Space-to-Earth Weapons
The Case for U.S. Deployment

By Garrett M. Mills

Submitted to
Professor John Calabrese
Foreign Policy II

American University Washington Semester
Spring 2005

Is orbital space likely to become the next battlefield? If so, what, if anything, should the United States do to prepare for this eventuality? This paper examines whether the United States should start down this path. The paper starts from the premise that the deployment of space-to-earth weapons is feasible and, though not achievable any time in the near future, could conceivably occur within the next 50 years. The paper shows that, in order to be able to launch its own space-to-earth weapons within that time frame, the United States would have to begin now to take active measures toward achieving that capability. In determining whether it is prudent to embark on this effort, the paper considers both the strategic implications of the weapons for the US, good and ill, and the political ramifications of their pursuit and deployment. The principal finding of this research is that it is indeed in the United States' best interest to pursue such weapons, despite their marginal adverse political consequences and expense of development, for the strategic benefits they will impart with little or no cost to overall US strategic position.

Table of Contents

Introduction

The ventures of mankind into space began with military concerns. The first man-made object ever sent into space was a 120-kilogram shell fired from the German "Paris Gun" to an altitude of 40 kilometers during World War I. The next time that this barrier was touched was again by the Germans in World War II with their rocket-powered V-2 weapons. These ballistic missiles, used by the Third Reich in a last-ditch attempt to try to break the resolve of the Allies, could reach an altitude of 85 km, practically escaping the atmosphere of Earth entirely. It was these weapons that captured the imaginations of the Allied powers following V-E day. At the end of the war the USSR captured the plans and prototypes that the Germans had failed to destroy and the United States took in all of the great minds that had been behind Germany's rocketry experiments. These men, headed by Wernher Von Braun, led the US into the space age and gave it the edge in the space race with the USSR.

From 1957 to 1969, the US and USSR were locked into a competition that would come to be known as the "Space Race," starting with the Russian launch of Sputnik and the civilian phase effectively ending with the American landing of *Apollo 11*'s *Eagle* on the Moon's Sea of Tranquility. In the course of and following this race, both nations experienced an equally dramatic increase in military space technology as they did in civilian applications. While the United States developed Earth surveillance satellites and the Strategic Defense Initiative ICMB-interception technology the Soviet Union pursued anti-satellites and methods of deploying nuclear weapons from space.

With the development of both civilian and military space technologies, the two superpowers often came to the negotiating table to supplement their security through treaty agreements to restrict certain military actions in space. Each had certain strength above the Earth, but at the same time, many possibilities became far too dangerous and expensive to both to be allowed continued legality. Thus, in many ways, the saving terror of "mutually assured destruction" was preserved by international and bilateral agreements involving the two nations.

However, the Soviet Union and the threat it posed to the United States have disappeared, leaving the US with significant military advantages and a both in the conventional sense and in space. Though Russia and its allies had significantly more satellites in orbit as of 2003, the United States has been pulling ahead in terms of number of satellite launches per year. Thus, the space

assets of Russia are becoming increasingly antiquated in comparison to those of the US and in time, provided the current trend continues, the US will have far superior numbers as well.[1]

Combined with this increasing advantage has been the more than decade-long initiative on the part of the US to integrate US space assets more smoothly into the operations of conventional forces. At this time, the US military is the heaviest user of space assets, allowing for superior communication between units and theaters, to gather intelligence on actual and potential enemy forces, and to help guide "smart" munitions. To accomplish this, it uses both government- and civilian-owned satellite constellations to transmit what are phenomenal amounts of data during campaigns. The advantage of superiority of space assets was first put to significant field use in the first Gulf War.[2]

The development of this advantage and the adjustments that it has caused in US military doctrine has simultaneously brought about the development of a dependency, and thus, a potentially crippling vulnerability. If US space assets supporting the military were to be reduced or eliminated by chance, accident, or intent, the US ability to stage a military campaign would be all but crippled. It was in many ways concern over this weakness that the US government ordered the forming of the Commission to Assess United States National Security Space Management and Organization to look into how the US should approach space control and how it might prevent or deal with a "space Pearl Harbor."[3]

This concern over space vulnerability has increased simultaneously with the increased space capabilities of other powers considered possibly rivals to the US, not the least of which being the People's Republic of China (PRC). China has been launching satellites into space since 1970 and in 2003 launched its first successful manned space mission. In the future, there is little doubt that more will join the ranks of space-capable and space-faring nations, a security and military reality that the US will need to adjust to sooner rather than later.

---

[1] O'Hanlon, Michael E. 2004. 35.

[2] Coalition forces coordinated movements over satellite communications and use of the new Global Positioning System and staged precision strikes on Iraqi military installations, anti-aircraft systems, and other priority or sensitive targets through the use of satellite-guided bombs called JDAMs. The extent of the success that Coalition forces accomplished is a perfect testament to the success that the US military has had in integrating space assets into its joint operations.

[3] Commission to Assess United States National Security Space Management and Organization. 11 January 2001. 25. A phrase as often cited in discussions of US space policy as "Axis of Evil" is in discussions of US foreign policy.

The security of current US space assets is not the primary interest of this inquiry, however, though it is a concern. What follows is an overview of United States outer space policy relevant to military issues and US military space capabilities and interests; a proposal for a new type of earth-bombarding space weapon; and an analysis of the prudence of its use, the strategic military costs and benefits attached to it, and its political ramifications.

Such an inquiry is one that has been largely dismissed through to the present time. The concept of a weapon capable of striking targets on Earth from space is something usually relegated to the fancies of science fiction. However, the advance of technology demands that the possibilities of space-to-earth weapons (STEW) be seriously considered.[4]

It goes largely without saying at this point in time that in terms of tactical and strategic strike capabilities the United States military is second to none. US bombers can strike nearly anywhere on the globe from their airfields in the US an in international bases given enough time. The US also has aircraft carrier groups stationed worldwide with their Navy Air Corp contingents able to stage fighter/bomber strikes or launch on-board tomahawk cruise missiles. With the advances in technology, the next generation of US ships of the line will in all likelihood be able to mount precision bombardment on land targets with their deck guns far beyond what current munitions are able to manage.[5] Clearly the strike capabilities of the current US military are significant and diverse. That said, it must also be kept in mind that each of these methods requires proximity of launching points of the weapons-delivery unit to the target. Bombers can take a great deal of time to reach something on the opposite side of the globe from the US. The Navy, though widely deployed is a finite force limited by the range of its weapons in staging a strike on inland targets. Thus, there is a definite niche without anything to fill the place in current US strike capabilities: a weapon that can stage a rapid precision strike anywhere on the globe. STEW and the hypothetical system proposed here present one technology that could fill this gap in US strike capabilities.

---

[4] What is a STEW? The definition of "weapon" in the negotiation and interpretation of arms treaties regarding space has historically been a particularly difficult issue (see Lambakis. 2001. 65-6). For the purposes of this paper, a space weapon will be a device designed to be stationed in orbit and inflict damage and destruction upon targets—in this case, targets on Earth. One distinction worth emphasizing here is that of the weapon being stationed to Earth. There is one proposed weapons program in the US involving a vehicle that would be launch to do a fractional orbit before re-entering the atmosphere and delivering its payload. This is only in the weakest senses a space weapon and will thus fall outside the scope of this inquiry.

[5] Adams, David Allan. *Naval Rail Guns are Revolutionary*. 2003.

There is also another need arising in US strike capabilities that the system proposed here would be very successful in filling. An increasing number of countries are concealing and protecting strategic assets in hardened underground facilities. Given the reality of increased prolifieration of nuclear weapons and other WMD in recent years, it is becoming more necessary for the US to have the ability to strike and destroy such underground facilities and their contents on short notice and in remote parts of the world. STEW present one option for providing "bunker busting" power anywhere in the world on short notice. The next alternative for the US would quite possibly require the use of tactical-scale nuclear weapons with all of their implications and subject to the same restrictions of usability as the other conventional weapons systems described above.

Clearly then it behooves the United States military and policy community to consider the development, deployment, and conditions of use for STEW. This analysis seeks to be a primer for just that inquiry—to consider whether or not STEW would be a wise addition to the US arsenal. The core of this analysis will reflect on the political and strategic questions surrounding the development and deployment of STEW and will ultimately show that the United States should pursue STEW with all due haste.

I

The History and Potential of US Spaceborne Weapons Systems

The ink of the surrender documents on board the USS Missouri was hardly dry by the time the United States was looking to expand into space. The interest of the US in outer space was first displayed in a document produced in 1946 by the RAND Corporation entitled *Preliminary Design of an Experimental World Circling Spaceship*. This document sponsored by the Army Air Force has earned great fame as a first for the US on the issue of space, but since the Army followed this inquiry with little action, the Navy is more properly the pioneer for US space exploration.[6] The Navy's Bureau of Aeronautics had taken immediate interest in the German V-2 program and was the first, in 1945, to propose a satellite program for the US. However, the Army Air Force quickly realized with the release of this proposal that its territory was being threatened and moved to compete with the Navy over control of US space operations. The Army justified its entry into the competition on a premise that has influenced space strategic thinking ever since: that as a medium of conflict space is an extension of the air.[7]

I. 20th Century Space Policy

The Eisenhower Years 1953-61). The next critical step to US activity in space was the its 1955 announcement of its intention to launch an artificial satellite to participate in the International Geophysical Year activities. Such was the start of the Eisenhower presidency in space policy. The second was the NSC paper 5520, "U.S. Scientific Satellite Programs," which made a statement that steers U.S. space policy to this day (though with some debate). This pivotal document made the claim that "U.S. scientific programs should be conducted so as to preserve U.S. freedom of action in space" and also "that no actions should be taken in space research that would require the prior consent of other nations for U.S. space activities."[8] However, as any account of the space race will tell you, though the U.S. was moving along in the Vanguard program, significant action by the U.S. in space did not become a priority issue until the Russian satellite *Sputnik I* beeped over American

[6] Stares, Paul B. 1985. 24-5.
[7] Ibid. 25-6.
[8] Lambakis, Steven. 2001. 213.

skies on 4 October 1957. This achievement by the Soviets put to shame America's Vanguard project that was yet uncompleted. On 31 January 1958, after putting the space program in the sole control of the Army Air force late in the previous year, the U.S. responded to the launching of *Sputnik I & II* with the placing of *Explorer I* in orbit.

In these early days of the U.S. space program, Eisenhower did his best to frame it as an entirely peaceful venture (taking shape in NSC 5814/1: "Preliminary U.S. Policy in Outer Space") and simultaneously was trying to get the Soviets to come to an agreement that outer space be used for peaceful purposes only.[9] However, this overture was rebuffed, and the two nations continued to keep open the possibility of developing space weapons. In addition, bending to public pressure, Eisenhower reinforced his policy goal to have peaceful space by establishing a separate civilian space agency through the National Aeronautics and Space Act of 1958, which declared that "activities in space should be devoted to peaceful purposes for the benefit of mankind."[10]

Space policy was likely not an idealistic crusade on the part of Eisenhower, though. Starting in 1960, the National Reconnaissance Office worked alongside the CIA to develop spy satellites, an idea that originated in 1958.[11] This reveals a two important turns in the space policy that Eisenhower sought to create. First, when he pushed for a peaceful space, he was not necessarily looking to make it an entirely demilitarized zone—only de-weaponized. The second point stems from the first, namely, that if he could establish space as a weaponless realm where each nation had the right to free peaceful passage, U.S. spy satellites could operate without fear of harm from the U.S.S.R. or any other nation that might come into its own in space in the years to come.[12] This idea was presented quite clearly in NSC 5814/1, which stated that the U.S. should "seek urgently a political framework which will place the uses of U.S. reconnaissance satellites in a political and psychological context most favorable to the United States."[13] In general, this was the direction that he took—to use space to enhance the information gathering and processing capabilities of the U.S. beyond that of any competition—even as numerous space weapons concepts were being developed and proposed.[14] Though the military was permitted to continue inquiring into possible space

[9] Lambakis, Steven. 2001. 214.
[10] Ibid. 217.
[11] Stares, Paul B. 1985. 44.
[12] Lambakis, Steven. 2001. 214-5.
[13] Stares, Paul B. 1985. 55.
[14] Lambakis, Steven. 2001. 219.

weapons systems, they were not allowed to conduct anything more than basic investigations into concept weapons.[15]

From Camelot to Tranquility (1961-74). Shortly before he took office, President Kennedy stated: "If the Soviets control space, they can control Earth, as in past centuries the nation that controlled the seas dominated the continents." This statement set the stage for what would be one of the greatest space initiatives in history. However, as with Eisenhower, Kennedy's statement should not be construed as a call for space weaponization. After about two years in office he said this:

> I do not say that we should or will go unprotected against the hostile misuse of space any more than we go unprotected against the hostile use of land or sea, but I do say that space can be explored and mastered without feeding the fires of war, without repeating the mistakes that man has made in extending his writ around this globe of ours.

