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Should the United States "Weaponize" Space?
Military and Commercial Implications

by Charles V. Peña and Edward L. Hudgins

Executive Summary

Control of space is at the crux of the debate about the future of U.S. military space policy. The question is not about militarizing space. Clearly, we have been using and will continue to use space for military purposes. But, whereas we are currently using space assets to support terrestrial (ground, sea, and air) military operations, what Sen. Robert C. Smith (R-N.H.), the Space Commission (which was chaired by current Secretary of Defense Donald Rumsfeld), and others have proposed is that the United States move toward "weaponizing" space for space control.

Advocates of a more aggressive U.S. military policy for space argue that the United States is more reliant on the use of space than is any other nation, that space systems are vulnerable to attack, and that U.S. space systems are thus an attractive candidate for a "space Pearl Harbor." But as important and potentially vulnerable as current U.S. space-based assets may be, deploying actual weapons (whether defensive or offensive) will likely be perceived by the rest of the world as more threatening than the status quo. Any move by the United States to introduce weapons into space will surely lead to the development and deployment of anti-satellite weapons by potentially hostile nations. As the dominant user of space for military and civilian functions, the United States would have the most to lose from such an arms race.

Although there are legitimate (and unique) military requirements for space assets, virtually all are "dual use." Military requirements should not necessarily dictate those other uses. In fact, commercial efforts in space often lead those of the government and the Department of Defense and usually have lower costs, due to market influences and competition.

National security must be one component of total U.S. space policy, but it must certainly not be the primary component. In the post–Cold War environment—with no immediate threat from a rival great power and none on the horizon—the United States must not establish overstated and costly military requirements for space-based resources. The military must make greater use of commercial space assets. Also, the United States should strive to foster an environment that allows commercial space activity to grow and flourish rather than use it to create a new area for costly military competition.

Charles V. Peña is senior defense policy analyst and Edward L. Hudgins is former director of regulatory studies at the Cato Institute.

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Introduction

Before becoming secretary of defense, Donald Rumsfeld chaired two blue ribbon commissions at the request of Congress. The first—called the Rumsfeld Commission—issued the "Report of the Commission to Assess the Ballistic Missile Threat to the United States." The report received much attention because it raised the specter of a ballistic missile threat to the United States by so-called "rogue states" and concluded that the threat was more imminent than had been predicted by an earlier National Intelligence Estimate. The second—but probably lesser known—commission chaired by Rumsfeld was the Commission to Assess United States National Security Space Management and Organization, more commonly referred to as the Space Commission. The report of this second Rumsfeld commission (released in January 2001) has received less attention, but its conclusions are similarly foreboding:

- The United States is more dependent than any other nation on the use of space.[1]
- Space systems can be vulnerable to a range of attacks.[2]
- Nations hostile to the United States possess or can acquire the means to disrupt or destroy U.S. space systems.[3]
- The United States is an attractive candidate for a "space Pearl Harbor"[4]

As a result, the Space Commission recommended "that U.S. national security space interests be recognized as a top national security priority"[5] and that "the U.S. must develop the means both to deter and to defend against hostile acts in and from space."[6] Even though the Space Commission report has received less media attention than the first Rumsfeld Commission report, its conclusions and recommendations could have a greater and broader impact now that Rumsfeld is secretary of defense.[7]

Space is the new military "high ground," as highlighted in a January 2001 war game—the first one that focused on space as the primary theater of operations. That war game, conducted at Schriever Air Force Base in Colorado, postulated a conflict taking place in 2017 between "Blue" and "Red" forces (resembling the United States and China, respectively). Both sides possessed space weapons as well as ground-based lasers. The Blue side had a national missile defense and the Red side had anti-satellite weapons.[8] For the first time, a war game actually fought a war with weapons in space rather than just using space systems to support ground, sea, and air operations—seemingly taking its cues from the Space Commission report and the incoming Bush administration's interest in the military uses of space.

Given that space is likely to be a new national security priority during the Bush administration, it is worth examining defense space policy in both its military and its commercial implications. This study will address the following issues:

- What are the military and civilian/commercial uses of space?
- What are the threats (both near- and long-term) to space assets?
- How can the United States best respond to those threats?
- How do the military uses of space affect (either adversely or positively) civilian/commercial uses?

It is important to point out that the issue is not whether the United States should militarize space. The militarization of space has already occurred and will continue. The more immediate issue is whether we should weaponize space, at least in the near- or mid-term, and more important, whether military uses and requirements in space should be the driving force behind our national space policy.

Military Uses of Space

More than a decade ago, John M. Collins at the Congressional Research Service wrote:

> Space, the ultimate "high ground," overarches planet Earth, its occupants, and all activities thereon. Effective use of that medium for military purposes therefore may be needed to safeguard national interests in survival, security, peace, power, stability, and freedom of action.
>
> Every technologically advanced land, sea, and air service already depends on space satellites. . . . Reliance continues to increase, because systems in space offer strategic and tactical advantages that are otherwise unavailable. . . .
>
> Military interests in space almost surely will intensify and spread during the next decade.[9]

In order to understand the debate over weaponization of space, one must know the military uses of space, which include integrated tactical warning and attack assessment (ITW&AA), weather and environmental monitoring, satellite communications (satcom), surveillance and reconnaissance, navigation and positioning, space control, ballistic missile defense (BMD), and force application (i.e., using weapons that travel through or are based in space). For more detail, see the Appendix.

ITW&AA

ITW&AA is a unique military requirement that cannot be met using nonmilitary resources. It is essentially monitoring the signs of attacking long-range aircraft and missiles, either toward the United States or within a theater/region of operations. The Defense Support Program satellites, using infrared sensors, currently provide early warning and assessment capability for attacks by long-range intercontinental ballistic missiles (ICBMs). The Space Based Infrared System (SBIR) high program is the planned follow-on to DSP.

Weather and Environmental Monitoring

Weather and environmental satellites are an example of dual-use space satellites. According to the RAND report: "Weather satellite information is crucial to mission planning for all the armed services, as well as vital to civilian public safety and scientific research around the world."[10] Currently, both the Department of Defense (DoD) and the National Oceanic and Atmospheric Administration have separate weather satellite programs, which use different orbital paths and instruments but use the same orbital vehicle or bus.

Satcom

Communications probably represents the single biggest use of space for both the military and civilian/commercial sectors. According to former U.S. Air Force vice chief of staff Gen. Thomas S. Moorman Jr. (ret.): "Space-based communications is the giant in space commerce. The giant clearly will be even more dominant in the future, and the information revolution will be the driver."[11]

Although the DoD operates several communications satellites (or payloads on other military satellites to provide communications services)—for example, the Defense Satellite Communications System, Air Force Satellite Communications System (AFSATCOM), Leasat, UHF Follow-On (UFO), and Military Strategic and Tactical Relay (MILSTAR)—this segment is largely commercially driven. Indeed, according to the RAND report: "The technology for new satellite communications, especially high-speed mobile services, is evolving so rapidly that the DoD is planning to make greater use of commercial systems rather than fielding its own systems."[12]

Surveillance and Reconnaissance

Space-based remote sensing for surveillance and reconnaissance is essentially an extension of aerial observation done previously by balloons and aircraft. Clearly, this is an area where the military might have some unique requirements—for example, a legitimate concern that remote-sensing data cannot be accessed by other (potentially hostile) users to reveal the disposition and movement of U.S. forces in times of crisis and war. This is

The Space Commission has proposed that the United States move toward weaponizing space for the purposes of controlling it.

