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Future Security in Space: Commercial, Military, and Arms Control Trade-Offs

James Clay Moltz, ed.

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FUTURE CHOICES IN SPACE

by James Clay Moltz
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Perhaps the single most important security debate of the early 21st century is the future status of activities in outer space. The international community of states is at a crossroads in this regard, facing a choice of several different directions for how best to proceed. Unfortunately, due to sharp differences of opinion between the United States and other countries over missile defenses and anti-satellite weapons, there are no serious international discussions going on at the governmental level regarding these issues. Similarly, there is currently no domestic forum in the United States where representatives of various perspectives and interests are discussing areas of consensus and possible compromise. This is not a productive state of affairs for any participants with an interest in future space activities.

Space is unique in the history of human activities in offering an example of early weaponization, then rapid retreat. After more than a dozen U.S. and Soviet nuclear weapons tests in space from 1958-62, however, the two sides re-thought the sagacity of this approach and agreed to halt these activities, instead extending new protections to space. These measures prevented future nuclear testing and thereby protected spacecraft from the harmful effects of electro-magnetic pulse radiation, which had proved very hazardous to reconnaissance and communications satellites during the years of space-based nuclear testing.

Instead of unrestrained competition, the space age witnessed a mix of competition and cooperation between the superpowers, allowing great advances to be made in manned space activity, space commerce, and passive military space systems that would not have been possible without the Limited Test Ban Treaty (1963), the Outer Space Treaty (1967), and other agreements.

Today, space weapons are again being considered by the United States and a few other countries, due to a perceived vulnerability of critical space assets to possible attack by states with medium- or longer-range missiles. Treaty loopholes from the 1960s have created gaps in the arms control framework in space, and there are concerns that hostile countries will move to exploit them. At the same time, there are possible new opportunities for strengthening protections in space, if states are able to reach consensus on the threats that exist and create reliable means of verifying that harmful activities can be prevented or limited in meaningful ways.

The purpose of this project on "Future Security in Space," initiated jointly by the Monterey Institute's Center for Nonproliferation Studies (CNS) and the University of Southampton's Mountbatten Centre, is to identify areas of common ground in the field of future space activity. By creating a new discussion forum that includes representatives from the defense community, industry, the space science community, the U.S. Congress and other legislatures, and executive branch officials from various space-faring countries, this project seeks to move beyond the existing stalemate at the Conference on Disarmament and at other international negotiating fora. It seeks to offer an unofficial mechanism to give all parties interested in consensus-building the opportunity to consider and discuss future priorities outside the constraints of formal government-to-government channels. Of course, the hope of this effort is that eventually these discussions will facilitate the development of fruitful new concepts for moving forward official governmental discussions on these issues.

The initial stage of this project brought together a wide range of space actors to discuss the relevant issues at a workshop held near Southampton, England, on May 28 to 29, 2002. Over 50 governmental officials, space industry representatives, and NGO experts from over 15 countries (including Argentina, Austria, Canada, China, France, Germany, India, Israel, Japan,

Pakistan, Russia, South Korea, Ukraine, the United Kingdom, and the United States) met for discussions on the future of space activity and means of breaking the current impasse at the international level in space security talks. The meeting allowed a very positive exchange of ideas and facilitated the development of a number of new diplomatic initiatives, particularly via off-line discussions among the government officials present. Many of the delegations expressed renewed optimism about chances for progress following the meeting, particularly thanks to the highlighting of attention on areas of consensus that do exist today—including, among others, shared goals of non-interference with satellites and enhanced mitigation of orbital debris as possible first steps. The various sides discussed ideas for new initiatives via unilateral pledges, bilateral commitments of non-interference (expanding upon existing U.S.-Russian pledges regarding arms control monitoring satellites), as well as multilateral resolutions or conventions on space debris.

This publication includes those presentations made at the off-the-record May meeting that officials and experts were willing to share publicly. Our goal is to provide these studies to a broader audience in a timely manner with the hope of stimulating further discussion and thinking about new avenues for international consensus-building regarding space. Pending funding, follow-on activities are planned to try to continue this process and to draw in other interested parties, particularly from the commercial space sector.

CNS and the Mountbatten Centre express their particular thanks to the Ploughshares Fund for a grant in support of this project, as well as the Carnegie Corporation, the Ford Foundation, the John Merck Fund, the Prospect Hill Foundation, the Scherman Foundation, and the W. Alton Jones Foundation for general support grants that have supported this work. As the editor of this collection, I would also like to thank my summer research assistant, Derek Turner, who provided valuable help in all phases of the production of this Occasional Paper.

DEFENSES IN SPACE: TREATY ISSUES

by Jonathan Dean
Union of Concerned Scientists

THE PRESENT SITUATION – ANARCHIC COEXISTENCE OF MILITARY AND COMMERCIAL ASSETS

The present rather anarchic coexistence of military and commercial assets on the space frontier may come to an end within the next five to 10 years. This could happen if a new stage—weaponization of space—begins and is followed by the first space weaponizing power's promulgation of its own rules of the road for space. Or, it could happen if the present near-anarchy is replaced by a new international rule of law, whether via a formal treaty or political agreements.

In any event, there cannot be much doubt that the weaponization of space will begin in the foreseeable future unless it is hindered by organized, effective international opposition or the current U.S. administration is replaced by an administration willing to cancel projects for weaponization of space in the face of considerable opposition from domestic proponents of weaponization.

This issue is not a theoretical one. Development of two specific space-based weapons, a kinetic kill weapon and a space-based laser, is official policy of the U.S. administration as part of its missile defense project. It is not a priority, but it has a specific development program and a budget of many millions projected over the next several years. The first space tests are scheduled to take place in five to six years, with deployment five to six years thereafter. This action is backed by an official doctrine calling for U.S. supremacy in space and doing what is needed to achieve that supremacy.

It is sometimes argued that space weapons won't work and therefore that concern over this subject is misplaced. This is a misleading argument. There are real doubts that some forms of missile defense will be effective, but this does not prevent justifiable concerns over the effects of U.S. deployment of nationwide missile defenses. The deployment of the first weapon in space within the next five to six years will cross the fateful line into the competitive weaponization of space.

It can be argued that, before these two missile defense weapons are orbited, the weaponization of space will begin with the deployment of the first ground-based interceptor missile in Alaska in 2004. It will be possible to use this system to destroy or incapacitate satellites moving in fixed orbit more easily than destroying an incoming missile. These interceptors will in practice be anti-satellite weapons, or ASATs. Beyond this, in May 2002, the House Armed Services Committee placed an unsolicited sum of $7 million in the fiscal 2003 budget for the Defense Department calling for continued development of a ground-based ASAT.

As weaponization appears to loom closer, there have appeared several suggestions for partial measures: "rules of the road" or confidence-building measures that would restrict weaponization or mitigate its effects if it comes. Some examples include: keep-out zones around satellites; non-interference and protection for manned space flight and manned space vehicles; and pre-launch notification and verification. One recent article suggests a mixed regime of some weaponization and some reassurance measures.[1]

Regardless of their motives, those advocating mixed regimes appear to assume that the weaponization of space is inevitable and that we might as well make the best of it. Must we take this outcome for granted? It would be far more desirable to reach agreement on a treaty prohibiting the weaponization of space, while also assuring use of space for both military and civilian observation and communications, with their own rules of the road governing this non-weaponized situation. I do not think this possibility can or should be ruled out. Furthermore, it should be possible to

[1] James Clay Moltz, "Breaking the Deadlock on Space Arms Control," *Arms Control Today* 32 (April 2002).

enter into dialogue with the United States to negotiate widely beneficial confidence-building measures while leaving open for later discussion the question of whether space-based weapons shall be permitted or banned.

EXISTING LEGAL STRUCTURE

In regards to the existing legal structure relating to space weapons, the principal relevant treaty is the 1967 Outer Space Treaty (OST), which prohibits the orbiting or stationing in space of weapons of mass destruction, but not other weapons. I will return to the OST in a moment. Five other treaties address outer space. They include: the Limited Test Ban Treaty of 1963, which prohibits nuclear tests (and any other nuclear explosion) in the atmosphere or in outer space; the Astronauts Rescue Agreement of 1968; the Liability Convention of 1972; the Registration Convention of 1976; and the Moon Agreement of 1984.[2] These last four treaties elaborate aspects of the 1967 treaty.

In addition, there are five relevant General Assembly resolutions: the Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space (1963); the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Use and Benefit and in the Interest of All States (1996); and also resolutions on Direct Television Broadcasting, Remote Sensing of the Earth from Outer Space, and the Use of Nuclear Power in Outer Space.[3] Since June 13, 2002, when U.S. withdrawal from the ABM Treaty became effective, there is no longer a treaty prohibition against testing or deploying weapons in space other than weapons of mass destruction. Lt. General Ronald Kadish of the Missile Defense Agency has already ordered ground-breaking at Fort Greeley for the missile defense installation there.

A sixth treaty is relevant to space weapons. The concept of non-interference with national technical means of verification first appeared in the SALT I Treaty of 1972 and was taken over into the START I Treaty, which has been prolonged to 2009. Similar protections are imbedded in the INF Treaty and the Conventional Forces in Europe (CFE) Treaty. The intent of these measures is to preserve from attack or interference satellites involved in verification. As I read it, it would be a violation of the provisions on noninterference with national means of verification in the START I and INF treaties to use weapons against any early warning, imaging, or intelligence satellite and, by extension, against any ocean surveillance, signals, intelligence or communications satellite of the U.S. or Russia. This obligation was made multilateral in the CFE Treaty.

[2] The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (the "Rescue Agreement"), opened for signature on April 22, 1968, entered into force on December 3, 1968, 87 ratifications; The Convention on International Liability for Damage Caused by Space Objects (the "Liability Convention"), opened for signature on March 29, 1972, entered into force on September 1, 1972, 81 ratifications; The Convention on Registration of Objects Launched into Outer Space (the "Registration Convention") opened for signature on January 14, 1975, entered into force on September 15, 1976, 43 ratifications; The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Agreement"), opened for signature on December 18, 1979, entered into force on July 11, 1984, 9 ratifications (As of February 1, 2001).

[3] The Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space (General Assembly resolution 1962 (XVIII) of December 13, 1963); The Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting (resolution 37/92 of December 10, 1982); The Principles Relating to Remote Sensing of the Earth from Outer Space (resolution 41/65 of December 3, 1986); The Principles Relevant to the Use of Nuclear Power Sources in Outer Space (resolution 47/68 of December 14, 1992); The Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (resolution 51/122 of December 13, 1996).

THE 1967 OUTER SPACE TREATY

The 1967 OST is based on "the common interest of all mankind in the . . . use of space for peaceful purposes." The treaty forbids the orbiting or stationing in space of weapons of mass destruction and prohibits the use of the moon or other celestial bodies for other than peaceful purposes. The treaty contains four explicit references to the peaceful use of outer space.

This language points to the fact that, during the 30-year existence of the OST, a powerful norm has emerged against the weaponization of space, for keeping armed conflict out of space, and for ensuring the peaceful use of space. This conclusion is documented by UN General Assembly resolutions each year for the past 21 years calling for maintaining peaceful uses of space and opposing its weaponization. Most of these resolutions have been unanimous and without opposition, although the United States and a few other governments have abstained. In the most recent version of December 2001, the General Assembly once again passed, by 156 votes for to zero opposed, a resolution calling for negotiation in the Geneva Conference on Disarmament of a treaty to prevent an arms race in outer space. This time, there were four abstentions to the resolution. The now customary trio of the United States, Micronesia, and Israel was joined by a fourth country, Georgia. The resolution asks all treaty parties to refrain from actions contrary to the peaceful use of outer space and calls for negotiation in the Conference on Disarmament on multilateral agreements to prevent an arms race in outer space.

These repeated, nearly unanimous resolutions, against which even the United States does not vote, are not only evidence for the existence of a norm against the weaponization of space. They also indicate a very widespread desire to expand existing multilateral agreements to make explicit a prohibition against all weapons in space.

Article IV of the OST prohibits placing in orbit around the earth any objects carrying nuclear weapons or other weapons of mass destruction. It also prohibits the testing and, I would argue, the deployment of any kind of weapon on the moon or other celestial bodies. There is no provision for verification. As is well known, the 1967 Treaty does not prohibit the orbiting in space of weapons other than nuclear weapons or other weapons of mass destruction.[4]

However, the OST is not without useful features relevant to the possible weaponization of space. Article VII makes treaty parties that launch objects into outer space liable for damage to the property of another treaty party—this is also spelled out in the Liability Convention of 1972. The Liability Convention foresees the establishment of a Claims Commission to determine the extent of liability for damage by the space objects of one country to the space objects or property of another state. Article IX of the OST provides for consultations if any treaty party believes an activity planned by another treaty party would cause "potentially harmful interference with activities in the peaceful exploration and use of outer space." Beyond this, the General Assembly could by majority vote request an Advisory Opinion from the International Court of Justice if either the peaceful uses language of the 1967 treaty or these two articles on liability and consultation come under dispute as the space-based component of the missile defense system advances.

In fact, requests for consultation or under Article IX, or also a General Assembly request for an advisory opinion, can and should come now to make world opinion aware of this issue before the damage has been done, and to motivate the United States government to study the issue seriously, including the possibility of rules of the road. The request for consultation under Article IX can come from any party or group of parties to the 1967 treaty. In addition, George Bunn and John Rhinelander point out in a letter to the editor in the June 2002 issue of *Arms Control Today*, that parties to the treaty

[4] Article IV of the 1967 Treaty states: "States 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." This language would appear to preclude orbiting weapons around the moon, but Article III of the 1979 Moon Treaty makes this prohibition explicit.

could convene and issue an interpretation that the U.S. testing or orbiting of space weapons was contrary to the peaceful uses language of the treaty, in effect amending it to preclude any weaponization. The General Assembly could then pass a resolution endorsing this interpretation.

Presumably, Russia, the United States, or any state party to the CFE Treaty could also take legal action based on treaty provisions prohibiting interference with national technical means of verification. In addition, legal action could be taken in U.S. courts by U.S. commercial users of space satellites if these satellites were endangered by U.S. space weapons. In theory, other legal actions might be taken by private corporations at the Hague Court of Arbitration if the defendant state is willing to permit this. In short, existing space law provides numerous opportunities to remind the United States that weaponization of space could be a complex and difficult process, to make it worthwhile for the U.S. government to negotiate on confidence-building measures, or, if necessary, to block early weaponizing measures.

It is relevant to this subject that there have been press reports that the U.S. Defense Science Board has expressed interest in reexamining the possibility of using nuclear warheads for missile defense purposes. Explosion of nuclear weapons in the atmosphere or in space is explicitly forbidden by the 1963 Limited Test Ban Treaty (LTBT). Action by the Defense Department to carry out these plans would be a violation of the LTBT and would in addition lead to a multitude of suits and injunctions under the Liability Convention. The same applies to tests of the GALOSH missile defense system around Moscow, which continues to be armed with nuclear warheads.

PROSPECTS FOR EXPANSION OF THE LEGAL REGIME

Driven by U.S. moves to weaponize space, it appears likely that the legal regime covering space weapons will expand in the next several years for a variety of reasons.

One possibility, of course, is action to fill in the gap in the 1967 OST and to prohibit any weaponization of space. Russia and China have proposed comprehensive treaties prohibiting weapons in space. In 2001, China presented component concepts of a draft treaty on this topic in the Conference on Disarmament (CD) and in May 2002, China and Russia presented a joint draft in the CD. The prospects for a comprehensive treaty depend in large part on the willingness of China, Russia, and other large countries to undertake a major international effort supported by non-governmental organizations (NGOs) in the face of U.S. opposition. For this effort to succeed, China, Russia, and other major states, including European Union members, would have to conclude that preventing the weaponization of space is a top priority national interest, justifying the sacrifice of other important national interests in a stand-off with the United States. They do not appear to have reached this conclusion yet. However, they still may reach this conclusion at some future point, especially if the United States continues to make major increases in funding for its missile defense program. But, otherwise, it is plausible that these countries may seek some compromise with the United States that could result in a mixed regime of some weaponization and some regulation.

Second, the same difficulty of prevailing upon the world's most powerful state, the United States, to renounce categorically its plans to place weapons in space has already led to suggestions from think tanks and NGOs that concede some weaponization and argue for a mixed regime of partial weaponization backed by limits and controls. Think tanks and NGOs may be joined in this approach by commercial users of space that have thus far held back from taking a position in this controversy.

Finally, if the U.S. policy of placing weapons in space proceeds and results in de facto space supremacy for the United States, Washington itself is likely to attempt to reach agreement with other spacefaring governments on rules of the road, like keep-out zones, to blunt some of their criticisms, and, in the final analysis, to prevent situations where the United States may be forced against its will to use its space weapons.

The combination of all these pressures seems quite likely to bring additional

agreements, both formal and informal, related to weapons in space and anti-satellite systems. The present quasi-anarchy of space law is likely to give way to a network of rules while preparations for weaponization proceed. This process and the discussion that will accompany it will also help to inform the U.S. electorate and perhaps incline it to back a preventive or corrective policy when the present U.S. administration is replaced after the next two to six years by its successor. The expanding legal regime in space will in any case benefit from the provision of maximum information to the American and world public and from maximum public discussion.

There is another, more hopeful, possibility; the protests and objections of foreign governments and military and commercial users of satellites may cause the United States to hold back from proceeding with the weaponization of space even while it resists pressures to negotiate a treaty prohibiting weaponization. This may be the best outcome we can hope for at this time, but it will require continued energetic opposition to weapons in space.

There is a possible comparison between the issue of weaponization of space and the emergence of nuclear weapons. Efforts to ban nuclear weapons completely gave way slowly to the efforts to tame these weapons. Efforts to control and tame space weapons are coming earlier in the cycle and space weaponization may emerge more slowly with a longer interval before the first use of these devices as weapons than was the time between Trinity and Hiroshima. Consequently, there may be more time to play out the recurrent contest between human capacity to invent new weapons and the efforts of human society to control them. Let us hope that this time is well used.

U.S. COMMERCIAL SPACE PROGRAMS: FUTURE PRIORITIES AND IMPLICATIONS FOR NATIONAL SECURITY

by Charles V. Peña
Cato Institute

Control of space is at the crux of the debate about the future of U.S. military space policy. 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. Space assets are currently used to great effect to support terrestrial (ground, sea, and air) military operations. The more immediate issue is whether the United States 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 how we think about space and space policy.

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." 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 an operational anti-satellite (ASAT) weapon that threatens U.S. satellites or 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.

Regardless of how one views the need to weaponize space, one thing is abundantly clear: the U.S. military greatly benefits from using commercial space systems. Former vice chief of staff of the Air Force, General Thomas S. Moorman, asserts that by making maximum use of commercial 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)."[1]

In all likelihood, in the future, the military will be even more reliant on commercial space systems. As General Moorman has also 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.[2]

Therefore, as U.S. Air Force Lt. Col. Peter Hays and Karl Mueller (both former professors at the School of Advanced Airpower Studies) argue: "It is no longer clear that the relationship between space and national security is, or should be, shaped primarily by international military competition."[3] Indeed, space as it relates to national security may be shaped and influenced more by the future of commercial space activities.

If there are significant military and national security advantages to be gained via commercial space, then it is important to recognize that there is the potential for great harm by placing military requirements at the forefront of how we think about space. While the January 2001 Space Commission report (and others) focus on

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[1] Thomas S. Moorman, Jr., "The Explosion of Commercial Space and the Implications for National Security," *Aerospace Power Journal* (Spring 1999),<www.airpower.maxwell.af.mil/airchronicles/apj/apj99/spr99/moorman.htm>.

[2] *Ibid.*

[3] Peter Hays and Karl Mueller, "Going Boldly—Where?" *Aerospace Power Journal* (Spring 2001), <www.airpower.maxwell.af.mil/airchronicles/apj/apj01/spr01/hays.htm>.

the vulnerability of U.S. space assets and the potential for a "space Pearl Harbor," there is a "flip side" that must also be considered. 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.[4]

And, as John Logsdon, director of the Space Policy Institute at the George Washington University points out: "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."[5]

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.

Certainly, there are some uses of space that are unique to the military – such as integrated tactical warning and attack assessment (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 (Defense Support Program) satellites, which monitor missile launches worldwide.

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 (Military Strategic and Tactical Relay) is a dedicated military satellite communications system that provides secure, jam-resistant, nuclear-hardened communications for all U.S. forces.

But, wherever possible, the Department of Defense (DOD) 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. Communications probably represents the single biggest use of space for both the military and civilian/commercial sectors. According to General Moorman: "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."[6]

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 MILSTAR—this segment is largely commercially driven. According to a 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

[4] John Newhouse, "The Missile Defense Debate," *Foreign Affairs* (July/August 2001), p. 105.

[5] John M. Logsdon, "Just Say Wait to Space Power," *Issues in Science and Technology* (Spring 2001), p. 36.

[6] Moorman, "The Explosion of Commercial Space…."

systems rather than fielding/g its own systems."[7]

Another area where the military can also make greater use of commercial assets is in satellite imaging, such as Earth Watch's EarlyBird 1, Space Imaging's Ikonos (which offers one-meter resolution, the highest resolution of any commercially available system), and Orbiting Image's OrbView. According to RAND: "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."[8] And 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."[9]

Indeed, during the U.S.-led military campaign in Afghanistan, the U.S. National Imagery and Mapping Agency (NIMA) purchased exclusive rights to pictures taken of the war zone by Space Imaging's Ikonos satellite, which has 1-meter black and white resolution and 4-meter color resolution. This "buy to deny" policy is an example that demonstrates the importance of and demand for commercial space assets by the military. Somewhat ironically, these high-tech, high-resolution images were initially delivered via "pony express." Ikonos imagery was recorded on the satellite and downloaded to Space Imaging ground stations in the United States. From there, it was delivered to NIMA's Commercial Satellite Imagery Library at Bolling Air Force Base in Washington, D.C. The Air Force had to send someone to the library to manually transfer the data to compact discs, which were then delivered by aircraft to Saudi Arabia. Eventually, the data was transmitted via the Pentagon's satellite-based Global Broadcast Service. So not only is there a commercial opportunity in imaging itself, but also possibly in how those images are transmitted—especially securely—to the customer.

The military should also 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. That approach is especially meritorious if there is a potential shortage of heavy-lift launch capability.

It is also important that 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).

Even if commercial space is not a panacea for the military, it should be the driving force of space and shape space policy. Indeed, commercial space efforts often lead those of the government and the DOD and usually have lower costs, due to market influences and competition. Therefore, 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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[7] Dana J. Johnson, Scott Pace, and C. Bryan Gabbard, *Space: Emerging Options for National Power*, RAND MR-517 (1998), p. 29.

[8] *Ibid.*, p. 32.

[9] Moorman, "The Explosion of Commercial Space…."

MILITARY APPROACHES TO SPACE VULNERABILITY: SEVEN QUESTIONS

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In analyzing the issue of space vulnerability, we will begin by attempting a broad examination of the relevant problems from a variety of different technical angles.[1] We will also weigh both weapons and non-weapons responses to these vulnerabilities. In our conclusion, we provide thoughts on a possible weaponization ban, which, after our analysis, is our preferred solution. Our approach is organized by considering seven questions.

Question 1: *What is the meaning of "space vulnerabilities"?*

Vulnerabilities potentially exist both *from* space and *in* space. Any careful analysis must include possible space-to-space threats, space-to-terrestrial (land/sea/air) threats, and terrestrial-to-space threats. There is considerable overlap in this regard: space targets can be attacked from space, from within the atmosphere or trans-atmospherically, and any technology that can strike terrestrial targets from space can almost certainly be applied to attack targets in orbit as well. This essay covers primarily the vulnerabilities faced by space-based assets, including threats from all quarters, and the response to such vulnerabilities. This is not to suggest that other aspects are immaterial, merely to note that we have chosen to limit our field of analysis for now.

Orbital assets potentially at risk from deliberate offensive action include both military and civilian assets. Military aspects include navigation, communication, remote sensing and related missions that contribute to national and international security. Civilian missions include commercial operations on which our economies increasingly depend, as well as missions of great scientific value. Distinctions are often in fact blurred: note the increasing number of dual (military/civilian) missions and commercial providers of military services.

Question 2: *What are the chief threats to space-based assets?*

A "space-based" system actually includes three parts: a ground segment (including telemetry, tracking and control (TT&C) facilities, communications earth station and/or data reception and archival facilities); the space segment itself (artificial satellites consisting of payloads and platforms), and the radio links (uplinks/downlinks that carry commands, communication traffic, signals, telemetry and data). Launch vehicles and their associated infrastructure necessary to place artificial satellites and their upper stages into orbits for subsequent operational service are also prerequisites for space-based systems.

