities would provoke a space arms race. The logical extension of such an argument contends a conflict fought in space would lead to catastrophic results, loss of critically important national assets, massive debris rendering the environment unusable for decades and perhaps centuries to come.[20] The opponents also point to the fact the United States relies more heavily on space for its national power than any other nation and thus has the most to lose if such a scenario comes to pass. Likewise, some critics argue unilateral deployment of weapons in the face of international objections cedes US soft power influence required to implement other aspects of the space defense strategy.[21] This argument represents the "space sanctuary" school of thought.

Given the disparity between the two theories, the choice to begin development of space weapons, as defined in chapter one, is black or white. The gray area in the decision surrounds the nature of any systems the United States opts to build. The United States must deliberately choose whether to seek capabilities for the express purpose of countering attacks on space-borne assets. Both the high ground and space sanctuary perspectives agree on the vital interests inherent in US space assets. In the context of this paper, an affirmative decision for developing space weapons can be made if even a single significant case exists where passive defenses alone cannot assure successful attainment of the space defense strategy objective. The previous discussion regarding strategy concepts versus actors analysis will provide the framework for cases to consider for this critical choice. Posing the most dangerous and least stable of the actor types, the non-peer spacefaring nation will be the hypothesis case in this dialectic since this actor is deemed to be the most likely actor to employ space weapons if it possesses them.

The potential exists for a rogue nation either to detonate an EMP weapon in space, disabling most satellites, or to destroy a critical US intelligence collection satellite in low earth orbit though a direct ascent ASAT weapon. One should first determine if it's possible to counter the effects of both threats strictly with passive defensive capabilities. In the case of an EMP detonation in space, all satellites theoretically could be hardened to an extreme extent to prevent damage induced by the various radiation types released, the dose levels and the dose rates. As for direct ascent ASAT weapons, theoretically these can be countered by improved space situational awareness (SSA) for ample warning time coupled with increased on-board fuel for satellite maneuvers to avoid the impending attack. As a singular event, passive defenses may seem to be a reasonable cost to bear. In reality, these passive defenses alone cannot insure the ability to survive and operate after such attacks. Intelligence, even with perfect SSA, is unlikely to discern the exact target for a direct ascent ASAT attack thus requiring all possible targets to maneuver for safety. Furthermore, the penalties for hardening all satellites and increasing on-board fuel are prohibitive and would come at the expense of payload capabilities and launch costs. Therefore, other defensive approaches short of space weapons should be considered.

An alternative approach to defeating the effect of an adversary's attack on US space assets is a rapid reconstitution capability. Contemporary space systems are typically 10-15 year acquisition efforts with multi-billion dollar price tags. In providing imaging, signals intelligence, communications, navigation, weather, and missile warning on a global basis, each constellation requires numerous satellites to achieve the degree of persistence required for economic activities and worldwide military operations. Rarely do commercial enterprises and government entities launch and store excess capacity on orbit. Within the US Government, building spare satellites for any constellation has become a cost prohibitive luxury given the reality of excessive program overruns and program delays.[22] DoD has long yearned for improved space access through reduced costs and launch timelines.

The latest effort to attain this goal is the Operationally Responsive Space (ORS) program. This multi-tier program aims "to meet the Joint Force Commander's urgent needs for on-demand space support, augmentation or reconstitution."[23] Successful demonstrations and future operational capabilities will figure prominently in the space defense strategy, but ORS will not obviate the continued need for some large, complex satellites providing enormous bandwidth, timely intelligence products, precision navigation and other key military requirements. The warfighter's insatiable needs for information to support terrestrial weapon systems continue to outpace the technological innovations, resulting in payloads usually larger than the capabilities they replace.[24] Unfortunately, some space missions such as protected communications do not lend themselves toward modular payloads on small satellites (smallsats) and launching on smaller ORS launch platforms. Understandably, the missions ORS has targeted for modular payloads to support rapid reconstitution will likely be lesser capable satellites. Although the ORS gapfilling concept for reconstitution must be pursued as a key element to deter attacks against US space systems, critical capabilities ORS cannot replace will remain lucrative targets for adversaries.

The inability to completely rely upon passive defenses and rapid reconstitution to defeat adversary attacks on US space assets presents a security dilemma that must be solved. The immense potential for damage to American economic and military interests demands a lower risk approach to guarantee freedom of action in space. Within the context of an overall space defense strategy, all viable capabilities must be explored to include space weapons. However, the DoD cannot and should not develop space weapons in isolation from, or opposing the interests of, other key interagency stakeholders, specifically the Departments of State and Commerce and the Office of Director of National Intelligence. Together, the interagency team must harmoniously implement an integrated space defense strategy in which space weapons support the overall plan.

Chapter 3 – Space Defense Strategy Means

"If, therefore, one of two commanders is resolved to seek a decision through major battles, he will have an excellent chance of success if he is certain that his opponent is pursuing a different policy. Conversely, the commander who wishes to adopt different ***means*** *[emphasis added] can reasonably do so only if he assumes his opponent to be equally unwilling to resort to major battles."*

- Carl von Clausewitz [25]

An effective space defense strategy necessitates an interagency approach in which all four of the nation's instruments of power are synchronized to achieve maximum effect. This chapter will briefly define and describe the actions available to national security decision makers within each of the instruments of power pertinent to defending America's space interests. From the vast array of options, an appropriate mix of measures and capabilities will be suggested to implement the strategy concepts of assurance, dissuasion, deterrence and defeat. The resulting matrix of strategy means will be employed in chapter four as the basis for a space defense roadmap. As a note, more focus will be devoted to the cost and time-intensive military capabilities, which must survive the prolonged and extensive technology development and DoD acquisition cycles.

Employing Instruments of Power

The four instruments of national power are diplomatic, economic, informational, and military. Although a superpower nation wields tremendous clout with each individual instrument, synergistically combining the instruments produces multiplicative effects greater than the sum of the four. Additionally, success hinges upon the degree to which a nation effectively links policy to strategy and then to the actions taken. However, one must account for the fact each nation simultaneously acts in the international arena forging an ever-changing game. Thus, the use of power must be flexible enough to be tailored to the situations at hand. In defining and describing the aspects of power relating to the space defense strategy, the available actions must be screened for their scalability for each actor type presented in chapter two as well as adaptability to shape and respond in crisis.

The first instrument to examine is the diplomatic instrument of power. Nations exercise diplomacy for the purpose of managing relations with other nations, negotiating issues, and persuading others for the purposes of furthering national objectives. In the space defense strategy, the United States will need to pursue diplomatic options considering positive rewards and negative consequences. Positive inducements come in the form of amity, security, or economic incentives. Conversely, negative diplomatic actions typically include censure and sanctions. For maximum effect, diplomatic actions are closely tied to other instruments for their implementation; for example, with the military instrument for arms control agreements, with the informational instrument for censure and amity, and with the economic instrument for sanctions, incentives and arms sales.

If duly endowed, a nation may use its economic power to influence the strategic environment with measures designed to protect one’s own prosperity or to affect another nation’s. Similar to diplomatic power, economic power is employed in a “carrot and stick” manner. Positive inducements may include favorable trade policies and foreign aid in the form of loans and grants. Economic power exercised in a negative manner includes trade policies enacted as sanctions or withholding foreign aid. When employing power, nations communicate their intent through the informational instrument of power.