Space-based assets themselves are not the most likely or easiest targets of attack.

less of a concern if the military uses dedicated satellites, but more of a concern if the military is relying on shared satellites. Despite this legitimate concern, "commercial remote sensing offers the U.S. military potential new sources of remote-sensing data without requiring it to pay for the development of the space system."[13] General Moorman believes "that these new commercial capabilities will both complement and reduce the numbers of military and intelligence systems required. The resulting savings could be substantial."[14]

Navigation and Positioning

The Department of Defense operates a constellation of 24 satellites that make up the space segment of the Global Positioning System. These satellites transmit precise time signals; and receivers in view of the satellites can calculate their positions and velocities anywhere in the world.[15]

Although GPS was originally developed for the military, the commercial GPS equipment industry (i.e., receiver sales) is growing rapidly. According to RAND, "Civilian and commercial sales are outstripping defense procurement of ground equipment, and the user equipment industry is being commercially driven by fierce competition in electronics packaging, manufacturing, and software technology."[16] A background paper prepared for the Space Commission by Linda J. Haller and Melvin S. Sakazaki claims that the location/navigation sector has been growing at a yearly rate of about 20–25 percent and is expected to continue that growth to become a major revenue-producing part of the worldwide commercial space industry within the next five years.[17]

Space Control

The term "space control" is often used in the context of ensuring free passage in and through space. The most common analogy is to guaranteeing maritime commerce on the high seas. However, Hays and Mueller, on the faculty at the School of Advanced Airpower Studies, reject this analogy. They contend that commercial space activities are fundamentally different from maritime merchant shipping and air transport. Whereas merchant shipping and air transport involve the movement of goods and passengers, space commerce involves either the collection or transmission of information. Therefore, they contend, commercial space activities have more in common with the telegraph and radio than with steamships and airliners.[18]

The real essence of space control is the ability to deny the use of space to an enemy. Sen. Robert C. Smith (R-N.H.) has stated:

> (1) America's future security and prosperity depend on our constant supremacy in space; (2) although we are ahead of any potential rival in exploiting space, we are not unchallenged, and our future dominance is by no means assured; and (3) to achieve true dominance, we must combine expansive thinking with a sustained and substantial commitment of resources and vest them in a dedicated, politically powerful, independent advocate for space power.[19]

Furthermore, according to Senator Smith: "With credible offensive and defensive space control, we will deter and dissuade our adversaries, reassure our allies, and guard our nation's growing reliance on global commerce. Without it, we will become vulnerable beyond our worst fears."[20]

Space control is at the crux of the current debate about the future of U.S. military space policy. Currently, space is used by the military to support ground, sea, and air operations. The Space Commission argues:

> Space is not simply a place from which information is acquired and transmitted or through which objects pass. It is a medium much the same as air, land, or sea. In the coming period, the U.S. will conduct operations to, from, in, and through space in support of its national interests both on earth and in space. As

with national capabilities in the air, on land, and at sea, the U.S. must have the capabilities to defend its space assets against hostile acts and to negate the hostile use of space against U.S. interests.[21]

Instead of merely using space assets to support terrestrial (ground, sea, and air) military operations as is done now, the Space Commission and others have proposed that the United States move toward weaponizing space for the purposes of controlling it—in other words, establishing space control by exerting force application in space.

The Costs of Weaponizing Space Outweigh the Benefits

There are those who feel the United States is currently at risk and should act now to seize the military high ground in space. Senator Smith has stated:

> I do see an opportunity for us to exploit this period of unchallenged conventional superiority on Earth to shift substantial resources to space. I believe we can and must do this, and, if we do, we will buy generations of security that all the ships, tanks and airplanes in the world will not provide. . . .
>
> Control of space is more than a new mission area—it is our moral legacy, our next Manifest Destiny, our chance to create security for centuries to come.[22]

Not surprisingly, Senator Smith was instrumental in getting the Congress to charter the Space Commission.

The chief of staff of the U.S. Air Force, Gen. Michael E. Ryan, has endorsed the deployment of space-based weapons to protect the nation's satellites and predicted that the United States would develop the capacity to shoot down other countries' satellites and spacecraft.[23] According to General Ryan: "We have to in some way be able to protect those assets, at least defensively. . . . I would suggest that sometime in the future here, we're going to have to come to a policy decision on whether we're going to use space for defensive and offensive capabilities."[24]

Critics of such a policy shift are concerned that weaponizing space could trigger a dangerous arms race. They are quick to point out that no country currently has weapons in space and that a U.S. move to deploy weapons (either offensive or defensive) would only provide unneeded impetus for other countries to follow suit. Jonathan Pike of Globalsecurity.org states, "It [weaponizing space] runs fundamentally against the main theme of our space policy for the last half century—to demonstrate America's power in space in a nonthreatening way."[25] And U.S. Air Force Lt. Col. Peter Hays and Karl Mueller (both faculty at the School of Advanced Airpower Studies) argue that "it is no longer clear that the relationship between space and national security is, or should be, shaped primarily by international military competition."[26]

Is there a clear and present danger in space? And is becoming more militarily active (including deploying weapons, either defensive or offensive) in space the next logical step?

Although U.S. satellites might be vulnerable to ASATs, the threat is more hypothetical than real.

Does the United States Risk a Space Pearl Harbor?

As noted above, the argument the Space Commission makes about the vulnerability of space and the need to "develop and deploy the means to deter and defend against hostile acts directed at U.S. space assets and against the uses of space hostile to U.S. interests"[27] is relatively straightforward:

- The United States is more dependent on space than any other nation.
- The U.S. military is increasingly dependent on space systems.
- U.S. security and economic well-being depend on the ability of the United States to operate successfully in space.
- Nations hostile to the United States

- either possess or can acquire the means to destroy U.S. space systems.
- U.S. space systems are vulnerable to a range of attacks.

Thus, the Space Commission warns that the United States has not paid sufficient attention to the threat and, as a result, "the U.S. is an attractive candidate for a 'Space Pearl Harbor.'"[28]

It is indeed true that the United States is more dependent on space than are other countries and that the U.S. military in particular is becoming increasingly dependent on space systems. Furthermore, space systems are currently undefended and, therefore, potentially vulnerable to attack. It does not necessarily follow, however, that the United States will suffer a "Space Pearl Harbor."

A less interventionist U.S. foreign policy vis-à-vis China could ultimately be more conducive to reducing any potential ASAT threat.

Ground Stations More Vulnerable

According to the Space Commission, "Nations hostile to the U.S. possess or can acquire the means to disrupt or destroy U.S. space systems by attacking the satellites in space, their communications nodes on the ground and in space, or ground nodes that command the satellites."[29] Much of the Space Commission's focus has been on the vulnerability of and threat posed to satellites in space. However, Hays and Mueller point out, "Satellites . . . are likely to be a more difficult and thus less attractive target set for direct attack under most circumstances than are other components of space systems, such as launch facilities or ground-control stations, and if they are attacked, it will most likely be through indirect means such as communications jamming."[30] A background paper prepared for the Rumsfeld Commission also states that "one of the easiest ways to disrupt, deny, degrade, or destroy the utility of space systems is to attack or sabotage the associated ground segments."[31]

Thus, the more immediate concern should be the vulnerability of ground-based components. Those elements could be susceptible to a variety of threats, including direct military attack (e.g., with aircraft or missiles), terrorist attack, sabotage, and jamming. Space-based assets themselves are not the most likely or easiest targets of attack, particularly for so-called poor rogue states. Thus, there is a less pressing need to focus on space itself and the potential threats to space-based assets.

Theater missile defense systems and air defense systems could be used to protect ground stations from short-range ballistic missiles, cruise missiles, and aircraft. Commando attacks are another potential threat, which requires appropriate responses and safeguards. Thus, perimeter security around satellite ground stations should be increased.

Jamming

Electronic jamming is already within the technical competence of many countries, including Russia, China, Iraq, North Korea, Iran, and Cuba.[32] Most commercial and civilian satellites do not have anti-jamming capability and are, therefore, susceptible to such attacks.