Each element is vulnerable to a variety of distinct threats. The ground segments and launch infrastructures are vulnerable to conventional attacks from opposing military forces. Radio links can be jammed, spoofed or otherwise hacked based on electronic transmissions from terrestrial, trans-atmospheric or orbital sources. The space segment is vulnerable to a range of attacks, including those from terrestrially-based trans-atmospheric vehicles (military space planes) or missile interceptors with nuclear, conventional explosive, or kinetic energy warheads; from terrestrial-based directed-energy weapons, such as lasers; and from space-based weapons such as mines, missile interceptors, directed energy weapons (including neutral particle beams or lasers), and devices designed to alter the trajectory of the target, to create highly damaging debris clouds or to generate electro-magnetic pulses (EMP).

Two points are worth stressing. First, the threat to a space-based system is not only to its space segment. Secondly and consequently, space-based countermeasures cannot help in

[1] This paper reflects the views of the authors and not necessarily the position of the Government of Canada.

some cases, and are not the only possible response in others.

Question 3: *How can these threats be countered?*

One broad way to counter these threats involves active counter-force, in other words, a direct attack on those enemy forces or weapons threatening the assets to be protected. This includes a range of options. Some are terrestrial, including physical attack on enemy forces, destruction of missile launch and satellite command and control nodes, and information operations including the jamming of communications links. Others are trans-atmospheric, for example, the destruction of orbiting weapons using land-, sea- or air-based lasers, terrestrially based missile interceptors or military space planes armed with conventional or other "exotic" anti-satellite weapons. Finally, some are space-based, including the mounting of "self defense" weapons on satellites with other primary payloads, assignment of weapons- dedicated satellites to escort valuable orbital assets, or the creation of a constellation of orbital weapon systems (featuring interceptors, directed-energy weapons, mine/debris fields, displacement devices, etc.) designed for counter- or pre-emptive attacks on any and all enemy space-based weapons.

It is worth noting that, in the second and third cases just mentioned, counter-force options to protect satellites would often involve developing and deploying the same sorts of weapons systems against which they are intended to defend. Or, to look at the other side of the same coin, many of the weapons systems that could be deployed to protect satellite assets could equally be used to destroy them.

There are also, however, other possible approaches to defending space-based assets, ones that do not depend on deploying counter-force approaches. Some examples:

- Redundancy/Reconstitution: existence of replacement satellites stored in orbit or terrestrially housed spares capable of launch-on-demand; large networked constellations of assets with a distributed architecture (so that destruction of one or even several satellites does not take down the entire system); designated back-up or redundant assets (both space segment and TT&C) in secure locations for critical missions; rapid in-orbit or trans-atmospheric repair capabilities; autonomous in-orbit navigation and housekeeping against the event that communication with the TT&C ground segment is severed for an extended period.
- Hardening/Shielding: alternative power sources (reducing the impact of damage to vulnerable solar arrays); rapid-acting shutters deployable against debris or intense illumination; radiation hardening; counter-electromagnetic pulse (EMP) measures such as grounding or Faraday cages; component selection for immunity to system-generated EMP (SGEMP) effects; enhanced encryption of the uplink and downlink; electronic countermeasures to safeguard communications systems (e.g., agile frequency hopping, signal power boosting and antenna nulling to defeat enemy jamming); and operation from higher and thus less accessible altitude orbits.
- Awareness/Maneuverability: enhanced situational vigilance to predict and detect attack, including improved operational intelligence, threat analysis, space surveillance and on-board *in situ* sensing, combined with built-in rapid maneuvering capability for critical or high-value orbital assets (allowing them to dodge some types of attacks), including robotic refuelling options for maneuvering thrusters.
- Denial/Deception: steps to make key orbital assets stealthy or harder to detect from Earth in the first place, *inter alia* through observational signature reduction, deception (reduced or disguised interaction with the ground segment) and enhanced security measures surrounding deployment and purpose.

- Passive Defense: increased fixed and mobile security features (e.g., personnel screening, physical barriers and guard forces) for the ground segment in particular.
- Diplomacy and Threat Reduction: reinforcement and extension of the international legal regime prohibiting space-based weapons, *inter alia* by negotiating and gaining broad adherence for international legal instruments (e.g., on anti-satellite weapons); cooperative measures to protect terrestrial military operations among allies and associates (e.g., multilateral shutter control mechanisms); strengthening of export controls and other nonproliferation measures on pertinent technology; and increased international pressure on violators of existing norms and obligations.

More radically, one could also consider whether too many eggs are being put in the same basket in terms of military reliance on satellites. Is it wise, some policymakers and experts have asked, to develop a military system architecture and doctrine with a single point of failure, necessitating complex and expensive counter-force defense structures? One alternative would be to enhance flexibility and reliability by adopting other approaches in tandem with current space-based ones—such as greater use of airborne assets or unmanned air vehicles (UAVs) where practical. Where space-based approaches are necessary, consideration could be given to downloading requirements to commercial systems (which may also be less expensive—compare the cost of MILSTAR and INTELSAT communications systems for example), reserving military satellites for critical missions only. Architecture and doctrine that centralizes data collection, processing and analysis could also be balanced with more widely dispersed and diverse nodes, serving to relieve computer, communications, command and control, intelligence, surveillance and reconnaissance (C^4ISR) network bottlenecks over intercontinental distances.

Few of these options are exclusive, and a mixture may well be the optimum solution. It seems worth underlining, however, that there are significant alternatives to space-based weapons if the primary goal is to defend space-based assets—as opposed to broader scenarios envisaging space control or space-based attack on terrestrial targets. The argument has been made that the increasing value of satellite assets requires the space equivalent of a "deep sea fleet" to protect the commerce of the sea lanes. Unless and until the threat comes *from* outer space, however, the need (if any) seems at most to be for the space equivalent of port-based coast guard squadrons and perhaps shore artillery.

Question 4: *Who has the capability to create such threats?*

Space-based weapons are possible for any state with the economic and technological capability to manufacture and launch ICBMs or rockets capable of putting satellites into orbit, and to control the actions of missiles and/or space objects from the ground. Theoretically, this could include the following states: the United States, the Russian Federation, China, the European Union (the European Space Agency and some individual member states), Japan, India, Ukraine, and Israel.

An anti-satellite (ASAT) attack from the ground might also be possible for states with a developed medium- or intermediate-range ballistic missile (IRBM) capability, even without satellite experience. Such states could for example theoretically include Iran, Pakistan and North Korea. If the attacking states possessed a nuclear device, an IRBM could place it on a sub-orbital trajectory to reach the "Starfish Prime" apogee of 400 km; even in the upper reaches of the atmosphere, a nuclear explosion would generate an EMP and SGEMP capable of adversely affecting satellites in the geostationary orbit and would significantly increase radiation in low-Earth orbit (LEO), degrading satellite lifetimes.

Space-based assets could also be hit with a very high-power laser designed to degrade, damage or destroy satellites from land-, sea- or air-based platforms. Unhardened satellites in LEO could be incapacitated, although satellites

above medium-Earth orbit and in geostationary Earth orbit are presumed safe against present day technology. A small number of states have sufficiently sophisticated R&D capabilities to create laser or other exotic weapons suitable for ASAT roles.

During the Cold War, the United States and the Soviet Union developed and tested both nuclear and non-nuclear ASAT-capable systems. Within the past few years, the United States has carried out well-publicized R&D programs on advanced space-based and related weapons systems with a range of primary and secondary mission capabilities. A small number of other states are reported in the open literature to be doing so as well, although none seems to have given such programs the policy, doctrinal, or financial priority recently accorded by Washington.

Compared to the space segment, the ground and radio-link segments are vulnerable to attack from a far larger range of potential opponents (indeed from anyone with the military and/or technological capability to attack terrestrial facilities or interfere with electronic signals). In addition to governmental forces, this could include terrorists and other non-state actors, whereas the latter are unlikely to develop early capabilities to attack the space segment.

In summary, we note that the direct threat to space-based assets is limited to a comparatively small number of countries. This factor, combined with the high cost and technological complexity of mounting such a threat, argues against the urgent inevitability of deployment of weapons in space and/or in an ASAT role. It means that action to prevent such weaponization through international agreement or other approaches need only convince a limited number of states. It is also worth noting, however, that a more widely-based threat may exist to non-space segments and pose greater overall vulnerability.

Question 5: *Does space weaponization have downsides?*

Let us therefore turn from the broad analytical context to a more specific consideration of space weaponization, defined as deployment of weapons in earth orbit or higher.

Advocates of weapons in space speak of the need for "space control" or "space dominance," including such aspects as assured access to outer space via one's own launch vehicles; assured use of one's own military assets in outer space for communications, navigation, remote sensing, and other missions; denial of an enemy's similar use of outer space; the ability to defend non-military space assets; and the use of space as a platform for attack on terrestrial targets, including missiles and ground objectives. If achievable, these would be very significant benefits for a given state from a military standpoint. Space-based weapons also have downsides, however, even from this same standpoint.

Since a space-based ASAT weapon will itself suffer from many of the same vulnerabilities as its quarry, the development of such weapons will promote the development of the counter-force means to defeat them, resulting in an arms race focused on space and a consequent erosion of initial advantage. Deployment is likely to move opponents up the threat ladder in terms of creating vulnerabilities in space, to an extent and at a pace they might well not have considered necessary, absent first deployment by another state. In the case where a potential first deployer already enjoyed a significant technological edge in military use of space, especially combined with a consequent dependency on space-based military missions, it is unclear why it would be to that state's long-term advantage to promote or provoke weaponization of that sphere.

Strategic advantage based on technological superiority has in any event often proven ephemeral in the past. Historically, the first use of new strategic technology has simultaneously provided three things: incentive for others to acquire either the same capabilities or an adequate asymmetrical response; a clear demonstration of what is technologically possible, obviating generations of R&D; and a licit (defense-shared or commercial) or illicit (espionage-mediated) source of that technology. Examples over the past half-century or so have included nuclear and thermonuclear weapons, long-range missiles of all types, and generations of spy satellites.

Deployment of space weapons is also likely to generate the sort of situation that fosters tension and risks poor decisionmaking. First deployment may face other states with unacceptable new vulnerabilities, resulting in unpredictable reactions. The Cuban Missile Crisis, it may be remembered, was itself the result of weapons deployment creating new and unexpected vulnerabilities. If, as suggested above, first deployment in fact spurs these other states to follow suit, this will in turn pose the first deployer with the need to decide how to respond: should the secondary deployments simply be allowed to take place, degrading the first deployer's strategic advantage, or should the first deployer threaten and if necessary take active steps to prevent or reverse such deployments? If the latter, what are likely to be the consequences in terms of conflict escalation, especially given the advanced military-technological levels of the states likely to be involved? Or, given the need in some scenarios for an extensive constellation of space-based weapons to deny other states access, will a nation challenged by a partial deployment be moved to take action to prevent the constellation becoming fully populated?

Indirect and unintended consequences must also be considered. One specific example that has generated considerable attention is the problem of orbital debris. Where use of weapons against targets in orbit results in the destruction or disarticulation, debris effects are likely, seriously degrading the survivability of all but the most heavily-protected assets in orbital paths. This result will likely pose a disproportionate threat to the overall security of military satellites and civilian assets, including those with a security-related dual mission. It is also worth asking how the formation of a debris cloud would contribute to a first deployer's assured access to outer space.

As a final thought in this regard, it seems important to consider not just *whether* to base weapons in space, but also the question *"why now?"* First may be arguably better than second in the field, but later may also be better than soon. Will greater security be achieved by defending the *status quo* of no weapons in space, even at the cost of accepting some uncertainty for the future, or alternatively by taking steps to bolster weaponization options at the risk of promoting armed rivalry?

Question 6: *Has a proper cost/benefit analysis been carried out?*

The authors have occasionally run into the firmly-held view that holding defense expenditure up to genuine cost-benefit analysis falls somewhere between "unpatriotic" and "must be illegal." Taking into account such factors as the technical practicability, tactical effectiveness and strategic impact of space-based weapons as a defense against attacks on orbital assets, it nevertheless seems worth carrying out a full calculation of this nature. Space (if nothing else) does not permit such an analysis to be presented at this point, but a few general comments may be pertinent.

First, it is clear that different cost-benefit comparisons can in fact be drawn up from a military, national security and international security perspective even within the same state. Furthermore, a given deployment's cost-benefit ratio for one state, alliance, or other group of states may not be the same as the same deployment's result for another state or group. This inescapable range of domestic and international variance needs to be remembered when debates are joined on the issue, given common rhetorical assumptions to the contrary.

At the international level, it must be stressed that the present situation in space operates to the benefit of many countries—launching states, countries like Canada with a strong space industry but without launch capacity and all nations benefiting from space-related services—in term of both civilian satellite operations and non-weapons military missions. Putting such benefits at risk would have an imputed cost that might or might not be offset by presumed increases in future security from active space-based defense, especially if such increases in security accrued asymmetrically to a small number of states.

This consideration includes the issue of collateral damage to states not themselves directly involved in any space-based deployment crisis or subsequent conflict. Inadvertent war damage or longer-term debris effects may, for example, have a major impact

on states with civilian or military assets or access to space services at risk, regardless of whether they have any direct stake in the issues generating the conflict. And the international community will hardly welcome the prospect of running a gauntlet of orbital weapons in order to benefit from the future exploitation of the riches of outer space. At the very least, the deployment of space-based weapons by one or a few states over the objections of the rest could undermine the amity underpinning a broad range of related international procedures and arrangements, such as cooperation on radio frequency assignments and current state practice of not interfering with remote sensing observations – representing another potential factor of indirect cost.

At the national level, even accepting the need for measures to defend space-based assets, the differential cost-benefit of space-based weapons as opposed to other possible passive and active defense measures (as outlined under Question 3 above) needs to be drawn up carefully. In this regard, it should be noted that space is probably the most expensive environment in which to place a weapon system. Quantitative and qualitative analysis of the actual threat is also important, taking into account intention and likelihood as well as current and potential capabilities. Space is an environment in which a threat to important assets can make use of cheaper, less sophisticated technology, so the risk of inducing such threats (along the lines discussed under the previous question) must be another factor in the analysis. Finally, cost-benefit and opportunity costs for favoring space-based weapons, as opposed to other defense priorities, must also be a significant consideration, absent the unlikely eventuality of no competition for budgetary allocations.

Question 7: *Can a space weapons ban create a safer environment for military space assets?*

Staying with the military perspective, let's look at the issue from another angle. Limiting the issue to protection of space-based military and other security-related assets, can a space-based weapons ban serve as a full or partial alternative to a defense capacity reliant on space-based weapons? Bearing in mind that we are talking about convincing hard-headed soldiers and not fuzzy-minded arms controllers? We would argue that the answer is *yes*, as long as the ban was implemented by the major launching states and other states capable of attacking into orbital space, and as long as it was effectively verified. We would argue that space non-weaponization should be seriously considered by military as well as diplomatic authorities – not just for moral or geopolitical reasons but as a genuine contribution to hard national security, based especially on the threat/capability comparisons, alternative approaches, downside arguments, cost-benefit and opportunity cost factors flagged above.

One option within the range of possibilities in this regard is a convention to ban space-based weapons—defined as damage-causing mechanisms (not associated elements such as sensors or command and control) actually based in space (not just transiting, like missiles or space planes). Space-based weapons as thus defined are not the only threat to space assets (as noted earlier), but a ban on such weapons represents a useful place to start and a fairly straightforward expansion from the current prohibitions in the Outer Space Treaty of 1967.

Considerable work has also been done on the issue of verification of such a ban, including the Canadian PAXSAT study in the mid-1980s, leading to the conclusion that the technical means for such verification existed – given the necessary political will. The passage of time since then has only reinforced this observation; recent developments in space surveillance and situational awareness linked to non-weapons missions in space have already greatly enhanced the means available to distinguish a weapon from an otherwise benign space object.

There appears to be considerable support for a space weaponization ban, in one form or another. Several countries, including Canada, have made such proposals in various international fora, differing somewhat in concept and degree of detail. Other states have suggested even more restrictive approaches, arguing for limitations on all military use of outer space, not just prohibitions on its weaponization. The last UN General Assembly voted 156 for, 0 against, and 4 abstaining in

favor of action within the Conference on Disarmament (CD) to convene an *ad hoc* working group on the prevention of an arms race in outer space (PAROS), which most states consider likely to focus on the issue of space weaponization. The December 2000 NATO report on the alliance's efforts in arms control and related fields meanwhile underlined the importance of work by the international community "to preserve and protect current economic and security benefits from the use of Outer Space while avoiding the creation of new and daunting military competitions in the future."

If the international community agreed, a step-by-step approach could be adopted. If negotiation of a comprehensive legally-binding space weapons ban was too much for some states as an initial step in the face of military concerns, then consideration could be given to a more cautious approach – consideration for example of establishing a discussion forum (such as a CD PAROS *ad hoc* committee), mandating the UN to seek the views of members on the issue, creating an inter-governmental experts group, promoting "no first deployment" pledges and establishing transparency and other confidence-building measures.

Reverting in closing to our true colors as arms controllers, we confess that it would be pleasant to be able to negotiate some useful mutual restraints before deployment took place in a fresh environment, rather than trying to claw back deployment after the fact. Waiting for a crisis to happen before starting work seems by contrast a poor option, especially given the current opportunities.

DEBRIS AND FUTURE SPACE ACTIVITIES

by Joel R. Primack
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Space is the most fragile environment that exists because it has the least ability to repair itself. Only the Earth's atmosphere can remove satellites from orbit. When the sun flares up in its 11-year cycle, it heats the upper atmosphere and makes it expand so that debris and spacecraft in low orbits are subjected to increased drag. But the higher the original orbit, the less air there is to collide with.

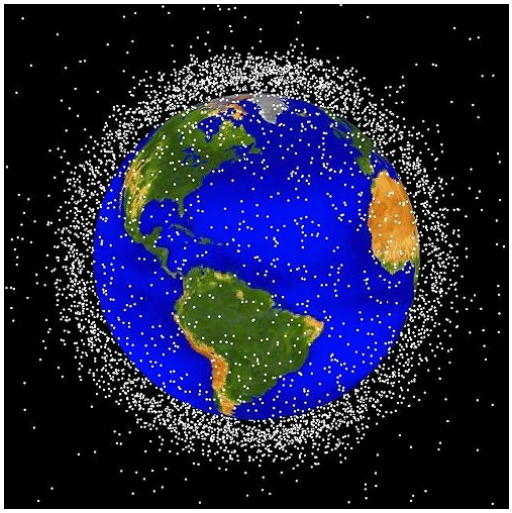
Near-Earth space is already at risk from human activities, and it is in great need of protection by scientists and humanity at large.[1] Scientists should be especially concerned, both because we are increasingly dependent on scientific instruments in near-Earth space, and also because we are in a position to foresee the problems human activities are causing and to propose measures to mitigate or avoid them. In particular, we need to emphasize that a war in space could create a battlefield that will last forever, encasing our entire planet in a shell of whizzing debris that will thereafter make space near the Earth highly hazardous for peaceful as well as military purposes. Debris in orbits higher than about 800 kilometers (km) above the Earth's surface will be up there for decades, above 1,000 km for centuries, and above 1,500 km effectively forever. Over 9,000 objects larger than 10 centimeters (cm) in diameter are currently tracked, and there are probably more than 100,000 pieces of orbiting debris larger than a marble.[2] But crowded near-Earth orbits are where the Bush administration wants to put parts of its proposed missile defense system, including space-based lasers and thousands of "brilliant pebbles" (space-based interceptors). Such weapons were forbidden by the 1972 Anti-Ballistic Missile (ABM) Treaty, but the United States withdrew from this treaty in June 2002.

Maybe the reason missile defense has gotten as far as it has is that so few people understand the laws of physics. The nickname "Star Wars" for missile defense all too accurately reflects the popular fantasy impression of how things work in space. In the Star Wars movies and in hundreds of other popular science fiction films, we see things blow up in space and the fragments quickly dissipate, leaving space clear again. But in reality, space never clears after an explosion near our planet. The fragments continue circling the Earth, their orbits crossing those of other objects. Paint chips, lost bolts, pieces of exploded rockets—all have already become tiny satellites, traveling about 27,000 km per hour, 10 times faster than a high-powered rifle bullet. There is no bucket we could ever put up there to catch them. Anything they hit will be destroyed and only increase the debris. A marble traveling at that speed would hit with the energy of a one-ton safe dropped from a three-story building. With enough orbiting debris, pieces will begin to hit other pieces, fragmenting them into pieces, which will in turn hit more pieces, setting off a chain reaction of destruction that will leave a lethal halo around

[1] G. B. Field, M. J. Rees, and D. N. Spergel, "Is the Space Environment at Risk?" *Nature* 336 (December 22, 1988), p. 725. J. R. Primack, "Protecting the Space Environment for Astronomy," in *Preservation of Near-Earth Space for Future Generations*, John A. Simpson, ed. (Cambridge, UK: Cambridge Univ. Press, 1994), pp. 71-76.

[2] A good introduction is N. L. Johnson, "Controlling Debris in Space," *Scientific American* 279 (August 1998). Standard references on space debris include N. L. Johnson and D. S. McKnight, *Artificial Space Debris* (Malabar, FL: Orbit Books, 1991); *Space Debris* (Paris: European Space Agency, 1988); *Orbital Debris: A Technical Assessment* (Washington, DC: National Academy Press, 1995); *Interagency Report on Orbital Debris* (Office of Science and Technology Policy, 1995), <www.sn.jsc.nasa.gov/debris/report95.html>; *Technical Report on Space Debris* (New York: United Nations, 1999); P. D. Anz-Meador, *History of On-Orbit Satellite Fragmentations*, 12th Edition, Johnson Space Center 29517 (July 2001), <orbitaldebris.jsc.nasa.gov/measure/SatelliteFragHistory/>; and NASA's Orbital Debris Quarterly, <orbitaldebris.jsc.nasa.gov/newsletter/news_index.html>.

the Earth. To operate a satellite within this cloud of millions of tiny missiles would become impossible: no more Hubble Space Telescopes or International Space Stations. Even the higher communications and GPS satellites would be endangered. Every person who cares about the human future in space should also realize that weaponizing space jeopardizes the possibility of space exploration.



Catalogued objects near earth.[3]

As a scientist whose research has benefited enormously from space observations, these prospects horrify me. Most of the important astronomical satellites have been placed in the low-Earth orbit (LEO) region (from the lowest practical orbits, about 300-km altitude, up to about 2,000 km). The Cosmic Background Explorer (COBE) satellite, in a polar orbit at 900-km altitude, allowed the discovery in 1992 of the fluctuations in the first light of the universe—the heat radiation that was emitted as the hot primordial plasma first cooled and became transparent about 300,000 years after the origin, long before the first stars formed. The temperature fluctuations COBE detected are relics of ancient differences in the density of the primordial universe from place to place. These initial conditions are what led over billions of years to the formation of galaxies and larger-scale structures in the universe, according to popular but—before COBE—unconfirmed theories such as Cold Dark Matter.[4]

The Hubble Space Telescope (HST), in a 600-km orbit, has observed many Cepheid variable stars in about 20 nearby galaxies, which has finally allowed accurate measurement of the expansion rate of the universe and thus, indirectly, the time since the Big Bang.[5] The Hubble Deep Fields—the longest time exposures with HST—have given us unprecedented images of the first galaxies, which are helping us to understand the history of our own cosmic home, the Milky Way galaxy.[6]

In the 17th century, Newton's separation of physics into universal laws and special initial conditions provided a paradigm that still guides the field, even though the universal laws themselves have been revised several times. Darwinian evolution plays a similar central role in biology, connecting the structures of organisms and of ecological communities with the underlying molecular genetics. Geology just advanced tremendously a few decades ago with the confirmation of the plate tectonics paradigm. Now it is cosmology's turn, with the crucial help of observations from astronomical satellites. The data from COBE, HST, and other new observatories should at last give astrophysicists a solid foundation on which to construct an overarching theory of the origin and evolution of the universe, an achievement that is also bound to have deep implications for the development of human culture.[7]

[3] Source: NASA Johnson Space Center (JSC) Office for Human Exploration Science website, <sn-callisto.jsc.nasa.gov/graphics/LEO640.jpg>.

[4] G. R. Blumenthal, S. M. Faber, J. R. Primack, and M. J. Rees, "Formation of Galaxies and Large-Scale Structure with Cold Dark Matter," *Nature* 311 (1984), pp. 517-525.

[5] W. L. Freedman, et al., "Final Results from the Hubble Space Telescope Key Project to Measure the Hubble Constant," *Astrophysics Journal* 553 (May 20, 2001), p. 47.