Coherently expressing policies is vitally important for democracies in today's highly globalized, interconnected world. Information shapes domestic and international public opinion on which successful strategies depend. Formal and informal discourse provides the foundation for expressing national strategy. In a formal sense, recognized nations have access to the United Nations (UN) General Assembly, and possibly the Security Council, as well as diplomatic missions and regional alliances. Informally, nations often communicate through lower level diplomatic or military contacts, academia, and commerce. The media plays a tremendous role in both facilitating and complicating communications between nations. Therefore, a solid strategic communications plan should lay the foundation for stating the nation's intentions in pursuing any particular policy.

Finally, the military instrument of power is not only useful for coercing acceptance of a nation's policies, but can be employed to shape the strategic environment. In their ultimate use, military capabilities are deployed for destructive purposes or to support application of such force. However, the development, testing and deployment of military systems and forces can also affect the relative power of other nations. Furthermore, other military power measures short of wartime employment include: military alliances; implementation of arms control agreements, multinational exercises and training programs; foreign military sales and cooperative weapons development; shared intelligence and early warning; and shows of force.

With the various instruments of power defined and general employment measures described, the next step is to tailor their application to the proposed space defense strategy.

Defining the Means

In this section, the four strategy concepts will be individually analyzed against the instruments of power to determine the means for achieving the objective of defending America's space interests. The nature of the threat environment was previously captured when characterizing the appropriate concept (or way) to achieve the strategy relative to each type of actor. However, the full range of possible means must be synchronized to ensure harmonious implementation, to preclude the various US Government agencies from creating stove-piped programs and possibly working at cross purposes. This chapter will present only high-level descriptions of the military means and the strategic communications plan needed for strategy implementation. The roadmap developed in chapter four will explain those means in greater detail.

Space assurance seeks to maintain the viability of the medium, permitting nations to reap the benefits of space access through peaceful pursuits.[26] All nations receive direct and indirect benefits from space, whether spacefaring or not. Foremost, the United States must specifically assure near-peer actors, such as China and Russia, and allied nations its intentions are peaceful in nature even while asserting the prerogative to actively defend space interests. Many contemporary space theorists contend confidence-building measures and rules of the road in space are needed to achieve space assurance.[27] To motivate near-peers, the United States should promote positive inducements in application of national power to foster cooperation and build confidence. Diplomacy should elicit confidence toward mutual security with economic incentives to cooperate. Similarly, military power should be geared toward cooperation and data sharing, where not negatively affecting national security. Finally, informational power should reinforce a consistent message influencing world opinion in clear support of peaceful uses of space with an unyielding will to defend all nations' access for such purposes.

As the most visible near-peer competitor in space, China should be induced toward greater transparency in its military space program through frequent diplomatic and military-to-military dialogs bridging the cultural and language barriers toward better understanding.[28] An active US role in China's space program would be a prudent approach toward mutual space assurance.[29] Regardless of US efforts in preventing proliferation, China has successfully obtained space technology to support its economic growth and national prestige, whether garnering assistance from European nations and Russia or developing indigenous capabilities. Economically, the United States should consider cooperative civil, military and commercial space programs, permitting direct commercial sales for certain regional space capabilities such as: narrow and wide-band communications, medium-resolution remote sensing and precision navigation and timing user equipment.[30] In linking Chinese human rights, currency valuation, and environmental protection policies to improved US-Chinese relations, perhaps space assurance offers positive inducements within an informational campaign.

In general, this space defense strategy should be implemented through the Space Policy Coordination Committee (PCC) under the auspices of the National Security Council (NSC). Table 2 below delineates all the suggested actions. However, as one of the key actions, the United States should proactively engage the international community to gain acceptance for a debris prevention regime.[31] Furthermore, the PCC should consider current regulations on exporting space technology as hindering cooperative space programs in light of the current strategic environment.[32] Militarily, sharing space situational awareness data for space flight safety purposes would protect manned space flight as part of a debris prevention regime. The combined effects of space assurance efforts would be to foster greater communication, closer working relations, and reduce hazards to manned and unmanned systems operating in space. In total, these actions serve as an earnest attempt to incentivize near-peer nations to avoid pursuing their own space weapons. In parallel with assuring near-peer nations of US peaceful intentions in space, non-peer nations and non-state actors must be targeted with dissuasion mechanisms.

Dissuasion is intended to persuade actors from acquiring capabilities for the purpose of willfully interfering with US space assets. The centerpiece of dissuasion will be counter-proliferation for key technologies to non-state actors with known links to terrorism as well as economic sanctions for nations discovered to be developing or acquiring space weapons. As mentioned in chapter one, space weapons are defined by their intent to impede freedom of action in space. Ground-based systems, such as lasers and uplink jammers, pose the greatest danger from non-spacefaring actors while a direct ascent kinetic ASAT is an additional danger posed by spacefaring nations. From the military perspective, on-board satellite defensive capabilities may present a means to deny would be aggressors the benefits derived from possessing ASAT capabilities.

There's little doubt to most informed observers US space assets lack any integrated space defensive capabilities, relying on the historical policy of space sanctuary for protection. Improved SSA would be a key enabler for real-time attack warning and assessment permitting timely use of passive satellite defenses. For purposes of dissuading non-peer actors, the United States must prioritize development of on-board sensors and countermeasures and mandate their employment on the next generation of the critical space assets. Demonstrating capabilities on future smallsat payloads would indicate US resolve. Coupled with the negative inducements in the diplomatic, economic and informational realms (shown in Table 2), a counter-ASAT program could serve as a prevention measure to dissuade acquisition of space weapons by non-peer nations and non-state actors. Barring dissuasion, the United States must be prepared to deter an attack by an adversary known to possess space weapons.

Space deterrence seeks to prevent an attack on US space assets by persuading the adversary "not to initiate a specific action because the perceived benefits do not justify the estimated costs and risks."[33] As shown in Table 2, the diplomatic, economic, and informational measures along with military shows of force are intended as mechanisms to increase an adversary's costs for attacking US space assets. A military show of force could demonstrate US resolve to respond with an asymmetric attack, if provoked. The adversary must be convinced that its attack will be attributable and space will be defended by threatening a proportional response and inflicting a punishment for attack upon US space assets. Depending on the phase of the conflict, the ability to impose some of these recommended costs may appear to be tokens at best. However, in the initial ramp up of hostilities for a limited conflict, US economic or diplomatic actions should factor into an adversary's calculus for escalating the conflict against our space assets. On the other side of the equation, the other military measures in Table 2 are intended as denial tactics eliminating benefits for attacks on US space assets.

Whereas dissuasion was deemed an "unresponsive" concept for technologically advanced near-peers, deterrence requires possessing defeat capabilities to counter more challenging and complex ASAT capabilities. Improved SSA and passive satellite defenses need further robustness against ASAT attacks originating on the ground (direct ascent ASAT, DE or RF weapons) and in space (co-orbital ASAT). Improved SSA must also support the needs of US active defenses (i.e., space weapons to defend against ASATs), requiring a space track "custody" concept (modeled after air traffic control) with precise accuracy and high-resolution in order to detect, track and discriminate targets from friendly assets.[34] Should deterrence fail, the same measures described herein must be capable of defeating an attack.