Electronic jamming is a legitimate concern because it can be done relatively easily and cheaply. For example, two rookie engineers from the U.S. Air Force Research Laboratory were able to build a homemade jammer using a petrol-driven electricity generator, wood, plastic piping, and copper tubing. The total cost was only $7,500, and all of the required parts were obtained at an electronics enthusiasts' swap meet.[33] According to Steve Blum, president of Tellus Venture Associates, a satellite consulting firm, sending a signal up to a given satellite and jamming it is nothing new.[34] Also, satellite jamming is relatively easy to trace.[35]

But jamming can be greatly mitigated by the use of encryption or the use of anti-jamming equipment. For example, Raytheon in the United Kingdom has developed an anti-jamming antenna for GPS that recognizes sources of interference and, by adjusting the way in which it receives the satellite signals, rejects the interference, thus allowing the navigation equipment to function accurately.[36]

Another effective way to defeat jamming is through "frequency hopping," which avoids interference from jamming on a particular frequency by switching to a new frequency after transmitting or receiving a packet of data.[37] When this method is used, the signal can be effectively jammed only if the jammer knows the frequencies being used, the time during which they are being used, and the sequence of use[38]—not easy information to come by. The signal is more resistant to jamming the faster the hops between frequencies and the shorter the information packets.

Since electronic jamming is an easier and less expensive alternative to direct attack, efforts should be made to employ as many anti-jamming techniques and technologies as possible, such as encryption, anti-jamming equipment, and frequency hopping.

No Anti-Satellite Threat

Although the Space Commission report and more ardent "space hawks" might lead one to believe otherwise, there is no current anti-satellite (ASAT) threat. In fact, operational ASATs are vestiges of the Cold War era. Richard L. Garwin, a physicist and senior fellow at the Council on Foreign Relations, writes, "In the Cold War era, it was perfectly clear that deployment of space weapons by the Soviet Union would have led to an effective ASAT deployed by the United States; conversely, the Soviet Union was fully capable of providing the necessary ASAT to counter U.S. space weapons."[39] But in the post-Soviet era, neither the United States nor Russia has dedicated space ASAT weapons deployed.[40] According to RAND, no other "nation possesses an operational ASAT capability that poses a significant threat to U.S. national security space systems."[41]

Thus, although U.S. satellites—both military and commercial—might be vulnerable to ASATs, the threat posed by ASATs is more hypothetical than real. Space Commission staff member Tom Wilson states:

> The proliferation of ballistic missile and space technology has made it easier to develop direct ascent anti-satellite weapons and to obtain the capability to deliver nuclear warheads into space. Studies have shown that the detonation of a low-yield nuclear weapon in LEO [low earth orbit] will not only fatally damage nearby satellites but will also increase the naturally occurring radiation around the earth, reducing most LEO satellites' lifetimes from years to months. Many countries such as China, India, Iran, Pakistan, and Russia have this capability.[42]

It is important to point out that "this capability" to which Wilson refers does not mean that those countries have operational ASATs. It means, rather, that those countries have a nuclear weapons capability or they have a capability to launch a payload into a low earth orbit. It does not mean that they have mated those two capabilities to develop and deploy an ASAT weapon.

Moreover, the ASAT threat that is postulated is a nuclear threat. According to noted defense analyst James Kitfield, "The U.S. military has long worried that an adversary might detonate *a crude nuclear weapon* in space, frying the delicate electronics of all satellites, and disproportionately hamstringing U.S. troops who rely on satellites for missile and bomb guidance and for communications."[43] If such a detonation were to occur, even though not directed at a terrestrial target, the nuclear threshold would have been crossed. Even a so-called "irrational" adversary would have to think twice before using a nuclear weapon. And, certainly, the United States would view such an attack differently than if a conventional weapon had been used and would respond accordingly. During the Cold War, a distinct demarcation between conventional and nuclear weapons existed. Even if lower yield battlefield or tactical nuclear weapons had been used (e.g., in a scenario involving a Warsaw Pact invasion of a NATO country), escalation to a larger-scale retaliation using the United States' strategic nuclear arsenal was a very real possibility. Although a "doc-

The best and least expensive way to increase surviv-ability against a potential microsatellite ASAT threat is to use decoys.

Possession of a technology by a potentially hostile power does not mean that the country will be able to translate the technology into an effective military system.

trine" may not be in place to respond to a low-yield nuclear ASAT scenario, the United States would probably go beyond the use of conventional weapons to retaliate. Potential adversaries know this. For example, the United States made clear to Iraq that use of chemical or biological weapons would trigger an appropriate U.S. response, including the possibility of nuclear weapons.[44]

Microsatellite ASATs

One nonnuclear ASAT threat comes in the form of microsatellites, also known as parasitic satellites. These are small, lightweight, inexpensive, and highly capable systems that could perform a variety of missions (many of them legitimate peacetime operations). According to Wilson, microsatellites could be used for counterspace operations by being flown alongside a target until commanded to disrupt, and then disable or destroy the target. Detecting and defending against such an attack would be difficult.[45]

Stephen Cambone, former special assistant to Secretary of Defense Rumsfeld and current principal deputy under secretary of defense for policy, notes, "There are any number of companies, both in the United States and abroad, that are preparing to deploy micro-satellites."[46] And Wilson cites Chinese plans to develop and deploy a microsatellite ASAT:

> The *Sing Tao* newspaper recently quoted Chinese sources as indicating that China is secretly developing a nanosatellite ASAT weapon called "parasitic satellite." The sources claim this ASAT recently completed ground testing and that planning was underway to conduct testing in space. The Chinese ASAT system is covertly deployed and attached to the enemy's satellite. During a conflict, commands are sent to the ASAT that will interfere with or destroy the host satellite in less than one minute.[47]

But historically, Chinese plans for high-technology weapon systems have vastly exceeded China's ability to successfully develop and field them. For example, China has not been able to develop and deploy a modern fighter aircraft that is even remotely on par with former Soviet or current U.S. planes.

Michael Krepon, founding president of the Henry L. Stimson Center, points out:

> Even if Washington decides not to put weapons in space, Moscow and Beijing might still pursue antisatellite technologies. Although neither Russia nor China can compete effectively with the United States in conventional or nuclear weapons or in missile defenses, either country could respond "asymmetrically" to American superiority by damaging U.S. satellites. The Pentagon defines asymmetrical warfare as "countering an adversary's strengths by focusing on its weaknesses." Asymmetrical warfare allows a weaker opponent to level the playing field by unorthodox means. Antisatellite programs are a good example of asymmetrical warfare: they are less expensive and technically challenging than engaging in conventional or missile-defense arms races but allow a weaker opponent to gain an edge (at least temporarily) over a stronger one.
>
> Given U.S. military predominance, it will be difficult to dissuade Russia and China from developing ASATs. *But it will be well worth the effort to try, and it can be accomplished only if the United States does not take the lead in pursuing ASATs.*[48]

In fact, a less interventionist U.S. foreign policy vis-à-vis China could ultimately be more conducive to reducing any potential ASAT threat than deploying weapons (either defensive or offensive) in space would be. A good example is current U.S. policy toward Taiwan and how it affects America's relations with China. The Cato Institute's vice president for defense and foreign policy studies, Ted Galen Carpenter, has stated:

> In addition to the balance of military forces, three factors are especially important in determining whether deterrence is likely to succeed or fail: the importance of the interests at stake to the guarantor power, the importance of those interests to the challenging power, and the inclination of the challenging power to gamble. All three factors work against the United States in the case of Taiwan.[49]

Recognizing that Taiwan is not a vital American national security interest, Carpenter recommends that the United States issue a firm statement that it will not become involved in any armed struggle between Taiwan and mainland China.[50] By reducing the likelihood of such armed conflict, this would reduce the incentive for China to directly challenge the United States by developing and deploying ASATs.

Even if the United States adopted a more restrained foreign policy toward China, however, it would be imprudent to dismiss the potential Chinese ASAT threat completely, especially given the reported ground testing by China of a microsatellite ASAT. But in the two years since that news was initially reported, there have been no apparent follow-on events to indicate that the Chinese are indeed moving forward with space testing and eventual deployment of the microsatellite ASAT.