[6] R. S. Somerville, J. R. Primack, and S. M. Faber, "The Nature of High-Redshift Galaxies," *Monthly Notices of the Royal Astronomy Society* 320 (February 2001), p. 504.

[7] N. E. Abrams and J. R. Primack, "Cosmology and 21st Century Culture," *Science* 293 (September 7, 2001), p. 1769.

In addition, most Earth-observing satellites are in LEO, both those that study changes in climate and vegetation and also military surveillance satellites. These low orbits permit the highest resolution imaging, and are also easiest to reach with existing launch vehicles. For example, NASA's LANDSAT-7 is in a 705-km orbit and the European Space Agency's ERS-2 is in a 780-km orbit. NASA's new international Aqua satellite was launched in May 2002 into a 705-km orbit. These satellites are all in sun-synchronous (near-polar) orbits.

But such satellites are already at increasing risk from space debris. At any moment, only about 200 kilograms (kg) of meteoroid mass is within 2,000 km of the Earth's surface. Within this same altitude range there is roughly 3,000,000 kg of orbiting debris introduced by human activities. Most of this mass is about 3,000 spent rocket stages and inactive payloads. Approximately 40,000 kg of debris is in some 4,000 additional objects several cm in size or larger, most of which resulted from more than 120 satellite fragmentations. The main threat to satellites near Earth is from the 1,000 kg of 1 cm or smaller debris particles, especially the approximately 300 kg of debris smaller than 1 mm. Such BB-size fragments of debris have the same destructive energy as a bowling ball moving at 100 km/hr. An average small satellite in an 800-km orbit now has about a one percent chance per year of failure due to collision with a BB-size piece of debris.[8] The danger to a large satellite such as Hubble Space Telescope or the International Space Station is even greater.[9] And the amount of small debris is increasing. Random collisions between man-made objects in LEO are still relatively rare, but the density of such objects may already be sufficiently great at 900-1,000 km and 1,500-1,700 km that a chain reaction or cascade of collisions can be sustained.[10] Further growth of the debris population will increase the threat at even lower orbital altitudes. The resulting debris environment will obviously be very hostile to satellites in LEO.

Sally Ride recalled a run-in with space debris on her first shuttle flight.

> About halfway through the flight there was a small pit in the window of the space shuttle and we didn't know what it was. An awful lot of analysis was done while we were in orbit to make sure that the strength of the window would sustain reentry. It did. We were all fine. But the analysis afterward showed that our window had been hit by an orbiting fleck of paint, and the relative velocities were enough that the paint actually made a small but visible gouge in the window. Well, a fleck of paint is not the same as a small piece of metal traveling at that same speed. So, as soon as you start increasing the amount of junk in a low-Earth orbit, you have an unintended byproduct that starts putting some of your own

[8] D. J. Kessler, R. C. Reynolds, and P. D. Anz-Meador, "Orbital Debris Environment for Spacecraft in Low Earth Orbit," NASA Technical Memorandum 100-471 (April 1988); J. M. Ryan, "Tossed in Space: Orbital Debris Endangers Instruments and Astronauts," *The Sciences* 30 (July/August 1990)

[9] NASA has designed portions of the space station with shielding to provide protection against objects smaller than 1 centimeter. It has concluded that shielding against larger objects would be too costly. Debris from about 0.5 to 20 cm in diameter is of most concern because the debris may be too large to shield against and too small to track and avoid. NASA will require DOD to detect, track, and catalog objects as small as 1 cm. However, DOD stated that achieving this capability would be technically challenging, according to *Space Surveillance*, General Accounting Office Report GAO/NSAID-98-42, pp. 16-17

[10] D. J. Kessler and B. G. Cour-Palais, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt," *Journal of Geophysical Research* 83 (June 1, 1978), p. 2637; D. J. Kessler, "Collision Probability at Low Altitudes Resulting from Elliptical Orbits," *Advances in Space Research* 10 (3) (1990), p. 393; D. J. Kessler, "Collisional Cascading: The Limits of Population Growth in Low Earth Orbit," *Advances in Space Research* 11 (12) (1991) p. 63. Complete breakup is likely to occur in a collision when (impactor kinetic energy)/(colliding object mass) > 40J/g, so a 0.1 kg piece of debris can fragment a 100 kg satellite if it hits at 10 km/s velocity; see *Orbital Debris* (ftn. 2), p. 91.

quite valuable satellites at possible risk.[11]

Ride asked: "What if anti-satellite testing proceeds and we start testing rockets that clobber satellites and explode them in space? What if enough of that goes on that there's the equivalent to a test range up in low-Earth orbit?"[12]

Offensive weapons in space pose the worst threat to satellites in LEO. Fortunately, offensive weapons have not yet been introduced into space—except for a few tests such as a Soviet space mine explosion, or the intentional destruction in 1985 of the still-operating Solwind satellite in a demonstration by the U.S. military. Each of these tests generated hundreds of pieces of trackable debris. But kinetic kill vehicles such as the proposed thousands of "Brilliant Pebbles" are sure to generate great quantities of space debris just during their initial deployment, and far more if they are ever used. Since each of these attack satellites will circle the earth every 90 minutes, basing weapons in space requires hundreds of individual satellites in order that at least one be near its time-urgent target, such as a missile in boost phase.[13]

Any kind of space warfare will put all satellites at risk. The explosion of nuclear weapons in space (prohibited by the Outer Space Treaty, but routinely considered by military planners) would indiscriminately destroy unprotected satellites by electromagnetic pulse (EMP) or nuclear radiation.[14] Perhaps worst of all would be the deliberate injection into LEO of large numbers of particles as a cheap but effective anti-satellite measure. Any country that felt threatened by America's starting to place lasers or other weapons into space would only have to launch the equivalent of gravel to destroy the sophisticated weaponry. Many of these pieces of metallic gravel and fragments of broken weaponry would join all the other debris in orbit. It would hasten the fragmentation of the 3,000,000 kg of dead satellites and rocket bodies now in LEO, and thus produce an enormous cloud of debris that would threaten all satellites in LEO.

Policies that can help avert a space "tragedy of the commons"[15] include the following:

- Do not introduce attack weapons into space
- Avoid fragmentation of satellites from explosions due to accidents and anti-satellite weapons tests, the main cause of space debris. Prohibit explosions of any kind in space.
- Design boost and deployment systems for satellites that minimize the production of space debris. Require all satellites in LEO to carry a mechanism, such as rockets or inflatable devices to increase drag, which will cause them to reenter within a period of (say) 25 years after their useful lives are over.
- Ban nuclear reactors in orbit, since they are an environmental threat and they are useful only for military purposes.[16]

[11] Sally Ride, Drell Lecture, Stanford Center for International Security and Cooperation, April 10, 2002, as quoted in Stanford University press release

[12] Ibid.

[13] Suppose, for example, that Space Based Lasers are placed in orbit at about 500 km altitude. Lower orbits are impractical since the satellites would re-enter in only a few years, while higher orbits may be impractical since power falls off as the square of the distance. The number of such satellites necessary in order that one be over (within a 45 degree angle of) any given point on the Earth's surface is then just 4 r^2, where r is the ratio of the satellite's altitude to the Earth's radius, 6,400 km. For this example, the number of satellites required is 650. If polar latitudes are not covered this number would shrink slightly, but if two satellites are to be over a given target at any time the number of satellites required would be about 1,000.

[14] See, e.g., J. R. Wertz and W. J. Larson, eds., *Space Mission Analysis and Design* (Dordrecht, Holland: Kluwer Academic Publishers, , 1991), esp. sec. 8.2.

[15] G. Hardin, "Tragedy of the Commons," Science 162 (1968), p. 1243. See also G. Hardin and J. Baden, eds., *Managing the Commons* (New York: Freeman, 1979).

[16] See, e.g., J. R. Primack, "Gamma-Ray Observations of Orbiting Nuclear Reactors," *Science* 244 (June 16, 1989); J. R. Primack, N. E. Abrams, et

- Minimize light pollution from orbit.

The space age is only 45 years old, yet we humans may already have placed so many artificial objects in the near-Earth environment that random collisions between them can produce a cascading number of debris fragments that will threaten and eventually prevent scientific and other uses of LEO. Such a debris belt would have other unfortunate consequences: for example, fragmentation of this debris by further collisions could eventually produce enough dust to cause a lingering twilight as it is illuminated by sunlight, a new and particularly unpleasant sort of light pollution.[17] It will without doubt be necessary for all space agencies to take active steps to prevent the buildup of debris, and it is an encouraging first step that NASA and ESA have succeeded in eliminating the Delta and Ariane upper stage explosions that were a major source of orbital debris. But much more effort will be needed, and it may even be necessary to deploy special spacecraft to remove some of the larger pieces of space debris at the altitudes where the critical density for a cascade have already been reached. Designing such devices will be a useful exercise,[18] not least because it will help to impress on public officials the cost of space debris.

National political leaders usually take a short-range view, hardly ever stretching past the next change of government. Astronomers measure time in millions and billions of years. We must help to educate the general public to think with at least an intermediate perspective of centuries and millennia about the environmental degradation that our increasingly powerful technology is causing on and near our beautiful but fragile planet—the only one like it that we know in the entire universe.

Author's Note: The Powerpoint presentation of this talk—as presented at the Conference on Future Security in Space, at New Place (near Southampton, England) on May 28-29, 2002, organized by the Monterey Institute of International Studies Center for Nonproliferation Studies and by the University of Southampton's Mountbatten Centre—is available as a pdf file on the Internet at: <physics.ucsc.edu/cosmo/mountbatten.pdf>.

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al., "Space Reactor Arms Control: Overview," *Science and Global Security* 1 (1) (1989), pp. 59-82.; S. Aftergood, D. W. Hafemeister, J. R. Primack, O. F. Prilutsky, and S. N. Rodionov, "Nuclear Power in Space," *Scientific American* 264 (June 1991), p. 42.

[17] S. van den Bergh, "Summary Paper," in *Light Pollution, Radio Interference, and Space Debris*, D. L. Crawford, ed. (San Francisco: Astronomical Society of the Pacific, 1991), p. 329; D. McNally and R. H. Rast, "The Effect of Spacecraft and Space Debris on Astronomical Observations," *Advances in Space Research* 23 (1) (1999), p. 255; J.-C. Mandeville, J.-M. Perrin, and A. Vuillemin, "Space Borne Photometry Perturbations from Solar Light Scattered by Debris: a First Estimate," *Acta Astronautica* 48 (February 2001), p. 229.

[18] See, for example, D. Rex, "Space Debris Mitigation and Space Systems Design," *Acta Astronautica* 41 (August 11, 1997), p. 311. Cf. R. Crowther, "Space Junk—Protecting Space for Future Generations," *Science* 296 (May 17, 2002), p. 1241.

PUTTING MILITARY USES OF SPACE IN CONTEXT

by Steven Lambakis
National Institute for Public Policy

In the debate over the military uses of space, many often ask the wrong questions. All too often, questions about weaponizing space are divorced from life and death struggles here on earth and the reality that we live in a dangerous world full of political-strategic uncertainties. It is not helpful to talk abstractly about the weaponization of space, or to talk about it as the road to apocalypse. Times being what they are, we should rather look more closely at possible life-saving advantages.

The Rumsfeld Commission on Space Organization and Management reported last year that space is becoming increasingly important, not only to the United States, but also to other countries, especially in the area of national security. Space warfare is a "virtual certainty," it said, and this, to be sure, has aroused interest and, in some quarters, panic. The commission recommended that Washington look hard at the advantages of expanding the military uses of space to enhance deterrence and improve defense.

Yet for all its talk of reducing U.S. vulnerabilities in space and its advice to policymakers to begin thinking about the possible wartime advantages of seizing the orbital high ground, the Rumsfeld Commission expressly did not put forth plans and programs to continue what many call the weaponization of space. And well it should not have. Who would embark on such an unfocused project? What does weaponizing space mean? What would such a plan look like? How would a government accomplish it? And for what purpose?

These are fair questions that help make the following point: that any meaningful discussion of this subject must have a context. And there are two reasons for this.

First, the concept of space weaponization is far too abstract to take us too far along in our discussions. We do not talk in terms of weaponizing the air, land, or sea. Governments do not make decisions to "weaponize" space either. But they do make policies and strategies, establish organizations, and create programs to develop and deploy systems to bolster deterrence, strengthen defenses, and increase military efficiencies.

So how we talk about this is important. How we pose questions about using space for military purposes changes the possible answers. Are people against placing weapons in space? I suppose they would be, if that is all you ask.

But moral, military, and strategic contexts make a difference. To ask someone to consider whether they're in favor of putting weapons in space is different from asking that same person whether he would support basing interceptors in orbit to intercept long-range ballistic missiles to protect his city. Indeed, when asked about whether they want a missile defense, polls have consistently shown over the past two decades that the American people support such defenses. It is also quite a different thing to ask a person whether he would support the development of a weapon, a tool, to physically knock out a satellite that had uncovered the positions of our sons in uniform, who happened to be cornered in some dangerous valley in Afghanistan. Who would not favor removing the threat?

Second, there is historical context to consider. Critics of expanding the military uses of space are wont to make a clean-cut distinction between "militarizing" space, on the one hand, which they say already has happened, and "weaponizing" space on the other, which they say has yet to occur. But this is a distinction without a meaningful difference, because the combat or force function, which naturally involves the use of arms, is a potential part of any military activity. Even some peacekeepers carry arms.

Viewed in this light, the term "weaponization" may be used, in a general way, to characterize activities that countries have undertaken for nearly 60 years. In other words, the so-called weaponization of space is happening under our very noses.

Space weaponization started in September 1944, when the first German V-2 missile came rocketing down from the edge of space and exploded on the residents and buildings of London. The quest for a long- distance strike advantage continued with the development of warheads to travel at even higher altitudes through space and across continents towards their targets. Add countermeasures to the ICBM reentry vehicle, balloon decoys and maneuvering capability, and we have an even more capable offensive weapon engineered to take advantage of the space environment to evade interceptors.

The military transformation of space took on other forms. By improving intelligence and military operations, earth-circling platforms became attractive targets for military countermeasures. During the Cold War, Soviet Electronic Ocean Reconnaissance Satellites and Radar Ocean Reconnaissance Satellites tracked and could help target U.S. naval ships. The U.S. anti-satellite (ASAT) response, which never did materialize, was a natural reaction to this threat.

Likewise, U.S. reconnaissance satellites, and commercial systems like Ikonos and SPOT, which provide militarily useful images to anyone who can pay, also will face threats from countries that now deploy and experiment with ASAT technologies. Some of these readily available technologies include radio-frequency jammers, blinding lasers, and missiles capable of exploding shrapnel in the vicinity of spacecraft. Different governments have developed and tested over the years anti-satellite technologies and considered deploying robust, dedicated ASAT systems.

In the 1980s, the use of space to enhance weapons continued when the United States deployed Global Positioning System (GPS) satellites to aid military navigation and positioning. Early on, there was only a very accurate military signal for use by U.S. forces. The United States later added a less accurate civilian signal, and this became so popular and successful that Washington arranged for all parties to have the military signal. These signals guide and increase the accuracy of deadly weapons launched on Earth to their targets and are available today to all countries for military use. The United States does not have a monopoly in this area. The Russian GLONASS system performs a similar function, and the European Union may be giving the world a third alternative with the proposed Galileo system.

As a final example of space weapon evolution, for the past two decades the United States has been developing and testing surface-launched hit-to-kill interceptors to knock down short-, medium-, and long-range ballistic missiles. These tests, these defensive combat engagements, take place well overhead, many of them, by necessity, in space. With today's technologies, it is advantageous to have a layered defense that includes elements to strike a target in space, in the boost or midcourse of its flight.

Washington already has conducted tests in space from the ground. To counter a long-range ballistic missile that may be used against the U.S. homeland, the government has engineered and successfully tested a hit-to-kill sensor-propulsion package called the "exo-atmospheric kill" vehicle, part of the Ground-based Midcourse Defense under what was called National Missile Defense under the Clinton Administration. Though never talked about as such in the United States or abroad, this is a "space weapon" that spends most of its time on the ground. This interceptor was designed to be launched into space, to be "based" there for a matter of minutes, and then to put itself onto a collision path with a hostile warhead. Now this does not comport with our traditional understanding of what it means to "base" something in space, but it may be argued that we are indeed engaged in a type of basing operation so as to set up a collision—an explosive clash of arms in space.

So, we are in space today because we must be—some 60 years of increasingly intense military activity in space, and the world has not fallen apart. These are all examples of evolutionary events that have been shaped by pressing, even urgent, national security requirements. And this is how it will continue to be.

There are some potential military advantages of operating in, from, or through space. For context, I will look primarily at the missile defense mission area. In all cases, we need to consider the best tools for doing the

job, and then ask ourselves why it is we would want to limit ourselves to Earth-bound options.

Intercepting a ballistic missile is a significant technical challenge. The defender must deal with very high speeds, very small objects, and uncertain launch and target points. Where he places an interceptor and sensor can make an enormous difference, so that space may be able to provide unique positional advantages for countering the ballistic missile threat.

Space can offer global reach and host a capability to strike targets in a timely manner. Given the great distances that missiles travel, a defender will have to operate in and from space to defend different areas around the globe. Lasers, or speed of light weapons, in space may provide an even better tool for conquering distance, in a very short span of time, perhaps allowing the defender to counter hostile missiles a few thousand miles away. Given adequate numbers of satellites, space also accommodates around the clock coverage of the earth, helping to provide early warning, track threat missiles, and discriminate target complexes.

These are some of the potential military advantages of moving the ballistic missile defense mission to space. And, as with all other military procurement activities, there are always questions to answer having to do with trade-offs with other military mission areas (internal to and external to the ballistic missile defense mission area): costs, operational feasibility, legal obligations, and, of course, foreign policy. In this case, space debris too must be considered.

There are other offensive or defensive combat mission areas that could benefit from more imaginative uses of space. These might include developing capabilities to counter hostile satellites in space, or active defenses to protect high-value spacecraft. Some have proposed using space to strike targets on earth, to use the high speeds and unique reentry angles that may be achieved, for example, to 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? From my point of view, I would rather not use a nuclear weapon, and I would rather have some options available for taking out a highly dangerous site in a timely manner.

Several countries, to include the United States, have developed and considered a variety of weapon systems to strike distant targets, including conventionally armed intercontinental ballistic missiles, long-range cruise missiles, or a new generation of strategic bomber. But why limit arsenals to terrestrial options for delivering force to a distant target, especially when you may want to do it quickly?

History supports the view that countries will not stop looking at new combat techniques, new ways to exploit technology, to include new ways to strike targets. As Russian Major General Vyacheslav Bezborodov observed about space back in 1995, "A clash of different countries' interests is inevitable here considering the strategic importance of space, contradictions existing in the world, and the danger of outbreak of conflicts and wars."

There are sound political and strategic justifications for looking to space. First, a weapon that exploits Earth's orbit may increase the number of foreign policy and military options available to our leaders and commanders. More options mean that a leader may not be forced to take a more destructive or weaker course of action, that he has choices on how his country should act in a dynamic, complex, and often dangerous world. Effective military options, in other words, can work to improve deterrence and stability and help leaders deal more intelligently, even more diplomatically, with surprises.

Second, enhanced military power in the hands of states that uphold the rule of international law can work to improve peace and stability in the world. Treaties dealing with the space environment are written to establish stability and order on the space frontier. And this is good. Washington has never considered space to be a domain of anarchy. Indeed, it is in the U.S. interest to develop proper laws and exercise force in a restrained and responsible manner to prevent space from devolving into a lawless, disorderly realm.

Some international treaties act as arms control agreements to ban, reduce, or limit weapons. But 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. This view of arms in space is consistent with the freedom of space principle and the peaceful uses of space tradition that Washington has followed throughout the space era.

What do we mean when we say "peaceful uses" of outer space. The writers of treaties and arms control agreements have not been crystal clear on this subject. I would only say here that peaceful purposes, as it has evolved over the years, means non-aggressive. Using space for peaceful purposes does not translate into non-military purposes. In other words, military actions by some states can support peaceful purposes and provide security essential for peace.

And, as we know from our experience with the land, sea, and air environments, peaceful, stable conditions are essential for commercial practices. Trade, commercial activities, and economic growth cannot flourish in an unstable environment.

Let us put the question about space arms in perspective. The blame for warfare in any environment must be placed on the aggressor, and not on the defender. Criticize, in other words, the government or group that launched the nuclear warhead into space, not those who, in seeking protection, attack that weapon in space, rather than let it fall on their city.

Warlike actions by aggressive states do significant damage to stability and the conditions required to conduct business. But we must all agree—the right to self-defense is inviolable. Clearly, combat that reaches into space could upset commerce and even destroy commercial satellites. But what is at stake may be far larger than commerce—we could be talking about loss of freedom or the prolongation of warfare. We must also ask ourselves, in what other environment is commerce ever unaffected or commercial craft ever fully protected in wartime?

So we need to talk less about trade-offs between commercial space operations and national security space operations, and more in terms of the dependent relationship that all commercial activity has with military power.

There are those who differ, and who argue, for example, that space must remain weapons-free and a sanctuary. But while tactical and operational activities may be quite different in space compared to other environments, from the strategist's point of view there is no discernible line of separation in space at the levels of strategy and policy. Indeed, we already have crossed that line. Only a sincere and universal political decision can create this imaginary boundary line between the Earth, where we fight wars, and space, where we do not fight wars. But because there is no universal political will, no consensus or agreement among nations on this point, this line, in the end, is not enforceable.

Different governments have very different ambitions and policy objectives. Arms control is an instrument of policy. And so are weapons. States do not go to war because of weapons. Weapons do not have a moral say, one way or the other. Governments go to war because of a clash of policies.

So without universal political will, without agreement on fundamental ends, arms control must be a weak tool—not entirely irrelevant, but weak. As we learned in the 1930s and '40s with the Washington and London naval disarmament accords, it restrains the law-abiding, but not the criminal. If arms control is to be successful, it must reflect political realities.

Many say that introducing weapons into space will cause an arms race. I am not certain what an arms race is—weapons programs and the make-up of armed forces around the world have always changed with the times. Countermeasures and offense/defense competition have always been a part of the natural evolution in military capabilities. Yet it is asserted that a U.S. program to build ASATs will cause others to do the same, to compete, I suppose, with the United States.

States, of course, have many incentives to start a weapons program, (not just reacting to what Washington does). So we can't ignore unique national security requirements. I would also observe that there is no evidence that unique capabilities residing in U.S. stealth bombers and fighters, its aircraft carriers, advanced satellites, and superior land power forces have sparked *in-kind* arms racing, although governments do seek ways to counter U.S. superiority in less direct, unconventional

ways. The rise of American aircraft carriers did not spark hell-bent arms racing for carriers. The appearance of U.S. stealth planes, and specialized advanced satellites, did not turn the world upside down, with adversaries focused single-mindedly on matching the United States in these areas.

Why do we presume that other states will not jump to space simply to counter the operational advantages the United States currently enjoys there? History tells us that this is what will happen. States will not need the incentive of an American ASAT program to do so.

By way of summary, there is a strong case for considering possible uses of space to enhance ballistic missile defense, and for investigating more effective ways to accomplish space control. And, in the end, of course, these questions must be considered in full view of national requirements for safety, international obligations, and associated costs. This is the normal process in the United States. We should allow ourselves the opportunity to investigate these new military possibilities freely without arbitrarily restricting that investigation by casually adopting more familiar theoretical assumptions about space warfare.

Many observe that "America has the most to lose in space." But this is precisely why we should expect adversaries to strike there and why Washington should not foreclose its options in space. If we're serious about addressing honest concerns, it's very important we consider context (who, what, when, where, and why?), and recognize the complexity of the questions before us.

In the end, all concerns about weapons in space must be balanced against legitimate defense imperatives in a world of proliferating weapon technologies and political-strategic surprises.

SPACE WEAPONS: MORE SECURITY OR LESS?

by Theresa Hitchens
Center for Defense Information

Under the administration of President George W. Bush, the United States is reassessing its long-standing ambivalence toward putting weapons in space. A review of U.S. space policy, the first since 1996, is being launched by National Security Adviser Condoleezza Rice. With only a cursory read of the Washington tea leaves, it is apparent that this review more likely than not will result in a reversal of direction: sending the U.S. military into orbit in a way not seen since the dawn of the space age.

On one hand, it is commendable that the administration is launching a space policy review—especially in light of plans for missile defense that include near-term space-based elements. For example, there is a goal embedded in current budget plans that the Missile Defense Agency be able to make a production decision about space-based kinetic kill interceptors by 2006. On the other hand, there are indications that the review may not be as far-reaching as it should be. According to media reports, Rice's key concerns are the growing worldwide access to commercial remote sensing and imagery and problems in U.S. space transportation (still too slow and expensive).