Here JFK reaffirms the U.S. policy of uncompromised sovereignty over its possessions that was established under Eisenhower. It was also in Kennedy's administration that the U.S. was first threatened from space when in 1961 Khrushchev first warned the U.S. of the possibility of being attacked with orbital nuclear bombs.[16] While this threat did not push the administration to assemble its own space-based weapons, it did prompt the development of means to do so if needed (such as developing the necessary weapons technology and boosters) and to start the first anti-satellite missiles program under the code name MUDFLAP which would use a Nike Zeus missile system, a concept that was first proposed during the Eisenhower era.[17]

Over time, the pressure of the threat of nuclear weapons in space moved the United States to take two paths of diplomatic action. The first was the start of a trend: In September 1962 the administration started to seek a ban on nuclear weapons being stationed or detonated in space, though Kennedy would not live to see such an agreement made. The second was the claim that it was beneficial for security for there to be no weapons in space.[18] Then Deputy Secretary of Defense Roswell Gilpatrick stated:

> I can think of no greater stimulus for a Soviet thermonuclear arms effort in space than a United States commitment to such a program. This we will not do … We will of course take

[15] Stares, Paul B. 1985. 49.
[16] Ibid. 74-5.
[17] Ibid. 1985. 76-7.
[18] Lambakis, Steven. 2001. 222.
Stares, Paul B. 1985. 85-6.

> such steps as necessary to defend ourselves and our allies, if the Soviet Union forces us to do so.[19]

As will be discussed later, this statement encapsulates a school of thought—perhaps one of the more powerful ones—on space weaponization today. It was this philosophy of free and safe passage in exchange for non-weaponization that had largely steered the Eisenhower and it was the mantra of the Kennedy administration throughout.

While the U.S. space policy remained relatively consistent with past precedent, the Johnson administration presided over an impressive step in outer space policy in the form of the "1967 Outer Space Treaty." This treaty fulfilled a hope that was started in the previous administration, the banning of nuclear weapons in outer space—a matter that had become a special concern with the Soviet development of the Fractional Orbital Bombardment System (FOBS). This threat also drove Johnson to announce publicly that the U.S. was and had been pursuing an anti-satellite missile system following from MUDFLAP.[20]

The 1967 Outer Space Treaty (OST)—bearing the official title *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*—followed in the tradition of the earlier and successful Antarctic Treaty which established said continent as an international territory. The OST sought to do the same for celestial bodies, essentially applying the rules of the sea to space. More important for this investigation is Article IV, the section of the treaty addressing arms control, which stipulates:

> State Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner. The Moon and other celestial bodies shall be used by all State Parties to the Treaty exclusively for peaceful purposes.[21]

The treaty did not, however, ban military units from operating in space or on celestial bodies for "peaceful purposes." The OST made one other key tacit exception: while weapons of any kind were banned on celestial objects, only weapons of mass destruction were otherwise banned, leaving space and the orbits of the earth open for any other type of weaponry. This loophole has yet to be filled.

During the Nixon Administration the United States witnessed its greatest triumph in space, landing men on the Moon. In terms of space military possibility, despite Nixon's relative disinterest

---

[19] Stares, Paul B. 1985. 85.
[20] Lambakis, Steven. 2001. 223-4.
Stares, Paul B. 1985. 92-4.
[21] U.S. Department of State. 27 January 1967.

in the question of space, his administration can be credited with two major pieces of international policy that had impact on the military status of space, the ABM Treaty and the Strategic Arms Limitation Talks (SALT). The ABM Treaty ruled out the option for the U.S. and other signatories to deploy or otherwise develop a space-based anti-ballistic missile systems or components of any variety (see also "Agreed Statement D").[22] This measure, though it did limit weapons in space, did not explicitly ban any weapons system from space, it only banned a certain function. This restriction would however become moot with the withdrawal of the U.S. from the treaty in 2001 during the first term of the administration of George W. Bush. SALT also placed limitations on interference with the peaceful operation of reconnaissance satellites, further reinforcing the initiative that Eisenhower had started.[23]

A New Medium Considered (1974-81. In issues impacting STEW, the Ford Administration did not do anything of great import. It did, however, take significant action in the field of ASATs, eliminating nuclear missile based ASAT systems and instead turning to an ASAT missile that could be deployed from an F-15.[24]

Jimmy Carter's primary focus was on the question of ASATs, though whether his administration actually made any headway in coming to an international consensus on the matter is debatable. A working group was formed to decide how best to word a restriction on ASATs, but ran into problems with systems that, while not originally intended as ASATs, could serve that function if wanted. In the end, the Joint Chiefs resisted the idea of an outright ban and Soviet actions in Afghanistan called to a halt the talks with nothing done.[25] In addition, Carter also issued the first public announcement by the U.S. that it was engaged in a photoreconnaissance satellite program and was determined to continue to use it to keep U.S. intelligence dominant. Most important perhaps was Carter's issuing of Presidential Directive (PD) 37. PD-37 proposed that space was not simply a means to enhance forces on Earth, but had the potential to be a combat medium in itself.[26]

SDI Then and Now (1981-Present). The Reagan Administration is nothing if not famous for its hand in space weapons concepts tied to the Strategic Defense Initiative, otherwise known as "Star

[22] U.S. Department of State. 26 May 1972.
[23] Lambakis, Steven. 2001. 224.
[24] Ibid. 225.
[25] Stares, Paul B. 1985. 194-9.
Lambakis, Steven. 2001. 226-7.
[26] Lambakis, Steven. 2001. 226-7.

Wars." Reagan followed the precedent set by Carter's PD-37 by issuing National Security Decision Directive (NSDD) 42 by pushing the DoD to ready the United States for the possibility of engagement in space warfare by stressing system durability and continuing the development of space surveillance and ASAT systems. In addition, Reagan widened the interpretation of the "peaceful purposes" phrase in the OST to allow for all actions that were not actively aggressive.[27]

The Bush 41 White House expanded only slightly on the Reagan military space policy. His administration continued to support ASAT development and also stressed that the U.S. should continue to pursue the ability to insure its access and free use of space. In addition, emphasis was placed on the ability of space to be a means for applying force.[28]

Though weapons in space and related concerns received little attention from the Clinton White House, space observation and navigation systems experienced a boom. It was under Clinton that the Global Positioning System was completed.[29] These advances were certainly worthwhile with respect to STEW (even though they are non-weapons), for they provide the technology and perhaps even the infrastructure for STEW to be targeted.

In addition, the United States Space Command issued its critical document, *Vision for 2020*, in 1997. This document formulated the modern view of the possibilities of space warfare. The *Vision* claims what Carter first anticipated: "Just as land dominance, sea control, and air superiority have become critical elements of current military strategy, space superiority is emerging as an essential element of battlefield success and future warfare."[30] Further, the *Vision* promotes the principle of "global engagement" for space operations: "the application of precision force from, to, and through space … Global engagement combines global surveillance with the potential for a space-based global precision strike capability."[31] U.S. Space Command could be aiming for nothing less than the STEW, which are the center of this discussion.

Finally, one of the most critical documents to date in the debate on space weaponization to date was released in the final days of the Clinton Administration early in 2001. This document is the *Report of the Commission to Assess United States National Security Space Management and Organization* (the Report). The Report is largely an expansion of Space Command's *Vision for 2020*, citing space as a

[27] Lambakis, Steven. 2001. 227.
[28] Ibid. 231.
[29] Ibid. 231-2.
[30] U.S. Space Command. 1997.
[31] Ibid. 1997.

new medium for combat and a space to be used to enhance U.S. forces on the ground and again advocating "power projection in, from and through space."[32]

During the presidency of Bush 43 there has been great renewal of interest and activity surrounding the question of space weapons. There is some reason to believe that this is a combination of technology becoming available that makes such weapons practical and the presence of an administration and military that is more receptive to the possibilities of space weapons and even STEW, though they will not say so outright. At the same time, there has been great resistance to the idea from the other side of the debate believing that for one reason or another the U.S. and perhaps the world would be better off without weapons in space. These different schools of thought shall be discussed in the following chapter.

When asked about the President's stance on "space-based offensive weapons" in 2001, Press Secretary Ari Fleischer answered vaguely, but still clearly enough:

> The President has asked the Department of Defense to take a look at its defense needs. And Secretary Rumsfeld is reviewing the overall military strategy to help preserve the peace. And this week, as you know, the Secretary made a personnel management decision to create a four-star general to oversee space programs. And that's the President's view.[33]

Though it is an evasive enough answer to give the Administration room to dodge the bad feelings that surround space weapons, the fact of his investigation into the matter and the reorganization of space programs under the military clearly indicates that Bush 43 is interested in the prospects of offensive space weapons. It is also likely that the Bush Administration has taken the suggestions of the Space Commission to heart and will continue to look into and develop concepts for space weapons systems.

There has been both domestic and international disapproval of space weapons during Bush's term in office. In 2002, Congressman Dennis Kucinich presented the "Space Preservation Act of 2002" to the House of Representatives, seeking to "preserve the cooperative, peaceful uses of space for the benefit of all humankind by prohibiting the basing of weapons in space and the use of weapons to destroy or damage objects in space that are in orbit, and for other purposes."[34] While the actions that the United Nations has taken on the matter in recent times have not had the force of law, the UN has made its stance on the matter clear. For some time the General Assembly has

---

[32] Commission to Assess United States National Security Space Management and Organization. January 2001. 33.
[33] U.S. Office of the Press Secretary. 9 May 2001.
[34] Kucinich, Dennis. 23 January 2002.

passed Resolutions titled "Prevention of an Arms Race in Outer Space" on an annual basis with increasing unanimity. The U.S. has consistently abstained from the vote, as has Israel and a varying collection of others. It can be certain that if the U.S. under any administration should pursue space-based weapons, it would meet resistance from within and without.

II. The Technology of Space-to-Earth Weapons

Before the legal, political, and strategic aspects of the weaponization can be brought into discussion, the matter of whether or not STEW are even *practical* must first be considered. If they are not a practical concept, there is little point in carrying on any further on the subject. That they are something for consideration is something amazing in itself. They have been imagined for some time in films, books, and games dealing with the future or alternate universes. Now perhaps—as is so often said when new technologies are coming over the horizon—fiction is becoming fact. Technology is becoming available that can allow for fortresses in space capable of staging tactical strikes on Earth from orbit while perhaps even maintaining the ability to mount active defenses.

This is not to say that STEW are a certainty in the near future—there are a lot of hurdles to be cleared before it is a viable weapons system concept. However, there is enough evidence to believe that such a system might be feasible and possibly even cost effective. At this time, it appears that such a weapon would not be the "death ray" so often depicted in popular science fiction, but rather a bombardment system based around a kinetic energy weapon—an electromagnetic (EM) gun—more commonly know as a "rail gun." What follows is a brief review of the state of the art of relevant technologies involved in such a space weapon. No doubt, the matter is a difficult engineering concern, and there is little chance that this essay will have a chance of covering the full complexity of the problem.

Directed Energy Weapons. Why not a "death ray" though? *Prima facie*, the concept of a laser [often termed a "directed Energy Weapon" (DEW) in engineering circles] makes a great deal of sense in comparison to a kinetic energy weapon—the attack would be virtually instantaneous and would not require any ammunition in the conventional sense. It has been for this reason that this weapon concept has been of such great interest to those trying to develop an anti-ballistic missile system. In fact, it has been this interest that has brought laser technology to where it is today. Unfortunately for defense planners and engineers (as well as the author) things are not as simple as building the miracle weapon, which is why the bulk of U.S. laser technology prototypes continues to

populate the White Sands Missile Range in New Mexico instead of the battlefield. The capability of instantaneous attack is of course present in DEW, but an effectively unlimited supply of ammunition is not available for all of them. There is also a plethora of other technicalities that vary in the two systems that will be covered that range from the effects of the atmosphere on a laser beam, cooling considerations, and effective range among others.

Chemical Lasers. Until recently, chemical lasers have been the most promising candidates for laser weaponry. Development of chemical lasers began in the 1970s and the first megawatt-class (potential combat capability) chemical laser to lase was the MIRACL (Mid-Infrared Advanced Chemical Laser) in 1980. Since its completion, the MIRACL has since been adapted from a test piece to an actual combat system through a joint U.S.-Israeli program: the Tactical High-Energy Laser (THEL) and the Mobile Tactical High-Energy Laser (MTHEL). The purpose of this program was to develop a point-defense system that could defeat mortars, rockets, artillery, and cruise missiles with the idea of neutralizing Palestinian terrorist attacks among others. The THEL/MTHEL has in fact proven its ability in successfully shooting down a significant number of rockets singly and in salvos in tests at White Sands in 2000 and 2001.[35]

This ability does have its shortfalls, however. The first initially sounds like good news to defense personnel: The laser is fuelled by common chemicals that come in a relatively compact package and at a cost of about $5,000 per shot with each magazine holding 20 shots worth of chemicals. However, this means that the chemical laser needs an ammunition supply. Also, at this point, the package is not terribly compact, with the entire MTHEL system being deployed from three large trucks.[36]

Solid-State Lasers. Where progress in the field of chemical lasers has essentially ground to a halt, the field of diode-pumped solid-state lasers (SSL) has been burgeoning.[37] Not only are SSLs advancing at a rapid pace in comparison to the chemical laser, their weapons potential is also far greater. Their first and perhaps primary advantage is that they have no ammunition per se. Where chemical lasers require their chemicals to provide their radiation, SSLs need only electricity. This

[35] Mowthorpe, Matthew. 8 March 2002.
Northrop Grumman Space Technology. *Directed Energy Weapons Fact Sheet.*
[36] Northrop Grumman Space and Missions Corporation. September 2004.
Northrop Grumman Space Technology. *Directed Energy Weapons Fact Sheet.*
[37] Hecht, Jeff. January 2003. 42.

fixes the cost of the laser system and also makes it more compact overall, making it a far more attractive system in the long run with regard to expense and logistical cost.[38]

The current weapon concept being tested at White Sands is the solid-state heat-capacity laser (SSHCL). In recent tests this laser "burned a 1-centimeter-diameter hole straight through a 2-centimeter thick stack of steel samples in 6 seconds" and it did so with power from a standard wall socket and at the cost of 30 cents.[39] The system is the first to appear to have the capability to be a fully mobile battlefield system—small enough (2x1 m) to be mounted on board a Humvee. At this time, the most powerful version of the SSHCL requires a power feed or 1 megawatt to create a 13-watt beam firing up to 10-second bursts. The goal for the project is to create a laser that has an output of up to 100 kilowatts on the same 1 megawatt of input while keeping it in a small package. Indicators are good as the team has already produced a 41 kW diode array and the 100 kW is in the works and all of the other components are coming along equally as well.[40] Even better, the mobile 100 kW variant is projected to be available by 2007.[41]

The greatest difficulty with the SSL at this point is making the beam effective at range. Currently the beam is neither very accurate nor able to maintain coherency over significant distances.[42] In parallel with the production of the more powerful models of the SSHCL, an adaptive optics system is being designed that is likely to allow the beam to be effective at a range of 10 kilometers.[43] Thus, overall, the SSHCL and SSLs in general appear to be very promising concepts in future weapons systems with definite applications in space-based systems.

