PERSPECTIVES ON SPACE SECURITY

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Foreword

With the generous support of grants from the John D. and Catherine T. MacArthur Foundation, The Space Policy Institute and the Security Policy Studies Program of George Washington University's Elliott School of International Affairs, beginning in Fall 2001, have organized a Security Space Forum (http://www.gwu.edu/~spi). Serving as co-organizers have been Professor Gordon Adams, Director of the Security Policy Studies Program, and Professor John M. Logsdon, Director of the Space Policy Institute.

The goal of the Security Space Forum has been to serve as the one place in Washington where specialists in military space policy, national security analysts, policy-makers, researchers, advocates, industry, and the media can come together to exchange different viewpoints on issues of space security, defined by the Space Security Index project as "secure and sustainable access to and use of space, and freedom from space-based threats." The purpose of the Security Space Forum is thus straightforward: to bring together space specialists and national security generalists, both advocates and critics of current US policies and plans, in a neutral setting, with an eye to expanding the policy debate.

Forum activities over the past several years have included an ongoing series of luncheon discussions and a May 12, 2005 all-day conference. This publication contains selected papers from those commissioned during the 2003-2005 period. These papers give particular attention to the international dimensions of space security, as increasingly this has become an issue of global concern.

A number of individuals have contributed to the Forum's efforts and deserve our gratitude. In particular, Lukas Haynes and Kenette Benedict of the MacArthur Foundation have provided consistent support. Todd Robinson, Rachel Wanner,

and Daniel Melenby of the Security Policy Studies Program and Ryan Carter and Lauren Hall of the Space Policy Institute helped us organize Forum activities. Graduate student Audrey Schaffer made invaluable contributions to the preparation of this publication, and thus she is appropriately acknowledged as co-editor together with John Logsdon.

We continue to hope that the activities of the Security Space Forum and the publication of the papers in this volume can contribute to increased understanding of the links between emerging space capabilities, not only in the United States but around the world, and international security.

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About the Authors

Robert S. Dickman is executive director of the American Institute of Aeronautics and Astronautics, an individual-membership technical society with more than 35,000 members in 79 countries. As executive director, he oversees a nonprofit organization with 100 staff and a $20 million budget; AIAA's activities include publishing, conferences, standards development, a full range of student programs, professional development, and government relations. He is only the third executive director since AIAA's formation in 1963.

Previously, Mr. Dickman served as Deputy for Military Space, Office of the Undersecretary of the Air Force, Washington, D.C. He supported the Undersecretary, who was also the Director of the National Reconnaissance Office, in executing space responsibilities, which included managing the planning, programming, and acquisition of space systems for the Air Force and other military services.

Mr. Dickman was born in Brooklyn, N.Y., grew up in New Jersey, and entered the Air Force as a distinguished graduate of the ROTC program at Union College, Schenectady, N.Y. He has had a varied career in space operations and acquisition and planning, including being assigned at the Space and Missile Systems Center, the Pentagon, North American Aerospace Defense Command, US Space Command, Air Force Space Command, and the National Reconnaissance Office. While serving on active duty, he was the first Vice Commander of the 2nd (now 50th) Space Wing, Schriever Air Force Base, Colorado, Commander of the 45th Space Wing, Patrick Air Force Base, Florida, Department of Defense Space Architect, and the senior military officer at the NRO in Washington, D.C. He was the 1998 recipient of the National Space Club Astronautics Engineer award and one of Space News' "100 Who Made a Difference, 1989-2004." He retired from active duty in 2000 in the rank of major general, and was appointed to the Senior Executive Service in March 2002. He assumed his current position in February 2005.

Nancy Gallagher is the Associate Director for Research at the Center for International and Security Studies at Maryland (CISSM). Her research has examined how interests, ideas, scientific debates, and domestic politics have combined to shape the negotiation and ratification of arms control agreements. In her current position, she co-directs the Advanced Methods of Cooperative Security Program, an interdisciplinary effort to address the security implications of globalization by developing more refined rules of behavior and more comprehensive transparency arrangements.

Before coming to the University of Maryland, Dr. Gallagher was the Executive Director of the Comprehensive Test Ban Treaty Task Force and worked closely with the Special Advisor to the President and Secretary of State on recommendations to build bipartisan support for US ratification. From 1998-2000, she served as an arms control specialist in the State Department and a Foster Fellow in the Arms Control and Disarmament Agency. She was a member of the Government Department at Wesleyan University from 1990-1999 and has also taught at the University of Maryland and George Washington University.