Even if such a threat were to evolve, the question is: What is the appropriate response? If the supposed microsatellite ASAT were nonnuclear, then "hardening" satellites against nuclear explosions or electromagnetic pulse would not increase their survivability. According to Tom Wilson, maneuverability would allow a satellite to evade or dodge a directed ASAT attack, but adding maneuverability to a satellite system would increase the total cost by between 10 and 20 percent, depending on the satellite altitude (warning time), nature of the threat, and threat detection efficiency.[51] Also, self-defense would be problematic because a microsatellite ASAT would be difficult to detect and would probably reside in an otherwise nonthreatening satellite. And, of course, the United States should not adopt a policy of shooting down every Chinese satellite launched on the presumption that it might contain a microsatellite ASAT. Perhaps the best and least expensive way to increase survivability against a potential microsatellite ASAT threat is to use decoys that simulate the radar and optical signatures of the target satellite. Jamming systems could also be employed to confuse an ASAT's homing system. Analysts estimate that satellite decoys would increase the total system cost by between 1 and 10 percent.[52]

A military requirement to protect satellites may be a way to pursue development and deployment of a global NMD.

Other Potential ASAT Threats

Other potential ASAT weapons include laser, radio frequency (RF), and particle beam weapons.[53] Laser weapons would generate intense beams of light to inflict thermal damage on the target satellite. RF weapons would emit an intense burst of radio energy—usually either high power microwave (HPM) or ultrawideband (UWB)—to disable the satellite's electronic components. Particle beam weapons use accelerated atomic particles (such as negative hydrogen or deuterium ions) to generate an intense beam that disables electronic components. Again, it is important to emphasize that these are postulated—not operational—ASAT weapons. Further, they are all very technologically advanced, extremely expensive, and therefore outside the capabilities of most—if not all—potential adversaries, especially rogue states.

The Quality and Costs of Space Systems

When evaluating a threat to U.S. space-based military and commercial assets, it is important to note that possession of a technology by a potentially hostile power does not mean that the country will be able to translate the technology into an effective military system. During the Cold War, the Soviet

U.S. security could ultimately be reduced if hostile nations are spurred to develop and deploy ASATs in response to U.S. deployment of space-based missile defense.

Union had scientists and engineers doing cutting-edge work, but it often found it extremely costly and difficult to produce in quantity—or sometimes prototype—the most cutting-edge systems, equipment, or devices. The race to the moon was a case in point. The Soviet Union produced many space firsts but ultimately could not produce refined, quality systems that could be launched successfully, time after time. America had its major mistakes as well, such as the fire on the launch pad of Apollo 1 in 1967. But America learned from its mistakes and constantly improved its systems, even ones run by the American government.

In the late-1960s, the Soviet Union built what for some years was the world's largest telescope, the Bolschoi Teleskop Azimultalnyi. The problem was that it rarely worked properly. At a more basic and humble level, the Soviet Union was not able to produce quality consumer products in quantity.

China, the country often feared as threatening U.S. space-based assets, has quality problems similar to those of the old Soviet Union. For example, it has never been able to produce in quantity a quality fighter plane, which would be far more important to its military needs than exotic space weapons. Thus, the fact that a country possesses a technology that could be developed to threaten U.S. space assets is a reason for attention and concern, but it is not a reason for new, costly programs to counter phantom threats.

More to Lose Than to Gain

As important and potentially vulnerable as current U.S. space-based assets might be, deploying actual weapons (whether defensive or offensive) would likely be perceived as very threatening to the status quo. Because of this, any move to weaponize space would likely precipitate a response to counter such capability. And weapons in space would indeed be tempting targets for a preemptive attack by an adversary. To be sure, not deploying weapons in space is no guarantee that potentially hostile nations (such as China) will not develop and deploy ASATs. However, it is virtually certain that deploying U.S. weapons in space will lead to the development and deployment of ASATs to counter such weapons. The United States should therefore not be the first to weaponize space—either with defensive weapons or with offensive ASATs. But deploying defensive decoys—rather than weapons—would not inevitably lead to such an arms race.

In the final analysis, any near-term moves toward weaponizing space are premature. If the U.S. government is concerned that some nations may find its military and commercial satellites tempting targets, then the United States ought to look first to its foreign policy and military posture as a factor in motivating those nations to take hostile actions toward the United States. According to Richard Betts at the Council on Foreign Relations, "American activism to guarantee international stability is, paradoxically, the prime source of American vulnerability."[54]

To the extent that the U.S. government is concerned that a potential enemy might try to knock out satellite-provided military capability, such as GPS, it needs to also understand the consequences of such action to the attacker. If an adversary were to jam or destroy GPS satellites, it would deny such capability not only to the United States but also to itself (unless, of course, it was using the Russian Global Navigation Satellite System, or GLONASS). Furthermore, the United States can switch the encrypted military P-code back on if deemed necessary for national security reasons; it is presumably more jam resistant than the commercial C/A-code. Even in a worst-case scenario where U.S. forces might be denied GPS signals, our military personnel are sufficiently trained to be able to use a map and compass to navigate and determine their location.

Space and National Missile Defense

Although it can be considered part of the space control mission, ballistic missile defense (BMD) is usually treated separately.

And distinctions are usually made between theater missile defense (TMD) and national missile defense (NMD). The whole subject of NMD and the debate surrounding it is beyond the scope and purpose of this paper.[55] However, in the Bush administration, it is important to understand that there is a relationship between NMD and space defense policy.

The Bush administration has made clear its intentions to build and deploy an NMD system. Despite opposition and concerns from many different sources—domestic, allied, and foreign (notably Russia and China)[56]—the administration intends to build a missile defense test site in Alaska (presumably as a precursor to a land-based deployment) and begin development within four years of a multilayered shield that will include ship-launched missiles and lasers mounted on airplanes.[57]

Although the Bush administration has yet to lay out in detail an exact plan or architecture for a national missile defense system, during the presidential campaign Bush argued forcefully that a U.S. missile defense system must protect not only the United States but also friends, allies, and forces deployed overseas.[58] Bush also repeatedly made clear that to move forward on NMD, he intended to abandon the ABM Treaty.[59] He recently carried out this pledge by giving Russia the requisite six months' notice of U.S. withdrawal from the treaty.[60]

Certainly, any NMD system will need to rely on space systems—at a minimum for launch detection and early warning (currently provided by the DSP satellites, which are supposed to be replaced by the SBIRS high satellites).[61] Even a ground-based system (i.e., interceptors and radars) might be supported by space-based sensors for midcourse tracking and discrimination (such as the proposed SBIRS low satellites).[62]

The question the president has left open, at least for now, is whether NMD will include space-based weapons. Bush has not specifically excluded space-based weapons as part of NMD and has abandoned the ABM Treaty—hints that space-based weapons could eventually become a reality.

Perhaps more important, however, is the fact the Secretary of Defense Rumsfeld is viewed by many as the architect and moving force behind both missile defense[63] and space policy in the Bush administration. If Rumsfeld is indeed the architect, then it is reasonable to conclude that the prescription for space policy outlined in the Space Commission report might represent a blueprint for action.

Specifically, the report argues that the United States needs space-based weapons (to defend satellites) and implies that we should employ them as part of national missile defense.[64] United States space policy and capabilities—as they have been described in the Space Commission report and discussed by some in the military—are, by their very nature, global. As such, they only serve to foster a global, space-based NMD system. In other words, the only way to defend the panoply of satellites orbiting the earth is to have a constellation of space-based weapons to provide "space superiority." And those space-based weapons will have an inherent capability to shoot at ballistic missiles (whether they threaten the satellites or not). Thus, a military requirement to protect satellites (even in the absence of a true anti-satellite or ASAT threat) may be a way to pursue development and deployment of a global NMD in a potentially less visible and publicly debated way.

Previous Cato Institute reports have argued that a national missile defense system should be a truly national defense to protect the United States homeland and not a global defense to provide worldwide protection.[65] The reasons that NMD should be limited to protecting the United States include the following:

- The technology for a limited land-based system is the most mature and is currently in its early stages of operational testing.
- U.S. allies are wealthy enough to build their own missile defenses.

A vibrant commercial space industry will support and enhance U.S. military capabilities far better than letting military requirements dominate space policy.

Lower costs for space activities—produced by private-sector efforts—would mean a greater capacity for defense.