A final note of encouragement on laser technology comes from a team of personnel, military and civilian, associated with laser research; they claim that laser technology is about to experience a boom, claiming that the combination of the past progress of laser technology and the application of Moore's Law (which states that technological capabilities advance exponentially) leaves us on the "elbow" of the graph of progress in the field. They claim that if interest persists, the theorized exponential growth of the technology will start to pay significant dividends.[44]

EM "Rail Guns". This weapons system, currently being researched by various divisions of the U.S. Armed Forces is probably going to be the heart of any STEW that might be developed in

[38] Lamberson, Donald L.; Edward Duff; Don Washburn; Courtney Holmberg. Spring 2004.
[39] Parker, Ann. "Bright Future for Tactical Laser Weapons."
[40] Ibid.
[41] Hecht, Jeff. January 2003. 45.
[42] Ibid. 45.
[43] Parker, Ann. "Bright Future for Tactical Laser Weapons."
[44] Lamberson, Donald L.; Edward Duff; Don Washburn; Courtney Holmberg. Spring 2004.

the near future. Rail guns show promise to be the replacement for conventional cannon in the coming decades. As the range and muzzle velocity of contemporary cannon reaches its theoretical maximum, its limited accuracy becomes more apparent, and its armor-piercing capability reaches the limits of available material compounded by the purported environmental hazard of depleted Uranium-tipped rounds. In theory, EM weaponry is supposed to overcome all of these shortfalls while presenting the U.S. military with an all-around more economical system (excluding R&D costs).

The concept of rail guns is deceptively simple. A solid slug with a conducting base is placed between two conductive rails. When fired, the two rails are made into electromagnets that send current through the slug, and through a "Lorentz Force" of opposing charge, rapidly catapulting the slug forward along the rails until it is discharged. The rail gun slugs themselves will have no explosives on board but rather will derive all of their destructive force from their kinetic energy. While the physics of the device are far more complex, this explanation will suffice.

The Navy is seemingly at the forefront of the efforts to develop this system. In an effort to make their fleets more flexible, the Navy is seeking to integrate rail guns into their new ship designs [such as the DD(X) destroyer] as the primary deck guns and method of staging precision strikes. As with concept laser systems, there are some problems to work out on the practicability of rail guns; however, the current impression of rail guns is that they will be very usable as a weapon in the relatively near future. The Marine Corps will be running its development and demonstration phase from 2004-2008, and hopes to have a version that could be mounted on an Abrams tank between 2012 and 2015.[45]

As far as the technical capabilities of these rail guns are concerned, military experts expect field systems to be able to fire their projectiles at an unprecedented 2.5 to 6.0 km/s.[46] Tests show that to match the kinetic energy delivered by a 155mm shell (the standard shell caliber for U.S. artillery pieces) a rail gun would have to fire a 1 kg slug at a velocity of 2 km/s. Designers have their eyes on more powerful systems though and have designed systems to fire rounds between 5 and 10 kilograms in mass at velocities up to 3 km/s. What does this translate to in more tangible effects?

> One test demonstrated that the release of the rail gun projectile's kinetic energy alone would create a 10-foot diameter crater, 10 feet deep in solid ground, and achieve projectile penetration to 40 feet. Hypervelocity projectiles provide deep penetration to destroy hardened targets that are extremely hard to kill by other methods … Lethality studies suggest

[45] Jonson, Nick. 29 April 2003.
[46] Adams, David Allan. 2003. 2.

> that rail gun KE projectile concepts will be sufficiently lethal—three to five times more deadly than current gun systems.[47]

Such a system would be very well suited for the tactical and strategic world that the U.S. is in today. With more and more nations keeping their strategic assets underground and the concept of a nuclear bunker buster being highly contested, an orbital EM gun would rebalance the scales for the U.S. when it needs to strike hardened positions. Another consideration will be the size of the entire package—while gun barrel itself will be substantial at about 10-12 meters, the slugs will help save space as they are much smaller (and safer!) than standard projectiles as they lack propellant and explosive warheads.[48]

Before an EM weapon satellite can be deployed, there is a survivability issue that will need to be addressed. A problem that has plagued rail gun development is the maintenance of the rails. Up until more recent trials, there has been trouble of wearing out the rails over the course of a small number of firings. While the problem of the slugs gouging the rails in the course of firings has been solved by the use of more conductive rails, there is still some (though "manageable") wear on the rails.[49] Though no doubt there will need to be some future improvements on this, by the time a final design is ready, these problems will likely be brought to the level of insignificance.

Practicability. The first real problem for lasers—and in truth, the showstopper—is that their beams are composed of infrared radiation. Short wavelength radiation is the most effective way of causing physical damage to an object, but it is also the radiation the Earth's atmosphere most easily absorbs. While some radiation would make it to the surface of Earth, it would not be substantial enough in power to cause significant—if any—damage, at least in the state of the technology as it will be in the near future. The atmosphere also causes the problem of distorting light. The aiming of the laser would be difficult enough at the distance it would need to be fired at, but with the addition of the effects of the atmosphere in bending and dispersing it, the problem would be significantly compounded.

There is another issue that makes rail guns appear to be little more practical than their light-based counterparts: they have to deliver a *physical* payload through the atmosphere. From what the average person knows about atmospheric re-entry, this seems like it would make the weapon

---

[47] Adams, David Allan. 2003. 4.
[48] Adams, David; M. Palmer; S. B. Pratap; W. A. Walls; W. F. Weldon. 1998. 3.
Adams, David Allan. 2003. 4.
[49] Adams, David; M. Palmer; S. B. Pratap; W. A. Walls; W. F. Weldon. 1998. 5.
Adams, David Allan. 2003. 5.

unusable as its payload would simply burn up during re-entry. This comparison is not entirely accurate for a number of reasons. First, the slugs will be made of high-density metal and thus be quite durable. Second, unlike a spacecraft on re-entry, a slug from an orbiting rail gun would not be trying to slow in the atmosphere and take a long path across the sky. No matter where the rail gun would be firing, it would send the slug all but straight down to the earth and with the idea of maintain its full velocity. Third, this high speed would be instrumental to the slug braving re-entry. The slug would be crafted to be very aerodynamic and minimize the friction that causes the heat-up of re-entry and the high velocity of it would actually reduce the drag involved.[50]

A problem that is extant for all of the above systems is that of power requirements. All of these weapons require power supplies into the megawatt range where satellites currently in orbit have a maximum requirement in the tens of kilowatts. Though this is indeed a daunting gap, there is technology that can provide this magnitude of power without putting nuclear reactors in orbit (an idea that would make all of the above systems likely politically unavailable). The solution is an advanced solar array being developed by the space engineer Ivan Bekey. Where typical solar arrays reach a maximum efficiency of approximately 20%, Bekey has developed arrays that reach 52%, very close to the theoretical maximum of 60%. He claims that he could develop a one-megawatt power system at the weight of 2,000 kilograms for roughly $20 million.[51] While this is no small price, it is practically nothing compared to the overall price of the average NASA mission.

Comparing experimental systems to current technology. Finally, in the discussion of the practicality of a system, the monetary cost must be taken into consideration. A good starting point is establishing what the cost of launching satellites would be. Any of the above satellites would be launched into geosynchronous orbit (GEO), a very expensive proposition. A rough estimate of the cost of launching cargo into this orbit is $13,200-$39,600 per kilogram. Unfortunately, there are no mass estimates for any of the weapons systems that would be launched, so this figure can only be used to give anyone considering such a system perspective. As an example, some of the more massive imaging satellites in orbit weigh in at approximately 14,000 kg and cost $400 million each to launch.[52] Take this figure and adapt it to the cost of the likely ammunition for an orbital rail gun. The cost of production plus launch would be $142,000-$426,000 per round. While this might seem like a very high price, it actually is comparable to equivalent systems used by the U.S. armed forces

[50] Adams, David; M. Palmer; S. B. Pratap; W. A. Walls; W. F. Weldon. 1998. 2.
[51] Watts, Barry D. 2001. 82-3.
[52] O'Hanlon, Michael E. 2004. 33-4.

for precision tactical strikes at present. Popular systems include the Tomahawk missile at a unit price of $569,000, the Maverick missile at $180,000, the SLAM ER at $500,000, the AGM-88 HARM at $284,000, and the AGM-154 at $198,000.[53] It should also be noted that these figures do not include the cost incurred in fuel and the aircraft and/or ship where applicable.[54] When framed in this fashion, the price per shot is not too outlandish.

The other advantage that is usually claimed of STEW is their rapid strike capabilities. At the very least, it seems that this ability should be at least equal to that of weapons currently in use. Assuming that an EM weapon would be firing from GEO (at an altitude of 36,000 km) with a velocity of 2.5 km/s to 6 km/s, and without taking gravity and air resistance into consideration, a projectile could be delivered within 100-240 minutes. Earth's gravity would speed the projectile for the duration of its trip, and as has been said above, the effects of traveling through the atmosphere at extreme hypersonic velocities would be negligible.

Thus, with technologies as they appear today, a STEW centered around an EM weapon seems to be a feasible concept in the relatively near future and would be of use. For better for worse, it does not appear at this time that DEWs would be usable for this function, but could probably be instrumental in the defense of any STEW that would be deployed. Naturally, such a satellite would become a priority-one target for any nation worried about being on the wrong end of it and might seek to eliminate it through the use of anti-satellite satellites (ASAT). It should also be mentioned that a satellite in GEO would be out of reach of any nation's missile fleet should they seek to eliminate a STEW by that means as the limit for most earthbound missiles is low earth orbit (1,500 km above the surface of the earth). Therefore, since it seems that STEW are possible, the next question must be approached: Are they prudent?

[53] U.S. Navy. 9 February 2005.
[54] Watts, Barry D. 2001. 86.

II

Factions and Issues on the Weaponization of Space

The debate on the installation of STEW in orbit is a matter that has yet to begin in earnest. It has been shown above that an EM gun system is practicable and potentially economical and thus in competition for being a useful primary or alternative tool for tactical precision strikes. As such, each of the schools of thought that usually pass judgment on ASATs and ASATs alone must be made to reconsider STEW, not in terms of practicability, but principle and prudence. While some comments are made by various commentators on the question of STEW and force projection from space, most only speak on ASAT-based weaponization and force projection through space. Thus, in order to present relevant and coherent platforms, these ideas will have to be translated into stances regarding STEW.

The schools of thought that shall be included in this debate are four. Any significant amount of reading will bring any inquirer to the same conclusion on the number and type of the factions and that such a scheme very thorough covers the present range of opinions without excessive pigeonholing. For the purposes of this paper, the labels and descriptions (with some modification) provided by Colonel Peter Hays in "Military Space Cooperation" shall be used. They are: Space Hawks, Inevitable Weaponizers, Militarization Realists, and Space Doves.[55]

What shall be addressed is what these four groups believe concerning the inevitability of space weaponization, the strategic value and impact (and thus desirability) of STEW for the US, the potential benefits and possibilities of diplomatic measures and any comparative advantage they might have, and then what action should be taken.

I. Space Hawks

This group sees space as becoming an important if not dominant source of military power in the future of warfare. Given this belief, they naturally think that any thought of an arms race aside it is in the best interest of the U.S. to develop and make use of a new advantage in military affairs. When a powerful new capability is available, it would be strategically imprudent to not put it in the field as soon as possible. As such, hawks are opposed to any cooperation be it in restricting the use

[55] Hays, Peter L. 2002. 32-4.

of space weapons or the development of them—they simply want to take the most direct path available to deploying them.[56]

Arms Race? There is no Arms Race. Hawks, by the nature of their arguments on the combat potential of space, believe that the weaponization of it is inevitable and thus the U.S. would do well to lead the charge to space weapons. Sounds like an arms race, right? According to hawks, this is not necessarily so, be it a matter of fact or semantics. Semantically speaking, there is no more an arms race as there is a race between nations to raise their, say, life expectancy—all nations want to be as capable as possible in these things, irregardless of the status of others. There is no characteristic competition per se in the desire of nations to enhance their military capabilities when they have the chance.