However, the space policy question now facing U.S. decisionmakers is a much more fundamental one. Will moves to put weapons in space, for any reason, enhance U.S. and global security or detract from it? It is not an easy question to answer. Indeed, the answer may be different depending on what sorts of weapons are being considered: missile defenses, anti-satellite weapons (ASATs), or weapons aimed at targets in the air or on the ground. It also may be different depending on whether one is looking at the next 10 years or the next 25 years as a time horizon.

It is thus imperative that any U.S. national policy review consider the military, political and economic ramifications, both short- and long-term, of overturning the decades-long policy of self-restraint on deployment of space-based weaponry.

There are some reasons to be concerned that by expanding the battlefield to space, the United States could actually undermine, rather than enhance, its own security as well as global stability. Risks include the potential for starting a damaging and destabilizing space race; the potential for space weapons testing, let alone space warfare, to damage or destroy civilian space research and commercial assets; and the possibility that weaponizing space might harm the U.S. commercial space and telecommunications industry.

IS A SPACE RACE WINNABLE?

The United States already enjoys an overwhelming advantage in military uses of space. Assets such as the Global Positioning System (GPS) satellite network have proven invaluable in improving precision targeting, thus giving the U.S. military a decisive battlefield edge. There could be an even more formidable military advantage to possession of weapons in space, particularly those aimed at terrestrial or airborne targets: global power projection and the enormous difficulty in defending against space weapons.

"It is…possible to project power through and from space in response to events anywhere in the world. Having this capability would give the United States a much stronger deterrent and, in a conflict, an extraordinary military advantage," states the January 2001 report of the Commission to Assess the United States National Security Space Management and Organization—better known as the Space Commission, chaired by Donald Rumsfeld before he was tapped by Bush as defense secretary.

Space weapons—especially those aimed at terrestrial targets but also even those primarily designed for defense of U.S. satellites—would have inherent offensive and first-strike capabilities. Thus, they would likely demand a military and political response from U.S. competitors.

China and Russia long have been worried about possible U.S. breakout in space-based weaponry. Both countries are key proponents of negotiations at the UN Conference on Disarmament to expand the 1967 Outer Space Treaty to ban all types of weapons. The effort to start talks known as PAROS, for "prevention of an arms race in outer space," has been stalled due in large part to the objection of the United States.

It is almost inconceivable that either Russia or China would allow the United States to become the sole nation with space-based weapons. "Once a nation embarks down the road to gain a huge asymmetric advantage, the natural tendency of others is to close that gap. An arms race tends to develop an inertia of its own," writes Dr. Bruce DeBlois, a former Air Force officer now at the Council for Foreign Relations.[1]

Chinese moves to put weapons in space could trigger regional rival India to consider the same; China and India both already are space-faring powers. As always, any Indian move might spur Pakistan to strive for parity. Even U.S. allies in Europe might feel pressure to meet U.S., Russian, or Chinese capabilities in some manner.

On the one hand, one can argue about whether a space race is likely or even all that serious a possibility, given that the costs of entry are very high and conventional space weapons are not likely to be nearly as destructive as nuclear weapons.

Indeed, some experts argue that the more likely path would be for U.S. competitors to look for asymmetric challenges to U.S. space dominance. After all, the easiest ways of disrupting space operations are to target ground facilities and communications links. Asymmetric challenges from those who could not afford to be participants in a space race also would be costly in strategic, and possibly economic, terms.

Dr. Karl Mueller, a former Air Force analyst now at RAND, writes:

> The United States would not be able to maintain unchallenged hegemony in the weaponization of space, and while a space-weapons race would threaten international stability, it would be even more dangerous to U.S. security and relative power projection capability, due to other states' significant ability and probably inclination to balance symmetrically and asymmetrically against ascendant U.S. power.[2]

On the other hand, a space race cannot be ruled out as a likely outcome—especially given that many countries with much fewer economic and technical resources than the United States are already going to space. A strategic-level space race could have negative consequences for U.S. security in the long run that could outweigh any short-term advantage of being the first with space-based weapons. In particular, it would be costly in dollar terms to sustain orbital weapon systems and stay ahead of opponents intent on matching U.S. space-weapon capabilities. The price tag of space-weapon systems and protective measures would not be trivial for anyone choosing to pursue them—with maintenance costs a key issue.

One problem is that space weapons, just like satellites, would have inherent vulnerabilities (for example, fixed orbital paths), raising the specter of an ever-spiraling need for better weapons and force protection. Just as it is difficult to protect satellites, it is difficult to protect space weapons. For example, satellites or space weapons traveling in fixed paths in low-Earth orbit (LEO) are virtual sitting ducks for ground-based ASATs or even fighter aircraft equipped with rockets, not to mention space-based ASATs.

The other related negative side effect of the inherent vulnerability of orbiting weapons is the pressure to use them first. The strategic dynamic of space-based weapons could perhaps be compared to that of nuclear intercontinental

[1] Lt. Col. Bruce M. DeBlois, "Space Sanctuary: A Viable National Strategy," *Airpower Journal* (Winter 1998).

[2] Karl Mueller, "Space Weapons and U.S. Security: The Dangers of Fortifying the High Frontier," paper prepared for the 1998 Annual Meeting of the American Political Science Association, Boston, Mass.

ballistic missiles— offense-dominant weapons with inherent vulnerabilities (fixed sites). This is a recipe for instability, as the United States and Soviet Union soon found in their nuclear competition.

Spurring other nations to acquire space-based weapons, either ASATs or weapons aimed at terrestrial targets, would undercut the ability of U.S. forces to operate freely on the ground on a global basis and thus negate what today is a unique advantage of being the world's only military superpower.[3] Along with military assets in space, U.S. commercial satellites would also become targets (especially because the U.S. military is heavily reliant on commercial providers, particularly in communications).

In other words, the United States could be in the position of creating strategic and military problems for itself, rather than solving them.

TESTING AND DEBRIS

Another serious concern about moving weapons into orbit is the question of how testing, let alone actual warfare, in space might affect ongoing and future civil exploration efforts and commercial satellites. The reason is orbital debris.

There already is a good deal of debris in orbit, primarily from satellites accidentally exploding. Some 9,000 orbiting objects of a certain size (including about 600 working satellites) are constantly tracked by U.S. Space Command to avoid collisions.

Even tiny pieces of material orbiting in space can cause destruction of a satellite or numerous satellites, as such debris moves at very high speeds. According to a fact sheet put together by Union of Concerned Scientists physicist Al Saperstein, "Impact with a small pebble, traveling at average relative speed in space, is equivalent to being hit with a 22 caliber long rifle bullet." Indeed, Saperstein and other scientists have suggested that one easily built space weapon, or missile defense countermeasure, could be a bus that shoots large amounts of sand or gravel rocketing through LEO.[4]

Despite the U.S. Army's program to develop a kinetic kill ASAT, army officials have expressed concerns that using such weapons could create debris clouds that could render useless the U.S. military's own space assets in a kind of "orbital own goal" (to use a soccer term) or "space fratricide" (to use a military term). This concern has been echoed by top officials at U.S. Space Command. According to Saperstein, there are at least 24 U.S. military reconnaissance, electronic intelligence, and meteorological satellites in LEO (below 1,000 miles or 1,667 kilometers) alone—the orbit in which satellites currently are the most vulnerable to ground-based ASATs, precisely because it is easiest to reach. This is also the orbit where today's commercial imagery satellites are parked, not only those in U.S. corporate hands but also the French and Russian systems—as well as the many satellites used for scientific Earth observation, including the International Space Station.[5]

In fact, the United States has been quite concerned about limiting debris, including in its missile defense testing program, and is one of the leading nations raising the issue on the international stage. However, other countries entering into a space weapons race might not be so diligent. Increased space-based testing, especially of kinetic kill or explosive ASATs, could result in serious problems with space debris.

Finally, another potential problem for the civilian space community would be the political fallout from U.S. moves to build and deploy space weapons. A competition in military space might have a dampening effect on international cooperation in space exploration, and that in turn could slow the advance of science.

ECONOMIC RISKS

Finally, there also is reason to be concerned about the possibility that moves toward weaponizing space could damage the

[3] Air Force Maj. William L. Spacy II, "Does the United States Need Space-Based Weapons?" CADRE Paper, Air University Press, Maxwell Air Force Base, Ala. (September 1999).

[4] Al Saperstein, "Space: What's Up There? Why Is It Important? What Threatens It?" Union of Concerned Scientists, Fact Sheet (April 25, 2002).

[5] Ibid.

competitiveness of the U.S. space industry, which currently dominates the international marketplace and therefore bolsters U.S. economic and military power.

While commercial space was a booming business during most of 1990s, the market has contracted over the past two years. Further, there is excess capacity in the commercial space market place, with five major manufacturers (three U.S., two European). Notably, however, U.S. industry has not done as well as the overall market over the past two years—and industrialists partially blame government regulatory requirements and export controls. The global marketplace is highly competitive, and U.S. policy and regulations are a major factor in determining U.S. industry competitiveness.

U.S. industry officials also are uncomfortable about Pentagon plans to deny potential enemies access to (or even to shoot down) U.S. commercial space assets, including those providing imagery and communications services. Lt. Gen. Joseph M. Cosumano, Jr., commander of the Army Space and Missile Defense Command, admitted to reporters on July 15, 2001, at a conference sponsored by the U.S. Army Space and Missile Defense Command, in Huntsville, Ala., that "some of these assets belong to U.S. companies and they don't feel too good about the idea that we might shoot them out of the sky."[6]

The U.S. Defense Department already has the legal right to exercise so-called shutter control of U.S. civilian imagery satellites—that is, the ability to shut down a satellite to prevent enemies from accessing the data. Besides the United States, France, Israel, and Russia are in the imagery satellite business. Obviously, U.S. industrialists could not be expected to cheer the idea that defense policy may be stimulating the creation of stronger competitors for them. In addition, the European Union already is moving to buy a European version of GPS, called Galileo, in part due to fears that future access to GPS might be denied or downgraded by the U.S. military.

The competitive and cost challenges the U.S. satellite industry faces could be increased if the United States moved to make space a battlefield. Until now, the threat that commercial satellites could become direct wartime casualties has been negligible. But an aggressive U.S. pursuit of ASATs would likely encourage others to do the same, thus potentially heightening the threat to commercial satellites. This could be costly for industry, especially because current commercial satellites have little protection (electronic hardening, for example, has been considered too expensive). There would be costs for increasing protection, not to mention the likely further skyrocketing of already sky-high insurance costs, and it is not at all clear that the U.S. government would cover all those costs.

In addition, there already are issues of competition between Pentagon needs and industry needs. The most visible is in the area of access to spectrum and frequency allocations, but—if a number of new military satellites/weapons are to be launched—there also could be issues regarding orbital slots.

CONCLUSION

U.S. moves to weaponize space would come laden with a wide array of risks across the strategic, military, political, and economic spectra. At the same time, space assets are becoming more important to U.S. military operations and more vulnerable. Given these issues, it would seem only prudent for the Bush administration to undertake a broad look at the costs vs. benefits of spaced-based weaponry, as well as alternatives for protecting space-based assets, during the upcoming National Space Policy review.

[6] Author's own notes from the conference.

MILITARY SPACE COOPERATION: OPPORTUNITIES AND CHALLENGES

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Military space cooperation, like many space issues, is a complex and contentious issue area. This essay presents a skeptical view about the prospects for many or broad-ranging cooperative military space efforts by examining the following subjects: space weaponization; recent space arms control; control of high-resolution commercial satellite imagery, global utilities, and spectrum crowding; orbital debris; and space traffic control. Analyzing opportunities and challenges in military space cooperation may help to illuminate several of the most likely paths forward for future space activity and highlight the security implications of these developments.

SPACE WEAPONIZATION

At a fundamental level, virtually all issues of space strategy and military space cooperation are shaped by the spectrum of views on the utility of weaponizing space. Major questions include: whether space will be weaponized, how and when that might happen, which states and other actors might be most interested in leading or opposing weaponization, and how any of these space weaponization issues might best be managed. At the political level, there is, of course, a broad spectrum of opinion on these issues but most of the major tenets in mainstream views on weaponizing space can usefully be grouped into four major camps: space hawks, inevitable weaponizers, militarization realists, and space doves.[1]

Space Hawks

Adherents to this camp believe that space already is or holds the potential to become the dominant source of military power. Accordingly, they believe that the United States should move quickly and directly to develop and deploy space weapons in order to control and project power from this dominant theater of combat operations. According to Republican Senator Bob Smith of New Hampshire, for example, concerted development of space weapons by the United States "will buy generations of security that all the ships, tanks, and airplanes in the world will not provide.... Without it, we will become vulnerable beyond our worst fears."[2] In addition, space hawks often point to space-based ballistic missile defense (BMD) as a potentially decisive weapon capable of fundamentally reordering the strategic balance. Space hawks tend to oppose virtually all space-related arms control and are lukewarm at best on military space cooperation because of the potential of these activities to slow or derail rapid and direct space weaponization.

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[1] The four camps are presented from a U.S. national security perspective. There are many strands of thought within any of these camps. The four camps are similar to the four space doctrines discussed in Lt. Col. David E. Lupton, *On Space Warfare: A Space Power Doctrine* (Maxwell AFB, AL: Air University Press, June 1988) and have been derived from the schools of thought about space weaponization discussed in Lt. Col. Peter Hays and Dr. Karl Mueller, "Going Boldly—Where? Aerospace Integration, the Space Commission, and the Air Force's Vision for Space," *Aerospace Power Journal* 15 (Spring 2001), pp. 34-49. The growing importance of commercial space activity adds a new dimension to this analysis that few of the traditional approaches seem well prepared to incorporate or even address. For a groundbreaking analysis that advocates using economic criteria to separate traditional military space functions from more regulatory functions that would be performed by a new U.S. Space Guard (modeled after the Coast Guard), see Lt Col Cynthia A. S. McKinley, "The Guardians of Space: Organizing America's Space Assets for the Twenty-First Century," *Aerospace Power Journal* 14, no. 1 (Spring 2000), pp. 37–45.

[2] Sen. Bob Smith, "The Challenge of Space Power," *Airpower Journal* 13 (Spring 1999), p. 33. Prominent space hawk groups include High Frontier, the Heritage Foundation, and the Center for Security Policy.

Inevitable Weaponizers

This group believes that space, like all other environments man has encountered, will eventually be weaponized. They differ from space hawks in two important ways: they are not convinced that space weaponization would be beneficial for U.S. or global security, and they are unsure that space will prove to be the decisive theater of combat operations. The January 2001 Space Commission Report is a good example of this camp: "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 United States must develop the means both to deter and to defend against hostile acts in and from space."[3] Inevitable weaponizers take a nuanced view of space arms control and cooperation. They generally support confidence- and security-building measures (CSBMs) and other cooperative mechanisms designed to slow military competition and channel it in predictable ways. But they are less supportive of broad efforts to ban space weapons because they see them as futile or even dangerous due to their potential to lull the United States into complacency or otherwise cause it to be outmaneuvered by states that successfully circumvent space weaponization accords.

Militarization Realists

Members of this camp oppose space weaponization because they believe U.S. security interests are best served by the *status quo* in space. They believe that the United States has little to gain but much to lose by weaponizing space because it is both the leading user of space and, enabled by this space use, the dominant terrestrial military power. Militarization realists also believe that if the United States takes the lead in weaponizing space, it would become easier for other states to follow due to lower political and technological barriers. For these reasons, militarization realists believe that "fighting *into* space looks feasible and we should plan for the eventuality. Fighting *in* space shows little promise, while fighting *from* space looks impractical for the foreseeable future, with or without treaties."[4] Militarization realists support space-related arms control and cooperation that precludes other states from weaponizing or even militarizing space. Most of them believe, however, that this support must be balanced against the increased attention that formalized arms control efforts could draw to America's already formidable space-enabled force enhancement capabilities and the political, military, and arms control fallout this increased scrutiny might cause. Informal cooperation might be one of the best ways to circumvent this potential difficulty.

Space Doves

Finally, a wide range of organizations and viewpoints can be grouped together in the space dove camp because they all oppose space weaponization for a variety of reasons, including moral, arms control, conflict resolution, stability, and ideology arguments. Most space doves also oppose any militarization of space beyond the limited missions they see as stabilizing—national technical means (NTM) of arms control verification, early warning, and hotline communications—because they see any military missions beyond these as the "slippery slope" to space weaponization. Most space doves emphasize how destabilizing most space militarization and all space weaponization would be. "Unlike the strategy for nuclear weapons, there exists no obvious strategy for employing space weapons that will enhance global stability. If the precedent of evading destabilizing situations is to continue—and that is compatible with a long history of U.S. foreign policy—one ought to avoid space-based

[3] *Report of the Commission to Assess United States National Security Space Management and Organization*, (Washington, D.C., January 11, 2001), p. x. Most U.S. space policy, military space doctrine, and military officers probably fall into this camp.

[4] Maj. William L. Spacy II, USAF, "Does the United States Need Space-Based Weapons?" *Cadre Paper 4* (Maxwell AFB, Ala.: Air University Press, September 1999), p. 109. See also Maj. David W. Zeigler, "Safe Heavens: Military Strategy and Space Sanctuary," in Col. Bruce M. DeBlois, ed., *Beyond the Paths of Heaven: The Emergence of Space Power Thought* (Maxwell AFB, Ala.: Air University Press, September 1999), pp. 185–245.

weapons."[5] They also highlight the deep roots of President Eisenhower's "space for peaceful purposes" policy and argue that, especially in the post-Cold War era, there is no rationale for space weaponization that is strong enough to overturn the basic strategic logic America developed at the opening of the space age. Space doves support space arms control and cooperation more strongly than any other camp. Since they do not believe the United States (or other states) would reap strategic benefits from weaponizing space, they are not overly concerned about the numerous arms control challenges identified by the other camps. Moreover, like Paul Stares, most space doves would not support using two-track approaches to space arms control.[6]

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 to establish a dialogue concerning the interrelationships between space and security. It is difficult to see a clear cooperative path forward for the United States or global space community. The Realist lens in global politics and Graham Allison's rational actor (Model I) lens in domestic politics portend a rocky path forward.[7] Likewise, it is also difficult to see clear lines of military space cooperation through regimes or epistemic communities or by applying Allison's Models II and III to the multiplicity of organizations and individuals that contribute to the pulling and hauling of governmental decision making within a pluralist democracy such as the United States. Clearly, it would be a formidable challenge to provide enough incentives and assemble coalitions capable of pushing forward any camp's preferred vision for space competition or cooperation. Given this environment, it seems unlikely that the United States can or will provide strong or consistent leadership for military space cooperation. It is more likely that the United States would move forward in response to external space arms control initiatives or trigger events related to the weaponization of space.[8]

On the technical side of the equation, space arms control and formalized cooperation designed to control the weaponization of space face all of the problems that plagued previous attempts to develop these control mechanisms. The most serious of these problems include: disagreements over the proper scope and object of negotiations; basic definitional issues about what a space system is and how it might be categorized as offensive or defensive, stabilizing or destabilizing; and questions concerning how any agreement might be adequately verified. These problems relate to a number of very thorny specific issues such as: whether the negotiations should be bilateral or multilateral, formal or informal; what satellites and other systems should be covered; whether the object should be control of space weapons or CSBMs for space; which types of CSBMs, such as rules of the road or keep out zones, for example, might be most useful and how these might be reconciled with existing space law such as the Outer Space Treaty (OST); and verification problems, such as how to address residual anti-satellite (ASAT) capabilities or deal with the significant military potential of even a small number of covert ASAT systems.

New space system technologies, the growth of the commercial space sector, and new verification and transparency technologies interact with these existing problems in complex ways. Some of the changes would seem to favor arms control and cooperation, such as better radars and optical systems for

[5] Lt. Col. Bruce M. DeBlois, "Space Sanctuary: A Viable National Strategy," *Airpower Journal* 12 (Winter 1998), pp. 41–57. This article is one of the most comprehensive and persuasive expositions of the space dove camp.

[6] Paul B. Stares, *The Weaponization of Space, U.S. Policy 1945-1984* (Ithaca: Cornell University Press, 1985).

[7] Model I (rational actor), Model II (organizational process), and Model III (bureaucratic politics) are commonly used lenses for examining governmental decision making that were developed by Graham T. Allison in *Essence of Decision: Explaining the Cuban Missile Crisis* (Boston: Little, Brown and Company, 1971).

[8] See, in particular, the outstanding analysis of trigger events for space weaponization in Barry D. Watts, *The Military Use of Space: A Diagnostic Assessment* (Washington, D.C.: Center for Strategic and Budgetary Assessments, February 2001), pp. 97–106.

improved space situation awareness and verification, technologies for better space system diagnostics, and the stabilizing potential of microsatellite-based distributed and robust space architectures. Many other trends, however, would seem to make space arms control and cooperation even more difficult. For example, stealthy microsatellites might be used as virtually undetectable active ASATs or passive space mines; the proliferation of space technology has radically increased the number of significant space actors, and these ranks now include a number of important nonstate actors; and growth in the commercial space sector raises issues such as how quasi-military systems should be protected or negated and the unclear security implications of emerging markets for dual-use systems. Cumulatively, just as with the political factors that animate the four space camps discussed above, it is hard to see many technical factors that would clearly advance space arms control and cooperation designed to control space weaponization.

RECENT SPACE-RELATED ARMS CONTROL DEVELOPMENTS

With the end of the Cold War, many formal arms control efforts have been de-emphasized, and most space-related arms control efforts are no exception. There have been, nonetheless, some very important but perhaps under appreciated space-related provisions in recent treaties and agreements. Moreover, the recent growth in commercial space activity undoubtedly creates an opportunity if not a need for expanded regulation and control in this area.

START I and II

The 1991 Strategic Arms Reduction Treaty I is a bilateral treaty between the United States and Soviet Union designed to reduce the number of deployed strategic offensive arms (warheads and delivery vehicles) maintained by each.[9] Several of the broad provisions in START I build on previous arms control treaties. For example, START I repeats the NTM provisions first contained in the Anti-Ballistic Missile Treaty (ABMT) but also relies on extensive on-site verification (OSI) verification protocols to assure compliance.[10] In addition, START I strengthens the OST prohibition on the placement of weapons of mass destruction in outer space. Article V, Paragraph 18 of the Treaty prohibits each party from producing, testing, or deploying systems, including missiles, for placing nuclear weapons or any other kinds of weapons of mass destruction into earth orbit or a fraction of an earth orbit.[11] This is an important provision designed to ban fractional orbital bombardment systems such as the one successfully tested by the Soviet Union from 1965 to 1971.[12]

START I has many new implications for military space operations as well. There are several restrictions on the use of intercontinental ballistic missiles (ICBMs) or submarine-launched ballistic missiles (SLBMs) as space-launch boosters. For example, the treaty places restrictions on the number, type, and location of ICBMs and SLBMs used to boost objects into the upper atmosphere or space, and limits the number and location of space-launch facilities used to support such launches.[13] Objects launched by ICBMs or

[9] Treaty between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms (START I), signed July 31, 1991, entered into force December 5, 1994. Most of the discussion and analysis on START I and II below is drawn directly from Lt. Col. Thomas W. Billick, "Arms Control Implications for Military Operations in Space," Research Report for USAF Institute for National Security Studies, USAF Academy, CO (May 2001), pp. 24–30.

[10] See "Article-by-Article Analysis of Treaty Text," available on-line from the State Department website at: <http://www.state.gov/www/global/arms/start htm/start/abatext.html#IX>.

[11] Ibid.

[12] Stares, *Militarization of Space*, pp. 99-100.