- Any defense expenditure must be commensurate with the threat, and the limited ballistic missile threat does not justify the large expenditures required for a global, layered defense system.
- If thicker and wider missile defenses cause U.S. policymakers to feel more secure against missile attacks, they may be more tempted to engage in reckless overseas military adventures, which would actually reduce U.S. security.

The concern here is that—much as missile defense advocates have used sea-based missile defense as an attempt to open the door to a larger, more expensive global missile defense[66]—space defense policy will be used as a way justify and achieve a global—as opposed to national—missile defense. Indeed, if space policy is implemented as outlined in the Space Commission report, a global missile defense may be inevitable.

And if there are any doubts about the inextricable relationship between space policy and NMD under Rumsfeld, consider the following statement by Senator Smith:

> With the completion of the Rumsfeld national missile defense and space commissions, followed by the choice of Rumsfeld to serve as the first Secretary of Defense for the 21st century, we were already batting three-for-three. . . . Now, if Rumsfeld is able to weave space and missile defense into our national defense posture in a way that makes them absolutely essential, which I'm convinced he is determined to do, then the potential is there for a historic grand slam.[67]

Yet building a global NMD system may actually be counterproductive. Such a system would be able to shoot down not only ballistic missiles but also ASATs as well as orbiting satellites and spacecraft. Nations that feel that the United States is trying to hold their satellites at risk or prevent them from launching satellites will have incentives (that would be nonexistant in the absence of such a threat) to develop ASATs, regardless of the technological hurdles, and will be more likely to expend the necessary resources to acquire such a capability. Those ASATs could put the whole constellation of U.S. military and civilian satellites at risk. With the greatest dependence of any nation on space assets (both civilian and military), U.S. security could ultimately be reduced if hostile nations are spurred to develop and deploy ASATs (which they currently do not have) in response to U.S. deployment of space-based NMD.

Weaponizing Space Could Harm the Civilian Space Industry

It is also important to consider the chain of events that is likely to occur if the United States tries to dominate space militarily and the effects that weaponizing space could have on the commercial space sector. John Newhouse, senior fellow at the Center for Defense Information, states:

> The [Space Commission] report does not call for but implies a U.S. need to accelerate development of antisatellite weapons, some of them space-based. But deploying such weapons will press other countries to develop and deploy countermeasures. And in any such tit for tat, the United States has the most to lose, since it is far more dependent on satellites for commercial communications and data-gathering operations than any other country. Among the effects could be a sharp rise in the cost of insuring commercial satellites and an outcry from industry.[68]

In other words, weaponizing space could be costly to an American industry that has great promise to grow and increase its contribution to the U.S. (and world) economy.

Ultimately, a vibrant commercial space industry will support and enhance U.S. military capabilities far better than letting military requirements dominate space policy. Therefore, the government should avoid overregulating commercial space activities and imposing costly military requirements. For example, the Heritage Foundation has recommended designating the Global Positioning System as critical national infrastructure, making the Department of Defense the lead agency responsible for GPS, and deploying a more secure GPS satellite network.[69] Although GPS was originally designed for and is operated by the U.S. military,[70] it is now interconnected with commercial satellites, and civilian and commercial use now dwarfs military use. More stringent military requirements imposed on the GPS system could have adverse effects on the commercial sector, such as increased complexity and higher cost of equipment.

The past decade has seen expanded commercial use of sophisticated communications satellites for the Internet, television, and other broadband applications, but commercial suppliers still struggle under tight launch and export restrictions. Currently there are major efforts afoot in Congress to ease federal regulations imposed on private commercial space ventures, to deal with structural problems caused by activities of the National Aeronautics and Space Administration, and to promote private space ventures.[71] Space-related defense systems and strategies, if not wisely structured, could seriously hinder the development of future commercial activities in space and, in the long run, could harm America's defense capabilities. Conversely, the Pentagon's ability to defend the nation could benefit from a flourishing of commercial activities.

The weaponization of space could ultimately lead to the federal government regulating commercial satellites for military purposes. As a result, the growth of private-industry ventures in space could be hindered by poorly conceived specifications and regulations in the name of national defense. There are unintended consequences of military requirements on certain kinds of dual-use technology. Consider NASA's experience with designing the Space Shuttle.[72] In order to garner political support for the shuttle, NASA asked the Pentagon what capabilities it would want in such a vehicle. The Pentagon replied that it wanted the shuttle to be able to maneuver in the atmosphere so that it might land at any number of bases in the United States. Thus, the shuttle, which had to be designed with large wings, heated up more on reentry than would a nonmaneuverable craft with far smaller wings. This design required 34,000 heat resistant tiles, which of course added cost to the shuttle. A nonmaneuverable vehicle might have been able to use a different heat-resisting system. Further, in the early years of the shuttle project, these custom-made tiles tended to fall off, requiring more time and cost to maintain the vehicles. In addition, the tiles altogether weighed some 25,000 pounds, cutting the shuttle cargo capacity in half.[73]

Thus, it is no mystery why the shuttle cost so much and never became a commercially viable system. In this case, the Pentagon did not mandate the design of the craft, but instead NASA chose the design for political reasons. This example shows how the unintended consequences of technology mandates can hinder the development of the very technology that is the target of the mandates.

Another current example of a government intervention that is hindering space commercialization is export licensing. The Strom Thurmond National Defense Authorization Act, passed in 1998, transferred export licensing from the Commerce Department to the State Department. The State Department has been much stricter on exports than Commerce, producing serious delays for businesses.

Sometimes the consequences of the export control process are truly destructive to private space efforts. Take the case of the company MirCorp, owned 40 percent by private Western investors and 60 percent by the mostly private Russian rocket company Energia. MirCorp wanted to export from the United States to Russia a tether that would be launched from Russia up to the Mir space station, which MirCorp was in the process of

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commercializing. That tether would have been deployed outside of Mir to provide the station with power. But the State Department delayed approval, only granting export permission the day after the Russian government decided to de-orbit Mir.

Certainly there are security concerns about space-related exports. But the current system does not focus narrowly on keeping dangerous technology out of the hands of America's enemies. Rather, its overbroad and often arbitrary rules cause considerable collateral damage to American entrepreneurs.

To further illustrate how Defense Department requirements imposed on the commercial sector could stunt innovation and growth, consider an analogy with the computer and information sector. Lower launch costs could revolutionize satellites in the same way that personal computers (PCs), software, and the Internet—developed together, free from regulations—created synergies that revolutionized the PC itself. PCs in the early 1980s, like their large mainframe brothers, were used principally for storing data and crunching numbers. Now PCs are tools for entertainment, communications, and undreamed of potential applications.

The development of the PC also has been characterized by unprecedented increases in processing capacity, hard drive space, and reductions in price. For example, Moore's Law, (named after Gordon Moore, one of the founders of Intel) states that processor speed doubles, while prices drop by half, every 18 months. Although it is conceivable that some of the technologies incorporated into PCs—for example, the mouse—could have been devised in government defense labs, making PCs at prices that anyone can afford was the achievement of private entrepreneurs.

Farsighted defense planners have long recognized the importance of commercial sector innovation to defense. For example, a December 1999 report issued by the Defense Science Board Task Force on Globalization and Security discussed how the Department of Defense depends on the private sector in the United States to move faster than its overseas competitors in developing new products and new applications of technology.[74] The Pentagon builds on such commercial progress.

The benefits of the free-market growth in PCs and software to national defense can be seen in flight simulator software. For example, Mike Coligny, the CEO of Flyit Simulators of San Diego, observed that "we developed a [helicopter] simulator that the government typically would pay millions of dollars for, and ours cost $65,000. It's been on the market since late July [2000]."[75] And Ensign Herb Lacy at the Pensacola Naval Air Station purchased a $50 Microsoft Flight Simulator game that he modified to recreate the controls of a T-34C Turbo Mentor, for a total cost of only $250. Using the same software as Lacy, the Navy created six makeshift simulators at a cost of $6,000 each, compared to millions of dollars for conventional simulators.[76]

But the Pentagon's interest in space activities could short-circuit this process. For example, defense specialists foresee greater defense use of the commercial communications network currently in orbit and are concerned that the network should not be compromised or blinded by an adversary. This concern could prompt the Pentagon to seek authority to mandate certain specifications for commercial satellites that would make them less vulnerable to potential enemies. But such mandates could have adverse unintended consequences similar to those that might have occurred had the Pentagon decided to set specifications on PCs to protect them from disabling electromagnetic pulses caused by atomic blasts. Twenty years ago, the Pentagon might have reasoned that such a requirement would make PCs more appropriate for defense uses. Yet we know after the fact that such a requirement would have added significantly to the cost of PCs and forced manufacturers to take such requirements into account in every new phase of PC development. In the end, the PC revolution as we now know it might have been stillborn.