The defeat concept must deny, with high probability of mission success, would-be aggressors their desired benefits in attacking US space assets. While the diplomatic, economic, and informational means are the same as the deterrence concept, the military means are slightly different. In addition to passively and actively defending against the attack, the United States must have a means to rapidly reconstitute at least some portion of any capability destroyed or damaged by the attack. DoD's ORS program seeks to improve routine space access as well as provide some measure of reconstitution through smaller, modular payloads. Finally, the military means should consider carrying out counterstrikes, preferably non-escalatory, against the adversary as a punishment mechanism to coerce against further ASAT attacks.

Implementing this space defense strategy requires a long-term coordinated and disciplined approach--unusual given the short-term focus of American domestic politics to address long-term national security threats. The nature of the strategy incorporates key elements of space sanctuary and high ground theories promoting the best opportunity for defending American space interests. Chapter four will project ahead to a future time when this strategy has been fully implemented and then work backward to explain the steps taken in a process called Prospective Hindsight. The results of that method will be the basis for the recommended roadmap.

	Assurance (Near-peers)	Dissuasion (All actors)	Deterrence (Near-peers and non spacefaring actors)	Defeat (All actors)
Diplomatic	- Debris prevention regime - Cooperative civil programs	- Counter-proliferation efforts - Debris prevention regime - Cooperative programs	- International censure - UN Sanctions	- International censure - UN Sanctions
Informational	- Strategic Comm plan - Linkage to other interests - World opinion	- Strategic Comm plan - Linkage to other interests - World opinion	- Strategic Comm plan - Linkage to other interests - World opinion	- Strategic Comm plan - Linkage to other interests - World opinion
Economic	- Linkage to trade policies - ITAR overhaul - Limited technology sharing - Direct commercial sales	- Withhold foreign aid - Impose sanctions	- Withhold foreign aid - Impose sanctions - Suspend commercial sales	- Withhold foreign aid - Impose sanctions - Suspend commercial sales
Military	- Military-to-military dialogs - SSA sharing for flight safety	- Improved SSA capabilities - Passive defensive measures - Capability demonstrations	- Improved SSA capabilities - Passive defensive measures - ASAT defeat capability - Show of force	- Improved SSA capabilities - Passive defensive measures - ASAT defeat capability - Asymmetric response - Rapid reconstitution

Table 2 - Space Defense Strategy Means

Chapter 4 – Roadmap for Success

"The defense policy of the United States is based on a simple premise: The United States does not start fights. We will never be an aggressor. We maintain our strength in order to deter and defend against aggression -- to preserve freedom and peace."

- President Ronald W. Reagan [35]

While 2030 seems a distant future, the full implementation of the space defense strategy will require a commitment of decades to accomplish. In the first 50 years of space flight, space sanctuary has been the guiding light in which satellites enjoy freedom of overflight with relatively minor instances of purposeful interference.[36] Not coincidentally, the foresight of past US Administrations starting with President Eisenhower has shaped the space environment. In a similar manner, the next three to four Administrations must shape the environment lest others will do so.

This chapter will postulate the future in 2030 when the US space defense strategy has been fully exercised with 100% success. Employing the construct of Prospective Hindsight, the key actions from 2030 back to 2009 will retroactively show how the implementation reality evolved from its vision. As a product of this approach, a roadmap going forward in time will be proposed with specific recommendations for President Obama and his Administration. Two of the critical elements of the plan, military capabilities for passive and active defense and the strategic communications plan, will be emphasized in the roadmap and recommendations.

2030: Visualizing Success

The United States remains the unparalleled military power in the world in an absolute sense. Since 2009, all elements of US military strength have realized dramatic improvements driven by computer processing, advanced materials, and efficient energy technologies. Despite superior military power, the United States' relative national power in the post-Cold War era has declined with respect to rising powers of China, Russia, India, and Brazil, among others. After the great economic crisis of 2008-2009, globalization rebounded and further intensified once the great powers innovatively began to wean themselves from dependence on petroleum to new and abundant forms of energy. Cooperative energy programs for a gradual and deliberate transition by the globalized nations led by the United States prevented tremendous world instability, especially in oil-producing regions and nations. This success reflects a renewed US commitment to diplomatic greatness offsetting the relative decline in economic and military power.

In the future, the primary sources of trans-regional, interstate and intra-state conflict are non-globalized, failed nations and ideologically motivated non-state actors. Even though sporadic tensions between major globalized nations have occurred, the resulting violent clashes have not lead to high-intensity conflicts. US conventional military power supported by well-protected space systems has remained the key deterrent against major power war. In space, the United States retains preeminence for support to the world's sole global expeditionary military. Over the course of 20 years, the United States bolstered its commercial and civil space industrial base with foreign space system exports and international cooperative programs. Joint ventures in manned space flight with the major spacefaring nations returned mankind to the moon for scientific exploration investigating extraction of key minerals, energy sources, and launch bases for more ambitious space travel opportunities. Despite orbiting US anti-ballistic missile systems, a space arms race never materialized with respect to ASAT weapons. The confluence of interagency efforts shaped the strategic environment in which the world perceives the United States as the enforcer of peaceful uses of space.

Tracing the Roots of Success

After concluding developmental and operational testing, the Defense Department announces the initial operating capability of an integrated space defense system in 2030. The system consists of improved SSA, passive defenses on-board satellites both space and ground-based active space defenses, and rapid reconstitution for certain space missions. Table 3 describes in detail the components of the integrated space defense system. Coinciding with the system initial operational capability (IOC), the US Government (USG) announces a voluntary program called the Global Space Defense Initiative (GSDI) demonstrating resolve for peaceful use of space by all nations. The United States offers an unclassified version of its passive defense measures to other governments and commercial enterprises in exchange for a pre-launch verification inspection of the payload and customer-provided post-launch tracking data for the space catalog.[37] SSA upgrades permit the USG to guarantee customers will receive timely space warning notifications for collision warning, expected radio frequency interference, and space weather events. Ultimately, GSDI seeks to reduce the number of space objects requiring routine tracking and assessment revisit by the space surveillance system sensors.

By 2025, the Missile Defense Agency (MDA) declares the operational Ballistic Missile Defense System (BMDS) capable of countering ground-launched direct ascent ASAT weapons. This declaration leads to a Presidential Decision Directive (PDD) stating US critical space assets will be protected as extensions of the homeland. In concert with this PDD, a State Department initiative reinforces the 1975 Registration Convention.[38] The United States emphasizes the importance of pre-launch notification especially in heightened periods of tension to preclude misperceptions that an unannounced launch could be either a ballistic missile attack or an ASAT attack against US space assets. Furthermore, the USG denounces co-orbital ASATs and directs development of space systems capable of visual inspection of suspected objects and the ability to disable the offending object's command and control antennas. Finally, integrated space defenses including on-board sensors and countermeasures attain operational status on US military and intelligence satellites.

In 2020, the Air Force completes an overhaul of its space surveillance network sensors and the central processing facilities in the space surveillance center. All sensors receive signal processing upgrades for improved acquisition, tracking and object discrimination while ground-based sensors also replace aged front-end transceivers. MDA ground and space-based sensors are integrated into the space surveillance network, injecting the high precision inherent in the BMDS mission. In a cooperative effort with the ORS office, the Air Force Research Lab (AFRL) demonstrates a prototype integrated passive defense package on a TacSat mission proving a semi-autonomous capability in an operationally realistic environment.[39] Both China and the United States individually accomplish manned missions to the moon. After which, the two nations announce a multi-national commercial venture to pursue a lunar base for mineral and energy research.