[13] START I, Paragraph 4 of Article IV provides limits on ICBMs and SLBMs used for delivering objects into the upper atmosphere or space. The parties recognized that such use of ICBMs and SLBMs is valid and economical, but they also recognized that such use must be limited because such missiles could also be used for their original purpose of weapons delivery. In order to limit the potential for breakout, paragraph 4 limits each Party to no more than five space launch facilities, which are defined as specified facilities from which objects

SLBMs into the upper atmosphere or space are also subject to the treaty's telemetry requirements. In a major departure from past practice, the treaty requires the party conducting any peacetime launch of an ICBM or SLBM to make onboard technical measurements, broadcast all telemetric information obtained from such measurements in a way that allows full access to the information, and then provide a recording and analysis of that data to the other party. For objects delivered by ICBMs or SLBMs into the upper atmosphere or space, the telemetry provisions only apply until the object(s) being delivered either are in orbit or have achieved escape velocity.[14] Furthermore, advance launch notification must be made to the other treaty party whenever an ICBM or SLBM is used as a booster for delivering objects into the upper atmosphere or space. Such notification is provided in accordance with the provisions of START I and the Ballistic Missile Launch Notification Agreement.[15] START I might also affect ongoing space control and force application initiatives. For example, if the planned space operations vehicle was designed with a conventional strike capability, it might be held accountable under START I limitations on heavy bombers equipped for nuclear armaments other than long-range nuclear air-launched cruise missiles. No exhibition would be required, but the vehicle's distinguishing features would be listed in the START memorandum of understanding. In addition, the facility where the vehicle is based would have to be declared as a heavy bomber base but would not be subject to inspection unless it contained a weapons storage area. A determination of treaty applicability, if any, would be subject to discussion between the parties.[16]

Restrictions contained in the 1993 Strategic Arms Reduction Treaty II (START II) between the United States and Russia have now been bypassed, due to the U.S. withdrawal from the Anti-Ballistic Missile Treaty in June 2002 and the subsequent Russian declaration that it would no longer abide by START II.

Finally, in addition to the notifications required by the START Treaties and the

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are delivered into the upper atmosphere or space using ICBMs or SLBMs. Paragraph 4 also provides that these facilities may not overlap ICBM bases; limits each Party to a total of no more than 20 ICBM or SLBM launchers at those facilities, of which no more than ten may be silo and mobile launchers, unless otherwise agreed; and limits the number of ICBMs or SLBMs at a given space launch facility to no more than the number of launchers at that facility. Space launch facilities are not subject to inspection. The number of space launch facilities and the number of launchers at those facilities may be increased or decreased if the parties agree. Such changes would not require an amendment to the Treaty.

[14] START I, Article X, and the Telemetry Protocol. During the Cold War, the United States invested billions of dollars in intelligence-gathering equipment designed primarily to obtain telemetry data on Soviet ballistic missiles. Gathering and analyzing this information was among the most difficult intelligence challenges of the Cold War.

[15] Agreement between the United States of America and the Union of Soviet Socialist Republics on Notifications of Launches of Intercontinental Ballistic Missiles and Submarine-Launched Ballistic Missiles (Ballistic Missile Launch Notification Agreement), signed and entered into force on May 31, 1988, in Moscow.

[16] START I article by article legal analysis makes specific reference to the national aerospace plane in describing the treaty definition of *airplane* and the treaty prohibition against flight-testing, equipping, and deploying nuclear armaments on an airplane that was not initially constructed as a bomber but has a range of 8,000 km (kilometers) or more or an integrated planform area over 310 square meters. However, the parties did not reach agreement on the applicability of the treaty to future non-nuclear systems. During the negotiations, the United States stated its view that a future non-nuclear system could not be considered a new kind of strategic offensive arm and, thus, would not be subject to the treaty. The Soviet Union did not accept this view. The parties agreed, in the Second Agreed Statement, that, if "new kinds" of arms emerge in the future and if the parties disagree about whether they are strategic offensive arms, then such arms would be subject to discussion in the Joint Compliance and Inspection Commission. Of course, if one party deploys a new kind of arm that it asserts is not subject to the treaty, and the other party challenges this assertion, the deploying party would be obligated to attempt to resolve the issue. There is, however, no obligation to delay deployment pending such resolution.

Ballistic Missile Launch Notification Agreement, the United States and Russia have signed two new agreements expanding launch notifications to include all space launch vehicles. On June 4, 2000, President William J. Clinton and Russian President Putin signed a memorandum of agreement to establish a joint data exchange center (JDEC) in Moscow to share early warning information on missile and space launches.[17] Once the JDEC is completed and commences operations, the two countries are supposed to exchange information obtained from their respective ground- and space-based early warning systems on U.S. and Russian space launches (with rare exceptions) including time of launch, generic missile class, geographic area of the launch, and launch azimuth. Eventually this exchange of data will also include data sharing on detected space launches of other states. On December 16, 2000, U.S. Secretary of State Madeline K. Albright and Russian Foreign Minister Igor Ivanov signed a memorandum of understanding establishing a Pre- and Post-Launch Notification System (PLNS) for launches of ballistic missiles and, with rare exceptions, space launch vehicles, identifying launch window, time of launch, generic missile class, geographic area of the launch, and launch azimuth.[18] The PLNS Information Center will be an Internet-based system operated as part of the JDEC. Both agreements provide for the voluntary notification of satellites forced from orbit and certain space experiments that could adversely affect the operation of early warning radars, and both agreements leave open the possibility of negotiations on future data sharing on missiles that intercept objects not located on earth's surface. The JDEC and PLNS are among the most detailed and comprehensive space-related CSBM ever negotiated. They are designed to enhance stability by limiting flexibility and clandestine operations. The operation of these agreements should be studied carefully to assess prospects for creating a truly shared early warning system as well as the applicability and utility of providing this data among more states. The wide spectrum of opinion on the utility of these latest agreements is another excellent illustration of how fundamental disagreements on military space strategy can color all subsequent analysis.[19]

CONTROL OF HIGH-RESOLUTION COMMERCIAL IMAGERY

The strategic, conceptual, and pragmatic difficulties associated with controlling high-resolution commercial space imagery is an excellent illustration of other challenges to military space cooperation. A number of complex interdependencies have and will continue to shape the global high-resolution commercial remote sensing market. The United States should carefully and continuously re-evaluate whether the benefits that Presidential Decision Directive 23 (PDD-23) is designed to create—such as greater transparency and market preeminence—do, in practice, actually outweigh the costs, including the possible use of this data for nefarious ends. Regulatory mechanisms, such as shutter control that the United States has put in place, appear to provide an equitable balance between economic considerations and national security concerns. These mechanisms should also be self-regulating to a large degree. If the United States overuses shutter control, it may drive potential customers to foreign imagery providers; but such a control is required before the United States should create incentives for its high-resolution commercial remote sensing

[17] Memorandum of Agreement between the United States of America and the Russian Federation on the Establishment of a Joint Center for the Exchange of Data from Early Warning Systems and Notifications of Missile Launches (JDEC MOA), signed in Moscow and entered into force on June 4, 2000; available on-line at: <http://www.clw.org/coalition/summit060400launch.htm>.

[18] Memorandum of Understanding on Notifications of Missile Launches (PLNS MOU), signed December 16, 2000.

[19] On the spectrum of opinion concerning the JDEC and PLNS see, for example, John Steinbruner, "Sharing Missile Launch Data," Pugwash, available on-line at http://www.pugwash.org/publication/nl/nlv38n1/essay-steinbruner.htm; and "National Security Alert," Center for Security Policy, December 8, 2000, available on-line from the Center for Security Policy's website at http://www.security-policy.org/papers/2000/00-A44.html.

industry to dominate the global market. The United States should also study the applicability of this regulatory model for other states that operate high-resolution imagery satellites, as well as the way the United States might create incentives for these states to adopt similar internal controls over dissemination of satellite imagery. Thus far, the United States has attempted to shape the world market via mostly economic benefits, rather than security considerations. It should rebalance that equation toward national security, perhaps by formal arms control restrictions on high-resolution commercial remote sensing, if the benefits do not outweigh the costs. If it becomes prudent to move in this direction, there are a number of unilateral and multilateral regulation and control options that the United States could pursue.[20]

In the latest developments in this area, during the early stages of Operation Enduring Freedom in Afghanistan, the National Imagery and Mapping Agency (NIMA) established *de facto* shutter control by signing an "agreement of assured access" with the Space Imaging Corporation, reportedly for $1.9 million per month. Under the terms of this renewed agreement, Space Imaging was not to sell or share its Afghanistan theater imagery with anyone except the U.S. government (USG) until after January 5, 2002.[21] This "checkbook shutter control" agreement opens many interesting issues related to the utility of limiting information dissemination for public diplomacy, the media, and exploitation of enemy information channels. It also raises the issue of whether this agreement using market mechanisms has set a precedent that might well make it more difficult to invoke formal shutter control without buying up all the imagery in the future.

High-Resolution Commercial Imagery and Deception

Digital imagery may create novel challenges for transparency and cooperation efforts because digitized data streams designed to produce imagery are ideally suited for deception. This is because digitized data must always be mathematically processed to create images, and this processing is subject to manipulation in a variety of ways—many of which are not available for manipulating film images. As Steven Livingston explains:

> Mathematically altering the value of the pixels alters *seamlessly* the representation. "Since it is purely a mathematically process, the source images can be altered fundamentally and undetectably before and/or during their production." Elements can be added or subtracted, changed in color, brightness, or contrast. Changes are made not by altering the computer code that produces the image, and not in the image itself as in analog manipulation. In fact, it is more accurate perhaps to say that no image exists beyond the mathematical equations that create a particular array of pixels. The equations are the image. Therefore as computer processors become faster and more

[20] On June 9, 1999, the Canadian Ministries of Foreign Affairs and Defense announced that they had formed an interdepartmental team of experts who are charged with developing new "access control" legislation to control Canadian commercial remote sensing satellites. The principles guiding the interdepartmental team are very similar to PDD-23, and the process of drafting and implementing the policy is expected to take up to two years. The News Release and a Backgrounder are available on-line at: <http://198.103.104.118/minpub/Publication.asp?FileSpec=/Min_Pub_Docs/101271.htm>.

[21] Kerry Gildea, "NIMA Extends Deal with Space Imaging for Exclusive Imagery Over Afghanistan," *Defense Daily*, November 7, 2001, p. 2; "Eye Spy," *The Economist*, November 10-16, 2001; and Pamela Hess, "DOD Won't Release Pix Until 5 Jan," *Washington Times*, November 7, 2001. In addition, the French Ministry of Defense barred SPOT Image from selling or distributing images of Afghanistan and the surrounding regions to anyone except that ministry. "Shutter Control for SPOT Over Afghanistan," *Space Newsfeed*, 28 (October 2001), available at: <http://www.spacenewsfeed.co.uk/2001/28October2001.html>. These decisions have left Cypress-based ImageSat International as the only company able to provide one-meter commercial imagery of Afghanistan and the surrounding region. Barbara Opall-Rome, "U.S. Data Purchase Opens Doors for ImageSat," *Space News*, October 22, 2001, p. 6.

> powerful, so too does the ability to alter digital information.[22]

The phrase "altered fundamentally and undetectably" is absolutely loaded with implications. For starters, it means that virtually *anything* can be added, subtracted, or changed in digital imagery (or to any digital information) and that even experts cannot necessarily detect these changes. The possibilities for deception through manipulating digital imagery are literally unlimited. Perhaps even more alarmingly, all of this can happen in real time as the data stream is converted into manipulated imagery. It is no wonder that the digital age creates a number of legal conundrums and that the veracity of digitized information is increasingly being questioned in courtrooms.[23] The requirement for imagery providers to use only USG-approved encryption devices that allow USG access during periods of shutter control, especially when coupled with the potential to use digital data for deception, certainly presents some interesting possibilities for control and exploitation by leaving systems operating rather than shutting them off. At the very least, as *No More Secrets* summarizes, "Commercially available high-resolution satellite imagery will trigger the development of more robust denial and deception and antisatellite countermeasures."[24] Given this potential for deception, governments and the news media should adopt a "dual phenomenology" requirement as a way to attempt to confirm the veracity of digitized imagery.

Global Utilities

Because of all the growth in space systems and the services they provide, some analysts believe they create novel avenues for cooperation and should now be considered in a new way as the global utilities that enable the global information infrastructure. In some ways, the concept of global utilities is just another recognition of how much the commercial space sector has grown and how important it has become; but it is also clear that the global information infrastructure, as it currently exists, simply could not function without space systems and the services they provide.

Global utilities have been defined as: "Civil, military, or commercial systems—some or all of which are based in space—that provide communication, environmental, position, image, location, timing, or other vital technical services or data to global users."[25] To date, all space-based global utilities provide information services, but they are analogous to earth-bound utility services that provide a foundation for modern life such as water and electricity. And like these earth-bound utility services, space-based global utilities may be subject to regulation and control at the local, state, national, and international levels. Two relatively minor recent failures illustrate just how embedded global utilities have become in the global information infrastructure. In 1996, a controller at the Air Force Global Positioning System (GPS) control center accidentally put the wrong time into just one of the 24 satellites, and this erroneous signal was broadcast for just six seconds before automatic systems turned the signal off. That momentary error caused more than 100 of the 800 cellular telephone networks on the U.S. East Coast to shut down,

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[22] Steven Livingston, "Transparency or Opacity? Information Technology and Deception Operations," paper presented at the International Studies Association Annual Meeting, Chicago, February 21-24, 2001. Livingston's quote is from Don E. Tomlinson, *Computer Manipulation and Creation of Images and Sounds: Assessing the Impact* (Washington, D.C.: The Annenberg Washington Program, 1993). See also Ivan Amato, "Lying with Pixels," *Technology Review* (July/August 2000).

[23] Kimberly Amaral, "The Digital Imaging Revolution: Legal Implications and Possible Solutions," on-line, Internet, available from http://www.umassd.edu/Public/People/KAmaral/Thesis/digitalimaging.html.

[24] Yahya Dehqanzada and Ann Florini, eds., *No More Secrets*, conference proceedings from May 26, 1999, Carnegie Endowment, p. viii.

[25] Lt. Gen. Bruce Carlson, USAF, "Protecting Global Utilities: Safeguarding the Next Millennium's Space-Based Public Services," *Aerospace Power Journal* 14 (Summer 2000), p. 37. For a more detailed discussion, see Scott Pace et al., *The Global Positioning System: Assessing National Policies* (Washington, D.C.: RAND Critical Technologies Institute, 1995), pp. 184–89.

and some took hours or even days to recover.[26] In May 1998, "40–45 million pager subscribers lost service; some ATM and credit card machines could not process transactions; news bureaus could not transmit information; and many areas lost television service—all because of the loss of *one* satellite."[27] Clearly, space systems have become an increasingly important part of the global information infrastructure, but questions remain about how they should be regulated and protected.

How global utilities should be controlled and regulated is a complex issue that depends on a number of factors, such as the specific systems in question, the services they provide, and the primary users. Communication satellites are already subject to significant control and regulation at the international level through the International Telecommunications Union (ITU) and, in the United States, through the Federal Communications Commission (FCC). This high level of regulation for communication satellites is justified both because of the threat of harmful interference in the radio spectrum and due to the lucrative nature of these services. Other areas within the commercial space sector that have yet to demonstrate much profitability, such as high-resolution remote sensing, are also subject to regulation and control, but it is generally at a lower level. The United States provides other global utility services, such as meteorological data and GPS timing signals, free to all users worldwide as a public good. Given the current range of existing regulation and control for global utility services, it is not clear what cooperative, national security, or economic objectives would be served by attempting to regulate these services in the same or even similar ways.

In addition, the United States and the rest of the global space community should consider how global utilities might best be protected and fostered as an enabling technology within the global information infrastructure. Unfortunately, no clear or easy answers stand out, and there is a wide range of views on the best path forward. Despite the many threats detailed above, to date there has been almost "no demand from the operators of commercial communications satellites for defense of their multibillion dollar assets."[28] The current lack of support from industry for protection of global utilities is particularly disappointing to United States Space Command (USSPACECOM) because during the late 1990s, they had attempted to advance the argument that such protection was needed and would be demanded as space commercialization grew.[29] Some analysts believe that a multilateral approach to protection for global utilities would be best and argue that this function should be performed by an international organization such as the UN. This approach would likely, however, be filled with all the political, economic, and technical difficulties that have plagued almost all international space efforts. The rocky path of the International Space Station certainly does not inspire confidence in this approach to providing protection for global utilities. At the opposite end of the spectrum are those who advocate that the U.S. military, and the Air Force in particular, should take on the global utility protection mission regardless of international opposition or a lack of support from industry. On top of the political opposition to this approach, creating a viable defense for global utilities also faces daunting economic and especially technical challenges such as those presented by a high-altitude nuclear detonation. Based on the technologies currently being examined, only a robust space-based system would stand much chance of providing an effective defense against the most threatening attacks on global utilities.[30]

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[26] Carlson, "Protecting Global Utilities," p, 38. All modern "digital compression" telecommunication protocols such as time division multiple access or code division multiple access require highly accurate timing signals to operate.

[27] Ibid., p. 37. The PanAmSat Corporation's *Galaxy 4* satellite failed on May 19, 1998.

[28] John M. Logsdon, "Just Say Wait to Space Power," *Issues in Science and Technology* (Spring 2001), n. p.; on-line, Internet, 24 April 2001, available at: <http://www.nap.edu/issues/17.3/p_logsdon.htm>.

[29] USSPACECOM perhaps made this "Flag Follows Trade" argument most strongly in *Long Range Plan: Implementing USSPACECOM Vision for 2020* (Peterson AFB, Colo.: US Space Command, Director of Plans, March 1998).

[30] Carlson, "Protecting Global Utilities," p. 41.

Spectrum Crowding, Orbital Debris, and Space Traffic Control

The final military space cooperation areas to be examined relate to the cumulative effects of greater use of space. Current and projected use of space is creating challenges particularly in the areas of crowding of the radio spectrum for space, orbital debris, and the possible need for space traffic control. Recent growth in commercial space activity has exacerbated crowding of the radio spectrum for space applications, and there are currently significant pressures on portions of the spectrum now allocated to military uses. In particular, today there is significant pressure to move the U.S. Department of Defense (DOD) out of the 1755 to 1850 megahertz (MHz) radio frequency band in order to auction it off for third-generation communications applications. It is not clear, however, that cooperation, U.S. national security, or even economic interests would benefit from moving DOD out of this band. As the General Accounting Office (GAO) report on this issue makes clear, more study is required.[31] In particular, the issue must be carefully reconsidered in light of the global war on terrorism and the radically reduced bandwidth requirements that will undoubtedly accompany the economic downturn toward which the global economy may be moving. More generally, the increasing pressure on the radio spectrum due to more commercial use of space has been somewhat balanced by the use of new technologies and different orbits that lessen the effects of increased use. For example, modern satellites in geostationary orbit (GSO) have only two degrees of spacing between them (versus three or more degrees in the past) for most systems providing fixed satellite services. Likewise, increasing use of non-geostationary orbits for communication satellite networks has decreased the pressure on overcrowding the GSO in terms of spectrum and spacing. In sum, then, current trends for the space radio spectrum do not augur major changes in the current regulatory structure. Moving the ITU to auctions for its coordination/registration process would undoubtedly produce greater efficiency and generate income, but these benefits would need to be weighed against the equal access concerns of the developing world and the fact that there currently seems to be little support for moving in this direction.

Cooperative approaches to mitigating orbital debris may represent the single, most potentially useful window of opportunity for space arms control and regulation for the United States and the global space-faring community.[32] The National Aeronautics and Space Administration (NASA) defines "orbital debris" as "any man-made object in orbit about the Earth which no longer serves a useful purpose."[33] Human space activity has generated a lot of debris: there are over 9,000 objects larger than 10 centimeters (cm) and an estimated 100,000-plus objects between one and 10 cm in size.[34] The largest single source of this debris has been intentional and unintentional satellite explosions on orbit.[35]

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[31] "Defense Spectrum Management: More Analysis Needed to Support Spectrum Use Decisions for the 1755–1850 MHz Band" (Washington, D.C.: General Accounting Office, August 2001).

[32] Planetary defense or the effort to track and eventually defend against potentially life threatening near-Earth objects that might impact earth is another high-profile window for cooperation on a space-related issue, but it does not appear to be a traditional control or regulation effort and is not discussed in this paper. For more information about planetary defense, see, for example, "Preparing for Planetary Defense: Detection and Interception of Asteroids on Collision Course with Earth," *SPACECAST 2020,* appendix R, available at: <http://www.au.af.mil/Spacecast/app-r/app-r.doc>; *Air Force 2025* Research Paper, "Planetary Defense: Catastrophic Health Insurance for Planet Earth," available on-line from the website of the Air University at Maxwell Air Force Base at: <http://www.au.af.mil/au/2025/volume3/chap16/v3c16-1.htm>; and Brig. Gen. S. Pete Worden, "NEOs, Planetary Defense and Government: A View from the Pentagon," available on-line at: <http://www.spaceviews.com/2000/04/article2a.html>.

[33] "Frequently Asked Questions about Orbital Debris," NASA-Johnson Space Center, Space Science Branch, on-line, Internet, available at: <http://orbitaldebris.jsc.nasa.gov/faq/faq.html>.

[34] Ibid.

[35] The European Space Agency (ESA) estimates that 44 percent of the catalogued orbit population (larger

Orbital debris generally moves at very high speeds relative to operational satellites and thereby poses a risk to these systems due to its enormous kinetic energy.[36] Only three collisions between operational systems and orbital debris are known to have occurred thus far, but concerns about this hazard are growing due to the increasing number of operational space systems and the five percent growth rate in low-Earth orbit (LEO) orbital debris each year.[37] There is even concern about the potential for orbital debris "chain reactions" due to collisions in big-LEO communication satellite constellations or due to the debris clouds that could be created by use of kinetic energy ASATs in LEO.

Since the 1980s, the United States has led the world in publicizing the risks due to orbital debris, and it has made programs to mitigate debris an increasingly important part of its overall space policy.[38] There is, however, undoubtedly more the United States could do on the orbital debris front. The United States should explore several options such as unilaterally pledging not to create space debris through testing or operations of any ASAT system, creating strict unilateral regulations that mandate debris mitigation for U.S. commercial space operators (perhaps as a part of a "spaceworthiness license" required before commercial space systems can bid in spectrum auctions, apply for export licenses, or compete for government business), multilateral efforts to "clean up" debris using lasers and other techniques, and creating strict multilateral regulations for debris mitigation. These and other creative approaches should be explored vigorously in order to ensure that man's increasing use of space does not impose unacceptable risks on this activity.

Finally, due again to the increasing use of space, the United States and global space community must carefully consider the need for and implications of space traffic control systems (STCS) that could be analogous to current air traffic control systems. The idea for such a system is obviously related to the orbital debris problem discussed above, but it goes well beyond just this problem to include a wide range of factors such as: how space traffic might coordinate and be approved for specific orbital positions, how space traffic would be located and tracked, sanctions and liability for noncompliance and collisions under an STCS, and how such a regime might be established and funded. As with many space-related issues, the technology to at least begin implementing such a system appears to be closer at hand than is the political will to begin down this path. For example, the Ballistic Missile Defense Organization's Midcourse Space Experiment (MSX) satellite launched in April 1996 is the

than 10 cm) originated from the 129 on-orbit fragmentations recorded since 1961. See European Space Agency, "Introduction to Space Debris," available at: <http://www.esoc.esa.de/external/mso/debris.html>; and the Aerospace Corporation's "What is Orbital Debris?" website available from <http://www.aero.org/cords/orbdebris.html>. Until fairly recently, several space-faring states (Russia in particular) routinely blew up their satellites at the end of their useful life. Inadvertent mixing of propellant and oxidizer and over pressurization of residual fuel or batteries are the most common causes of unintentional explosions.

[36] In LEO (less than 2,000 km altitude) the average relative velocity at impact is 10 km per second. At this speed: "An aluminum sphere 1.3 mm in diameter has damage potential similar to that of a .22-caliber long rifle bullet. An aluminum sphere 1 cm in diameter is comparable to a 400 lb safe traveling at 60 mph. A fragment 10 cm long is roughly comparable to 25 sticks of dynamite." See "What are the Risks of Orbital Debris?" available at: <http://www.aero.org/cords/debrisks.html>.

[37] The Aerospace Corporation, "What is the Future Trend?" available from their website on-line at <http://www.aero.org/cords/future.html>. The space shuttle must infrequently (every year or two) maneuver away from known orbital debris. Critical components on the International Space Station have been designed to withstand the impact of debris up to 1 cm in diameter.

[38] Historic Space Policy documents are available from the Air War College's Space Operations & Resources Gateway at: <http://www.au.af.mil/au/awc/awcgate/histpol.htm>. The first emphasis on orbital debris in National Space Policy came in President Reagan's February 11, 1988 National Space Policy and by the Clinton administration's September 19, 1996 National Space Policy, mitigation of orbital debris was a major intersector guideline.

only operational space-based surveillance instrument. It has found some "150 objects in the last three years that were completely lost" and demonstrated the potential value of space-based sensors to an STCS.[39] Likewise, GPS positioning signals could be used to locate many space systems very accurately, and a transponder-like system aboard space systems could provide this data automatically in response to queries from the STCS.[40] On the political side of the equation, however, the United States must consider very carefully how its objectives in space might benefit or be harmed via the creation and operation of an STCS. It is not obvious that an air traffic control model is the appropriate regime for space, or that the political and financial costs of creating and operating such a system (many of which would likely be borne by the United States) would be outweighed by its benefits. Most of the benefits would seem to be in the commercial and civilian space sectors, while the potential drawbacks might be most severe for the military and intelligence sectors. The United States most likely would not, for example, want the ephemeris on its military and intelligence-gathering satellites to be preapproved and available worldwide through an STCS. At the very least, since an STCS could be such a powerful tool for denial, deception, and even targeting, the United States and other members of the global space-faring community must think through very carefully exactly what type of control regime would be most appropriate for space and how such a regime would operate in practice.