The bottom line is that if the Pentagon needs satellites that are more resistant to attack, it would be better to commission hardened satellites specifically for its needs. Buying such specialized satellites would be a legitimate defense expenditure. The Pentagon would likely have to spend more money than it would if the government forced manufacturers to accept certain costly standards, but the latter approach would simply shift costs to the private sector. Such private, societal costs would likely be higher than the government's budget expenditures dedicated to military satellites. The Pentagon would need to plan its strategies on the assumption that a private space network would be more vulnerable than it might find ideal. But the alternative, in the long term, would be a weakened overall private satellite network that would be less useful for defense purposes.

In any case, commercialization of space, which could lead to lower launch costs and more versatile satellites, would make for a more extensive, redundant, and secure satellite system. This redundancy would be good for the Pentagon as a hedge against technical failure, as well as making it more difficult and costly for a potential adversary to destroy.

Other private efforts could also be a boon for America's defense. For example, Nevada businessman Robert Bigelow and his company Bigelow Aerospace plan to devote as much as $500 million to developing a private space station based on light yet durable inflatable structures that would, with three launches, place into orbit the same volume of interior station space that would take NASA dozens of launches, thus radically cutting costs.[77] And the Space Island Group, a U.S. company developing space transportation systems and destinations, proposes that the 150-foot tall external fuel tanks for the shuttle, which currently are jettisoned and burn up in the atmosphere just before the shuttle enters orbit, be placed in orbit as well to serve as platforms for space activities.[78] (Using tanks for stations is not a new idea. It was the second stage of a Saturn 5 rocket that served as Skylab in the mid-1970s.) Further, the Space Island Group is discussing with Boeing the possibility of developing a Shuttle II that would cost only 10 percent of what the current shuttle costs. The proposed Shuttle II would simply ferry tanks, passengers, or cargo to orbiting platforms, eliminating the requirements—and high costs—associated with the current Space Shuttle design for long stays in orbit.[79]

The combination of a private Shuttle II and cheap orbiting platforms (e.g., privately owned space stations) could be used to transport military equipment in only one hour to any point on the planet (compared with several hours for aircraft and days for ships). Other military support technologies likely would result from increased commercial activity. For example, extensive private space activity would result in an increasing demand for satellites that repair or reengineer other satellites while in orbit.

Moreover, the Pentagon might be able to utilize such repair satellites or other commercial advances in satellite technology to frustrate or counter the use of microsatellite ASATs by a potential enemy. Developing microsatellites that can be used to disable American satellites would be an expensive and time-consuming enterprise in any case. If American satellite technology advances to the point of making countermeasures easier, that would add further to the costs of microsatellite systems and make their effectiveness problematic. These factors might cause an opponent such as China to abandon development of such systems.

America's defense has relied on space technologies and will continue to do so. During the Cold War, submarine-launched nuclear missiles and land-based intercontinental ballistic missiles were considered the ultimate insurance against a Soviet attack. Overflights of Soviet territory by reconnaissance planes gave way to orbiting surveillance satellites. Today's sophisticated imaging satellites played a crucial role in military operations in Afghanistan. Communications satellites form an indispensable part of the defense command-and-control infrastructure. And a potential future missile defense system (even one with only ground-based interceptors) by its nature will rely on space-based technologies. Therefore, lower costs for space activi-

The Department of Defense should make use of commercial assets rather than spend needlessly on unique military assets.

ties—produced by private-sector efforts—would mean a greater capacity for defense.

Conclusion

The current threat to U.S. satellites does not warrant the near-term weaponization of space. Civilian space assets (which the United States depends on more and more in day-to-day life) are relatively more vulnerable than military systems; they are not hardened against nuclear attack and do not have anti-jamming capabilities. John Logsdon, director of the Space Policy Institute at the George Washington University has stated: "There appears to be no demand from the operators of commercial communication satellites for defense of their multibillion-dollar assets. *If there were to be active military operations in space, it could be difficult not to interfere with the functioning of civilian space systems.*"[80]

Just as important is the relationship between military and commercial uses of space. Certainly, there are some uses of space that are unique to the military—such as ITW&AA. This is an area where military needs and requirements cannot be met by commercial systems. That is, the military will be the sole user for systems such as DSP satellites, which monitor missile launches worldwide.[81]

But virtually all other applications of space are "dual use." To be sure, military needs and requirements must be recognized. For example, the military and intelligence agencies may have unique requirements for surveillance and reconnaissance that can be met only with their own dedicated satellites—either for reasons of security of data or technical requirements (e.g., resolution, processing time). A similar situation exists with regard to communications. For example, Milstar is a dedicated military satellite communications system that provides secure, jam-resistant, nuclear-hardened communications for all U.S. forces.[82] But in general, the military should make greater use of commercial space satellites.

Wherever possible, the military should consider using distributed and redundant commercial satellite systems as a means to reduce vulnerability to attack.

First, wherever possible, the Department of Defense should make use of commercial assets rather than spend needlessly on unique military assets. For example, the military should use existing communications satellites for its nonsecure communications capability. Former vice chief of staff of the Air Force General Moorman asserts that by making maximum use of civilian satellites, "military satellite communications will benefit in terms of access to additional capacity (tremendous increases in available bandwidth and flexibility, as well as multiplicity of alternative communications paths)."[83] Also, the military can make use of commercial imaging satellites, such as Earth Watch's EarlyBird 1, Space Imaging's EOSAT (which will initially offer one-meter resolution, the highest resolution of any commercially available system),[84] and Orbiting Image's OrbView.

Second, wherever possible, the military should consider using distributed and redundant commercial satellite systems as a means to reduce vulnerability to attack rather than deploying unique military systems that are likely to be more expensive and take longer to deploy. For example, it may be more cost-effective to develop and deploy smaller satellites in a distributed system configuration designed to operate at low earth orbit and medium earth orbit than larger, heavier satellites operating in geosynchronous (stationary) orbit.[85] That approach is especially meritorious if there is a potential shortage of heavy-lift launch capability.

Third, military requirements should not be imposed on shared nonmilitary satellites. For example, the military should not require hardening against electromagnetic pulse on commercial satellites that are also used by the military. To the extent that such requirements are absolute needs, the military should deploy its own dedicated systems to meet those requirements. Neither commercial satellite operators nor the other users of commercial satellites should shoulder any cost burdens imposed by the military (and clearly, the military must be more realistic about its requirements).

In short, in the future, the military will likely have greater reliance on commercial space systems. As General Moorman has stated:

> On the one hand, commercialization is not a total panacea. . . . On the other hand, the commercial space industry is expanding at such a rate and with such marvelous capabilities that it seems reasonable if not inevitable that a number of missions—heretofore the exclusive province of the government—can be satisfied or augmented commercially. We can also realize significant efficiencies by taking advantage of commercial space.[86]

However, even if commercial space is not a panacea for the military, it should be the driving force of space and shape space policy. In other words, defense and national security need to be one component of overall U.S. space policy, but certainly not the primary component. In the post–Cold War environment—with no immediate threat from another great power and none on the horizon (at least in the near- to mid-term)—the U.S. government must avoid establishing inflated and costly military requirements for space-based resources. U.S. space policy should strive to foster an environment that allows commercial space activity to grow and flourish rather than create a new area for costly military competition.