By 2015, the Defense Advanced Research Programs Agency (DARPA), AFRL, and the Space and Missile Systems Center (SMC) complete ground component testing for an integrated space defense package leading to formal approval for program initiation by the Undersecretary of Defense for Acquisition, Technology and Logistics (USD/AT&L).[40] The NSC and Congress mandate incorporation of passive defenses on the following next-generation space systems:

Transformational Satellite Communications System (TSAT), Wideband Global SATCOM (WGS) Follow-on, National Polar Orbiting Environmental Sensing System (NPOESS) Follow-on, MDA space-based interceptors and sensing satellites, and national intelligence satellites. As a hedge against future aggression in space, the President's Budget includes funding for MDA to develop hardware and software modifications to its systems providing for counter-ASAT capability. Lastly, China completes its first-ever docking with the International Space Station as a mission partner.

On 20 January 2009, the President Obama is inaugurated. Heightened tensions with Russia over components of the BMDS in Poland and the Czech Republic lead to a comprehensive review of the US defense posture for homeland defense. In parallel, the NSC accepts the Allard Commission recommendations and charters the Space PCC to develop a national space strategy. The PCC emphasizes defending America's space interests in the national space strategy. In protecting US space assets, the strategy is founded on "space for peaceful purposes" and includes measures to assure, dissuade, deter, and defeat those would challenge the United States in the space domain. Discouraging near-term ASAT testing, the United States proposes a space code of conduct to the UN Committee on Peaceful Uses of Outer Space (UNCOPUOS) meeting attendees, limiting debris size and persistence as a barrier to further destructive ASAT tests.

Space Situational Awareness (SSA)	•BMEWS/PAVE PAWS/Eglin UEWR, SLEP and front-end upgrades[39] •Space Surveillance Network signal processing upgrades •Incorporate MDA ground and space-based systems as contributing sensors •Track custody concept •Use of on-board sensors (satellite as a sensor concept)
Passive Defense Measures	•Stealth materials against radars and optical sensors •On-board attack warning and assessment for semi-autonomous response •Decoy dispensers (reflective balloons, chaff, flares)[40] •Hardening against radiation and DE/RF attack mechanisms •Propellant-less maneuverability[41] •Packages mandated by NSC on certain military satellites •Global Space Defense Initiative
Active Defense Measures	•MDA Ground-Based Interceptors (land- and sea-based)[42] •Airborne Laser for in-theater area coverage •MDA space-based Kinetic Kill Vehicles •Inspection TacSats disabling co-orbital ASAT weapons[43]
Rapid Reconstitution	•ORS missions to rapidly replace ISR, narrow-band comm., and navigation satellites

Table 3 - Integrated Space Defense System Concepts [41, 42, 43, 44, 45]

Roadmap

In navigating the course toward defending America's interests in space, the stakeholders across the USG must dedicate themselves to agreement on a roadmap. There are countless routes to take to arrive at the destination and one path is suggested herein. The roadmap consists of near-term and long-term actions with the first term of the new Administration chosen as the dividing line. The near-term actions form the foundation upon which the long-term actions culminate with achieving the strategy's objectives.

As previously suggested, the NSC should direct the Space PCC to drive consensus on the boundaries of the space defense issue with the various interagency stakeholders. Recalling the strategy concepts and uses of instruments of power in Table 2, the PCC should initially focus on assurance and dissuasion, lacking credible means to deter and defeat ASAT attacks today. The most important products of near-term efforts are direction for future capabilities to deter and defeat ASATs and a coherent strategic communications plan.

The lengthy technology development and systems acquisition cycles will pace the timelines recommended by the PCC and approved by the NSC. As such, the DoD requires policy guidance for planning, programming, budgeting and executing purposes in the next Administration's fiscal year 2011 (FY11) update to the future years defense budget (FYDP).[46] The NSC direction will likely trigger current programs in early stages of development to incorporate elements of the space defense strategy in Joint Capabilities Integration Development System (JCIDS) products and Defense Space Acquisition Board milestones.[47] Timely direction from NSC is imperative or the next generation of communications, early warning, weather, and intelligence satellites will proceed without provisions for these defensive measures. Despite spiral development and evolutionary acquisition practices, these next generation constellations must inject protection measures in current development programs or another 10-15 years will elapse before the generation after next (or block build) can be affected.

Secondly, a solid strategic communications plan must result from the PCC and NSC efforts. Some key aspects of a solid plan include a good message, measurable results, and steady pressure to ensure success.[48] The crux of the message must be the United States' unwavering commitment to peaceful use of space, denouncing any purposeful impedance of space-borne assets by nations or non-state actors while reserving the right of any nation to actively defend its space assets (in accordance with Article VII of the UN Charter). This message should visibly include actions to promote cooperative scientific research and commerce in space by removing impediments induced by overly restrictive technology-sharing regulations where possible. Lastly, the United States should be at the forefront of spacefaring nations defining rules of the road preventing persistent debris-causing experiments and fostering spaceflight safety measures. This strategic communications plan will convey measurable messages to the international community and will require steady pressure in the long-term to achieve.

For the far-term, Congress will play the pivotal role in the success of the space defense strategy. Enacting legislation and consistent funding to enforce space defense would drastically improve the probability of attaining the goals. Such legislation boosts international community confidence in US policy for peaceful use of space while preserving the right of self-defense. The Legislative and Executive Branches must partner in actions toward near-peers to carefully and deliberately link space issues with other pressing domestic and foreign policy matters. Commitment to the long-term strategy will ultimately lead to security for the United States and all nations sharing the goal of peaceful pursuits in space.

Chapter 5 – Summary

"Si Vis Pacem, Para Bellum."
- Flavius Vegetius Renatus[49]

Reuters News reported on 8 April 2008 the world spent $251 billion on space activities, both governmental and commercial sectors, in 2007.[50] Conservatively, the world will cumulatively spend $8.120 trillion on space between 2007 and 2030, assuming only modest 2.5% annual inflation. One can ascertain space is a critical national security interest for all nations judging by global investments. In particular, the United States relies on space capabilities for military advantage, economic growth and scientific study. The Air Force's Air Combat Command performed "A Day Without Space" study to demonstrate its reliance on space and the vulnerabilities inherent in that reliance.[51] A similar study on a worldwide basis might shed startling results to say the least. Because of this dependence, space has become a contested environment for military purposes.

Projecting 20 years into the future, the United States will likely face challenges from competitors to retain its dominant warfighting advantage. The US military has organized, trained and equipped its forces around information generated from and flowing through the space medium. While superior nuclear and conventional military capabilities can do much to prevent war among near-peers, the United States must be prepared to encounter conflict with non-peer nations (spacefaring or not) and non-state actors. In the post Cold War era, these actors have proven their resolve to pursue self interests notwithstanding their overwhelming disadvantages militarily. The non-peer, spacefaring nation represents an especially dangerous actor who would be the most likely to lash out against US space assets to curb its asymmetric disadvantage or act as a dangerous proxy in facilitating another state or non-state actor. The difficulty in deterring this type of actor necessitates the US development of active countermeasures against ASAT weapons in defense of America's space interests. Employment of defensive space weapons must be considered in the context of an overarching space defense strategy.