[39] Leonard David, "Eye in the Sky to Track Space Junk," *Space.com*, November 7, 2000, available at: <http://www.space.com/businesstechnology/technology/ space_trafficcontrol_001102.html>.

[40] For a detailed discussion of STCS (especially the technical requirements for such a system), see "Space Traffic Control: The Culmination of Improved Space Traffic Operations," *SPACECAST 2020*, append. D, available at: <http://www.au.af.mil/Spacecast/app-d/app-d.html>.

ENHANCING GLOBAL SECURITY THROUGH IMPROVED SPACE MANAGEMENT: A RUSSIAN PERSPECTIVE

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The rapid development of new technologies and their use for military purposes has highlighted the need to solve the problem posed by technological progress toward the weaponization of outer space. If no action is taken, such developments will create a new channel for the arms race, which will have far-reaching negative consequences. The most dangerous outcome in the near future would be development and deployment of a space-based echelon of ballistic missile defenses and anti-satellite (ASAT) weapons.

Currently, several international instruments regulate state activities in space. Several of them play a key role in maintaining global security and safeguarding outer space from weapons. The agreements in question include, in the first place, the 1963 Limited Test Ban Treaty, which halted such tests in space. Next, the 1967 Outer Space Treaty committed the state parties not to place in orbit around the Earth any objects carrying nuclear weapons or any other weapons of mass destruction, not to install such weapons on celestial bodies, and not to station such weapons in outer space in any other manner. Another important instrument is the 1979 Agreement on the Activities of States on the Moon and Other Celestial Bodies, which extended a ban of any weapons in regards to the celestial bodies. A major contribution was made by the 1972 U.S.-Soviet Anti-Ballistic Missile (ABM) Treaty, which obliged the two countries, *inter alia*, not to develop, test or deploy ABM systems or components that are space-based and not to interfere with the national technical means of verification of the other party. An important set of limitations is also outlined in the 1977 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Techniques, which includes space. And, finally, there is the Missile Technology Control Regime established in 1987. It is a voluntary, non-treaty mechanism combining 33 countries that have undertaken to observe common guidelines with regard to the transfer of missiles and missile technology, but is not designed to impede national space programs or international cooperation, so long as such programs do not contribute to delivery systems for weapons of mass destruction.

It was a significant achievement in itself that outer space has become a nuclear-free zone in conformity with international agreements. Even during the troubled years of the Cold War it was possible to build if not a perfect, at least a significant international treaty structure that narrowed the sphere of military use of outer space. Today, we should be ready to improve upon this structure now that the Cold War is over. It is worth noting that the number of countries joining the outer space club is on the increase. Under these circumstances, particular attention must be paid to the threat of conventional arms and their components in space, as well as weapons based on new physical principles.

Clearly, the non-militarization of space is a complex and not well-defined question. On the one hand, this is due to the lack of precise legal formulas regarding certain notions, for example, the exact meaning of the use of space for military purposes, what is "aggressive" military use, and whether military intelligence from space or ballistic missiles with a space flight trajectory constitute elements of space militarization, etc. On the other hand, the real reasons for the absence of such formulas are to be found in the lack of political will on the part of certain countries to address the issue at all.

Certain space-based systems in existence today are in fact of dual use. This concerns communication satellites, remote sensing equipment, space navigation systems, and national technical means to verify arms control treaties and agreements. Having said this, it would not be entirely correct to speak of banning completely any military uses of space,

but rather of keeping outer space as a weapon-free zone and of preventing an arms race in outer space. In concrete terms, essentially it is a question of putting a ban on the placement of weapon systems in space and prohibiting warfare in space and from space.

Obviously, the existing legal structure is not adequate to save outer space from weapons considering its present use for certain military purposes. But it is the prevailing view of the world community that space should not become another sphere of military confrontation or theatre of operations. One can hardly agree with a commonplace argument that space—just like the land, the sea, and the world's airspace—with its gradual conquest by man should inevitably become a sphere of military activity. With the advent of weapons in outer space, the entire planet will be endangered, as will space assets in orbit.

Views expressed by competent experts on both sides of the Atlantic testify to this obvious fact. Speaking before the students of the Stanford University on April 18, 2002, Sally Ride, the first American woman to become an astronaut, stated that deployment of weapon systems in space would be a disaster. Particularly, she accentuated ASAT weapons. Testing such systems, she said, would create debris that could damage important space objects flying in low-Earth orbit. According to the report by UNESCO made public in London on April 28, 2002, there are already about 2.7 tons of various missile fragments in orbit, ranging from exploded missile stages to chips of missile cases. They fly at a velocity of 7.5 kilometers (km) per second, which is 10 times more than that of a rifle bullet. NASA keeps a catalogue of space contamination, which currently numbers 9,000 objects with a diameter exceeding 10 centimeters. The same report states that deployment of ballistic missile defenses will make it practically impossible for research satellites to penetrate orbits at the altitude between 320 and 2,400 km, and that weaponization of outer space is inconsistent with its use for research purposes.

In recent years weaponization of outer space has become a subject of particular attention, and the concerns to this effect expressed by various countries are on the rise. Each year, the UN General Assembly (UNGA) adopts a resolution on "Prevention of an Arms Race in Space" (PAROS). The People's Republic of China, whose initiative at the Conference on Disarmament (CD) on PAROS is well known, has taken a firm position on this matter. For some time now, a public campaign has been under way in the United States in support of a World Treaty Banning Space-based Weapons. Congressman Dennis Kucinich introduced into the House of Representatives last October a bill to this effect entitled the Space Preservation Act of 2001.

In Russia, a ban on deployment of weapons in space is considered to be an important element for ensuring global stability and security. The international conference "Space Without Weapons is the Arena for Peaceful Cooperation in 21-st Century" held in Moscow from April 11-14, 2001, was specifically devoted to the subject. Delegates from many countries stressed in particular that current international space law had not put sufficient barriers to weaponization of outer space. They pointed to the need for a comprehensive ban on deployment of weapons of any kind in space and for supplementing the present rules of conduct for states in space accordingly.

Suggestions have also been made to strengthen the international legal regime of outer space by modifying the current space-related treaties. Such an approach may also be a solution. However, amending one or two of the existing instruments will eventually necessitate changes in the rest of them. Consequently, it would be more productive to concentrate work on a single instrument.

The task of building the appropriate legal base could be realized, for example, within the framework of a comprehensive UN Convention on International Space Law. A proposal to this effect was submitted by Russia at the 39th session of the Legal Sub-Committee of the UN Outer Space Committee on March 31, 2000. The initiative has received broad support from the international community. In the course of the discussions that followed, six other countries representing all geographical groups joined the initiative as co-sponsors.

The issue of non-militarization of outer space is not a new one on the agenda of priorities in Russian policies. In 1958, the Soviet

Union raised the concept of a ban on the use of space for military purposes and submitted the relevant resolution to the UNGA First Committee. At the time, the world community was not yet ready for such a radical approach. And, as life has shown in the years that followed, certain military-oriented activities in space have played a stabilizing role (for navigation, verification of arms control agreements, search and rescue, etc.).

The key political and diplomatic initiatives of the former Soviet Union related to space weapons include: a draft treaty on banning deployment of weapons of any kind in outer space submitted at the UNGA in 1981; and a draft treaty on banning the use of force in outer space and from space against Earth, which was proposed at the UNGA in 1983 and supplemented in 1984 by a proposal to ban the use of force from the Earth against space objects. They have never been fruitfully discussed due to the opposition of some states.

There were also attempts to come to agreement on partial measures. In March 1988, our country submitted at the CD in Geneva a proposal to set up an international control system to prevent deployment of weapons of any kind in outer space. The main purpose of the proposed mechanism would have been to verify that objects launched or stationed in space are not weapons and do not carry weapons. The key element of such a mechanism would have been an international space inspectorate that—with the consent of all the state parties—would have access to any objects planned for launching or basing in outer space.

There have also been well-known unilateral steps. In 1983, the Soviet Union undertook a commitment not to launch to outer space any ASAT weapons. In other words, it decreed a unilateral moratorium on such launches, as long as other countries would abstain from such actions. In 1985, when the United States tested its ASAT system against a real target in space, the Soviet Union became free from its commitment. However, in the exercise of good will, it continued to abstain, and Russia keeps on abstaining from launching ASAT weapons into space.

It is well known that Russia is insistent on keeping outer space a weapon-free zone; each year it votes for the UNGA resolution on PAROS. Together with a number of other countries, it supports the reestablishment of the appropriate *Ad Hoc* Committee at the CD to negotiate a regime capable of preventing an arms race in outer space that could take the form of a legally binding instrument.

There are countries claiming that the issue is not ready for negotiations. This argument holds no water. The situation in arms control is a good lesson to learn that preventive measures taken in due time are a more sensible path to follow than to have subsequent talks on limitations, reductions, and costly elimination of armaments.

Much groundwork has been done at the CD to pave the way for PAROS negotiations. For nearly nine years, intensive work has been conducted along the following lines:

- examination and identification of problems related to PAROS;
- improvement of agreements currently in force related to PAROS; and
- development of current proposals and future initiatives on PAROS.

Discussions have focused on such issues as: the status of outer space and its use exclusively for peaceful purposes; the necessity of preventing an arms race in outer space; identification of possible dangers for the functioning of spacecraft; the interrelation between PAROS and limitation of armaments and disarmament; the correlation of bilateral and multilateral efforts on PAROS; terminological aspects of outer space problems; the necessity of improving the existing legal regime for outer space, including verification measures; and confidence-building and predictability measures in outer space activities.

The PAROS negotiations have now become an urgent matter. We propose the discussion of new initiatives aimed at getting these talks started. Specific proposals to this effect were put forward by the Minister of Foreign Affairs of the Russian Federation Igor S. Ivanov in his statement at the 56th session of the UNGA on September 24, 2001. He stressed especially that "Russia invites the world community to start working out a comprehensive agreement on the non-deployment of weapons in outer space and on

the non-use of force or threat of force against space objects." In particular, the agreement outlined by Mr. Ivanov contains the following elements:

- use of space only in conformity with international law and in the interests of maintaining peace and security;
- an obligation not to place in the orbit around the Earth any objects carrying any kinds of weapons, not to install such weapons on celestial bodies or station such weapons in outer space in any other manner;
- an obligation not to use or threaten to use force against space objects; and
- a provision establishing a verification mechanism for overseeing the implementation of the agreement on the basis of confidence-building measures and transparency in outer space.

As the first practical step in this direction, Mr. Ivanov stated that a moratorium should be declared on the deployment of weapons in outer space, pending a relevant international agreement. Russia would be willing to make such a commitment immediately, provided that the other leading space powers join this moratorium.

The current proposal on a moratorium is of a more extensive character than the 1983 initiative. It covers all space weapons, including space-based attack weapons against terrestrial targets, and space-based anti-satellite weapons.

Further promoting proposals on keeping space free from any weapons, Russia and the People's Republic of China have jointly drafted at the CD possible elements of a future international instrument on preventing deployment of weapons in outer space, and the use of force or threat of force against space objects. Such an agreement may be reached in the form of a treaty. In substance, it should mention that outer space is the common heritage of all mankind and plays an ever-increasing role in its future development. It should provide for basic obligations, including pledges: not to put into Earth orbit any objects carrying any kinds of weapons, to install such weapons on celestial bodies, or to station such weapons in outer space in any other manner; not to resort to threat of force in relation to space objects; and not to assist or encourage any state, group of states, international organizations to engage in activities prohibited by the treaty. There must be also provisions related to national measures on the implementation of the treaty, as well as to the use of space for peaceful purposes and for military purposes not prohibited by the treaty.

In elaborating the basic elements of a new space-related instrument, Russia and China have taken into account the views of the overwhelming majority of countries. If achieved, such an agreement would contribute to peaceful use of space in conformity with international law and in the interests of maintaining peace and security and developing multilateral cooperation in space exploration.

Preventing deployment of weapons in outer space, along with further reductions of nuclear arms, while adhering to the principle of equal security are indispensable steps for strengthening global security. What is of importance now is to find a suitable format for discussions at the CD. That is why Russia and a number of other countries are pursuing efforts to re-establish the *Ad Hoc* Committee on PAROS and to provide it with a negotiating mandate. Early elaboration of an agreement on non-deployment of weapons in outer space should become a priority task for the world community.

TREATIES AS AN APPROACH TO REDUCING SPACE VULNERABILITIES

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My remarks will focus on three aspects of the current debate on space security: 1) the need for a new international legal instrument on preventing space weaponization; 2) the possible elements of such an instrument; 3) and the ways and means to achieve it.

A NEW LEGAL INSTRUMENT ON SPACE SECURITY AND NON-WEAPONIZATION

Since the first successful launching of a man-made earth satellite nearly half a century ago, great progress has been made in the exploration and use of space for the benefit of mankind. During this process, we have witnessed two important trends. One is the ever increasing dependence of human society on space, to a greater extent than at any point in history. It would be no exaggeration to say that our daily life, economic activities, and scientific research, among other things, are almost inseparable from the use of space. It's difficult to imagine what would happen to human society if we were to lose access to space.

Parallel to this trend is the growing possibility of introducing weapons into space. Because of its unique military and strategic significance, space became an important arena for the arms race during the Cold War. We all remember the "Star Wars" program. But the end of the Cold War has not helped to curb this trend. Research and development on space weapons continues unfettered, and concepts and theories of space warfare are now being worked out. As a result, the weaponization of space seems closer than ever.

These two, above-mentioned trends pose an obvious contradiction in the eyes of the majority of people today. 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.

As an old Chinese saying goes, it is never too late to mend the sheep pen, even after some of the sheep have been lost. At a time when weapons have not yet been introduced into space—but when we are increasingly faced with such possibility—it is imperative for the international community to take effective preventive measures to forestall any possible mishaps. In light of the vulnerabilities of our space assets and our dependence upon them, space weapons are likely to become another new type of weapon of mass destruction. If we fail to prevent the weaponization of space, we may—in the future—have to address the issues of space weapons proliferation, space arms control and regulation, and disarmament, as is now the case with nuclear weapons.

As we often say in China, "To cure the disease, you must have the right medicine." The proper prescription for preventing space weaponization lies in concluding as early as possible a legal instrument banning all space weapons.

It is true that there have been already several treaties on regulating outer space activities. These treaties have played a positive role in promoting the exploration and peaceful utilization of outer space. However, as they were concluded decades ago, some of them have inherent flaws or loopholes. For example, the 1967 Outer Space Treaty only prohibits deployment of weapons of mass destruction in outer space, but not other weapons. Furthermore, the 1972 Anti-Ballistic Missile Treaty, which prohibited space-based anti-missile systems, recently ceased to be in effect.

Beginning with the 1980s, having realized the need for strengthening existing treaties, the international community has made unremitting efforts to this end. In 1981, the UN General

Assembly passed a resolution on the "Prevention of an Arms Race in Outer Space" (PAROS). Since then, the resolution has been adopted for 20 consecutive years. From 1991 to 1993, a UN Governmental Expert Panel on Confidence-Building Measures in Outer Space Activities was established and engaged in focused study of the relevant issues. The Geneva-based Conference on Disarmament (CD) set PAROS as an established item on its agenda beginning in 1982. From 1985 to 1994 an *Ad Hoc* Committee on PAROS was established and carried out considerable work on many aspects of outer space for 10 consecutive years. Many countries, including Australia, Canada, Egypt, Germany, France, Russia, Sri Lanka, Sweden, and China, have put forward numerous constructive proposals and ideas in the UN General Assembly and the CD. More than a few nongovernmental organizations (NGOs), experts, and scholars have also came up with useful ideas and draft texts. All these efforts have laid a solid basis for the commencement of substantive negotiations on a legal instrument on PAROS.

POSSIBLE ELEMENTS OF A LEGAL INSTRUMENT ON SPACE

China is dedicated to urging the international community to conclude an international legal instrument on both non-weaponization of space and PAROS. Given the importance of PAROS, China started to press in the late 1990s for the re-establishment in the CD of an *Ad Hoc* Committee with a negotiating mandate. On February 9, 2000, the Chinese delegation submitted to the CD a working paper (CD/1606), outlining China's preliminary ideas on such an instrument. A year later, having further substantiated and developed these ideas, China came up with a more detailed paper (CD/1645, June 6, 2001) entitled "Possible Elements of a Future International Legal Instrument on the Prevention of the Weaponization of Outer Space." This paper proposed concepts such as: the prohibition of testing, deployment, and use of weapons and weapon systems and their parts and components in outer space; and the prohibition of testing, deployment, and use of weapons, weapon systems and their parts and components from outer space against targets on land, sea, and air.

For the past several months, in consultation with the Russian delegation, the Chinese delegation has worked out a joint working paper in this regard, which was introduced to the CD members on May 28, 2002, in Geneva.

The joint working paper focuses on how to solve the problems of the deployment of weapons and use of force in outer space. As we see it, the envisaged instrument could be called the "Treaty on the Prevention of Deployment of Weapons in Outer Space and the Threat or Use of Force against Outer Space Objects." It would include such sections as: a Preamble, Basic Obligations, National Implementation Measures, Confidence-building Measures, Settlement of Disputes, and Executive Organization, as well as some other relevant provisions.

Among these, the Basic Obligations will naturally be the core of the future treaty. We believe that to achieve the objectives of non-weaponization and PAROS, the new treaty should at least include the following aspects:

- Not to place in orbit around the Earth any objects carrying any kinds of weapons, not to install such weapons on celestial bodies, and not to station such weapons in outer space in any other manner;
- Not to resort to the threat or use of force against any outer space objects; and
- Not to assist or encourage other states, groups of states, and international organizations to participate in activities prohibited by this treaty.

To be sure, the elements of the above-mentioned joint working paper are still tentative. Further amendments and improvements are welcome. As noted above, many countries and some experts and scholars have conducted in-depth research into this issue and put forward concrete proposals, even draft treaties. We believe all of these can serve as good food for thought for further substantive negotiations and deserve attention and study by all counties.

SPECIFIC MEANS TO NEGOTIATE AN OUTER SPACE TREATY

There are different views and proposals on how to negotiate a new legal instrument on outer space. Some propose to negotiate a specific treaty on anti-satellite weapons, some favor a treaty on confidence-building measures in outer space, and still others call for an additional protocol to the Outer Space Treaty. Amendment of the Outer Space Treaty is also mentioned. With regard to the negotiating mechanism, some propose to negotiate in the UN Committee on Peaceful Uses of Outer Space, some suggest the "Ottawa Process" model (an NGO-led effort used in regards to land mines), and still more states prefer to start substantive work, including the commencement of negotiations on a treaty in the CD, according to relevant UN resolutions.

In my opinion, it is not an important or substantial issue as to where and in what form to negotiate. So long as the relevant proposal is consistent with the general objectives of non-weaponization of space and PAROS and is conducive to universal participation by all parties, it deserves serious consideration. As the single multilateral disarmament negotiating forum, however, the CD has carried out considerable work already on PAROS. Relevant UN resolutions also call for the CD to play a primary role in this regard. Therefore, the CD is the best forum to negotiate a legal instrument on outer space. To this end, an *Ad Hoc* Committee should be re-established at an early date to start substantive work on the negotiation and conclusion of a legal instrument on non-weaponization of space.

To sum up, China strongly believes that it is now high time for concluding a legal instrument on non-weaponization of outer space. The main purpose of the instrument is to prohibit deployment of any weapon in space and the use of force against space objects. And the best forum to negotiate such an instrument is the Conference on Disarmament. We have entered the 21st century. The rapid progress of science and technology will provide human beings with unprecedented opportunities to explore and utilize outer space. For the welfare of the mankind and for the sake of peace among future generations, let us take actions and keep the genie of space weaponization and arms racing sealed tight in a bottle through the rule of law, rather than thinking it will stay there simply by magic.

A U.S. PERSPECTIVE ON SPACE

by Eric M. Javits
U.S. Department of State

THE UNITED STATES, OUTER SPACE, AND THE CONFERENCE ON DISARMAMENT (CD)

The United States continues to recognize the common interest of all countries in the exploration and use of outer space for peaceful purposes, as declared in the 1967 Outer Space Treaty. When our astronauts walked on the moon for the first time, they left the message that they "came in peace for all mankind." The United States and other nations have sent unmanned probes to explore outer space and the celestial bodies, to explore the surfaces and atmospheres of the other planets in our solar system in order to understand the environment beyond our world.

The exploration and use of space has not looked solely outward. Satellites orbiting the Earth monitor the weather, the climate, the growth of crops, and the impact of drought and land use. Communications satellites make possible rapid global sharing of information. Satellites have revolutionized terrestrial navigation and provided a new and powerful tool for accurate surveying of the Earth's surface. The peaceful exploration and use of outer space have also resulted in technological spin-offs that would take days to enumerate in their entirety.

The commitment of the United States to the exploration and use of outer space by all nations, for peaceful purposes and for the benefit of humanity, is clear. But the peaceful exploration and use of space obviously does not rule out activities in pursuit of national security goals.

The security and well being of many nations depend on the ability to operate in space, and Article 51 of the UN Charter makes it clear that all member states have the inherent right of individual and collective self-defense. The global responsibilities of the United States, and the new threats facing it in today's world, require that that right be exercised both on the Earth and above it. As Under Secretary John Bolton told the Conference on Disarmament in his January 24, 2002 statement, the security and well being of the United States and its allies depend on the ability to operate in space. And we are not alone in having military space programs. Russia and China, for example, have such programs too.

National security is the highest responsibility of a government, and each nation must decide on the elements of its security policy. Arms control and disarmament are not ends in themselves but tools to enhance security. Our discussion should be framed in that context.

Free access to space and use of space by space-faring nations are central to the preservation of peace and the protection of civil, commercial, and security interests. The United States sees no justification for limitations on the right of sovereign nations to acquire all forms of information from space.

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 outer space arms control agreements and opposes negotiation of a treaty on outer space arms control.

Some suggest that a new forum might be the appropriate place for outer space arms control efforts. We do not share this view. Changing venues would not change national positions. States would still have the same concerns that they have in existing fora.

THE EXISTING OUTER SPACE REGIME IS SUFFICIENT

A number of standing agreements already sufficiently regulate military activities in outer space. The Limited Test Ban Treaty of 1963 prohibits parties from conducting nuclear weapon test explosions or other nuclear explosions in outer space. The activities of the Committee on the Peaceful Uses of Outer

Space (COPUOS), which facilitated the negotiation of the Outer Space Treaty (OST) itself, also reinforce the existing regime. COPUOS does not deal with disarmament and arms control aspects of outer space, of course; but it is concerned with promoting international cooperation in the peaceful uses of space.

Most important, however, is the OST, to which the United States remains firmly committed. The OST puts celestial bodies off limits to all nuclear weapons or other weapons of mass destruction and prohibits states parties from placing in orbit or stationing such weapons in outer space—a far-reaching non-proliferation measure in itself. It also provides that celestial bodies shall be used exclusively for peaceful purposes and prohibits their use for military establishments or maneuvers, or for testing any type of weapons. In addition, the OST clearly establishes that states parties retain jurisdiction and control over objects they have launched into outer space, and have international responsibility for national objects in outer space, including whatever damage the launched item may cause.

In sum, there already exists an extensive and comprehensive system for limiting the uses of outer space to those that are peaceful and providing a framework for the legitimate military uses of outer space. We believe that this existing multilateral arms control regime adequately protects states' interests in outer space and does not require augmentation. There simply is no problem in outer space for arms control to solve. The problems we all need to address are right here on Earth—the need for effective implementation of, and full compliance with, key regimes that tackle the very real threat of weapons of mass destruction—above all the Nuclear Nonproliferation Treaty, Chemical Weapons Convention, and Biological Weapons Convention.

The United States is committed, through its national space policy, to ensuring that exploration and use of outer space remain open to all nations for peaceful purposes and for the benefit of all humanity. For us as for others, "peaceful purposes" does of course allow for activities that support and serve national security goals. Improving our ability to support military operations worldwide, monitor and respond to military threats, and monitor arms control and nonproliferation agreements are key priorities for our national security space activities—and they help strengthen international stability and security. The lawful military use of space provides broad benefits to the international community in the areas of communications, global positioning, navigation, environmental monitoring, combating terrorism, and cooperating in enforcement of UN Security Council sanctions.