Though by some arguments STEW will not be as provocative of war in space as ASATs, there is and will be concern that they might incite an arms race in outer space. That being said, some hawkish scholars like Steven Lambakis are not quite so convinced. They contend that the U.S. has more than enough in strategically and tactically beneficial resources in space to provoke other nations do deploy ASATs to space. Obviously though—the unknown or top secret notwithstanding—despite the threat that all of the U.S.'s surveillance and munitions-guiding satellites pose to other nations' national security and the extreme dependence of the U.S. on satellite communications, other nations have yet to deploy ASATs even though many of them could probably deploy at least primitive varieties of ASATs against US space assets. Thus, if the presence of these items in space has not spurred a rash of weaponization in space, there is little chance that the presence of actual weapons in space will cause any action either.[57]

There is in fact legitimate enough reason to believe that the fear of an arms race in outer space is no more than a remnant of the Cold War fear of nuclear annihilation. Out of the nuclear proliferation of the Cold War, there may have come a belief that the danger of an arms race exists in any area of military technology.

The Diplomatic Perspective. The idea of weapons being the problem is incorrect, and the banning of them would be folly. Claims analyst Colin Gray: "Armaments are not the problem: the problem is the propensity of government to use them. History … is littered with technical schemes for the control, and generally reduction, of armaments, schemes as ingenuous as they were politically

[56] Hays, Peter L. 2002. 32.
[57] Lambakis, Steven. 2001. 265-6. See also chapters 4 and 6 for additional rationale behind current US satellite constellations being the most pressing strategic threat of any to other countries.

irrelevant." He continues, saying that if peace is what is desired, arms control is not the path to take. Arms will remain inactive so long as governments do not wish to go to war. However, if war is necessary, so much the worse for any government that is hobbled from lack of arms. Finally, the existence of arms control agreements do not mean that all nations of military potential will sign them, much less obey them. Such was the problem in the 20th century and such is the problem today.[58]

Indeed, modern analysts such as Steven Lambakis find the entire concept of arms control to be flawed and believe that it displays a gross misunderstanding of human nature. According to Lambakis, man is flawed in his will, each person being capable of good and evil; thus there is no such thing as a "universal political will," and as such, the abolition of war is impossible. Where some say that the only problem is that the proper institutions have yet to be put in place to realize such peace, Lambakis claims that there will always be "outsiders" that make sure that there cannot be a monolithic will.[59]

Assuming that the space hawks are not hostile to the restrictions on military space operations as set out by the 1967 OST, they do not interpret the language of said treaty as blocking the weaponization of outer space. While many will say that this interpretation of the OST and related documents clearly go against their spirit, few contend that the placement of a non-nuclear ASAT or STEW would be an abrogation of any international agreements currently in place.

To Arms! When any hawks mention the issue of STEW, they usually express strong interest tempered only by concerns of how feasible or comparatively useful they would be—and overall they are quite hopeful. STEW are hailed in the defense community as taking the new high ground, the strategic advantage that has been sought on the battlefield from time immemorial. The Undersecretary of the Air Force, Peter Teets, encourages moving forward to realize force projection through and from space as discussed in the Space Commission Report.[60] At the same time, the Commander of the Air Force Space Command, General Lance Lord, also endorses the possibilities of conventional strikes from space, being especially enthusiastic about their ability to deliver precise global tactical strikes with a minimum of risk while also serving as a deterrent measure against

[58] Gray, Colin S. 1986. 135-6.
[59] Lambakis, Steven. 2001. 273-4.
[60] Teets, Peter B. (Winter 2002-03): 7.

potential belligerents.[61] Finally, Lambakis gives one of the strongest endorsements of STEW as a future tactical strike system:

> Some have proposed using space top strike targets on earth … [and] destroy—using nothing but kinetic energy—underground storage sites for weapons of mass destruction. Think about it. If the choice were to take out a hardened smallpox weapons storage site using a nuclear weapon or a precise non-nuclear strike from space, which would be the better option? … I would rather have some options available for taking out a highly dangerous site in a timely manner.[62]

For him, STEW would be a liberating addition to the U.S. arsenal for the leadership and military, making difficult decisions easier by making better options available in otherwise no-win situations.[63] To close, Lambakis's stance very much encapsulates the ideas of the space hawks: "We ought not lose sight of the fact that weapons, in the hands of the right governments, can serve the international common good and be a positive catalyst for stability—even in space."[64]

II. Inevitable Weaponizers

Though the Inevitable Weaponizers school may not have many willing advocates, it certainly has a great deal of believers. It often seems that the average person on the street does not really endorse space weapons, but believes they will happen one way or the other, and thus supports the U.S. being the first one in orbit. Keeping with this idea, the Inevitable Weaponizers are like the Hawks in that they want to be dominant in space, but they only want this because they believe somebody is going to be and it would be best for the U.S. to be that somebody, and not because they think that dominance will provide the U.S. with any new and great strategic advantage. At the same time, the group is quite willing to entertain diplomatic measures that would slow the process.[65]

A Two-Track Approach … kind of. Where Carter promoted the pursuit of ASAT development as a fallback in case his efforts at space weapons bans failed, the Inevitable Weaponizers seek to make space weapons and space regulation synergize to provide a diversified and effective method of protecting U.S. interests in space. In this way, the U.S. would be force to place all of its hopes in one approch, it would be able to use the best features of legal and actual defense.

---

[61] Lord, Lance W. (Winter 2002-03): 42.
[62] Lambakis, Steven. 2002. 25.
[63] Ibid. 25.
[64] Ibid. 2002. 25-6.
[65] Hays, Peter L. 2002. 33.

Overall, it is this position that the U.S. government has adopted outside of the Department of Defense (DoD). Whereas one of the outlets of military thinkers (military and civilian), the *Joint Force Quarterly*, and the official statements of Space Command have a largely hawkish alignment, the stance of the rest of the government, as set out in the documents surrounding the Space Commission, falls much more in line with the Inevitable Weaponizers. Both groups support space weaponization, but the latter does not do so for advantage, only out of a desire not to be left behind. The *Space Commission Report* makes its claim on the inevitability of space weaponization:

> We know from history that every medium—air, land and sea—has seen conflict. Reality indicates that space will be no different. Given this virtual certainty, the U.S. must develop the means both to deter and to defend against hostile acts in and from space. This will require superior space capabilities.[66]

However, the government line and the other members of this school do not at this time indicate a belief that the U.S. will be able to prevail if it relies on weaponization alone. The government—outside of immediate DoD circles and hawkish thinkers—and the rest of the faction are also interested in diplomatic measures to make the arming of space less shocking to the international system, though they by no means place their hopes entirely or even mostly in them. Indeed, Department of State (DoS) diplomat Eric Javits, the permanent representative for the U.S. at the Conference on Disarmement, stresses this point when speaking of the perspective of the US on military space policy:

> We fully understand that maintaining international peace and security is an overarching purpose that guides activities on Earth as well as in outer space, but in the final analysis, preserving national security is likewise necessary and essential. For these reasons, the United States sees no need for new outers space arms control agreements and opposes negotiation of a treaty on outer space arms control… There is simply no problem in outer space for arms control to solve.[67]

In addition, Javits points out that the U.S. believes that the weaponization of space will neither destabilize the strategic balance on Earth nor trigger the arms race in outer space that is feared by many. He goes so far as to call these concernes "groundless."[68] Thus, the U.S. supports arms control measures as they currently are and wishes to remain engaged to see to it that they are not significantly modified. However, it should be reiterated that this stance does not make impossible other diplomatic initiatives in the weaponization of space.

---

[66] Commission to Assess United States National Security Space Management and Organization. 2001. 100.
[67] Javits, Eric M. July 2002. 51-2.
[68] Ibid. 52.

The idea of "peaceful uses of outer space" as set out by the 1967 OST is a key principle in this camp, and the Inevitable Weaponizers in the U.S. government are determined to make sure that this remains the main prescription of international law over space.[69] The Space Commission Report states:

> The U.S. must participate actively in shaping the space legal and regulatory environment. Because of its investment in space and its increasing dependence on space-based capabilities, the U.S. has a large stake in how this environment evolves. To protect the country's interests, the U.S. must promote the peaceful use of space, monitor activities of regulatory bodies, and protect the rights of nations to defend their interests in and from space… The U.S. and most other nations interpret "peaceful" to mean "non-aggressive."[70]

While emphasizing the modified two-track approach, this statement from the *Report* also raises the other critical plank in the Inevitable Weaponizer platform: that defense of space assets and space control should be the first and primary goal of any US military space program. Thus, Javits best sums up the principles of the Inevitable Weaponizers: "Arms control and disarmament are not ends in themselves but tools to enhance security."[71]

Space Defense First. By this rationale, Inevitable Weaponizers seek space weapons, however reluctant they may or may not be. However, in terms of priorities, there is a clear order of importance for Inevitable Weaponizers: All U.S. space policy needs to be geared toward the central goal of protecting US assets in space and assuring space access for the U.S. military and civilian business interests. LTC Michael Smith concurs with these ideas when formulating two particularly erudite assumptions on space weaponization: that of the inevitability of space weaponization (the belief characteristic to this group) and the other that as a result, space control is not optional. He claims that "pragmatists must assume that [space weaponization] will happen—and act accordingly," and that as the U.S. must insure the continued use of its satellite resources, it must have the capacity to deny space access to hostiles.[72]

What then, do the Inevitable Weaponizers envision for the future of STEW? While they certainly do not stress the importance of their development, government sources are starting to quietly ponder their strategic utility. Just as the *Space Command Vision for 2020* had spoken of power projection from space, the *Space Commission Report* expresses its interest as well: "In the coming

---

[69] Commission to Assess United States National Security Space Management and Organization. 2001. 37.
[70] Ibid. 36.
[71] Javits, Eric M. July 2002. 51.
[72] Smith, Michael V. (Winter 2002-03): 57.

period, the U.S. will conduct operations to, *from*, in and through space."[73] Similarly, General Robert Fogleman of the Commission, during his presentation to the Senate Subcommittee hearing on the *Report*, added this preview of STEW:

> Space offers advantages for basing systems intended to affect air, land, and sea operations. It is possible to project power from space in response to events anywhere in the world. For example, during a conflict, a military space vehicle could attack distant targets within a very short period. Unlike weapons from aircraft, land forces, or ships, space missions could be carried out with almost no transit, weather, or other delay. Having this capability would give the United States an extraordinary military advantage.[74]

It can be concluded then from all of the above that, while the Inevitable Weaponizers do not wish to rush the process and stress the placement of defensive measures, they provide at least some support for the eventual launching of STEW.

III. Militarization Realists

Much in the same vein as the Inevitable Weaponizers, the Militarization Realists have a significant but slightly unwilling following. The members of this group typically believe that the current strategic situation of the US is better served by the prevention of space weaponization. They think this is so usually because the U.S. is the most militarily dependent on space assets and thus the most vulnerable to space weapons; that it has "little to gain but much to lose." Also, they make the claim that if the US would spearhead the weaponization of space, it would make it technologically and politically easier for other powers—including many undesirables—to follow. As such, for the sake of the security of the U.S., they advocate the international abolition of space weapons. Only if these measures should fail, when it becomes a matter of cutting losses, does this group support the weaponization of space.[75]

Leave Well Enough Alone. Ask any military analyst about the sources of the current U.S. global strategic advantage, and he will likely reply that the U.S. derives a great deal of its advantage from space resources. Though the U.S. has not a single weapon in space, satellites—military and private contracted—provide critical support to its military operations as a force multiplier through communications and information transmission to anywhere and with guiding precision munitions

[73] Commission to Assess United States National Security Space Management and Organization. 2001. 13. Emphasis added.
[74] U.S. Committee on Armed Services, United States Senate. 2002. 8.
[75] Hays, Peter L. 2002. 33.

such as the type used heavily in the first days of both Gulf Wars. No other country or group in the world has this capacity to the degree that the U.S. does, and the Militarization Realists believe that attempting to enhance this advantage would greatly endanger it by breaking the equilibrium that the U.S. has been able to enjoy so far.[76] Unfortunately, as Michael O'Hanlon concedes in his assessment of the situation, the balance may in time be ruined whether the U.S. disturbs it by taking action or not. It may be an equilibrium that nations such as China may well eventually be interested in disturbing.[77]

Rushing a Maybe. That being said, members of this faction do not tend to believe that space weaponization is inevitable, though they do not necessarily rule it out. There are a number of ways that it has been proposed that space weaponization is inevitable. Johann von Schiller's argument of human nature, man's bringing "his torment" everywhere with him is one and the example of the past another. However, these reasons and others, Militarization Realists will tell you, are not entirely compelling. Only one inevitability argument has some strength: that space weapons will simply be too tempting for the "rational statesman."[78]

If successfully developed and deployed, space weapons *prima facie* have a great deal of strategic appeal. Currently, this draw is felt the most by the U.S. statesmen while being out of reach for many others. As such, as Barry Watts claims, the decision will not be made for the U.S.:

> Conceivable trigger events and slippery-slope paths not withstanding, the emergence of space-based weapons and combat outside the atmosphere is not inevitable by 2025, and the decision to begin placing weapons in orbital space before then may ultimately be up to the United States.[79]

Karl Mueller concurs with this, though he does not give the U.S. so wide a window, claiming that it is unlikely that any other nations will have space weaponization capability before 2010. However, he also starts his argument with the question of whether space weaponization will have started in earnest by 2050, already showing that in his opinion, weapons in space may not be such an immediate reality.[80]

---

[76] O'Hanlon, Michael E. 2004. 61-2. Though the situation in space leaves the U.S. dominant, no other powers seem particularly determined to change this at this time. Thus, there seems to be a certain equilibrium despite the imbalance.
[77] Ibid. 65, 92.
[78] Mueller, Karl P. 2002.
[79] Watts, Barry D. 2001. 111.
[80] Mueller, Karl P. 2002.