The Congressionally-directed Allard Commission report emphasizes the need for a national space strategy to coalesce the efforts of the numerous stakeholders in the USG with space-related responsibilities. A strategy for protecting US interests in space must be at the heart of an overall national space strategy. As the master blueprint, the strategy will link the concepts of assurance, dissuasion, deterrence, and defeat with the means to accomplish the space defense objective. In truly interagency fashion, the means should merge all four of the instruments of US national power into a coordinated game plan with a phased implementation. By envisioning successful execution in 2030, this paper put forth a roadmap focusing on the following near-term recommendations.

1) The National Security Council directs the Space Policy Coordination Committee to generate a national space strategy, endorsing space defense as the cornerstone;

2) PCC produces a companion Strategic Communications plan to gain Congressional support and foster international commitment and understanding;

3) DoD, DoS, and DoC comprehensively re-evaluate restrictions for space technology exports in the International Traffic in Arms Regulations (ITAR) enabling civil and commercial international cooperative programs with added benefit of bolstering US industrial base;

4) DoS and DoD engage with China and the international spacefaring community through the UNCOPUOS to develop a Debris Prevention Regime as an initial element for a space code of conduct;

5) DoD elevates space defense as a top priority within the JCIDS and Defense Space Acquisition Board processes ensuring next-generation space assets are protected.

A serious commitment to space defense can no longer be placed on the back burner. Sobering world events over the last two years in which China tested an ASAT, Russia has threatened to place missiles on the Polish border, and Iran's continued defiance regarding its nuclear program must be a wake-up call to action. The United States must commit to peaceful use of space with equal resolve to defend the peace on behalf of all spacefaring nations.

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Acronym List

AEHF	Advanced Extremely High Frequency
AFRL	Air Force Research Laboratory
ASAT	Anti-Satellite
BMDS	Ballistic Missile Defense System
BMEWS	Ballistic Missile Early Warning System
DARPA	Defense Advanced Research Programs Agency
DE	Directed Energy
DoC	Department of Commerce
DoD	Department of Defense
DoS	Department of State
DSAB	Defense Space Acquisition Board
DSCS	Defense Sateliite Communications System
DSP	Defense Support Program
EMP	Electromagnetic Pulse
FY	Fiscal Year
FYDP	Future Years Defense Program
GEO	Geosynchronous
GSDI	Global Space Defense Initiative
ICBM	Intercontinental Ballistic Missile
IOC	Initial Operational Capability
ITAR	International Traffic in Arms Regulations
JCIDS	Joint Capabilities Integration Development System
MDA	Missile Defense Agency
MDAP	Major Defense Acquisition Program
NPOESS	National Polar Orbiting Environmental Satellite System
NSC	National Security Council
NSP	National Space Policy
ORS	Operationally Responsive Space
PAVE PAWS	PAVE Phased Array Warning System
PCC	Policy Coordination Committee
PDD	Presidential Decision Directive
PLA	People's Liberation Army
RF	Radiofrequency
SATCOM	Satellite Communications
SBIRS	Space-Based Infrared System
SDD	System Design and Development
SLEP	Service Life Extension Program
SMC	Space and Missile Systems Center
SSA	Space Situational Awareness
SWaP	Size, Weight and Power
TRL	Technology Readiness Level
TSAT	Transformational Satellite Communications System
UEWR	Upgraded Early Warning Radar
UHF	Ultra-High Frequency
UN	United Nations
UNCOPUOS	United Nations Committee on Peaceful Uses of Outer Space
US	United States
USA	US Army
USAF	US Air Force
USD/AT&L	Undersecretary of Defense for Acquisition, Technology and Logistics
USG	United States Government
USN	US Navy
VUCA	Volatility, Uncertainty, Complexity, Ambiguity
WGS	Wideband Global SATCOM

Interview Questions

- **What do you think are the major US interests in space?**
- **Define space weapon?**
  - **Do you consider ground-launched missiles (e.g., ICBMs, GBIs, AEGIS SM-2/3s) as space weapons?**
  - **Is electromagnetic energy considered a space weapon**
- **Do you see any legal or policy impediments to offensive and/or defensive space weapons?**
- **What are the key enabling technologies & capabilities the US must pursue for space superiority?**
- **If the US develops, tests and deploys space weapons (as defined previously), is an arms race inevitable?**
- **To promote a posture of deterrence, could elements of ORS and MDA capabilities be effective in altering an adversary's "cost and benefit" equation?**

End Notes

Chapter 1

[1] Institute for Defense Analysis, "*Leadership, Management, and Organization for National Security Space: Report to Congress of the Independent Assessment Panel on the Organization and Management of National Security Space,*" IDA Group Report GR-69, July 2008, ES-2. The following report authors are acknowledged experts in national security space: Mr. A. Thomas Young, Chairman; Lieutenant General Edward Anderson, USA (Ret.); Vice Admiral Lyle Bien, USN (Ret.) ; General Ronald R. Fogleman, USAF (Ret.); Mr. Keith Hall; General Lester Lyles, USAF (Ret.); and Dr. Hans Mark.
[2] President, "*The National Security Strategy of the United States of America*," March 2006, 18.
[3] National Space Policy, Section 2, 1-2, August 2006, http://www.ostp.gov/galleries/default-file/Unclassified%20National%20Space%20Policy%20--%20FINAL.pdf.
[4] Obama 2008 official Web site, "Defense Issues," http://www.barackobama.com/issues/defense/. Sen. Obama provided the following statement regarding his position on ensuring "Freedom of Space." "An Obama-Biden administration will restore American leadership on space issues, seeking a **worldwide ban on weapons that interfere with military and commercial satellites** [emphasis added]. He will thoroughly assess possible threats to U.S. space assets and the best options, military and diplomatic, for countering them, establishing contingency plans to ensure that U.S. forces can maintain or duplicate access to information from space assets and accelerating programs to harden U.S. satellites against attack."
[5] Mortimer J. Adler, *Dialectic* (New York: Harcourt, Brace & Company, Inc.), v. Mr. Adler defines dialectic reasoning as "an intellectual process in which all men engage in so far as they undertake to be critical of their own opinions, or the opinions of others." He further states, "Dialectic is relevant to human affairs whenever men find themselves in agreement or disagreement over matters of theory." In the case of this research, dialectic reasoning is an ideal method to analyze the polarizing debates over weaponzing space to defend one's interests.
[6] J. Edward Russo, Paul J. H. Schoemaker, with Margo Hittleman, *Winning Decisions: Getting it Right the First Time* (New York: Currency Doubleday, 2002), 111-112. The authors introduce the concept of Prospective Hindsight in which one postulates with certainty the occurrence of a situation or event and then works backwards with hindsight the reasons or circumstances. While the authors explain the concept for the purpose of personal or professional development, the Defense Acquisition University has extended this concept for use in assessing program management outcomes and paths to attain an end result. This paper intends to implement this concept by postulating the final thesis with certainty in 2030 and the working backwards to explain the path to attain that result.
[7] House, *Weaponizing Space: Is Current U.S. Policy Protecting Our National Security?: Hearing before the Subcommittee on National Security and Foreign Affairs*, 110th Cong., 1st sess., 23 May 2007, 14-18. The House subcommittee expressed reservations regarding the 2006 National Space Policy's emphasis on space control even while considering the growing threats demonstrated by the Chinese ASAT test in January 2007.
[8] National Space Policy, Section 3, 2, August 2006, http://www.ostp.gov/galleries/default-file/Unclassified%20National%20Space%20Policy%20--%20FINAL.pdf. US Space Policy Goals articulate the Administration's views on interests in space. In the 1996 NSP Fact Sheet (http://www.globalsecurity.org/space/library/policy/national/nstc-8.htm), the Clinton Administration's space policy goals are very similar even if less detailed and reflect differing priorities.
[9] United Nations, "*Treaty on Principles Governing the Activities Of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*." 10 October 1967, Article IV. The treaty explicitly prohibits weapons of mass destruction in space and on celestial bodies. Likewise the article states, "The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden." No specific prohibition is placed upon conventional weapons orbiting the earth. On page 2 of the 2006 National Space Policy, the US Government states its intention to avoid any further legal regimes restricting freedom action in space and developing systems to defend its interests in space.