TIME TO MOVE ON

The United States continues to hear calls for immediate negotiations in the CD to forestall all manner of ills: 1) the possibility that missile defense would upset strategic stability, leading to a new arms race here on Earth; 2) the potential for disruption of the arms control process; and 3) the risk of an arms race in outer space. The United States has always believed these concerns are groundless.

Clearly, missile defense has not upset strategic stability or led to a new arms race. The treaty signed in Moscow on May 24, 2002, shows that. Importantly, the Treaty of Moscow also demonstrates that pursuit of missile defense and the demise of the Anti-Ballistic Missile (ABM) Treaty are not an impediment to further reductions in nuclear weapons or to increased U.S.-Russian cooperation. Clearly also, U.S. missile defense efforts, and the various systems under development, are not directed against Russia or China. Rather, they are designed to defend against limited ballistic missile attack in a world where increasing numbers of states are striving to be able to threaten such an attack. Finally, as we have tried to make clear, it is not a replacement for deterrence through response or retaliation, but a supplement to it—adding a new dimension to deterrence. Indeed, if a non-state actor knew that a limited attack on the United States was not likely to succeed, they would be much less inclined to develop weapons of mass destruction. A system capable of defending against a large-scale attack with sophisticated weapons would be both qualitatively and quantitatively different from that which the United States is pursuing.

The United States remains committed to the arms control and disarmament process. The landmark strategic arms reductions agreement signed by Presidents George W. Bush and Vladimir Putin in Moscow on May 24 has reaffirmed that commitment and finally laid to rest the Cold War world and the arms race it spawned. There is no contradiction between that process and pursuit of a limited missile defense system. And while the United States and Russia have had different views on the merits of the ABM Treaty, its disappearance is simply not a problem. The reality is that U.S.-Russian relations are broad and strong enough to weather this sort of disagreement. As the Moscow Summit showed, it is a new and better day.

CONCLUSION

The United States continues to recognize the common interest of all mankind in the furtherance of the exploration and use of outer space for peaceful purposes, as declared in the 1967 OST. We see no need for further outer space treaties. We should move on to other themes that address immediate and serious threats to mankind.

GOVERNMENT-LED DISCUSSIONS REGARDING SPACE WEAPONS AND AVENUES FOR PROGRESS

by Vladimir Petrovsky
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The issue of future security in space is being debated at a crucial moment in the process of creating a new, broader architecture for security. The challenge of terrorism to the world community, the danger of the spread of weapons of mass destruction as well as missiles, particularly in view of regional developments, necessitate major changes in global security arrangements. As the May Russian-American summit in Moscow demonstrated, the key proponents of a new strategic framework—more respectful of this new security environment—have clearly expressed their political will for practical deeds. A Russian-American treaty has been concluded in the best diplomatic traditions, which imply the achievement of a balance of interests through compromise. The treaty creates the momentum to pilot positive change through the new security environment. It is high time to launch government-led discussions on arms regulation, in particular with regard to security in outer space.

In this essay, I do not intend to go into the details of future security arrangements in outer space. This is a task for negotiators. I would rather prefer to concentrate on the following issue: how and via which fora security in space can be dealt with in the most effective and reliable way, taking into account the different political, military, and commercial interests of the major players.

THE NEW CONCEPT OF "STRATEGIC SECURITY"

To begin with, there is a clear need to create a new regime allowing for the regulation of military activity in outer space, one that would be more than the Missile Technology Control Regime (MTCR), but less than general and complete de-weaponization. Such a regime, at least, could contribute to missile nonproliferation.

The core of this regime is a code of behavior, or, metaphorically speaking, "traffic rules" for outer space. Its political aim would be to make outer space more secure, thereby contributing to strategic security on Earth. The new concept of strategic security proclaimed at the Moscow Summit combines two leading principles—strategic stability and security in all its aspects—which have served as guidelines in the period of transition from a confrontational to a cooperative approach both in bilateral and multilateral diplomacy.

The idea of strategic stability was born out of the Strategic Arms Limitation Talks in the 1970s. The core of this idea is the stability of nuclear weapons relations between the two superpowers and the regulation and reduction of these weapons. Other important elements of strategic stability comprise the prevention of crisis situations and military confidence-building measures, including the exchange of information on certain forms of military activity as well as the creation of zones of limited military activity. The concept has been applied to both strategic offensive and defensive weapons, however, it fit within the context of mutually assured destruction.

At the end of 1991, Washington and Moscow created a working group on strategic stability, which had its only meeting in November 1991 before the disintegration of the Soviet Union. At that meeting, the idea of strategic stability was reconceptualized and applied not only to military, but also to all other international activities. It was indeed a first step towards a convergence with the other concept, that of security in all its aspects, which was jointly proposed by Moscow and Washington and unanimously adopted by the United Nations at its 44th session in 1989 (Resolution 44/21). This resolution means that security should be treated not only in military terms, but in a broader context, such as the security of individuals from violence, hunger, disease,

environmental degradation, and violation of human rights. The concept of security in all its aspects incorporated the ideas of comprehensive, common and cooperative security, which were advanced by that time both in the United Nations and in nongovernmental structures. In other words, the concept of strategic security is based on internationally accepted ideas.

The new paradigm of strategic security deals with military issues within a broader context and opens the opportunity for much more thorough discussions of the guarantees of such security on Earth from outer space. There can be two kinds of such guarantees:

- direct, which include political, diplomatic, and legal barriers to the danger of military attacks against Earth from outer space; and
- indirect, involving a cooperative approach to both military and peaceful activities in outer space which, in their turn, should strengthen political and legal measures aimed at strategic security.

To move forward with the regulation of military activity in outer space it is necessary to continue to be guided by the primacy of the legal approach.

From the very beginning of the outer space era, space has been considered in international treaties as the common property of all mankind. This implies that outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means. All countries have freedom of access to all its parts on equal terms.

Certain kinds of military activity are prohibited in outer space. According to existing treaties, outer space today is *de facto* a nuclear-weapon-free zone and as such is part of the existing regime of the nonproliferation of nuclear weapons. The deployment of other weapons of mass destruction is also banned.

Nevertheless, international treaties do not prohibit all military activity in outer space. The majority of states involved in outer space integrate the civil and military components of their activities. The military portion is designed for such purposes as early warning against possible missile attacks, intelligence gathering, communications, navigation, etc. These systems are not weapons in the strict sense of the word, because they are not designed for inflicting destruction and do not create the danger of an attack from outer space.

It is very important to note that existing treaties with regard to all kinds of activity in outer space—which declare a common obligation to maintain peace and security in this domain—also emphasize the *responsibility* of states for their behavior.

New negotiations concerning security in outer space should be based on the existing norms of international law, putting particular emphasis on legal rather than on military deterrence for those trying to use outer space in their own interests, contrary to international law. In other words, there should be a clear understanding that justice is best served before the bar and not by dropping bombs.

Legal deterrence also implies coercive actions, making it quite clear, though, that such actions should be undertaken in accordance with the UN Charter. These actions include sanctions and, as a last resort, the use of military force.

In these efforts, it is wrong to use the expression "rogue states," because it does not make a distinction between the decisionmakers in these countries and the people at large. To promote productive negotiations, it would be more appropriate to speak about "countries of concern," and for whenever coercive actions are to take place to keep in mind the "humanitarian imperative." In other words, the goal should be to minimize the damaging effects of coercive actions on vulnerable groups of the population. This is not a game of words. Such an approach, in practical terms, will help to facilitate positive changes in countries of concern.

There is no doubt that military activity in outer space has a place, but it does not mean that military activity in outer space should follow the Cold War logic of military confrontation and be used for unilateral advantages at the expense of others.

On the diplomatic side, efforts should be directed at achieving a balance of political,

military and commercial interests through a cooperative approach. As the summit in Moscow demonstrated, there is no alternative to compromise. It should be kept in mind that negotiations are not synonymous with treaty making, which is the final stage of the negotiating process. This stage is preceded by the difficult and sometimes long-lasting stages of preliminary consultations in search of the parameters of a future agreement.

Within the context of negotiations the issue of consensus is often raised. Of course, consensus on substantive issues is a must. However, it is necessary to avoid the temptation of creating a cult of consensus. In my opinion, its application should be confined only to substantive and not procedural issues.

Finally, from all viewpoints (i.e., the political, the legal, and the diplomatic), major lessons should be drawn from the experience of the nuclear nonproliferation regime: any effective military regulation process should be viewed as a vehicle not for codifying the *status quo* but rather for providing a framework for changes based on strategic security and effected through the force of law, but not the law of force.

HOW TO MOVE FORWARD

A regime allowing for the regulation of military activity in outer space should become the subject of government-led discussions at all existing levels—the bilateral, regional, transcontinental, and global.

Many bilateral, regional, and transcontinental bodies have been restructured and updated. Bilateral Russian-American machinery has been renewed and put into motion. The role of the 33 nations of the MTCR is also very important.

The major issue is how to reactivate multilateral bodies, which are critical in terms of the outcome. They give voice to populations whose lives and future are at stake in strategic decisionmaking. They create a sense of ownership of the negotiated instruments and are the best way to achieve the irreversibility of the arms regulation and disarmament process.

The Conference on Disarmament (CD) is the most proper body for multilateral negotiations. The CD has tremendous experience in treaty making. (In my time as secretary-general of the CD (1993–2002), it successfully dealt with two important arms regulation and disarmament treaties—the Chemical Weapons Convention and the Comprehensive Test Ban Treaty.)

From the legal and diplomatic points of view, the CD is an important source of know-how. The *Ad Hoc* Committee on PAROS, which functioned at the CD from 1985 to 1994, held discussions on definitions, principles, existing treaties, confidence-building measures, and accumulated experience, which could be useful for future negotiations.

It is tremendously important that the conference membership today expand to embrace all the military significant states, as well as countries of concern.

All member states and observers are represented at the CD by top disarmament experts, which provides ample opportunity for holding highly professional multilateral, as well as plurilateral and bilateral, talks. Taking into account that disarmament negotiators have become a special brand within the diplomatic profession, the CD is turning into a focal point for this brand. In my opinion, even the bilateral negotiations of the key players should be held either at the CD itself or in its outskirts.

However, the work of the conference is paralyzed today. The CD is unable to start substantive work on a set of issues regarded as priorities by its member states. In my opinion, controversies surrounding the outstanding issues remind us, regrettably, of the mentality of the Cold War, when all problems were tightly linked and an "all or nothing" rule often guided the negotiations.

In the new security situation, this mentality has truly become out of date. A new approach is needed, namely a comprehensive and balanced approach to all emerging issues. I am also convinced that a new tactic should be applied in dealing with these issues. It is important to avoid a situation where progress in one area is made contingent upon progress in another. The tactic of linkages, which is a relic of the Cold War mentality, should be replaced by "constructive parallelism" with

regard to all priorities on the disarmament agenda. The potential advantage of this approach is that progress in one area can *stimulate* progress in another.

What is required at this stage is the display by the governments of member states of the CD of the political will for compromise, which would allow them to take into consideration the concerns of all and to open the road for progress on all agenda items. Then, the CD will become fully operative. As for outer space security, the CD—as a first step for negotiating an international legal instrument—might discuss and review all pertinent issues of military activity in outer space, shortcomings of the existing legal instruments, and the key elements of future arrangements.

Not only the CD, but also the major bodies of the United Nations could be used more extensively by governments to deal with the new security situation.

First of all, the Security Council. There is much talk on the reform of the Security Council, but—for its involvement in dealing with arms regulation the provisions of Article 26—are quite sufficient. The Security Council created special subsidiary bodies in the 1940s to deal with arms regulation and disarmament. Why not revive this practice? Moreover, nothing prevents the Security Council from considering issues at the highest political level (heads of states, foreign ministers) and holding meetings in Geneva, Vienna, Brussels, and other locations from which the necessary signals of a new attitude to security issues could be transmitted to other international and regional structures.

The General Assembly provides a rostrum to help mobilize the global community in its support for a new view of the security situation. The Committee on Peaceful Uses of Outer Space can be also involved in dealing with security in all aspects of outer space.

In case of necessity, a special conference on outer space could be convened, not unlike the three UNISPACE conferences already held.

In other words, political will is very much in need both for reactivating the CD and for mobilizing the entire international machinery in order to counter the new threat, which could affect the whole of humankind.

While emphasizing the importance of political will, I do not want to create the impression that everything is perfect in the existing international machinery. One can expect of international bodies the exercise of responsible multilateralism. By this I understand, on the one hand, the recognition of the role that key actors require for bilateral and plurilateral policy formulation and, on the other, a responsiveness by the same key players to the broadly representative views of the global community.

From the perspective of the future, a certain restructuring of the international machinery is needed very much indeed. The time has come to give thought to how to bring all disarmament and arms control structures under one roof and to create an international arms regulation agency paralleled by a space agency that would deal with all kinds of allowed activities in space. Of course, it will take time for these ideas to be realized, but brainstorming should start without delay. Here, the academic community can make a tremendous impact.

Last, but not least, governments should begin viewing the NGO community as partners in discussions on arms regulation. We need this community to generate support within civil society in order to be able to meet the world's new security challenges. Moreover, NGOs hold views different from those of governments and can serve as an effective partner for elaborating governmental policies.

FINAL THOUGHTS

In conclusion, it should be emphasized that today, when new directions in strategic security are being explored and new strategic bargains are being canvassed, what is needed for future security in outer space are action-oriented discussions—productive exchanges that pool collective wisdom and in the long run will bring about tangible results.

COMMERCIAL-LED OPTIONS

by Alain Dupas
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One of the trends often emphasized in space activities is the rise of the commercial sector, which can be defined as public and private companies commercializing space products and services. But what are the relationships, if any, between this sector and military space programs? Could this sector have any role and influence on the planned projects for the basing of weapons in space?

Before addressing these issues, it is necessary to make some remarks about the perimeter of the commercial space sector and its international aspects. It is also interesting to consider the extent to which space commercial activities are increasingly mixed with governmental activities, often in public-private partnership (PPP) frameworks

THE SCOPE AND REAL IMPORTANCE OF COMMERCIAL SPACE ACTIVITIES

Commercial space activities are limited to a small number of fields, in contrast to governmental space activities, which include scientific missions, manned spaceflight, remote sensing, reconnaissance and surveillance, ferreting, telecommunication, etc. The dominant commercial space activity, by far, is space telecommunications; next is commercial space transportation, which depends considerably on space telecommunications as its largest market. The third commercial space activity, remote sensing, is far behind the others.

Figures quoted for space telecommunication revenues are huge: close to $100 billion in 2000. However, one must be very careful in considering these figures, which cover all revenues from space telecommunications, not only those going to space companies. In fact, about 80 percent of the quoted revenues come from the selling of services by operators who are not part of the space industry. For them, satellites are just a piece of infrastructure like any other. The real size of the commercial sector for the space industry is only about $20 billion. This is undoubtedly significant, but still smaller than governmental space budgets, which globally are close to $40 billion. Could new fields of commercial activities emerge? Positioning products and services are successful but there is almost a total separation between the space segment (the U.S. military's Global Positioning System, or GPS) and its civilian applications, in which the space industry is not directly involved. The situation should be different with the contemplated European space-positioning program Galileo, which will be much more service-oriented than GPS. Another new development in commercial space is tourism, but with only two space tourists so far, this activity has not become a full-blown industry yet.

DIFFERENCES BETWEEN THE EUROPEAN AND U.S. COMMERCIAL SPACE SECTOR

Internationally, the relative importance of the commercial sector is much larger in Europe than in the United States, which are the two dominant space powers. Two facts explain this situation.

First, governmental space budgets are much higher in the United States than in Europe. The ratio is about four to one in civilian space and close to twenty to one in military space. In fact, after the end of the Cold War and the fall of the Soviet Union, military space is nearly a U.S. monopoly, and this means naturally that European perspectives about militarization of space are very different from what they are in the United States.

Second, Europe managed to build a strong commercial space industry in launchers (Arianespace), satellite manufacturing (Astrium and Alcatel Space Industries), telecommunications services (Eutelsat, SES), and remote sensing (SPOT Image). This industry is able to compete successfully with U.S. industry in open commercial markets.

From the beginning, Europe has focused more on civilian and commercial space

activities. The European Space Agency (ESA), created in 1975, is mandated to conduct only "civilian" space programs. However, this does not prevent the use of rockets ESA develops to orbit satellites for military missions, as long as these programs can be categorized as pursuing "peaceful purposes" and are in agreement with the 1967 Outer Space Treaty. European military space programs are conducted outside of ESA in national or multinational frameworks and are very limited in scope: for reconnaissance (the French Helios program) and for telecommunications (Syracuse in France, Skynet in United Kingdom, Italsat in Italy, and Hispasat in Spain). Cooperation at the European level, in the framework of the "second pillar" of the European Union (Common European Security and Defense Policy), is progressing, but any projects will be strictly within the limits of international treaties on space. European countries have always considered the framework of international treaties, including bilateral treaties between the Soviet Union/Russia and the United States (the Strategic Arms Limitations Talks, the Anti-Ballistic Missile (ABM) Treaty, and the Strategic Arms Reduction Treaties) as the basis for international security. They have strongly objected to the U.S. decision to withdraw from the ABM Treaty.

THE GROWING IMPORTANCE OF PUBLIC-PRIVATE PARTNERSHIPS IN THE SPACE SECTOR

The Concept of PPPs

European commercial space activities are thus simultaneously more limited in scope and much more central than in the United States. But there is also an increase in the importance of activities that are neither purely commercial nor purely governmental (either civilian or military-oriented). The technologies involved are "dual-use" and the frameworks of these activities can be characterized as "public-private partnerships." PPPs are not new: they were introduced in the United States after World War II in order to make the management of facilities owned or conducted by the government more effective. The concept was implemented at the federal level with the so-called GOCOs (government owned contractor-operated) facilities and programs. A well-known example is the Department of Energy's Sandia National Laboratories, which is managed by a large aerospace industry contractor. The concept of PPPs is very broad and covers a wide range of business arrangements, from simple sub-contracting to real partnerships—where both commercial and governmental parties share visions and investments. The model has been widely applied from the federal to the city level in sectors as varied as environment, health, education, and transportation. The concept has been also applied extensively in United Kingdom.

The increasing importance of PPPs in the space sector blurs the frontier of commercial space and mixes the interests of commercial companies and governments in civilian and military activities. In fact, two of the three main commercial space fields might be more accurately characterized as the province of PPPs: commercial space transportation and remote sensing.

Space Transportation

Commercial space transportation in Europe and the United States relies on launchers that have been developed using government funds. This is obviously the case for the Ariane family of launchers in Europe and with the new U.S. Evolved Expandable Launch Vehicles (Atlas–5 and Delta-4). Ariane, Atlas, and Delta launchers are operated by commercial ventures (Arianespace, International Launch Services, and Boeing Launch Services) but make use of launch facilities owned by governments and benefit from strong governmental support.[1] Future generations of space transportation systems will be developed as governmental programs. There is, however, a difference between United States and Europe: American commercial space transportation operators could survive with only a governmental market, while Arianespace's survival depends on the commercial market.

[1] Private launch facilities can now be licensed in the United States, but this possibility is rarely used and the U.S. government is still responsible internationally for the launches conducted at these facilities.

The Case of Remote Sensing

Commercial remote sensing can also be characterized as the domain of PPPs. Historically, the most successful remote sensing venture, SPOT Image, has marketed images from satellites owned and controlled by the French space agency Centre National d'Etudes Spatiales (CNES). It is very close to a GOCO in the United States. New American commercial remote sensing companies (Space Imaging, Orbimage), by contrast, own and operate their satellites, but they cannot survive without orders from the U.S. government (mainly from the National Imaging and Mapping Agency). Compared to space transportation, however, remote sensing adds security issues to the PPP framework. Space images can be used by rogue states or possibly terrorists. Thus, their commercialization cannot be completely without restrictions. In the United States, the government has the right to exercise "shutter control" on U.S. commercial satellites in order to prevent what can be considered to be "risky" imaging. In the same spirit, the French government can prevent SPOT Image from selling images of certain regions in cases of military crises or other security concerns.

The Emergence of PPPs in the Space Telecommunications Sector

Only space telecommunications operators can be considered to be purely commercial entities. However, even in this sector the "dual use" character of space telecommunications technologies is causing change. Military organizations in the United States and Europe are now making extensive use of commercial space telecommunications capacities. In most cases, they behave as regular customers. But the relationships can be much broader and include PPP frameworks. This is, for example, the case with the British military space communication system. The future Skynet-5 system will be procured and operated by a private venture called Paradigm, which will also take over the operation of the existing Skynet-4 network.

What about positioning? The American GPS system is an extreme case of a PPP without any real relationship between the private and governmental parties. This quite awkward situation leaves the U.S. government free to impose at will any limitation it considers necessary for security reasons to the quality and availability of the positioning signal. The American position is understandable, but has played a major role in the European decision to move forward with its own Galileo system. This network will be oriented toward civilian applications, but security concerns will be addressed in the development of the project. The Galileo program will be developed and operated within a PPP framework, involving ESA, the European Union, and commercial companies.

COMMERCIAL SPACE ISSUES AND THE MILITARIZATION OF SPACE

In the space sector, the mix of private and governmental interests and of civilian and military applications is, as shown above, very complex. This situation imposes, however, a considerable responsibility on the governments of the major space powers: bold moves in the purely military space sector—such as the development of debris-creating anti-satellite weapons or other space-based offensive systems—could compromise the stability of the still fragile commercial space sector.

Commercial space activities are often considered by investors to be "exotic" and "risky," which makes them reluctant to provide the hundreds of millions of dollars (or more) needed for promising new projects. Irresponsible behavior in expanding the scope of space militarization will only worsen the assessment of space by the commercial market. This would be particularly dangerous for the European space industry, which relies much more on commercial ventures than the American space industry. It is in the interest of space companies and operators to make their governments aware of this risk. Such communication, one hopes, should be facilitated by the close relationship between these companies and their governments in the framework of existing PPPs.

NGO APPROACHES AND INITIATIVES FOR ADDRESSING SPACE SECURITY

by Rebecca Johnson
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Although a small number of non-governmental organizations, such as the Union of Concerned Scientists and the Global Network Against Weapons & Nuclear Power in Space have been concerned about the military uses of space for some time, for most NGOs awareness of the risks of space weaponization have grown out of their concerns about missile defense during the late 1990s. Though the issues of missile proliferation, missile defense and the weaponization of space may be connected, they give rise to different kinds of political questions and responses. It is perhaps premature to speak of NGO initiatives on space weaponization. There are, rather, a range of tasks that need to be undertaken, preferably through partnerships of NGO and government experts and practitioners, ideally together with constructive commercial and even military interests. Most importantly, there is the need to develop awareness, initiatives and approaches for addressing issues raised by current civilian and military activities in space and potential future developments that might jeopardize them or jeopardize the security and activities of life on Earth.

In determining an approach, designing a strategy or embarking on a campaign, some fundamental questions need to be asked.

1. What are the real, probable and potential threats and risks, both in relation to existing and future space assets, and from the potential weaponization of space?
2. Who wants to attack or weaponize space assets and why? In other words, who is promoting, researching, and developing capabilities to attack or weaponize in space? Not just the countries concerned, but agencies, personnel, and financial and political backers. What kind of weapons are under consideration—space based or space capable?
3. Does this pose a real threat – i.e. why should we worry? I mean this in terms not only of military security, but in the wider security definitions.
4. What are the drivers and obstacles and, of particular importance, the likely time frames?
5. What can we do about it? Should we take preventive and precautionary measures, and if so, of what type?

As other authors have addressed the first four issues, my purpose in this essay is to address the fifth question. But it is important to keep in mind that any consideration of what to do must take into account the other four questions, and must also be prepared to respond to any changes in the information or conditions pertaining to the first four questions. It is immediately obvious that much more work needs to be done to research the nature of the threats posed to space assets, and the costs, risks, and benefits of different security approaches. With this caveat, I will sketch out some of the considerations underlying various possible NGO-led approaches.