Strength in Waiting. When presenting three scenarios under which space weaponization may not occur, Mueller essentially enumerates the reasons why Militarization Realists do not support the U.S. taking the lead: it would cost too much or be impractical, it would endanger valuable U.S. space assets, and/or the U.S. would, over time, not be able to keep up with other rising powers in a possible weapons race in outer space which.[81] However, Militarization Realists are, well, realistic, and are careful to avoid simply postponing the disadvantage. As such, they realize that "extreme positions that would either hasten to weaponize space or permanently rule it out are not consistent with technological realities and U.S. security interests."[82] The final prescription of the Militarization Realists is not then one that would leave the two poles of the argument in a fury, but it would certainly not silence them. In particular, the school would probably encourage the U.S. to put limits on its own exploration into the weaponization of space without waiting for the rest of the world to follow suit and without calling the entire process to a halt.[83]

A similar caution would be exercised when approaching the issue of STEW. For the Militarization Realists, it seems to be largely a question of priorities. The group is already reluctant to weaponize space, and if they were to endorse it, they would be far more concerned with intra-space weaponry as a method to protect existing U.S. strategic space assets. The ASAT technology concept is much better explored as well. That said, the concept is only sent back to the drawing board, not to the wastebasket, as more conventional means of force projection over great distance for tactical strikes is far more reasonable according to the Reaslists.[84] Given this perception of the situation of STEW, O'Hanlon suggests that the debate over a ban on STEW should begin—again, not an outright rejection, but also not a stance abounding in enthusiasm.[85]

IV. Space Doves

As the polar opposite of Hawks, Space Doves unconditionally oppose any and all space weaponization and even oppose a great deal of space *militarization* due to fears of the problem of the "slippery slope" of policy. Doves oppose space weaponization primarily on ideological grounds, be it pacifism or a belief in the sanctity of a peaceful outer space, and do not think that the

[81] Mueller, Karl P. 2002.
[82] O'Hanlon, Michael E. 2004. 21.
[83] O'Hanlon, Michael E. 2004. 23-4.
[84] O'Hanlon, Michael E. 2004. 28.
Mueller, Karl P. 2002.
[85] O'Hanlon, Michael E. 2004. 107.

weaponization of space can contribute anything constructive to the overall global order. In this sense they are strong supporters, at least out of convenience, of the framework that President Eisenhower laid out, which kept space peaceful in order to insure the safe passage of his surveillance satellites. In this vein, they don't think that the U.S. or the rest of the world would gain any benefit in global security. Thus, the group is quite supportive of arms control measures, both domestic and international such as the 1967 OST, the series of UN General Assembly Resolutions titled *Prevention of an arms race in outer space*, and the House Bill titled as the "Space Preservation Act of 2002." Another important item to note is their opposition to a "two-track policy," again, the simultaneous pursuit of arms control measures and space weapons technologies in the interest of the U.S. hedging its bets.[86] The only point of compromise is that they normally do not seek to roll back the militarization of space that already occurred decades ago.[87]

Making "Peaceful" More Aggressive. Space Doves, unlike the parties of the other side, find the language of the 1967 OST to be too weak. It has not escaped their notice that "peaceful uses" has been interpreted to mean "non-aggressive," and knowing the battle over the language of the Treaty is probably already lost, they are seeking a new treaty to shore up the inadequacy. Also, support for this movement in outer space policy has come both from sources that should be expected and others that are more surprising. In the more conventional channel, there has been an effectively annual resolution for the "prevention of an arms race in outer space." More interesting have been the joint sponsorship of space weapon ban treaties put forth by China and Russia—a strange combination given the discord that seems to exist between this sponsorship and the usual perceived aggressive nature of these countries. Backing up this treaty sponsorship is Cheng Jingye of China's Ministry of Foreign Affairs who calls for a "legal instrument banning all space weapons."[88] There are also calls from the domestic sphere for the same, though both unilateral and multilateral action. As spelled out in Chapter 1 above, Representative Dennis Kucinich introduced H.R. 3616 which would halt U.S. weaponization of space of any kind. There is of course also private sector action, perhaps the most well populated division for the Space Doves. All sorts of policy institutes and groups of academics and other professionals are calling for both the U.S. and the international community to put an immediate and total halt to space weaponization.

---

[86] Hays, Peter L. 2002. 33-4.
Stares, Paul B. 1985. Chapter 9.
[87] Institute for Cooperation in Space. (17 March 2005).
[88] Jingye, Cheng. 2002. 48.

A Useful Pacifism. While there are, no doubt, those who support these measures for the sake of an ideal of an outer space without weapons, they and other usually cite certain rationale for such a policy knowing that not all share their ideals. Quite reasonably, the appeal is almost across the board one of strategic, economic, and scientific benefit. In his piece for the People's Republic of China, Jingye makes the claim that:

> Like many other countries, China is of the view that introducing weapons into space will not contribute to the goals of ensuring space security or reducing space vulnerabilities. Rather it will lead to an arms race in space, which will then be turned into another battleground, thus endangering our dependence upon space. This prospect is clearly not in the interest of any countries, and the space powers themselves are likely to become the biggest victims.[89]

Assuming that ASAT would be launched in response to STEW and that they would be used, Jingye is very much on the mark. In terms of benefits for the economy and science, the Institute for Cooperation in Space, much like many other NGOs, cites the damage that possible space warfare could deal to civilian efforts in space. Science and business ventures would becomes far too expensive to launch (literally) and support for them would dry-up, much to the detriment of all.[90]

With all of the above in mind, there is little need for the discussion of talking points for the Space Doves regarding STEW. They represent an uncompromising rejection of any an all armament in space. It is often hard enough to find the Space Hawks and Inevitable Weaponizers bringing up the issue of STEW and it is telling that the Space Doves explicitly broach the subject hardly at all.

V. Bridging the Great Divide

Hopefully, this chapter will have illuminated the (possible) debate over STEW, as again, the matter has yet to reach the forefront of the space weaponization question. With these platforms laid out, though, the stage for the debate is certainly set. When speaking of these schools of thought on space weaponization in general, Hays said that

> [these] ingrained but fundamentally divergent perspectives on space weaponization, space's strategic utility, and the role for space arms control are likely to make it quite difficult to craft cooperative approaches or even establish a dialogue concerning the interrelationships between space and security.[91]

[89] Jingye, Cheng. 2002. 48.
[90] Institute for Cooperation in Space. (17 March 2005).
[91] Hays, Peter L. 2002. 34.

The problem is further accentuated by the apparent polarization of the debate, with most observers tending to lean to the ends of the spectrum as opposed to toward the center. The U.S. government seems to be in the center of the hawkish side with some support from other groups while the better part of private groups tend to congregate on the far side of the dovish end, with some looking to stall the process as much as possible if not demanding the absolute abolition of space weapons of any kind. Had there been a less polarized spectrum of thought on the matter, a consensus would be more possible, but it seems what is required (or possible) in this case is not a compromise, but rather a thorough analysis and decision on what is most prudent given the information that all of the sides have to contribute.

III

The Case for Space-to-Earth Weapons

With all sides of the argument claiming to have the moral and strategic high ground, it must now be decided whether the United States should bring weapons to the high ground of orbital space. Hawks claim that the greatest disservice that could be done to U.S.—and for all intents and purposes world—security would be for the U.S. to fail to launch weapons with all possible haste and fall into line with many of the other nation-states of the world by developing an international treaty banning the weaponization of space, or even worse, rolling back the militarization of space. Then there are those, possibly the quiet majority, who have little faith that if any treaties or resolutions were to be passed they would last for long (in keeping with the precedent of the ABM Treaty). Militarization Realists place a little more faith in the durability of such treaties but possess a grim willingness to bring arms to space if other countries, by their actions, seem poised to do so. This, at least would be their stance with the conditions of launching ASATs. In terms of STEW, they would probably stand with the Doves by calling the idea of STEW not useful enough to justify the perceived risks. However, they would probably want a means of nullifying adversary STEW should any be launched. It is the hope of Doves that matters do not go this far, and it is interesting in a way that they seem to present no plans for how to approach an adversary launch.

This chapter will lay out why there are no longer any reasonable barriers standing in the way of the United States pursuing and deploying STEW. In doing so, it will set out how there are no current legal barriers to STEW, that pursuing any bans would ultimately be damaging to the U.S., and that STEW would neither bring about a new wave of space weaponization nor imperil U.S. security in space or on the ground. Following this, it will be argued that STEW will ultimately serve to enhance U.S. and international security, and that to realize this benefit, the U.S. should pursue a STEW through cautious unilateralism.

I: The Current Treaty Regime as it Pertains to STEW

With the state of international accords regarding space weaponization, any of the above groups could win the day. There are no active measures to prevent the launch of STEW, but there

is a precedent that, with the support of the U.S., could with little trouble be built upon to effect a ban of all weapons in outer space. Thus, all options are at this time open.

Though there is precedent, Doves are at the disadvantage of there currently being no blocks. They are at this advantage and they know it. The most important international agreement regarding the weaponization of space is the 1967 OST described in Chapter 1. To briefly reiterate, the treaty banned the deployment of nuclear arms in space and of any and all weapons on any celestial bodies. However, the treaty has no measures prohibiting the stationing of non-nuclear weapons in space and thus in orbit. As such, if one were to want to station a STEW-like emplacement on the Moon, it would not be permissible, but an artificial satellite STEW is perfectly legal under the 1967 OST.

The UN Charter, to which the U.S. is naturally a party to, also plays a part in the international treaty regime regarding space weaponization. As claimed in the 1967 OST, the Charter is itself part of the regulation of space.

> The prohibition in Article 2 of the charter of the threat or use of force for aggressive ends (i.e., not for purposes of individual or collective self-defense) also applies to attacks on space systems. A common interpretation of Article 51 allows for a nation to have a legitimate claim of self-defense; it is a justification for unilateral measures involving force that would be otherwise illegal under article 2(4).[92]

This is also the interpretation that the U.S. has officially adopted in into its stance on military issues in space.[93]

In addition, there are no other agreements that do anything to expand on what the 1967 OST established, though as alluded to above, there is substantial precedent toward that end in the form of UN General Assembly resolutions entitled *Prevention of an Arms Race in Outer Space*. These resolutions, citing the 1967 OST and UN Charter as described above, concede that the current legal framework does not block space weaponization and

> calls upon all states, in particular those with major space capabilities, to contribute actively to the objective of the peaceful use of outer space and of the prevention of an arms race in outer space and to refrain from actions contrary to that objective and to the relevant existing treaties in the interest of maintaining international peace and security and promoting international cooperation.[94]

As noted before, the U.S. does not support this Resolution and only a shrinking minority of other nations stands with the U.S. on this matter. One critical question, though, is whether or not these

[92] Lambakis, Steven. 2001. 65.
[93] Ibid. 212.
[94] United Nations. 2005.

resolutions carry the weight of law or if they are simply an expression of sentiments. According to Lambakis, while many lawyers argue that the resolutions have the strength of law, the tenacity of those who wish to work outside of such resolutions combined with the inaction of the UN in enforcing them (assuming they are indeed enforceable) makes them nothing more than a dead letter.[95]

Since international law governing space weapons presents no obstacle to the U.S. launching space weapons, the only thing that could impede the U.S., is a lack of means and/or of political will. According to Lambakis, the principle issue for the U.S. is that lack of a political will. He believes that the gateway to US space weaponization will be through space-based ABM systems and says that the U.S. is not likely to pursue any space weapons without an increased interest by the American public in doing so. He adds, that it will require a catastrophic occurrence to mobilize this interest given the power of the opposition.[96] Perhaps then, it is due time to examine the proposals of the dovish side of the debate to see whether their proposals for a space weapons ban are indeed the best course for the U.S. to take and in what form, or whether the U.S. should attempt to move toward the deployment of STEW perhaps without a disaster spurring the effort.

II: Banning Weapons in Space: The False Ideal

The movement for great restraint in developing or simply foreswearing weapons in space has been characterized by one as a "very vocal minority."[97] Though that may be, this minority has almost entirely stymied the space weaponization process.

Internationally, the greatest advocates for a ban on space weaponization are China (a rising power) and Russia (a declining power). Though one can question their motives, the fact is that they have sponsored a working paper in the UN entitled *Possible Elements for a Future International Legal Agreement on the Prevention of the Deployment of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects* that they hope will serve as the basis for a draft treaty.[98] Iinitiatives such as this are enthusiastically endorsed by groups like the Institute for Cooperation in Space (ICIS) and any number of other similar NGOs. The ICIS in fact goes so far as to push for a rollback of space

[95] Lambakis, Steven. 2001. 63.
[96] Lambakis, Steven. 2005.
[97] Ibid.
[98] It would be primarily based around the concept of confidence-building measures of complete disclosure of each signatory's space programs and the promise not to deploy space weapons.

systems being used as force-enhancers such as constellations that guide JDAMs.[99] The concept of space as a sanctuary brought down the SDI program under Reagan; and will have to be overcome in order for a decision to be made to move ahead on STEW or any other space weapons program.[100]

Another very, perhaps more popular proposal of how to regulate space is that of introducing "rules of the road" for outer space.[101] According to John Logsdon, Director of the George Washington University Space Policy Institute, rules of the road for space would be the preferable measure to begin with in space regulation and would include measures such as the advance announcement of space launch and purpose, space traffic management to have an international awareness of where all satellites are to avoid collisions and ASAT scares, among other confidence-building measures with all nations pulling away from space weapons research.[102] Though he suggests this should start on an informal level, it seems likely that such a system would quickly move to the Conference on Disarmament to become official international policy.