Chapter 2

[10] Sun Tzu, *The Art of War*, trans. and commentary by Ralph D. Sawyer (Boulder, CO: Westview Press, 1994), 183.
[11] Institute for Defense Analysis, "*Leadership, Management, and Organization for National Security Space: Report to Congress of the Independent Assessment Panel on the Organization and Management of National Security Space,*" IDA Group Report GR-69, July 2008, ES-4. The report concluded the following: "Capabilities for Space Situational Awareness and Space Control will require collaboration among several federal agencies. A national strategy with an oversight mechanism is needed to unify efforts, set priorities, establish roles and responsibilities, and adjudicate issues."
[12] Harry R. Yarger, *Strategic Theory for the 21st Century: The Little Book on Big Strategy*, (Carlisle, PA: Strategic Studies Institute, US Army War College, February 2006), 2.
[13] Notes, China, Space and Strategy Workshop III, Liu Institute, University of British Columbia, Vancouver, British Columbia, Canada, 4 September 2008. Workshop participants represented diverse views on the need to weaponize space. However, consensus among proponents and opponents exists that space assets are vital interests for all nations and must be protected. On page 2 of her book *Space as a Strategic Asset*, Joan Johnson-Freese, a distinguished opponent of space weapons, writes, "The militarization of space…has given the United States significant security advantages that must be protected in the future."
[14] Thomas P. M. Barnett, *The Pentagon's New Map: War and Peace in the Twenty-first Century*, (New York: Berkley Books, 2004), 1-8. In general, idealists optimistically subscribe to collective security with emphasis on strong international institutions. Believing the internal governance of a nation provides a good indicator of international behavior, some idealists such as Barnett espouse democratic peace theory. They posit great power war among democratic nations is unlikely given their preference for peace, prosperity and freedom. Conversely, future conflict and the conditions fostering conflict are likely to persist in the ungoverned, totalitarian, or unglobalized nations. From a space defense perspective, idealists would not consider near-peers nations as a key threat since the interdependence among globalized nations would deter major combat. Rogue nations within Barnett's "non-integrated gap" and non-state actors are the most likely threats to US space assets in an anti-access scenario or an asymmetric attack upon US economic interests.
[15] James Wood Forsyth, Jr. and Colonel Thomas E. Griffith, Jr., USAF "Through the Glass Darkly: The Unlikely Demise of Great-Power War." *Strategic Studies Quarterly*, Vol. 1, No. 1 (Fall 2007): 96-115. Realists adhere to the idea that nations will pursue their own best interests irrespective of the internal make-up of the other nations with whom they interact. Therefore, realists believe hard military power both deters aggression and is necessary to defeat attacks. Ultimately, one cannot rule out great power war if nations are compelled to protect their own interests--today's friends could be tomorrow's adversary. Thus, the full range of international actors presents threats to US space interests.
[16] Steven Lambakis, *On the Edge of Earth: The Future of American Space Power*, (Lexington, KY: The University Press of Kentucky, 2001), 45-46. Mr. Lambakis notes that historically a spacefaring nation was one possessing "a fairly robust launch infrastructure and indigenous capabilities to manufacture and operate space systems." Now, that definition should include "ownership and control over something functional in orbit, regardless of whether that something was boosted into space domestically." This opens the door to considering dozens of nations as "spacefaring." However, domestic launch infrastructure and indigenous manufacturing and operating capabilities translate more directly into the ability to impede another nation's freedom of action in space. Thus, this author will use spacefaring to indicate those nations (or future nations) with ability to credibly contest the space domain.
[17] Because non-spacefaring nations and non-state actors lack independent access to space, these two actors will be considered together. Short of third-party intervention, these actors are more likely to acquire and use ground-based RF or DE weapons to impair or damage space assets than employ kinetic capabilities to physically damage or destroy satellites.
[18] During the Cold War, competition in space between the superpowers emphasized national security and civil scientific research for national prestige over economic prosperity. As Mr Dean Cheng states, "It is important in setting the stage to recognize that the Chinese space program, while not necessarily *sui generis*, is by no means a mirror image of the American or Soviet programs. The apparent absence of early warning satellites, including missile launch and nuclear detonation satellites, suggests that it has somewhat different programmatic objectives than those of the two superpowers. Instead, where the U.S. and Soviet programs, especially in the very early days, were already aiming towards military intelligence objectives, along with issues of space science, Chinese writings have often emphasized instead the drive for prestige being a central factor and subsequently civil-military integration of the PRC's aerospace industries. The aim has generally been to contribute to what is termed "comprehensive national power" rather than to establish military capability per se. Nevertheless, the People's Liberation Army (PLA) is today showing steadily growing interest in space as reflected in their thinking about

future warfare." Larry Wortzel and Dean Cheng, *China's Military Ambitions in Space*, (Washington DC: George C. Marshall Institute, November 2006), 6. The participants at the Sep 08 China Space and Strategy III Workshop noted the blurring of civil, military and commercial space in Chinese society both organizationally and doctrinally. Unlike in the United States, organizational and policy boundaries separate American civil, military and commercial space programs, providing clearer insight into US intentions. The transparency between the superpowers during the Cold War provided a measure of stability and security for space assets which were key to deterring nuclear war.

[19] Michael Krepon (with Christopher Clary), *Space Assurance or Space Dominance? The Case Against Weaponizing Space* (Washington, D.C.: Henry L. Stimson Center, 2003), 33. With respect to militarization, Dr. Krepon states, "…over the course of the Cold War, space became an essential adjunct for war-fighting on the ground, without becoming another theater of combat." Militarization of space is generally regarded as the use of space information to support terrestrial warfighting. In this sense, militarization was achieved when the first satellites were orbited supporting military activities.

[20] Ambassador Donald A. Mahley, Acting Deputy Assistant Secretary for Threat Reduction, Export Controls (address, Space Policy Institute, Elliott School of International Affairs, The George Washington University, Washington DC, 24 January 2008), Department of State website, http://www.state.gov/t/isn/rm/2008/99746.htm. The Chinese experiment on 11 January 2007 destroyed an old weather satellite at an altitude of 850 km creating a massive debris field. According to Amb. Mahley, "To date, U.S. analyses indicate that China's intentional destruction of its satellite has generated over 2,600 pieces of trackable debris and an estimated 100,000 pieces of debris objects too small to track. This debris cloud will pose an increased risk to both human spaceflight and satellites for many decades, with some debris predicted to remain in orbit well into the Twenty-Second Century."