First, a note about language. Some diplomats and NGOs use the terms "militarization of space" and "weaponization of space" as if they were interchangeable. They are not. Others use the term "peaceful uses of space" in ways that ignore the national technical means (NTM), surveillance, and pinpointing technology that allows conventional weaponry to be finely aimed, controlled, and fired. Space is already considerably militarized with significant observation, intelligence, and communications assets. While (as far as we know) there are no specifically designed and deployed weapons in space yet, there are satellites that could be maneuvered to act as weapons and disable or destroy the space assets of others. The question of what makes a weapon is not so much one of specific technological function or capability, but of intention, context, and use. This recognition

has profound implications for the kind(s) of arms control or disarmament approaches that could be considered feasible. Furthermore, while some of the military uses of space have already gone beyond what I consider desirable, and there are some very gray areas surrounding technology such as targeting components, it is important to acknowledge the positive use of space-based intelligence for verifying arms control treaties, early warning of environmental and military threats, and so on. These distinctions and clarifications are important when considering ways to prevent the weaponization of space and develop a code of conduct for non-aggressive, non-offensive uses of space. Attempts to "demilitarize" space, as some NGOs demand, are non-starters. For the reasons given above, they are not feasible nor, I would contend, desirable.

THREE AREAS OF NGO CONTRIBUTION

NGOs, which can be local, national, or transnational, formally constituted or grouped in informal networks with common purpose, can contribute in three main areas of operation:

1. Raising wider public consciousness of the concerns, problems and options, mainly through public education, information exchange and engagement with the media and elected and governmental representatives, and with commercial and military communities with assets, investments, experience, and expertise in space and space-related matters;
2. Providing technical, legal, and political research, such as analysis of different approaches, definitions, parameters, strategies, and instruments, with a view to determining whether negotiations are necessary and, if so, preparing the ground for negotiations on the appropriate instrument or instruments;
3. Identifying and promoting measures to address the issue, including consultations, prenegotiations and negotiations, essentially: what, how, where, among whom and when?

Raising public awareness

At present, when it is clear that we need more information to determine the best way forward, research, academic, and policy-directed analysis will be a priority. There also has to be greater outreach towards the mainstream media, as well as specialist journals, to get them interested in the issue. As the informational base begins to develop, grassroots and town hall meetings can widen interest, get the issue into local media, and begin to generate pressure on elected representatives. The point to emphasize is that raising public awareness requires both solid, technically competent arguments and simple, direct, emotionally appealing messages. To get the public interested and concerned, it is important to enable people to *picture* the dangers. In local meetings around the United States, for example, some NGO representatives have been making very effective use of images and slogans from the U.S. Space Command's own promotional materials, such as *Vision for 2020*, which proclaimed (for example): "US Space Command— dominating the space dimension of military operations to protect US interests and investment" and "Integrating Space Forces into warfighting capabilities across the full spectrum of conflict."[1] The fact that these points were made so forcefully by proponents of space weaponization makes them a far better mobilizer than if the speakers were to allege these motivations and intentions.

To engage public attention, a range of arguments needs to be utilized, as different messages are likely to have different impacts on different kinds of audiences. European and many developing countries are already skeptical about missile defense, and the evocation of missile defense plans extending into space-based weapons and wars is already perceived as plausible and worrisome, if not a major political priority. Because sections of the Bush administration and the Pentagon are most optimistic about the prospects for weaponization of space, the U.S. homeland is perhaps the most important public constituency to reach. Religious people might be moved by

[1] United States Space Command, *Vision for 2020*, February 1997. Published as a visual presentation of images and slogans rather than in report form.

calls to "Keep the Heavens for Peace," for example, while others might get more nervous by the idea of debris raining down on Earth—remember the spate of movies about asteroids colliding with the Earth, and how worried people became when the Mir space station's orbit decayed and it plunged to Earth? Still others might perceive it as a political or ethical choice for the United States, essentially "Star Trek" or "Star Wars"—space for exploration and communication or for dominance and warfighting.

Fear that communication or satellite intelligence will be jeopardized is likely also to be a powerful argument, though this message cuts both ways. Businesses will back the option that offers the best chance of minimizing disruption. The military-vulnerability argument is dual use. Steven Lambakis evokes a trapped American soldier in Afghanistan who needs to call upon a space weapon to knock out a hostile satellite that has pinpointed his position. Posed in that way, Americans could not be expected to refuse to take the steps necessary to defend the military assets that protect their sons. But the same image of the trapped soldier can be used to convey a diametrically opposed message about weapons in space—imagine him trapped and isolated without GPS and satellite communication as a result of blackouts resulting from detonations in space.

Different messages will work for different people. Although it is widely recognized that fear can be a very effective political motivator, it is important not to use false or exaggerated information and claims in order to whip up fear and anxiety. Similarly, it is well known that terrible accidents or, preferably, near misses, can rouse a relatively quiescent public—the "Chernobyl effect"—but too much "Chicken Little and the falling sky," as appeared with the *Cassini* flyby, can leave NGOs looking foolish. Fear- and threat-based messages have to be based on realistic scenarios and handled without sensationalism. Misinformation might produce short-term effect, but it will undermine the credibility of one's message over the long term. So, I go back to the need for further research, and for consideration to be given for how to get the most important information across in a form and with language that makes sense and evokes an active response from the general public.

Technical, legal, diplomatic engagement

As a first step, it would be good to gather in one volume the most up-to-date research on existing and future activities, assets, and interests in space, military as well as commercial. Additionally, we need a study looking at the number and type of objects that would have to be placed in space if missile defense were to extend to the weaponization of space, and combine that with an analysis of the impact of increasing space debris. On the basis of forecasts, it would be helpful for NGOs to commission environmental impact assessments of weapons use or accidents involving the presence or use of weapons in space. Such information is intrinsically valuable, and can often also be used to raise public awareness through the media or meetings.

Conferences that bring together a range of experts and practitioners can be very useful. As prospects and understanding of the issue become clearer, it will be necessary to involve national politicians and diplomats from a wider range of countries in further meetings. These could either be informal, or become constituted as a "Group of Space Experts." There is a precedent for this: for some two decades before the Conference on Disarmament (CD) actually managed to agree to a Comprehensive Test Ban Treaty (CTBT) negotiating mandate, a governmental Group of Seismic Experts was convened to work on the seismic aspects of verification of a nuclear test ban. I would not necessarily argue for the same model, as the GSE suffered from an overly limiting mandate, but it is worth considering how a group of governmental and nongovernmental experts might be convened to study the problem and options more formally, perhaps in the margins of the CD or a Prevention of an Arms Race in Outer Space (PAROS) Committee—if one ever gets convened—in Geneva, or potentially through the United Nations and the Committee on the Peaceful Uses of Outer Space (COPUOS). Such an initiative could yield useful information, prepare the ground for negotiations and also raise awareness of the issues.

Measures to address the issue

I think it is a mistake to regard the "great treaty" vs. a "step-by-step" approach as dichotomous or as mutually exclusive alternatives; it would be better to see them as part of a spectrum of possible approaches. There is as yet no "grand treaty" in the pipeline: there are different kinds of treaties that could be considered, from the very radical demand made by some NGOs that want a comprehensive treaty banning weapons and nuclear power used in or passing through space, or the treaty elements sketched out by China, to a normative treaty prohibiting the use of weapons in space or against space objects. Similarly, a step-by-step approach could range from establishment of a voluntary, regulative regime, a sort of agreed code of conduct or rules of the road governing civilian and military space activities, to a partial treaty banning certain kinds of space-related weapons or activities, either along the lines one analyst has proposed in a recent *Arms Control Today* article[2] or something like an ASAT ban, as was regularly proposed by various governments during the 1980s. As a first step, states could hold talks to consider setting up arrangements for transparency, pre-launch notification, protection of space assets and joint approaches for dealing with the problems of space crowding and debris.

We often hear the pessimistic argument that the U.S. government will never agree to prohibit space weaponization and that it is pointless to go ahead with negotiations without the United States. While agreeing that we should beware of creating a club of the virtuous, I want to argue that there is a wide operating space between excluding or bypassing the United States and giving Washington a *carte blanche* to do whatever it chooses to do in space, combined with a veto to block international efforts to set up a "space sanctuary" regime of collective security, restraint or prohibition with regard to space. Finding the best approach is a matter both of aims and objectives—the type of instrument or treaty, for example—and the forum, i.e., the structure, context, and participation base for consultations or negotiations.

For a particular multilateral disarmament measure, the "effective power" of the state proponents combined with the "effective engagement" of civil society must outweigh the effective power of state opponents. To create the conditions for successful multilateral arms control or disarmament, therefore, attention has to be paid to diminishing the effective power available to opponents, increasing the effective power of proponents, and increasing the effective engagement of civil society. Recognizing that power is principally a product of domestic and international political factors and the state's military and economic force, the effective power of opponents and proponents will depend on the number of governments who oppose or support a particular measure and their national cohesion and available international power to push through their perceived interests on this issue. The drive toward space weapons comes almost exclusively from what is still a relatively small section in the Pentagon, admittedly close to U.S. Defense Secretary Donald Rumsfeld, on the premise that space war is inevitable and that pre-emptive U.S. military dominance of space is the only way to defend against future threats to U.S. military and commercial assets. It is not therefore surprising that the primary opponent of CD negotiations on preventing an arms race in space is the United States. Britain, Germany, and Israel are prepared to give some low key support to the US position, although Britain and Germany traditionally join the majority in voting in favor of the PAROS resolutions year-by-year at the UN General Assembly.

The United States may be only one state, but it is the sole remaining superpower, with enormous financial, military, and political power. It was also established as a pluralist society, with a constitutional separation between the legislative, executive, and judicial powers, and press freedom, albeit circumscribed by advertising biases and who controls the purse. The effective power that the U.S. government can deploy in opposing some form of space sanctuary agreement or treaty banning weapons in space can be diminished through mobilizing commercial, public and, very importantly, congressional

[2] James Clay Moltz, "Breaking the Deadlock on Space Arms Control," *Arms Control Today* (April 2002).

support for such a measure. To prepare the ground for multilateral negotiations on space, therefore, the strategy must be consciously aimed at fostering opposition to the US Space Command's concept that the weaponization of space is inevitable and that the only real question is who gets there first. Similarly, the effective power of proponents for addressing this issue may be diminished through divisions, arising from disagreements about the objective or approach or from larger political considerations. Proponents may on paper include almost all the countries represented in the United Nations, but some have very little power, while others are caught between their perceived national security interests (to ban weapons in space) and strong ties of alliance with the United States (NATO, etc.).

In exploring the space between US exclusion and U.S. veto, let us now briefly consider the implications of some of the measures on that spectrum.

SPACE PRESERVATION

The most uncompromising of the NGOs working on space issues, the Global Network Against Weapons & Nuclear Power in Space, helped initiate and strongly supports a Space Preservation Bill tabled in the House of Representative by Dennis Kucinich (D-Ohio) as H.R. 3616 (January 2002). In essence, the bill calls on the United States to ban all research, development, testing, and deployment of space-based weapons. If passed, it would also require the United States to enter negotiations toward an international treaty to ban weapons in space. The Global Network is now soliciting American groups and individuals and international groups to pledge their support to Kucinich's bill. Such initiatives, although unlikely to be successful *per se*, can be very useful in raising the issue and focusing public and political attention. There is, however, one potential danger that has to be taken into account by proponents of national legislation and particularly by advocates of early international treaty negotiations: that premature legislative initiatives may also serve to focus and strengthen the opposition to such measures, thereby "inoculating" the issue against later, more pragmatically targeted initiatives to prevent the weaponization of space. I am not making an argument against initiatives such as the Kucinich bill, which can be a very helpful rallying point for activists, so much as sounding a note of caution about how it is used.

MULTILATERAL NEGOTIATIONS ON A TREATY TO PROHIBIT WEAPONS AND WAR IN SPACE (SPACE SANCTUARY TREATY)

In my April 2001 presentation at a large international space conference in Moscow,[3] I concluded that programs to weaponize space would destabilize strategic relations, harm international security and jeopardize civilian and existing military assets in space. Thus, I argued for early international action to prohibit the research and development of military programs that would result in the deployment of weapons in space. Consequently, I proposed negotiations on a treaty to prohibit weapons and war in space, with the following three components:

- banning the deployment and use of all kinds of weapons in space, thereby extending and strengthening the 1967 Outer Space Treaty's prohibitions on weapons of mass destruction in space so that laser and other directed energy weapons (DEW) and kinetic energy weapons (KEW) are also banned, as well as any other potential offensive innovations that military researchers or planners might dream up;
- banning the testing, deployment and use of anti-satellite (ASAT) weapons, whether earth-based or space-based; and
- establishing a code of conduct for the peace-supporting, non-offensive and non-aggressive uses of space.

A treaty such as this would probably need to be normative, rather than relying on

[3] See Rebecca Johnson, "Multilateral Approaches to Preventing the Weaponization of Space," *Disarmament Diplomacy* 56 (April 2001). The article was based on the presentation to the International Space Conference on "Space Without Weapons—Arena of Peaceful Cooperation in the 21st Century," in Moscow, April 11-14, 2001.

technical definitions and elaborate verification, although there are measures relating to transparency, launch notification and even mutual observation agreements that could enhance confidence. Nevertheless, while some forms of weaponry could be defined technically, it would be more important to prohibit certain kinds of activities, pre-eminently the use of any space-based object to attack, disable, or destroy others. The ASAT ban would also have to be viewed in the context of further initiatives to control missile development and proliferation.

In the context of the April 2001 paper, I noted that in view of the political realities, which meant that PAROS issues were unlikely to get properly addressed, never mind negotiated in the CD, a space-focused Ottawa-type process should be considered. Among those who disagree with me about this, too many fail to acknowledge that I noted that the Ottawa process was not easily reproducible and that there were significant differences in conditions and circumstances between potential space weaponization and the 1993-97 Ottawa process to ban land mines. In this regard, I want to make three important clarifications. The term "Ottawa process" is short-hand for denoting a negotiating process that has two salient features: an initiative led and characterized by partnership between governmental and nongovernmental experts, practitioners, and negotiators; and multilateral negotiations outside the established forum of the CD. No other similarities are implied. As my presentation today clearly shows, I recognize the pointlessness of negotiating space issues without the United States. My contention is that it may be worthwhile to bypass the veto-promoting consensus-based structure of the CD, when one or a small number of key governments block a negotiating mandate, providing that sufficient groundwork has been laid to ensure that powerful constituencies within opposing states will support and participate in negotiations. Secondly, the decision to go outside the CD is not a decision to be taken early or lightly. But, at the same time, we need to distinguish between the institution of multilateralism, which has an important role to play in norm building and regime-creation, and particular multilateral institutions, such as the CD, with its genealogy straight from the Cold War.

Thirdly, it should be remembered that before the land mines campaigners bypassed the CD with the Ottawa process, they had sought to have the issue addressed in Geneva through the Convention on Certain Weapons (CCW) and at the CD. As public and political momentum grew, and it became clear that the time was ripe for negotiations despite persistent obstacles in the CD, the Ottawa process emerged as the logical process to achieve a ban. It is true that many key countries stayed outside, although it can be argued that the normative attributes of the ban and continuing attention by international civil society will act as a weighty restraint on producers and users. However, it must also be acknowledged that though the CTBT was negotiated multilaterally in the CD, India tried to block its adoption, and several of the most active negotiators, including India, Pakistan, China, and the United States, have nevertheless failed to support the completed treaty. So, an all-inclusive multilateral process in the UN's established fora does not guarantee ownership and full participation in the final product either. By the time a negotiating mandate is decided, the battle is more than half won. Therefore the question of negotiating forum is one for the end game, and acknowledging a possible future consideration of negotiations outside the CD should not be made into a strategic stumbling block at this early stage. I regard it as premature to push forward with drafting a model treaty along the lines I suggested—a great deal more work must be done to lay the groundwork and build the necessary partnership with a small cross-section of states willing to take the lead in pursuing negotiations to achieve a far-reaching and preventive space sanctuary agreement.

AMENDING OR ADDING TO THE 1967 OUTER SPACE TREATY

Some states, including Russia, have proposed negotiating a protocol to strengthen the Outer Space Treaty (OST). This would first require the convening of a meeting of States Parties under the treaty. Since the United States is a party, the initiative would risk the Bush administration signaling its displeasure at being

summoned to the negotiating table, not only by blocking adoption of any protocol (à la the 1991 Partial Test Ban Treaty [PTBT] Amendment Conference), but, more seriously, by declaring the Outer Space Treaty an outdated encumbrance (as it has with the Anti-Ballistic Missile Treaty). Since the OST remains useful in its prohibition of weapons of mass destruction in outer space, any initiative to amend or add to it should be very carefully thought through, in case (by the law of unintended consequences) it has the damaging effect of weakening U.S. commitment to the existing treaty provisions.

PARTIAL TREATIES OR MEASURES

Inevitably, when proponents and opponents seem to be so far apart, there will be attempts to find a middle ground that can address aspects of the problem in ways that are more acceptable to the other side. Attempting to find a compromise between the Bush Administration's commitment to missile defense and the "purist" position of opponents, one U.S. analyst has proposed prohibiting the stationing of weapons of any kind in low-Earth orbit (or LEO, 60-500 miles above Earth), forbidding attacks on permanent objects in space and prohibiting shooting from space, but permitting attacks on missiles traveling through LEO. In that way, much of the administration's missile defense plans might be allowed, while clear barriers would prevent escalation to higher levels of space weaponization.[4] While this is an interesting initiative to gain attention from moderates in the Bush administration, it runs the risk of all partial measures—either buying off public concern, or failing to stimulate sufficient public support to ensure that negotiations actually go ahead. The 1963 PTBT, for example, put nuclear testing out of sight, underground, thereby defusing much of the public concern, although nuclear testing continued to fuel the nuclear arms race. As noted earlier, opposition to space weaponization is linked internationally with opposition to missile defense. A "technical fix" or partial measure that permits testing and deployment of weapons and interceptors in LEO might be welcomed by U.S. military and political constituencies (because they do not have plans and intentions to go beyond that), but it would not address the basic concerns of most other space sanctuary advocates. It would be a pity to divert the growing interest in this arms control issue prematurely into a *cul-de-sac* equivalent to the Threshold Test Ban Treaty and Peaceful Nuclear Explosions Treaty of 1974 and 1976, widely regarded as window dressing (since both the USSR and USA had no further interest in test explosions above 150 kilotons).

The step-by-step approach is not meant to be a substitute for addressing a problem fully, but rather a strategy for identifying and undertaking partial but systematic and progressive measures. If the objective is only the first step, as often meant in such approaches, then this is not part of a step-by-step approach, but rather a partial measure designed to deal only with an immediate manifestation of the problem. Despite my doubts about an approach that leaves the United States free to do most of the destabilizing space developments currently planned or forecasted, I very much welcome the thinking that goes into such proposals. It is perhaps important at this stage not to rule anything out, but to try to engage those on all sides of the argument in a conversation about the best ways to address space security.

VOLUNTARY REGULATORY OR CONFIDENCE-BUILDING MEASURES

The OST refers to the importance of international cooperation and use of outer space and makes a suggestion for parties to observe the flight of space objects launched by other states. Restraint regimes are generally more successful when they have both incentives (shared technology or participation rights, for example) for those who renounce their own programs, as well as transparency and confidence-building measures. In this regard, there are a range of measures, relating not only to space-vehicle/missile launches, but also to shared concerns about space collisions and debris, which could be profitably discussed in the run-up to negotiations. Agreed measures

[4] Moltz, "Breaking the Deadlock on Space Arms Control."

could be established voluntarily to begin with, and then incorporated into a negotiated instrument when the time came.

THE CD OR NOT THE CD, THAT IS THE QUESTION

Having explained earlier why I think that we should be prepared to go outside the CD when and if it becomes necessary (and only if the three basic requirements of groundwork, mobilization, and leadership are properly in place), I want to argue against the current Chinese (and, to a lesser extent, Russian) position of insisting on a negotiating mandate for the PAROS committee equivalent to the Fissile Material Cut-Off Treaty (FMCT) negotiating mandate as a condition of agreeing to the CD's program of work. Unless the United States is now going to step back from its earlier agreement to an *ad hoc* PAROS committee without a negotiating mandate, CD members should embrace the chance to get started on PAROS discussions, inviting NGO experts and so on. They could start with an analysis of threats and risks, and go on to consider confidence-building measures and so on, all of which needs to be discussed before anyone sits down to negotiate an actual treaty. There is also COPUOS: but that body, by agreement, does not address military-related questions; the UN First Committee—where debate would certainly proceed in the margins, focused around the text of the annual resolution, but is limited by the pressure of considering some 40-50 resolutions; or even the UN Security Council, if members wish to raise space security as a priority issue. Of all these, however, the CD would be the most appropriate forum for getting to grips with the complex legal, technical, and political issues, if only the FMCT/PAROS linkage were not hindering agreement on a program of work.

CONCLUDING REMARKS

At this stage, when the prime task is to raise consciousness, a scattershot approach can sow lots of fertile seeds. Thus, although some of the proposals being put forward are barely formed, and others might have serious weaknesses, all approaches can (and should) be explored and critically examined. It may be possible to move forward relatively quickly on some transparency or regulatory measures, and build a wider NGO-government-commercial constituency in the United States, and also in the other three major regions of space interests—the European Union, India and Japan—to take more far-reaching legal and institutional measures. Personally, I think it will be necessary at some point to negotiate a new and preventive space sanctuary instrument—either a single treaty that incorporates all three dimensions I proposed in the Moscow paper (space weapons ban, ASAT ban, and code of conduct for non-aggressive uses of space), or a series of interlinked agreements and instruments, some of which would be essentially norm-building expressions of expectation and prohibition, while others may be subject to internationally agreed verification measures. Insisting at this stage on one true approach would be likely to divide proponents and therefore diminish their effective power early on. It is more important to get generalized agreement to begin the process of discussion and exploration of the threats and options.

Although Secretary Rumsfeld moved rather swiftly to consolidate U.S. Space Command personnel and structures more centrally in the Pentagon, space weaponization is still likely to be some years off. The Bush administration has a long way to go to prove the technology for the terrestrial-based elements of its vague and "multi-layered" missile defense schemes, and some programs are now overshadowed by the budgetary black hole of the post-September 11 "war against terrorism"; so it seems unlikely that Congress will vote further large sums for R&D on space weapons in the near future. We therefore have a special opportunity to take time, conduct good research, and consider the options before we nail our colors to a particular masthead. We have time to build effective constituencies, but we do not have unlimited time. It would be short-sighted to wait until the first weapons were deployed (or the first accident occurred) and then try to establish a retrospective nonproliferation or disarmament regime in space. Much better to seize the early initiative to take preventive and precautionary measures before too much serious investment of money

and prestige goes into convincing the public and politicians that weapons in space will keep them safe.

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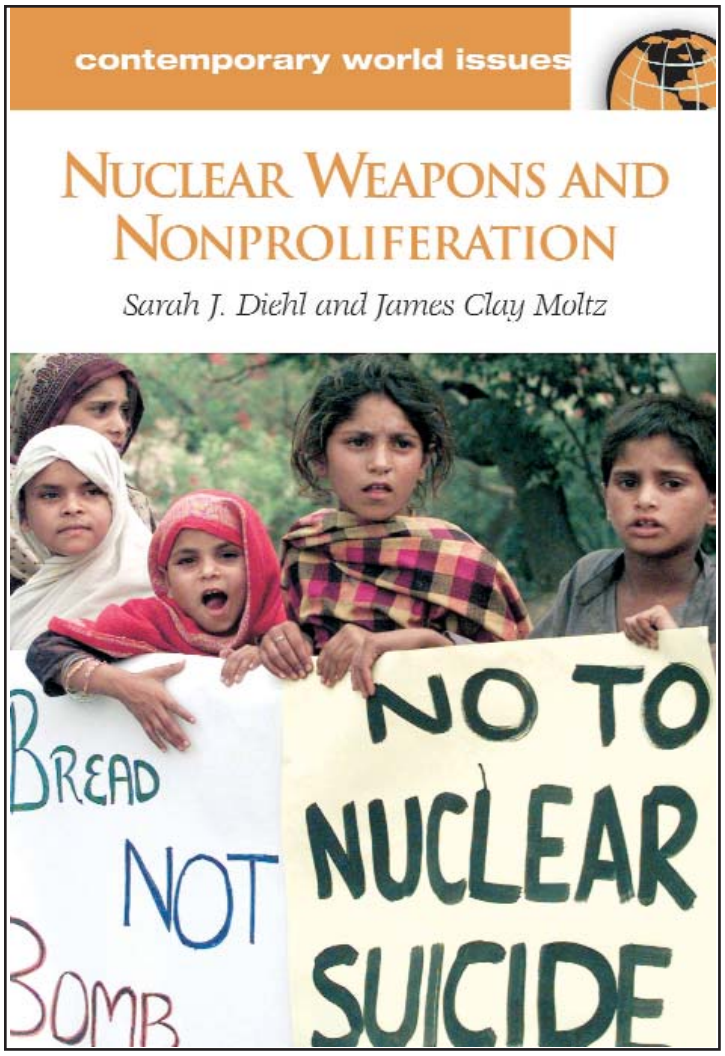

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