Against US Interests: A Unilateral Ban. Returning to the concept of a unilateral ban, it takes little time or imagination to conclude that for the U.S. to conclude that such a ban would be irresponsible to the point of being criminal. By statutorily ceding its right to develop and deploy space weapons (recalling that the bill presented by Kucinich would not only ban weapons in space, but also weapons that could be used on space targets) and not similarly binding other nations, the U.S. would become a fortress with a flaw, and it would announce that flaw to the entire world. As space cannot be armed immediately, it would not be of immediate detriment to the U.S., but it would halt its development of weapons; If and when the U.S. should find itself in need of space weapons, it would be quite unable to act with any speed. Such a position, given the U.S. military use of space at this time, is completely unacceptable and it can thus be considered extremely fortunate that the extremism of Kucinich's bill leaves it with little support.[103] Even Logsdon claimed that in banning space weapons "a unilateral action would be silly."[104]

---

[99] Institute for Cooperation in Space. 2005.
[100] Lambakis, Steven. 2001. 257-9.
[101] These rules are reminiscent of the establishment of laws of the sea that lay out how the rights of sovereignty of nations are and are not present for ships at sea. Some examples include what waters are sovereign territory, under what conditions a ship may be boarded, and the like. Although the laws of the sea were only established after there were issues of legality arising in maritime affairs, advocates of space rules of the road want to take action before any problems arise.
[102] Logsdon, John M. 2005.
[103] Lambakis, Steven. 2005.
[104] Logsdon, John M. 2005.

Against U.S. Interests: An International Ban. Whether or not an international agreement is a safer path is a far more difficult question, one that goes far beyond the space weapons alone. The Space Commission advises that while the U.S. should engage in international discussions of space regulation, it should do everything in its power to maintain the 1967 OST as the core of regulation, "particularly the traditional interpretation of the Treaty's 'peaceful purposes' language to mean that both self-defense and non-aggressive military use of space are allowed." It adds, and rightly so, that the U.S. must be careful to not engage in any treaties that may in the future interfere with U.S. space ambitions or strategic necessities.[105] Logsdon stands with this view though he takes a more liberal view of the process. He warns against the U.S. abstaining from discussions lest an international framework be established that is not in its interests, but seems to imply that the U.S. would do well to see to it that there be some regulation, if for no other reason than to placate others so that they let the matter rest after that round of treaty-writing.[106]

Lambakis seems to make the strongest case when he says that "the worst thing we could do is strike a treaty when we don't know exactly what we want to do with space."[107] The very fact that these words are being written is testament to this concern—the U.S. is at a crossroads in deciding the future of space. Indeed, the United States is going to be *the* decision-maker, even if its decision is simply to pass the buck (discussion of inevitability to come).

Against Deferral. One might say that the matter can be deferred until the point when the weaponization debate is resolved, but this argument is, in fact, flawed. Any nation will ultimately do what is best for its interests and thus its security. Though the debate *may* today or in the future show that space weapons are not necessary or useful enough as part of national defense, this does not have much bearing on the future.

Each medium of warfare only becomes more instrumental with time and the progression of technology. Though many would like to deny it, space is a medium of warfare, even if it has yet to be used as such. It has been the responsibility of the U.S. government from the start to recognize this reality.

Treaties Ultimately Ineffectual and Dangerous. A far more difficult reality to accept is the fallibility of international accords—be they bilateral agreements or multinational treaties—especially when they are responsible for setting the terms for some aspect of warfare in general or the structure of

[105] Commission to Assess United States National Security Space Management and Organization. 2001. 37-8.
[106] Logsdon, John M. 2002-03. 75.
[107] Lambakis, Steven. 2005

particular conflicts. When treaties are used as a substitute for good defense, the results can be catastrophic. As Lambakis notes:

> We must not overlook the reality … that international law is for all peace-loving nations that agree to relinquish a measure of their sovereignty for the common good. If a state believes that its national goals are not served well by the prevalent international judicial order, it may act contrarily and express itself with hostility… War is a permanent feature in international politics.[108]

If the world were made up of stable democracies, liberal or otherwise, it would be far safer for the U.S. to rely on international agreements for its security. However, there are a great many government with significant military capability and dubious self-control. It should also be borne in mind, however, that all government will in the end do what is in their best interests, and this in some instances puts international agreements in jeopardy. This casts doubt on the endurance of all of the treaties the U.S. is currently engaged in.

In fact, the actions of the U.S. itself show well the frailty of treaties dealing with space weapons. In 2001, the U.S. withdrew from the ABM Treaty which had restricted the deployment of ABM satellites in Earth orbit. Thus, whether any treaties in which the U.S. might engage would last is questionable. Such treaties are not subject to enforcement by any power above sovereign states, and thus nations can choose to ignore or withdraw from any treaties that cease to serve its purposes.[109] While there is a political cost to this, rogue states will care little about such matters. While more stable countries will want to guard their image of being "law-abiding states," Logsdon says, he also admits that this is only worth so much: witness the limited international reaction to the U.S. withdrawal from the ABM treaty.[110]

The conclusion that can be reached from this then is that the U.S. should remain involved in deciding international regulations concerning space weapons, but should do what it can to maintain the status quo. The current framework, made up of the 1967 OST—as traditional interpreted—in conjunction with a number of "rules of the road" that are already in place though other agreements, go far in upholding the much-prized sanctity of outer space. Additional restrictions would conceivably place at risk the defense needs of the United States.

[108] Lambakis, Steven. 2001. 70.
[109] Watts, Barry D. 2001. 85.
[110] Logdson, John M. 2005.

III: The Satellite that Launches a Thousand More?

The U.S. is without question the premier space power at this time. However, despite the clear military advantage that this affords the US, there have been no significant signs of rivalry to deny the U.S. continued enjoyment of that status. Will the U.S. launch of STEW be the final straw that puts space power on the military priorities of rival powers—will it bring the launch of ASATs? This is arguably the majority opinion among those involved in the debate of space weaponization, but the majority might not necessarily be correct.

As the concept of STEW is based on the idea that they would be a tool for enhancing U.S. security, it would be absurd to consider their launch if in fact they proved detrimental to U.S. security. It is a safe assumption that the population of space with ASATs would be undesirable if it merely replicated what was already in the U.S. arsenal. Can space weaponization be reasonably expected in the near future in the absence of U.S. action? And what measures could the U.S. take to make its possessions in orbit more resilient to space weapons, and thus mitigate any risks involved in launching STEW?

Somewhere, A Clock is Ticking. Speakers on the topic of space weaponization inevitability—the intellectually rigorous ones at least—usually say that it is improbable that, in the next 20 to 50 years, barring U.S. launch, that space weaponization will take place; interestingly enough, this is probably close to the amount of time that it would take to develop a STEW program.[111] Thus, conceivably by the time the U.S. could launch STEW, there is a chance that the orbits of Earth might already be inhabited by ASATs. What is argued here regarding inevitability is that if the lure of space as a "new high ground" is not strong enough to spur weaponization by rival powers, then the presence of U.S. strategic assets currently in place makes rival weaponization mandatory. Thus, the addition of U.S. space weapons does little to alter the equation. Strategically speaking, the high ground has been sought as a military advantage since well before the ancient Greeks started building their marching camps on hilltops. All nations by nature seek to maximize their security, and for most, this would be realizing and exploiting the advantages of taking to the "unflankable" high ground of space. It is possible for a nation to exercise significant control and awareness of the rest of Earth if it captures space with the proper tools. As its power in space increases, the nation would become increasingly unassailable.[112] Thus, although this paper only goes into whether or not the U.S. should pursue

[111] For example, Watts makes his predictions to a horizon of 2020-2025 and Mueller through to 2050.
[112] Dolman, Everett Carl. 2003. 46-8.

STEW, it must be recognized that many nations would see benefit in placing military tools in space, including weapons that can fight through and from space. That the U.S. is currently the premier nation in terms of space potential will not halt or slow the efforts of others. Others will obey their security requirements regardless of the actions of the U.S., even if inaction by the U.S. means they might not proceed with quite so much haste.[113]

The current obstruction in the path to space power is only that of affordable technology ("affordable" in so far as military budgets are concerned). As this has been mentioned as the delaying factor in any potential U.S. STEW program, so too this what is greatly holding back other nations. "Space is relatively safe today because capabilities for cheaply and routinely exploiting space have not yet arrived. We have every reason to expect that this will change."[114]

Thus, when experts are pressed, they seem to be of the mind that the question is not whether space will be weaponized, but when and by whom. The more important question is not so much whether the weaponization of space is inevitable, but how "slippery" the "slippery slope" really is. The conventional concern is that the U.S., the most able nation in military and space matters, will decide to weaponize space and that this will trigger an unstoppable surge of space weapons deployment from powers all over the globe. The real worry is that the resulting rush of launches will not only destroy space as a sanctuary, but that orbital space will become a high-tension point of conflict, much like what was had between the nuclear arsenals of the U.S. and U.S.S.R., and so put the U.S. in a far less pleasant strategic position than it had started in.

Gain or Loss in US Security?: Hostile Powers. There is the warning that "offense always produces defense" and that given the extent of U.S. dependence on space assets, it would have the most to lose.[115] O'Hanlon seconds concurs that the U.S. should be quite happy with its current position. According to O'Hanlon the U.S. should try to maintain this position as it "enjoys a remarkably favorable military position in space today, without suffering much political and strategic fallout for making major use of the heavens for military purpose."[116] Those who issue these warnings either overlook, or do not give enough weight to, a number of salient factors.

First, as has been said, the U.S. already has assets in space that are of vital strategic importance and are thus, in the view of adversary nations, already a grave threat. The U.S. has developed a robust reconnaissance-strike complex that is centered around space assets and allows

[113] Lambakis, Steven. 2005.
[114] Lambakis, Steven. 2001. 271.
[115] Logsdon, John M. 2005.
[116] O'Hanlon, Michael E. 2004. 21.

for the faster and lighter military that the DoD is currently seeking to develop. Any competing strategic power would have to realize that in order to stage an effective campaign against the U.S. armed forces, it would need to be able to defeat its space assets. Lambakis observes:

> We ought to recognize … that U.S. satellite constellations will be the primary motivation driving other countries back to the drawing board to devise counterweapons to present-day information-gathering and data-handling advantages in space. The United States will not have to develop space weapons to encourage foreign ASAT development.[117]

In fact, many nations that could rival the U.S. have this capability in the most destructive of ways without having developed dedicated ASAT systems. It is within the capabilities of most nuclear powers to launch a low-yield nuclear weapon into low Earth orbit and detonate it there. While this is a crude method of ASAT warfare, it would be very effective. Not only would any satellites in close proximity to the detonation be eradicated, but the radiation that would be trapped in the Van Allen belts would render billions of dollars worth of satellites inoperable over the course of about a month.[118] While such an action is certainly illegal according to international law, it must be stressed here, as above, that international law only applies to those interested in following it. Thus, there is already a significant threat of U.S. space asset destruction.

Furthermore, the addition of space-to-earth bombardment capabilities in the form described here would do very little to change the strategic calculus of any nation considering attack upon U.S. space assets for two reasons. First, STEW do not strictly speaking introduce a new capability to the U.S. arsenal; rather, they enhance pre-existing capabilities with added flexibility and firepower. The U.S. can strike anywhere on the globe with its air fleet and missile strike capabilities (the added value of STEW is covered below). As such, it is likely that they would not be perceived as a new threat demanding nullification. Second, geostationary STEW would be in a far different orbit than the majority of U.S. strategic space assets, making it impossible to attack both with the same means. In addition, geostationary STEW would be far more difficult to reach by any means and thus would be out of reach for most if not all adversary powers.

Gain or Loss in US Security?: Non-Hostile Powers. This takes care of the threat of hostile powers. But what of the military reactions of more stable and friendly powers? In this case the nature of the U.S. must be kept in mind in attempting to calculate the possible reaction. "The disciplined, responsible display and use of U.S. military power is accepted internationally and even

[117] Lambakis, Steven. 2001. 266.
[118] O'Hanlon, Michael E. 2004. 8-9.
Watts, Barry D. 2001. 98-9.

praised and courted by allies." Complaints only arise when the question of U.S. space power comes to the front.[119] While no friendly government complains to any significant degree, if at all, about the U.S. possession of a vast nuclear arsenal capable of reducing the Earth to a brick of charcoal orbiting the Sun or tries to match its scale, Europe is developing its own GPS capability despite U.S. willingness to share that capability with them.[120] As such, it is hard to judge what their military reaction would be. That this is so, however, is largely inconsequential. Just as the U.S. is unconcerned with stable democracies possessing nuclear weaponry, it should not, and likely will not, be or feel threatened by those same government possessing space weapons assuming they develop them at all.[121]

IV: The Diplomatic Cost of Deployment

Beyond the concern of matching the U.S. in military strength, there is significant and undeniable international antipathy toward the idea of the U.S. deploying space weapons. The United States has already caught a great deal of flak from many of its European allies, among others, for its invasion of Iraq, not signing the Kyoto Protocol, and withdrawal from the ABM treaty. The U.S. is used to acting on a unilateral basis and the rest of the world has become less and less accepting of this habit. If the U.S. were indeed to decide to launch space weapons, or even just a space weapons program, there would no doubt be protests both from within and from without. In the long term, the protest from without would be the far greater concern. Just as it was with the strategic and military side of the question, the diplomatic aspect of space weaponization and its effects on any U.S. STEW efforts need to be understood before an informal decision can be made. First it must be understood why exactly many foreign powers would probably oppose the U.S. launch of STEW, what the effects of this protest would be, and how the U.S. should seek to address this problem—deciding whether therefore to drop the program, find a way to make it more acceptable, or proceed without adjusting to suit concerned powers.