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Appendix

Table 1
Illustration of Space Support for Peace, Peacekeeping/Humanitarian, and Counterinsurgency Operations

Type of Operation and Operational Objectives	ITW &AA	Weather/Environmental Monitoring	Space Launch	Satcom	Surveillance/ Reconnaissance	Navigation/ Positioning	Space Control	BMD	Force Application
				Peacetime Operations					
Inhibit surprise attack	Detect, track, and assess missile launches		Provide capability to deploy satellites on short notice				Ensure surviv-ability of space assets	Deter threat of ballistic missile attack	Deter threat of attack against U.S. forces overseas
Monitor arms control agreements				Support U.S. diplomatic operations	Monitor treaty compliance				
Provide routine operational support		Monitor weather for military exercises	Maintain adequate satellite constellations	Maintain secure communications to forces		Provide position location to troops in field	Routinely monitor satellites in orbit		
				Peacekeeping/Humanitarian					
Establish and defend safe areas	Monitor theater ballistic missile launches in areas of crisis		Ensure secure communica-tions between U.S. and coali-tion forces	Deny infiltration in regions of concern	Establish accurate boundaries of safe areas	Ensure freedom of movement to, from, and in space	Monitor potential threats to safe areas		
Protect and rescue U.S. citizens overseas		Assess terrain for rescue operations		Monitor aggres-sive troop movements					Deter threat of attack against U.S. forces engaged in hostage rescue
Conduct disaster relief		Monitor weather for humanitarian operations	Maintain adequate satellite constellations	Establish communication links in disaster areas	Assess terrain for rescue operations				
				Counterinsurgency					
Provide foreign internal defense support	Monitor weather over areas of interest	Ensure secure communications	Conduct surveillance in areas of potential insurgent activity		Provide accurate position location to U.S. advisers	Protect allied space capabilites			

Source: Dana J. Johnson, Scott Pace, and C. Bryan Gabbard, *Space: Emerging Options for National Power*, RAND MR- 517, 1998.

Table 2
Illustration of Space Support for Anti-Terrorism, Crisis, and Country Conflict Operations

Type of Operation and Operational Objectives	ITW &AA	Weather/Environ-mental Monitoring	Space Launch	Satcom	Surveillance/ Reconnaissance	Navigation/ Positioning	Space Control	BMD	Force Application
				Anti-Terrorism					
Locate and destroy centers of terrorist activity	Provide warning of potential missile launches			Ensure reliable, secure communi-cations	Locate areas of terrorist activity		Ensure survivability of U.S. space assets		Destroy terrorist command-and-control centers through timely application of force from space
				Crisis					
Monitor, assess, and respond to theater crisis	Monitor threat regions for missile launches	Assess weather in theater for possible air operations	Maintain or enhance on-orbit assets through timely launch	Ensure reliable, secure, and timely communication links in theater	Conduct surveillance in threat areas in support of developing theater air campaign	Provide accurate position location to theater forces	Identify potential threats to space systems		
Deter aggressive aggressive actions by belligerents		Assess sea state effects on enemy naval activities			Conduct surveillance on troop movements in theater	Neutralize hostile artillery		Initiate preparatory BMD actions	
				Country Conflict					
Monitor situation to protect U.S. interests			Launch additional space capabilities as required	Relay critical information on situation		Maintain position location of possible belligerents	Protect ground stations, other space assets in country		

Source: Dana J. Johnson, Scott Pace, and C. Bryan Gabbard, *Space: Emerging Options for National Power*, RAND MR-517, 1998.

Table 3

Illustration of Space Support for Regional Conflict and Sustained Nuclear Operations

Type of Operation and Operational Objectives	ITW &AA	Weather/Environmental Monitoring	Space Launch	Satcom	Surveillance/ Reconnaissance	Navigation/ Positioning	Space Control	BMD	Force Application
				Regional Conflict (MRC Level)					
Achieve and maintain air supremacy	Provide warning of threats to air assets	Assess weather for all air operations		Relay effects of air supremacy campaign	Locate threats to U.S. and allied air operations				Supress enemy air defenses
Ensure access to space			Provide alternative launch capabilities				Protect space launch site	Detect, track, destroy threats to naval operations	
Halt or evict invading armies				Ensure adequate and secure communications to respond	Determine routes of attack	Maintain position location of U.S. and allied forces			Deny enemy advances on battlefield by destroying command-and-control sites
Achieve and maintain sea control	Detect and track sea-launched missiles	Assess weather effects on sea control	Maintain on-orbit capabilities to ensure sea control	Provide secure, reliable communications	Maintain situational awareness of enemy naval forces	Maintain accurate position of U.S. naval forces	Protect space assets providing support to naval forces	Deter missile threats to naval operations	
Suppress war-supporting industry		Conduct adaptive route planning			Identify possible targets of interest				
				Sustained Nuclear					
Provide unambiguous warning of attack	Detect, track, and assess missile launches			Maintain secure, reliable communication links to NCA and forces		Provide accurate position location for responding forces		Initiate BMD actions	

Disrupt forces and war-supporting industry			Maintain survivable quick launch capability			Maintain survivability of U.S. and allied space assets	
Limit U.S. damage	Identify impact points	Assess effects of attack on U.S. allies		Reconfigure U.S. C3	Determine effects on U.S. and allies	Defend against ballistic missile attack	Deny/ destroy means of long-range attack

Source: Dana J. Johnson, Scott Pace, and C. Bryan Gabbard, *Space: Emerging Options for National Power*, RAND MR-517, 1998.

Notes

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2. Ibid., p. 17.

3. Ibid., p. 19.

4. Ibid., p. 22.

5. Ibid., p. 99.

6. Ibid., p. 100.

7. It is also worth noting that the staff director for both Rumsfeld commissions was Stephen A. Cambone, who then became a special assistant to Rumsfeld and is currently principal deputy under secretary of defense for policy. See Al Kamen, "Senators Have a Cambone to Pick," *Washington Post,* June 27, 2001, p. A23.

8. See Thomas E. Ricks, "Space Is Playing Field for Newest War Game," *Washington Post*, January 29, 2001, p. A1; and Jonathan Broder, "Forward, March . . . into Space," MSNBC, http://www.msnbc.com/news/546843.asp.

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12. Johnson, Pace, and Gabbard, p. 29.

13. Ibid., p. 32.

14. Moorman.

15. Johnson, Pace, and Gabbard, p. 35.

16. Ibid., p. 36.

17. Linda L. Haller and Melvin S. Sakazaki, "Commercial Space and United States National Security," Commission to Assess United States National Security Space Management and Organization, www.space.gov/commission/support-docs/aritcle06/aritcle06.html.

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22. Smith.

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24. Quoted in ibid.

25. Quoted in ibid. See also Michael Krepon, "Lost in Space: The Misguided Drive toward Antisatellite Weapons," *Foreign Affairs,* May/June 2001; and John M. Logsdon, "Just Say Wait to Space Power," *Issues in Science and Technology,* Spring 2001.

26. Hays and Mueller.

27. Space Commission, p. 27.

28. Ibid., p. xiii.

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30. Hays and Mueller.

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32. Space Commission, p. 19.

33. "Backyard Satellite Jammers Concern US Airforce," *News in Science,* April 25, 2000, www.abc.net.au/science/news/stories/s120537.htm.

34. Corey Grice, "Satellite Hack Raises Security Questions," *CNET News.com,* March 3, 1999, http://news.cnet.com/news/0-1004-200-339481. html.

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36. "GPS Anti-Jam Technology," Raytheon, www.raytheon.co.uk/raytheonnoflash/sections/products/product_systems/navigation_system_defence/navigation_system_defence.htm.

37. "What's the Advantage of Frequency-Hopping?" Johnson Consulting, www.swedetrack.com/images/bluet11.htm.

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39. Richard L. Garwin, *Toward National Security: The Role of Space Weapons, Antisatellite Weapon Tests, and National Missile Defense*, October 21, 1999, www.fas.org/rlg/102599-lakhdhir.htm.

40. According to Hays and Mueller: "'Space weapons such as the U.S. nuclear-tipped Program 505 and 427 antisatellite (ASAT) systems or the Soviet Fractional Orbital Bombardment System and co-orbital ASAT systems were actually deployed to a limited extent beginning in the 1960s but . . . no such dedicated systems are deployed today."