[21] Joan Johnson-Freese, *Space as a Strategic Asset*, (New York: Columbia University Press, 2007), 81. Dr Johnson-Freese advocates US manned space flight pursuits as an expression of space leadership and soft power in convincing would-be space aggressors to avert a course toward weapons in space.

[22] United States General Accounting Office, *DEFENSE ACQUISITIONS: Assessment of Select Weapon Programs*, GAO-08-467SP **(**Washington, DC: General Accounting Office, 2008), 2. Forty-four percent of the 95 major defense acquisition programs (MDAPs) reviewed by the GAO in 2008 had cost increases in excess of 25% with an average delay of 21 months in initial delivery of capability. The chart on page 2 of the report indicates a worsening trend in cost and schedule for DoD programs. Approximately 10% of the 95 programs reviewed by the GAO in the 2008 review were space portfolio programs. With DoD programs overrun by $295B in total, some space programs, such as Advanced Extremely High Frequency (AEHF) and TSAT, do not include replenishment spares nor provisions for a failed launch. The result is **either** risk avoidance through schedule delay and cost growth to extend contractor efforts in system design and development (SDD) phase **or** potentially catastrophic operational risk in the event of launch and orbital failures.

[23] Department of Defense, *Implementation Plan for Operationally Responsive Space*, 15 April 2008, 1.

[24] Size, weight, and power (SWaP) aspects are the key design drivers for space assets. Advances in technology routinely require greater trade-off decisions among SWaP considerations of the design. User requirements for high-capacity bandwidth, improved resolution, and accuracy tolerances typically exceed the reductions in SWaP offered by advanced technology. *Air Force Magazine* ("Gallery of USAF Weapons," *Air Force* Magazine, May 2008, 159-161) published specifications data for the following space systems: Milstar, AEHF, Defense Support Program (DSP), Space Based Infrared System (SBIRS) Geosynchronous (GEO), Defense Satellite Communications System (DSCS) Phase III, and WGS.

	First Year Launched	Weight (lbs)	Power Generation (watts)
Protected Communications			
Milstar	1994	10,000	8,000
AEHF	TBD	14,500 (launch wt)	Not Available
Wideband Communications			
DSCS III	1982	2,716	1,500
WGS	2007	13,000	9,934
Early Warning			
DSP	1970	~5,000	1,485
SBIRS GEO	TBD	5,442	2,435

Chapter 3

[25] Carl von Clausewitz, *On War*, trans. and translated by Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 98.
[26] Michael Krepon and Christopher Clay, *Space Assurance or Space Dominance? The Case Against Weaponizing Space*, (Washington DC: The Henry L. Stimson Center, 2003), 87. A noted space sanctuary theorist, Dr Krepon views space assurance for the purpose that "space will remain a reliable transmission belt for global commerce and a realm of exploration for the benefit of all humanity." Often criticized for leaning toward the high ground theory, the 2006 National Space Policy advocates for peaceful purposes in space consistent with the Outer Space Treaty of 1967.
[27] Notable theorists include: Dr. Michael Krepon, Dr. Joan Johnson-Freese, and Theresa Hitchens. This author personally met all three in the Fall of 2008 and discussed their views on confidence-building measures for bolstering space assurance. Likewise, interviews with US Government officials also expressed the need for rules of the road with near-peers such as China and Russia.
[28] The China, Space and Strategy III Workshop on 4 September 2008 provides an example of a mechanism to foster more frequent dialog toward cooperation in building mutual space assurance.
[29] Mr. Gary Payton (Deputy Undersecretary of the Air Force), interview by the author, 10 Oct 08. Mr Payton remarked that if China was as reliant on space as the United States, they might be hesitant to engage in activities that would harm the viability of the space environment.
[30] Ibid., cooperative efforts which increase Chinese reliance on space could simultaneously strengthen the health of the ailing US space defense industry. Implementing this approach would necessarily require State Department, Commerce Department, Office of Director of National Intelligence, and Congressional review of current export restrictions of space technology imposed by the International Traffic in Arms Regulations (ITAR) and the Cox Commission.
[31] Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Space, *Technical Report on Space Debris*, (New York: United Nations, 1999), 27. According to the UN Committee on the Peaceful Uses of Space (UNCOPUOS) Report, "the principal risk factors [of space debris] are the spatial density and average relative collisional velocity along the orbit (altitude and inclination) of the space object of interest, the cross-sectional area of the space object and the duration of the flight." Given the higher risk level inherent in larger and more persistent space debris likely resulting from ASAT tests, the United States should reach out to the UNCOPUOS to negotiate an agreement to prevent such harmful debris. One course of action could be an agreement to avoid activities in space which could cause debris smaller than "x" cm (a reasonable limit based on space tracking capabilities) persisting for greater than a specific time period before re-entering earth's atmosphere (such as "yyy" days). Note: the actual size of debris and time period must be modeled for appropriate values. Given US policy to eschew further constrictive space treaties, such an agreement would only indirectly restrict developmental and operational testing of anti-satellite weapons (and ballistic missile defense systems) without completely prohibiting them. As long as testing occurred in low earth orbit, no legal restrictions other than those in effect today would be imposed upon BMDS. For example, this type of agreement would have prohibited the Chinese ASAT test in Jan 07 due to the debris size and the persistence of the field. However, the US action to destroy a decaying satellite in May 08 would have been allowable despite the fact there would be debris pieces smaller than 5 cm because the debris field was not expected to persist for less than 6-8 weeks.
[32] The United States, through Congressional legislation and the state-sponsored terrorism list, would still restrict dual-use technology to the most dangerous nations. However, the economic loss facing US space industry (and its long-term health) may present a more compelling reason to engage in cooperative programs and technology sharing with nations like China. A robust US space industry is needed to maintain the next-generation, technological edge over near-peers.
[33] Robert A. Pape, *Bombing to Win: Air Power and Coercion in War*, (Ithaca, NY: Cornell University Press, 1996), 12. Deterrence seeks to maintain a status quo; in this case, to maintain peaceful use of space by avoiding an attack on a space asset. As long as costs outweigh benefits, there's no rational reason to proceed with an attack. Most importantly, the adversary must know with certainty the costs to be imposed by the action contemplated. In a very clear manner, the space defense strategy must simultaneously articulate the United States' response an adversary can anticipate and the denial of benefit through engagement of defensive capabilities.
[34] Two interviewees (Mr. Gary Payton and Colonel Tom Cristler) with this author advocated the need to develop custody-based SSA. As described, space track custody would parallel air track custody performed by the Federal

Aviation Agency. From the moment an airplane leaves the departure gate until the moment it arrives at its destination gate, a traffic controller maintains track custody for that airplane. The track is handed off countless times on its journey. Similarly, senior AF leaders advocate the need for space track custody from the moment a space object is detected in powered flight, enters space, attains its initial parking orbit, and attains a final mission orbit. It's through track custody that some recommend SSA improve to discern potential sleeper co-orbital ASATs and support tracking and targeting direct ascent ASATs.