[119] Lambakis, Steven. 2001. 245.
[120] Logsdon, John M. 2005.
[121] As a general point of military policy, though, the author will advocate that the U.S. government and DoD pay some attention to the Space Commission Report and work to make U.S. space assets more reliable, durable, and replaceable. Whether or not it chooses to deploy space weapons of any kind, the U.S. needs to come to terms with its vulnerability above Earth take appropriate action to make sure that it does not lose its critical space capabilities at an inopportune time. See Space Commission Report pgs. 17-25 for a more thorough explanation of U.S. space asset vulnerabilities and potential remedies.

Fear of US Space Hegemony. The U.S. is the most powerful nation in the world. Though many do not like it, this is the truth of the times. It is this very fact, though, that upsets many nations of the world. Just as no person likes to feel like he is not in control, so it is with any world power. When the U.S. does not heed the will of the international community (though Lambakis would assert that there is no such thing), the power of the rest is lost. Many nations, including a large number of U.S. allies, have made their opposition to the weaponization of space clear in their actions on the world stage, supporting various initiatives to see to the continued un-weaponized state of space.[122] For the U.S. to go forward with a STEW program would be to emphasize to the others their lack of power relative to the U.S. The world is worried about U.S. space dominance and as such, the world can expect to face opposition.[123]

The next question would then be: what would be the ramifications of this international opposition? Were there no opposition, the U.S. would not really need to pay other nations any regard. But this is impossible. Nevertheless, the effects of the opposition are unlikely to be cataclysmic. While there would certainly be opposition on the international stage to a U.S. STEW program, it does not necessarily follow that the effects of this opposition would be terribly damaging to the U.S.

> A decision by the United States to use the space environment for protection will bring the acrimony of the entire world against Washington, asphyxiating U.S. national and economic security. This is not strategic thought—this is the worst-case, even unimaginable-case scenario played to the hilt.[124]

A far more likely reading of the result of a unilateral action on the part of the U.S. would be a greater difficulty in receiving international cooperation when it did desire to have it, just the same as it works in the domestic political sphere. There is certainly no risk of military retaliation and any sort of economic sanctions would be very unlikely. This being said, even though the matter is simply one of perception, life is more pleasant for all parties if there is cooperation. Further, the U.S. international diplomatic situation is already tarnished, whether that state is justified or not.

[122] O'Hanlon, Michael E. 2004. 16-7.
[123] Logsdon, John M. 2005.
[124] Lambakis, Steven. 2001. 259-60.

V: Toward U.S. Deployment of Space-to-Earth Weapons

These are the strategic and political facts of a United States space-to-earth weapons program: The bottom line is that while the U.S. would indeed be pursuing the weaponization of space, there is a distinction involved that is every bit as important as that between a militarized and a weaponized space. The U.S. would be using space to further enhance its strategic abilities on the ground and not be attempting to control space, the most significant point of fear and contention in possible U.S. space policy.

The Military Benefits of STEW. Regarding the benefits of STEW, Lambakis writes:

> "All the attention going to land-based options for destroying targets from a long distance with conventional explosives or kinetic energy impacts begs the question: If we are willing to invest great sums in the development of structures, materials, propulsion, guidance and controls for hypersonic cruise missiles, why not explore the feasibility of doing the same mission from space, an environment that might allow dramatic improvements in overall military and strategic efficiency?"[125]

With the diplomatic and strategic realities of STEW development and deployment laid out and the argument that the U.S. must take the unilateral path if it is to proceed at all established, the decision is now down to whether STEW would impart advantages worth the diplomatic price that would be paid for them.

Not the least of these would be that of keeping other expensive U.S. strategic assets out of harms way when staging precision strikes. U.S. fleets are facing increasing danger while on deployment: witness the increased deployment of "Sunburn" anti-ship missiles in China bought from Russia. Potential adversaries are figuring out the strengths and weaknesses of the U.S. and the U.S. must continue to change in order to maintain a strategic edge. Another issue that has come to the forefront with the 2003 Iraq War was access to bases. The use of STEW for critical strike missions would limit U.S. strategic reliance on the use of foreign basing and airspace by quite literally going over their heads.[126]

In addition, STEW can serve to provide the U.S. with a "virtual presence" throughout the world in a time when its foreign troop deployments are decreasing.[127] This presence would provide a deterrent effect on any powers that might be considering taking action against the security interests

[125] Lambakis, Steven. 2001. 96-7.
[126] O'Hanlon, Michael E. 2004. 17-8.
[127] Lambakis, Steven. 2001. 60, 79.

and ethical expectations of the U.S. While a STEW system would be an expensive venture, military operations are also very expensive, and in this role, a STEW program may be able to pay for itself in relatively short order.

In terms of actual function, STEW afford significant advantages in some areas compared to their more conventional counterparts. They will allow for the U.S. to break through any air defense system to open up a country for conventional air strikes. U.S. developments into the field of missile intercept technology shows that the day is not far off when it will be possible to neutralize missile attacks and the day is already here where surface-to-air missile capabilities can make areas unapproachable by combat aircraft. STEW would offer the U.S. a solution in the future to cracking open the hardest and most intricate of defenses when it should need to do so. A more immediately pressing concern for STEW employment may be something of great relevance to U.S. concerns: the elimination of WMD in the hands of irresponsible actors. To achieve this invaluable mission, the U.S. needs to be able to quickly and without warning destroy caches of such weapons, no matter how protected they may be in hardened installations.

> More than 70 countries have some capacity to operate underground, and the number of strategic underground facilities continues to grow. As it does, the number of targets that are essentially invulnerable to existing conventional weapons also grows. In some cases, the time window in which to attack a particular target or target set will be limited, placing a premium on timely strike options.[128]

Though STEW may never achieve the potential of tactical nuclear "bunker-buster" missiles, they will offer an attractive non-nuclear option that will go a long way in filling this gap in U.S. strategic capabilities.[129]

It should not be pretended that STEW will be a new "superweapon" for the U.S. or a successor for an existing means. It is, as has been said previously, a supplement to the U.S. arsenal.

> Assuming that space systems will eventually be able to target any location on earth with conventional bombs or other weapons does not mean they should simply replace aircraft for such missions. Space operations are expensive, and economic considerations alone will likely require air delivery for many munitions. Exceptions include times when cost is not a consideration, such as combat denied areas, situations when aircraft cannot quickly respond, targets best engaged by specialized weapons delivered from space, or conditions where surprise is vital.[130]

---

[128] Center for the Study of Weapons of Mass Destruction. 2005. 38-9.
[129] Lambakis, Steven. 2001. 98.
Watts, Barry D. 2001. 110.
[130] Smith, Michael V. 2002-03. 64.

Where STEW are a future consideration that needs to be considered now, the time when space weapons are able to take the role of airpower is well out of the predictable future. However, it is clear from the discussion above that STEW could be of great utility to the U.S. armed forces, especially in the strategic world it is entering into.

A New Joint Space Program? The most clear cut—and perhaps only—way for the United States to make a STEW program more agreeable to the rest of the world is to pursue it as a joint program, though this assumes that other nations would be interested. Lambakis is hopeful that there would be willing nations, the Russian Federation being one likely partner. The U.S. had cooperated with Russia on an SDI enterprise in recent history, before the Clinton administration had ended the program. Though Russia would probably be more reluctant this time, an agreement could probably be reached.[131]

For better or for worse, not all other nations would be so enthusiastic in joining a U.S. STEW initiative. Just as it had been with GPS, even though there are many common strategic priorities between the U.S. and Europe, it is likely that Europe would not be interested and would prefer to either continue its opposition to STEW and other space weapons, or to administer to its own program.[132] However, the U.S. and France have signed a Memorandum of Understanding agreeing to cooperate in military space projects. There are also a number of other countries outside of Europe that would be interested in contributing including Israel, Japan, and other nations of Southeast Asia.[133]

There would also be benefits beyond the diplomatic sphere if the U.S. were to engage in a joint program. In some cases, nations would be able to contribute knowledge that they have already acquired that would be relevant to STEW. For example, the United Kingdom already has an advanced rail gun prototype in Kirkauldy, Scotland. Perhaps even more importantly, would be the pooling of financial resources. Though the U.S. already has R&D programs that can yield results useful to the development in STEW, the full program would promise to be an expensive endeavor and the contributions of others would undeniably be of great help. In addition, it would make if far more likely that the program would not be cancelled before if was completed as there is great

[131] Lambakis, Steven. 2005.
[132] Lambakis, Steven. 2001. 49.
[133] Ibid. 53.

pressure involved in finishing international programs once they have been agreed to, even if it ceases to be attractive to one of the engaged parties.[134]

Yet, for all the benefits—diplomatic, practical, and financial—security interests might make the concept of a joint STEW program a non-starter. Until this time in the arms sphere of space cooperation, reactive systems have been the focus. In these cases, it makes sense for the system to be usable without consultation by all of the parties involved. It would not benefit any of the parties or cause any damage to another for a nation to use such a system when it would not be needed. A joint STEW program would be significantly more complex. All the nations involved would need, in order to make full and proper use of the system, unrestricted access. If the U.S. were to be staging a strike on a target during a military strike, it would not be tactically acceptable for it to have to get the approval of all of the other nations involved in the project. It would also certainly not be acceptable for other nations to be able to veto use by another nation, but at the same time it would be necessary. Imagine that a STEW constellation had been present before the 2003 Iraq War. The war was opposed by a number of powers, likely some that would have been involved in the STEW program. Though the U.S. would certainly want or need to be able to use STEW in the invasion, the opposition nations would have been able to bar U.S. use of them—an unacceptable scenario. It is also explicitly in U.S. policy that "no actions should be taken in space research or international negotiations that would require the prior consent of other nations for U.S. space activities."[135] Logsdon maintains that even though this document is relatively aged, its truth holds and the "U.S. would never stand for needing clearance to use such a weapon."[136] However, there are situations where the ability to block the action of another party would need to be present. There could be a situation where Russia would want to use STEW on the Chechens where it would be against U.S. policy. There would need to be a way for Washington to block this action. Thus, this presents a conflict on the usability of the system. To return to the starting point, it is one thing to be agreeable to letting a nation fend off attacks without clearance, and it is quite another design a joint operation model that does not go against national interests, whichever way it is geared.

Unilateralism in Space. Regardless of the benefits that a cooperative STEW effort would impart, the idea of going into a program intended to increase the security of the U.S. and the world that would end up compromising the same is unacceptable. As such, the U.S. should be prepared to

[134] Lambakis, Steven. 2001. 51.
[135] Ibid. 213. Referring to NSC paper 5520.
[136] Logsdon, John M. 2005.

engage in a unilateral STEW program and thus be prepared to contend with the disapproval of many other nations. Fortunately, there are a number of things that the U.S. can do to at least partially ameliorate international discontent.

First, the U.S. needs to engage its traditional allies in the early stages of the STEW program and try to win their peace with or endorsement of the program.[137] Part of the bad international press that the program would receive would likely result from misperceptions.

> World reaction will depend on how U.S. authorities understand their new capabilities and how they choose to talk about them with allies and other countries. Perceptions are realities for other nations, and in some cases foreign perceptions will not match reality. Let us make sure that the perceptions of other government leaders are accurate.[138]

While the results of such an initiative will probably not render uniform and complete support, they will certainly not cause any damage and will likely pay dividends in creating some support both within foreign populations and their governments.

This could be—and would in truth have to be—backed up with certain security guarantees, given the nature of the project: an orbiting weapons platform. While the program cannot be done on an allied basis, it can be used to benefit alliances and thus perhaps win it support. In other words it has been shown that STEW cannot be co-operated, but the U.S. can lend their support to the military needs of its allies and also use it to back up joint operations. This prospect would bring self-interest into the equation, a force that is not to be taken lightly.

To follow an analogy, it seems likely that whatever international disapproval does end up occurring will be like what happened with the U.S. development of ICBMs. Once the world powers were finished complaining about their development, other nations did nothing and just ended up in some cases developing their own, bearing them with the same restraint as the U.S.—they were ultimately accepted.[139] To apply another analogy, where the U.S. defied international opinion, the U.S. was the target of significant international resentment when it withdrew from the ABM Treaty. Chaos was predicted. It was thought that the U.S. would never again be able to get military allies or cooperation in treaties. This has obviously not materialized—the U.S. has engaged in two joint military actions since and interest in ABM programs is increased.[140]

---

[137] Lambakis, Steven. 2001. 285.
[138] Ibid. 286.
[139] Logsdon, John M. 2005.
[140] Lambakis, Steven. 2005.

The unfortunate truth of the matter is, as was stated earlier, that the U.S. is the target of great diplomatic pressure by default.