41. Johnson, Pace, and Gabbard, p. 41.

42. Wilson.

43. James Kitfield, "The Permanent Frontier," *Foreign Affairs*, March 17, 2001, p. 784. Emphasis added.

44. Secretary of Defense Dick Cheney said that he assumed Saddam Hussein knew "that if he were to resort to chemical weapons, that would be an escalation to weapons of mass destruction and that the possibility would then exist, certainly with respect to the Israelis, for example, that they might retaliate with unconventional weapons as well." Quoted in Robert Toth, "American Support Grows for Use of Nuclear Arms," *Los Angeles Times*, February 3, 1991, p 1. Also, according to Neil Livingston, "The American government reportedly used third-party channels to privately warn Iraq that 'in the event of a first use of a weapon of mass destruction by Iraq, the United States reserved the right to use any form of retaliation (presumably up to and including nuclear weapons).'" *Sea Power*, June 1991, pp 29–30.

45. Wilson.

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49. Ted Galen Carpenter, "Going Too Far: Bush's Pledge to Defend Taiwan," Cato Institute Foreign Policy Briefing no. 66, May 30, 2001, p. 1.

50. Ibid., p. 5.

51. Wilson.

52. Ibid.

53. See Wilson for a more detailed technical discussion of these weapons.

54. Richard K. Betts, "The New Threat of Mass Destruction," *Foreign Affairs*, January/February 1998, p. 28.

55. See Charles V. Peña and Barbara Conry, "National Missile Defense: Examining the Options," Cato Institute Policy Analysis no. 337, March 16, 1999, and Charles V. Peña, "Arms Control and Missile Defense: Not Mutually Exclusive," Cato Institute Policy Analysis no. 376, July 26, 2000, as two examples of more detailed analysis of national missile defense.

56. For example, see Thomas E. Ricks, "Rumsfeld Defends Missile Shield to Apprehensive Allies in Europe," *Washington Post*, February 4, 2001, p. A24; Roberto Suro, "Missile Defense Is Still Just a Pie in the Sky," *Washington Post*, February 12, 2001, pp. A3–A4; Jack Ruina, "46 Years, No Winners. Aim Elsewhere," *Washington Post*, March 4, 2001, p. B3; Steven Mufson, "Democrats Plot Strategy on Missile Defense," *Washington Post*, May 20, 2001, p. A14; Mark K. Anderson, "Nuke Shield Can't Stop Critics," *Wired News*, July 17, 2001, www.wired.com/news/politics/0,1283,45273,00.html; Charles Aldinger, "Russia Rejects U.S. Argument for Scrapping ABM," *Lycos News*, August 13, 2001, http://news.lycos.com/news/story.asp?section=Politics&pitem=POLITICS-RUSSIA-USA-DC&rev=20010813&pub_tag=REUTG; Charles Aldinger, "Russia Rejects U.S. Reasoning ABM Obsolete," *Lycos News*, August 13, 2001, http://news.lycos.com/news/story.asp?section=Breaking&pitem=NEWS-RUSSIA-USA-DC&rev=20010813&pub_tag=REUTG; and Robert Burns, "Russia Rejects ABM Withdrawal," *Lycos News*, August 13, 2001, http://news.lycos.com/news/story.asp?section=World&pitem=AP-Rumsfeld-Russia&rev=20010813&pub_ag=APONLINE.

57. Vernon Loeb and Thomas E. Ricks, "Bush Speeds Missile Defense Plans," *Washington Post*, July 12, 2001, p. A1.

58. Suro, "Missile Defense Is Still Just a Pie in the Sky," p. A3.

59. Carla Anne Robbins and Greg Jaffe, "U.S. May Violate the ABM Treaty 'Within Months,'" *Wall Street Journal*, July 12, 2001, p. A4.

60. See Terence Neilan, "Bush Pulls Out of ABM Treaty; Putin Calls Move a Mistake," *New York Times*, December 13, 2001, www.nytimes.com/

2001/12/13/international/13CND-BUSH.html.

61. Both the SBIRS high and low programs are experiencing cost, technical, and schedule problems. See Tony Cappacio, "Lockheed Missile Defense Program Is over Cost and 3 Years Late," *Bloomberg News*, November 14, 2001, www.bloomberg.com.

62. For a more detailed description of the SBIRS program, see "SBIRS: Space-Based Infrared System," *1997 United States Air Force Issues Book*, www.af.mil/lib/afissues/1997/app_b_18. html.

63. See Mark Thompson, "The Secretary of Missile Defense," *Time*, May 14, 2001.

64. In fact, the report explicitly states that "the U.S. Government should vigorously pursue the capabilities called for in the National Space Policy to ensure that the President will have the option to *deploy weapons in space to deter threats to and, if necessary, defend against attacks on U.S. interests.*" Emphasis added. Space Commission, p. 17.

65. Ivan Eland, "Let's Make National Missile Defense Truly 'National,'" Cato Institute Foreign Policy Briefing no. 58, June 27, 2000.

66. See Charles V. Peña, "From the Sea: National Missile Defense Is Neither Cheap Nor Easy," Cato Institute Foreign Policy Briefing no. 60, September 6, 2000.

67. Quoted in Kitfield, pp. 781–82.

68. John Newhouse, "The Missile Defense Debate," *Foreign Affairs*, July/August 2001, p. 105.

69. Heritage Foundation, *Defending the American Homeland*, January 8, 2002, pp. 19–21.

70. For a detailed discussion on GPS, see Peter H. Dana, "Global Positioning System Overview," http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html.

71. Among space-related reform bills under consideration by Congress are the following: The Invest in Space Now Act (H.R. 2177), introduced by Rep. Ken Calvert (R-Calif.), offers tax credits for investments in commercial space activities; the Spaceport Equity Act (H.R. 1931, S. 1243) would allow spaceports to raise construction and renovation funds through tax-exempt bonds; the Zero Gravity, Zero Tax Act (H.R. 2504), sponsored by Rep. Dana Rohrabacher (R-Calif.), would exclude from federal taxes income derived from certain products and services produced in space; and the Space Tourism Promotion Act (H.R. 2443), offered by Rep. Nick Lampson (D-Tex.), would give loan guarantees and capital gains tax exclusions for investments in space tourism.

72. David Gump, *Space Enterprise: Beyond NASA* (New York: Praeger, 1990), pp. 17–18.

73. Ibid.

74. "Final Report of the Defense Science Board Task Force on Globalization and Security," Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, December 1999, http://www.acq.osd.mil/dsb/globalization.pdf.

75. Quoted in Sandra I. Erwin, "$65K Flight Simulator Draws Skepticism from Military Buyers," *National Defense Magazine*, November 2000, www.national defensemagazine.org/article.cfm?Id-354.

76. Harold Kennedy, "Simulation Reshaping Military Training: Technology Jumping from Teenagers' Computers to Pilots' Cockpits," *National Defense Magazine*, November, 1999, www.nationaldefense magazine.org/article.cfm?Id=113.

77. Robert Bigalow, National Institute for Discovery Science, comments at Space Privatization Leadership Summit, June 11–12, 2001, Las Vegas, Nevada.

78. For a detailed discussion, see the Space Island Group website, www.spaceislandgroup.com/homepage.html.

79. Ibid.

80. John M. Logsdon, "Just Say Wait to Space Power," *Issues in Science and Technology*, Spring 2001, p. 36. Emphasis added.

81. For a thorough history of the DSP program, see Jeffrey Richelson, *America's Space Sentinels: DSP Satellites and National Security* (Lawrence: University Press of Kansas, 1999).

82. "Milstar Satellite Communications System," U.S. Air Force fact sheet, www.af.mil/news/factsheets/Milstar_Satellite_Communicati.html.

83. Moorman.

84. Ibid.

85. Low earth orbit is at an altitude of 60 to 300 miles, medium earth orbit is at an altitude of 5,000 to 10,000 miles, and geosynchronous orbit is at an altitude of 22,300 miles. Collins, p. 138.

86. Moorman.

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