Chapter 4

[35] President Ronald W. Reagan, "Star Wars Speech" (Address to the Nation on Defense and National Security, 23 March 1983).
[36] The author uses "relatively minor instance of purposeful interference" to characterize the first 50 years. Jamming and lasing events have occurred, but not on a scale which one could expect in a confrontation between major space powers armed with anti-satellite weapons.
[37] Potentially, nations volunteering to participate in the Global Space Defense Initiative could equip their space assets (satellites and expended rocket bodies) with GPS-enabled, secure, beacons to self-report their exact orbital positions into the space catalog. Once again the goal is to minimize the number of objects requiring non-cooperative space tracking by the space surveillance network.
[38] Michael W. Zehner (Deputy General Counsel for International Affairs, Department of the Air Force), "Legal Considerations for DoD Activities in Outer Space" (lecture, Air War College, Maxwell AFB, AL, 26 August 2008). As Mr. Zehner presented, "The Registration Convention applies to all satellites and requires UN notification 'as soon as practicable' after launch with the following data: date and location of launch, basic orbital parameters, and general function of orbit."
[39] National Aeronautics and Space Administration (NASA), "Technology Readiness Levels," http://ranier.hq.nasa.gov/Sensors_page/Background/TechLevels.html . The DoD system acquisition process incorporated the NASA Technology Readiness Levels (TRLs) into technology readiness assessments for major program milestone reviews. In order to enter a program into the formal SDD phase, all critical technologies must be assessed as TRL 6 as defined below. Flying a prototype integrated space defense system on a tactical satellite for testing purposes would constitute TRL 7 and demonstrate readiness to proceed with applications for future operational satellites.

Technology Readiness Levels
Basic Technology Research:
Level 1: Basic principles observed and reported
Research to Prove Feasibility:
Level 2: Technology concept and/or application formulated
Level 3: Analytical and experimental critical function and/or characteristic proof of concept
Technology Development:
Level 4: Component and/or breadboard validation in laboratory environment
Technology Demonstration:
Level 5: Component and/or breadboard validation in relevant environment
Level 6: System/subsystem model or prototype demonstration in a relevant environment (ground or space)
System/Subsystem Development:
Level 7: System prototype demonstration in a space environment
System Test, Launch and Operations:
Level 8: Actual system completed and "flight qualified" through test and demonstration (ground or space)
Level 9: Actual system "flight proven" through successful mission operations

[40] TRL 6 is accomplished with ground testing and establishes readiness to proceed with the SDD phase.
[41] The Ballistic Missile Early Warning System (BMEWS), PAVE Phased Array Warning System (PAVE PAWS), and Eglin phased array radar were developed with 1970s technology and became operational in the early 1980s. The systems provide early warning Ultrahigh Frequency (UHF) radar coverage to detect intercontinental ballistic missiles (ICBMs) and submarine-launched ballistic missiles (SLBMs) providing the President and Defense Secretary ample time to consider their response. As a collateral mission, both systems track low earth orbiting objects and provide their data to the space catalog. While both systems have undergone service life extension

programs (SLEP) and addition of X-band capability supporting the ballistic missile defense system (the key element of the Upgraded Early Warning Radar (UEWR) program), the UHF radar transceivers have not been upgraded since original installation. Upgraded electronics would expand the surveillance beam coverage and range by vastly reducing losses leading to enhanced acquisition, tracking and characterization of space objects beyond the ability of back-end signal processing upgrades only.

[42] Steven M. Kosiak, *Arming the Heavens: A Preliminary Assessment of the Potential Cost and Cost-Effectiveness of Space-Based Weapons*, (Washington DC: Center for Strategic and Budgetary Assessments, 2007), 97. Mr. Kosiak describes use of deception, specifically decoys, as a means to counter potential ASAT weapons. Dispensing decoys would impede homing for ASATs.

[43] Mr. Douglas Loverro (Executive Director, Space and Missile Systems Center), interview by author, 7 October 2008. During the interview, Mr. Loverro suggested examples of technologies critical to defending space interests. One such technology is propellant-less maneuverability for satellites. Currently satellite mean mission duration is paced by the amount of on-board fuel available for station-keeping. Using fuel for evasive maneuvers would reduce satellite life for mission operations. Propellant-less maneuvers would preserve satellite life and provide uncertainty for would-be aggressors seeking to damage or destroy a targeted satellite. While DARPA continues to explore and demonstrate low propellant thrusters, the USG should encourage feasibility studies and lab demonstrations of propellant-less engines, which would have military as well as civil and commercial uses.

[44] Operation Burnt Frost in March 08 involved firing a Navy Standard Missile 3 (SM-3) from the USS Lake Erie (Aegis ship) to destroy a re-entering satellite and prevented the spread of potentially hazardous fuel. The shoot down employed MDA and Air Force Space Command assets in unconventional manners but demonstrates an inherent capability for ground-based space defense.

[45] Some have suggested the use of space mines to thwart potential co-orbital ASAT attacks. The debris left from such a counter-attack would be as harmful to other orbiting satellites as the ASAT attack debris. This author suggests the development of a tactical satellite (TacSat) for inspection purposes, but also capable of incapacitating the suspected ASAT's command and control antenna. Such a counter strategy would render the space vehicle un-controllable for attack without creating harmful debris.

[46] While the Obama Administration will be in place prior to submission of the FY2010 President's Budget in February 2009, it's highly unlikely any major decisions regarding space policy will be high enough priority to warrant changes to the budget. Major budget changes are unusual in odd years. However, the FY2011 budget will probably be an exception with that budget being the first developed completely by the new Administration.

[47] JCIDS is the process by which the Chairman of the Joint Chiefs of Staff and the Secretary of Defense review warfighting requirements guiding the systems acquisition process. At various stages of development, major defense acquisition programs (MDAPs) undergo reviews chaired by the Undersecretary of Defense for Acquisition, Technology and Logistics (USD/AT&L) called Defense Acquisition Boards (or Defense Space Acquisition Boards for space MDAPs).

[48] General James G. Stavridis, "Strategic Communication and National Security," *Joint Forces Quarterly*, Issue 46, 3d Quarter, 2007. Gen Stavridis, CDRUSSOUTHCOM, states these three principles as guidelines for effective strategic communications.

Chapter 5

[49] Attributed to Flavius Vegetius Renatus, a military strategist circa 390 AD, the translation is, "If you want peace, prepare for war."

[50] Reuters, "Global Space Spending up 11 Percent to $251 Billion," *Reuters News*, 8 April 2008, http://www.reuters.com/article/domesticNews/idUSN0836688320080408 (Colorado Springs, CO).

[51] Air Combat Command, "*Terms of Reference for A Day Without Space: Essential Operations with Loss of Space Services*," 9 May 2008. The ACC Chief Scientist (ACC/ST) and ACC/A5 conducted the "Day Without Space" (DWOS) study to consider the effects on warfighting if space capabilities were not available. More specifically, the Terms of Reference (TOR) states, "The purpose of the study is to assess the impact of loss of a range of space services utilized by CAF forces during operations, and the recommended approaches to 'fight through' that loss." The study commenced in March 2008 and concluded in December 2008 with final results and recommendations provided to COMACC and AFSPC/CC. The ACC study correctly addresses all elements of space systems: satellites, links, and terrestrial equipment. The loss of any aspect of a space system results in loss of services. While this author has little insight into the options considered and final study results, the DWOS TOR focuses on mitigating the effects of a space attack (and natural causes for outages). This paper limited its strategy

recommendations for defense of the space-based portion of space systems against attack. Improved situational awareness, hardening, and rapid reconstitution are examples of capabilities to detect, resolve or restore space services resulting from natural phenomenon and system failures as well.