> No matter how the United States chooses to use its power (or chooses not to), there will be many who resent it. And it is precisely that power that is the focus of derision, and not prescribed action. This is evidenced by the routinely compatible foreign policies of Canada and the United States. Except in rare cases, these two independent nation-states hardly ever are in more than minor disagreement. Both jointly deploy forces overseas, enter into identical international treaties, and make similar moral pronouncements of the behavior of otheris in domestic and international forums. Yet the United States is often reviled and accused of neo-imperialism, while Canada is held up as a champion of international rights.[141]

The U.S. should do what it can to assuage the fears of others, but in the end it must accept that it will be the target of a certain degree of disapproval. It comes with the territory of being a premier world power and "our principles … do not stop people from deriding our motives."[142] There is a certain irony in that it is a different kind of inevitability that helps justify the U.S. moving forward with STEW.

[141] Dolman, Everett Carl. 2003. 78-9.
[142] Lambakis, Steven. 2005.

Conclusion

Something New Over the Earth, Nothing New Under the Sun

It seems that space power should develop in the fashion that air power did before it. In all likelihood it will—thus far it has fit the pattern perfectly. When military aviation gained an appreciable amount of significance in World War I, aircraft and dirigibles served primarily as observation posts, giving their possessor a better idea of the abilities of the opponent and the ability to more accurately direct their artillery fire. In other words, airpower in time served as an aid to and force multiplier for forces on the ground. This is the stage space power is currently in. US intelligence and armed forces are heavily dependent on satellite systems to act as scouts for plotting strategy and monitoring the strategic abilities of other nations following the initiative started by President Eisenhower. In addition, in recent times satellite constellations have come to be instrumental in staging precision tactical strikes with guided munitions such as JDAMs.

If this parallel trend is any indication, the next step is for possessions in space to become weapons themselves. Following their time as observers, the next mission that aircraft took on was as ground support weapons—albeit in a comparatively primitive sense. However, the parallels are clear enough: Aircraft began their combat role by dropping a limited amount of munitions on particular targets and the system projected and proposed by this essay is a space unit capable of "dropping" kinetic energy-based munitions on targets on the ground in a precision fashion, but now being at least as precise, with a potentially shorter command-to-impact duration, and with little or no fear of sustaining direct retaliation due to a being placed out of reach to adversaries. For military aircraft, it was only until after they had proven themselves as valuable ground support units that they by necessity needed to engage in air-to-air combat. Though there are some experts who attest that space weapons will have their genesis in either ASATs or ABM satellites before moving into the other and then STEW, there is, historically speaking, every reason to believe that the pattern for the progression of the military application of space will hold to the same logic.[143] This can readily been seen in the interests of U.S. R&D at this time, with the Air Force's development of the X-41 Common Aero Vehicle (CAV), a craft designed to act as a bomber that transits from base to target

[143] Lambakis. 2005.
Logsdon. 2005.

via a fractional orbit in space.[144] Thus, the only questions are how rapid the succession will be and how the R&D departments of the rest of the world will approach the problem and not so much whether STEW will be the first step to space weaponization.

Outstanding Issues. While the case has been made for the U.S. to pursue a STEW program, there are still some concerns that remain and warrant inquiry. The first problem is a classic case for the U.S. military: getting the branches to work together in developing the actual weapon system. The Air Force has the launch capability, the Navy is in charge of U.S. rail gun technology, and the Army has a strong share in laser research. All of these divisions will need to avoid any turf battles in order to be able to deploy a STEW system promptly.

Also, while this inquiry has broached the subject of ASATs, the debate on their deployment and regulation must still be resolved. The outcome of that discussion will have a great effect on all space policy and strategy, not to mention the use of STEW. Insofar as STEW are concerned, the U.S. should seek to do what it can to hold off the presence of ASAT systems in orbit. These can only serve to weaken the advantages that the U.S. would enjoy from any deployed STEW. At the same time, the U.S. should maintain its policy of not restricting itself through promoting any ASAT bans. At first glance, it seems that the best course would be for the U.S. to exert international pressure only to keep others from launching ASATs.

Another problem that the strategists of the U.S. will have to confront is what will be done at the point when another country develops and wants to deploy its own STEW.. Will this be tolerable to U.S. strategic interests, and for what nations will this be the case? The U.S. should be ready to accept the possibility and it seems reasonable to believe that the conventional allies of the U.S. obtaining STEW is perfectly acceptable.

America's Next Challenge in Space. It is clear that the U.S. needs to take action immediately, not just because of the strategic need to do so, but due to the state of the military in dealing with space security. U.S. national security policy has traditionally rejected allowing the deployment of any weapons in space. Despite this, USSPACECOM, now United States Air Force Space Command, is charged with:

> ensuring uninterrupted access to space for US forces and their allies, ensuring friendly freedom of operations in space, and, if necessary, denying others the use of space. Yet, insofar as these tasks require space-based weapons, the command neither possesses them

[144] Lambakis. 2005.

> nor currently plans more than tentative research that might one day lead to their development.[145]

This reality is one that will take no small amount of time to reverse, and if the U.S. hopes to deploy STEW any time soon, it would do well to start now.

If space turns into the battleground that is feared, it will not be by the U.S. launch of space-to-earth weapons. These weapons do not fight wars in space, they fight them from space. Further, they are only in a certain sense strategic weapons. As with all methods of precision strike in the past, STEW can turn the tide of a war, but they cannot stage a war by themselves.

That being understood, this study has shown that it is in the overall best interests of the United States to develop and deploy STEW. In this time of transformation for the U.S. military and for its adversaries, STEW could prove to be an essential addition to the U.S. arsenal in combating rogue states and WMD and thus undercutting the abilities of terrorist groups. This would be a priceless reward, and if the U.S. is willing to pay the slight and momentary diplomatic price and pay for an R&D program that has already been boosted by existing research, it and the rest of the world can stand to benefit in the not-so-distant future.

[145] Watts, Barry D. 2001. 3.

Works Cited

Primary Sources

Center for the Study of Weapons of Mass Destruction. *Combating WMD: Challenges for the Next 10 Years*. Washington, DC: National Defense University Press. February 2005.

Commission to Assess United States National Security Space Management and Organization. *Report of the Commission to Assess United States National Security Space Management and Organization*. 11 January 2001. <http://www.defenselink.mil/pubs/space20010111.pdf> 19 January 2005.

Institute for Cooperation in Space. *Space Preservation Talking Points*. <http://www.peaceinspace.com/sp_points.shtml> (17 March 2005).

Javits, Eric M. "A U.S. Perspective on Space." *Future Security in Space: Commercial, Military, and Arms Control Trade-Offs*, James Clay Moltz, ed. July 2002. <http://cns.miis.edu/pubs/opapers/op10/op10.pdf> (17 March 2005). 51-3.

Jingye, Cheng. "Treaties as an Approach to Reducing Space Vulnerabilities." *Future Security in Space: Commercial, Military, and Arms Control Trade-Offs*, James Clay Moltz, ed. July 2002. <http://cns.miis.edu/pubs/opapers/op10/op10.pdf> (17 March 2005). 48-50.

Kucinich, Dennis. *HR 3616: Space Prevention Act of 2002*. 23 January 2002. <http://thomas.loc.gov/cgi-bin/query/z?c107:H.R.3616:> (19 February 2005).

Lord, Lance W. "Forging Space Warriors." *Joint Force Quarterly*. 33 (Winter 2002-03): 38-43.

Northrop Grumman Space and Missions Corporation. *MTHEL Fact Sheet*. September 2004. <http://www.st.northropgrumman.com/media/SiteFiles/mediagallery/factsheet/MTHEL_Fact_Sheet_9-04.pdf> (19 February 2005).

Northrop Grumman Space Technology. *Directed Energy Weapons Fact Sheet*. <http://www.st.northropgrumman.com/media/SiteFiles/mediagallery/factsheet/MTHEL_Directed_Energy_Fact_Sheet_7-02.pdf> (19 February 2005).

United Nations. *Resolution 59/65: Prevention of an Arms Race in Outer Space*. <http://www.un.org/Depts/dhl/resguide/r59.htm> (19 January 2005).

U.S. Committee on Armed Services, United States Senate. *Hearing before the Subcommittee on Strategic of the Committee on Armed Services United States Senate*. 28 March 2001 (107th Congress, First Session). Washington, D.C.: U.S. Government Printing Office. 2002.

U.S. Department of State. *Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems*. 26 May 1972. <http://www.state.gov/www/global/arms/treaties/abm/abm2.html> (23 February 2005).

_____. *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*. 27 January 1967. <http://www.state.gov/t/ac/trt/5181.htm> (19 January 2005).

U.S. Navy. *United States Navy Fact File*. 9 February 2005. <http://www.chinfo.navy.mil/navpalib/factfile/ffiletop.html> (21 February 2005).

U.S. Office of the Press Secretary. *Press Briefing by Ari Fleischer*. 9 May 2001. <http://www.whitehouse.gov/news/briefings/20010509.html> (21 February 2005).

U.S. Space Command. *Vision for 2020*. 1997. <http://www.fas.org/spp/military/docops/usspac/visbook.pdf> (19 February 2005).

Watts, Barry D. *The Military Use of Space: A Diagnostic Assessment*. Washington, D.C.: Center for Strategic and Budgetary Assessments. 2001.

Interviews

Anonymous. Non-Attribution interview. 16 April 2005.

Lambakis, Steven. Telephone Interview. 7 April 2005.

Logsdon, John. Personal Interview. 14 April 2005.

Secondary Sources

Adams, David Allan. *Naval Rail Guns are Revolutionary*. 2003. <www.battelle.org/navy/railguns.pdf> (19 February 2005).

Adams, David; M. Palmer; S. B. Pratap; W. A. Walls; W. F. Weldon. *Application of Electromagnetic Guns to Future Naval Platforms*. 1998. <www.utexas.edu/research/cem/publications/PDF/PR253.pdf> (19 February 2005).

Dean, Jonathan. "Defenses in Space: Treaty Issues." *Future Security in Space: Commercial, Military, and Arms Control Trade-Offs*, James Clay Moltz, ed. July 2002. <http://cns.miis.edu/pubs/opapers/op10/op10.pdf> (17 March 2005). 3-7.

Dolman, Everett Carl. "Space Power and US Hegemony: Maintaining a Liberal World Order in the 21st Century." *Space Weapons: Are They Needed?* Washington, DC: Space Policy Institute of The George Washington University. October 2003. 39-86.

Gray, Colin S. "Space and Arms Control: A Skeptical View." *America Plans for Space*. Washington, DC: National Defense University Press. 1986. 133-53.

Hays, Peter L. "Military Space Cooperation: Opportunities and Challenges." *Future Security in Space: Commercial, Military, and Arms Control Trade-Offs*, James Clay Moltz, ed. July 2002. <http://cns.miis.edu/pubs/opapers/op10/op10.pdf> (17 March 2005). 32-43.

Hecht, Jeff. "Solid-State High-Energy Laser Weapons." *Optics and Photonics News*. January 2003. <http://www.osa-opn.org/view_file.cfm?doc=%24%28%2CK%28KP%20%20%0A&id=%24%28L7%2DI%40%20%20%0A> (19 February 2005).

Jonson, Nick. "Marines Seek Electromagnetic Gun for the MEFFV Family of Vehicles." *Aviation Weekly's Aerospace Daily & Defense Report*. 29 April 2003. <http://www.aviationnow.com/avnow/news/channel_aerospacedaily.jsp> (19 February 2005).

Lambakis, Steven. *On the Edge of the Earth: The Future of American Space Power*. Kentucky: The University Press of Kentucky. 2001.

_____. "Putting Military Uses of Space in Context." *Future Security in Space: Commercial, Military, and Arms Control Trade-Offs*, James Clay Moltz, ed. July 2002. <http://cns.miis.edu/pubs/opapers/op10/op10.pdf> (17 March 2005). 23-7.

Lamberson, Donald L.; Edward Duff; Don Washburn; Courtney Holmberg. "Whither High-Energy Lasers?" *Air & Space Power Journal*. Spring 2004. <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj04/spr04/lamberson.html> (19 February 2005).

Logsdon, John M. "Finding a Path to Spacepower." *Joint Force Quarterly*. 33 (Winter 2002-03): 72-7.

Mowthorpe, Matthew. "The Revolution in Military Affairs and Directed Energy Weapons." *Air & Space Power Chronicles*. 8 March 2002. <http://www.iwar.org.uk/rma/resources/energy-weapons/mowthorpe02.html> (19 February 2005).

Mueller, Karl P. *Is the Weaponization of Space Inevitable?* 27 March 2002. <http://www.isanet.org/noarchive/mueller.html> (19 January 2005).

O'Hanlon, Michael E. *Neither Star Wars nor Sanctuary: Constraining the Military Uses of Space*. Washington, D.C.: Brookings Institution Press. 2004.

Parker, Ann. "Bright Future for Tactical Laser Weapons." *U.S. Department of Energy Research News*. <http://www.eurekalert.org/features/doe/2002-04/dlnl-bff053102.php> (19 February 2005)

Smith, Michael V. "Some Propositions on Space Power." *Joint Force Quarterly*. 33 (Winter 2002-03): 56-64.

Stares, Paul B. *The Militarization of Space: U.S. Policy, 1945-1984*. Ithaca, NY: Cornell University Press. 1985.

Teets, Peter B. "National Security Space: Enabling Joint Warfighting." *Joint Force Quarterly*. 33 (Winter 2002-03): 32-7.