Dr. Gallagher is the author of *The Politics of Verification* (Johns Hopkins University Press, 1999) and the editor of *Arms Control: New Approaches to Theory and Policy* (Frank Cass, 1998). She has written articles on South Asian nuclear security, the gender gap in opinions about the use of force, and other topics related to international security cooperation

Dr. Gallagher received her undergraduate degree in history from Carleton College in 1983 and her Ph.D. in political science from the University of Illinois, Champaign-Urbana in 1990.

James A. Lewis is a senior fellow and director of the CSIS Technology and Public Policy program. Before joining CSIS, he was a career diplomat who worked on a range of national security issues during his federal service. Lewis's extensive diplomatic and regulatory experience includes negotiations on military basing in Southeast Asia, the Cambodia Peace Process, the Five Power Talks on Arms Transfer Restraint, the Wassenaar Arrangement, and several bilateral agreements on security and technology. Lewis was the head of the delegation, Wassenaar Experts Group for advanced civil and military technologies, and a political adviser to US Southern Command (for Just Cause), to US Central Command (for Desert Shield), and to the US Central American Task Force. He was responsible for the 1993 redrafting of the International Traffic in Arms Regulations, the 1997 regulations implementing the Wassenaar Agreement, numerous regulations on high-performance computing and satellites, and the 1999 and 2000 regulations liberalizing US controls on encryption products. Since coming to CSIS, he has authored numerous publications, including *Globalization and National Security* (2004), *Spectrum Management for the 21st Centur*y (2003), *Perils and Prospects for Internet Self-Regulation* (2002), *Assessing the Risk of Cyber Terrorism, Cyber War, and Other Cyber Threats* (2002), *Strengthening Law Enforcement Capabilities for Counterterrorism* (2001), *Preserving America's Strength in Satellite Technology* (2001), and *China as a Military Space Competitor* (forthcoming). His current research involves digital identity, innovation, military space, and China's information technology industry. In 2004, Lewis was elected the first chairman of the Electronic Authentication Partnership, an association of companies, nonprofits, and government organizations that develops rules for federated authentication. He received his Ph.D. from the University of Chicago in 1984.

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His research is currently focused on space and high technology policies and decision-making processes associated with national security strategies. He is working more specifically on US policies and on their impact on the transatlantic relationship in space, both in the civilian and military domains. He also conducts work on the NATO-European defense structure relationship in the domain of interoperability and coalition warfare.

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Towards a Reconsideration of the Rules for Space Security[1]

Nancy Gallagher

Since the space age began, two competing images have influenced policy debates about space security. One conception sees space as the "final frontier," a largely lawless environment where conflict is inevitable and superior firepower provides the only reliable protection for satellites and the terrestrial activities that depend on them. The alternative view uses imagery of "the heavens" to suggest that if, and only if, humans can transcend the fear and greed that generate earthly conflict, then there will be a natural harmony of interest that promotes the peaceful use of space for the benefit of all. Neither the "Realist" imagery of unbounded conflict nor the "Idealist" imagery of natural cooperation adequately reflects the amount of effort spent over the past half century on developing rules to manage space operations. When analysts and practitioners do write about the rules for space, they typically focus only on space law, especially those rights and obligations that have been codified by international treaties — another idealized conception of the rules governing space activity.

This paper broadly defines the rules for space as anything that induces regularity or restraint in behavior beyond what would be predicted on the basis of interests and power alone. This includes not only formal laws, but also principles, norms, informal understandings, common practices, agreed decision-making procedures, and institutional arrangements. In other words, this paper analyses space as an extension of an international system where governance occurs on a piecemeal basis in the absence of a world government with supranational law-making and enforcement powers.

The rules that regulated early space activities, while far from ideal in any sense of the word, were reasonably functional and stable because the formal laws, informal operating practices, and strategic context complemented and reinforced each other. Over time, fundamental processes associated with globalization have altered the strategic context and the operational practices for space activities, but international efforts to update the formal legal framework have not kept pace. Instead, the United States has embarked on a unilateral attempt to rewrite key rules related to space in ways that other countries find extremely threatening, while hoping to preserve international support for aspects of space law that the United States finds beneficial. This strategy underestimates negative international reaction both to the substance of US space security policy and to the process whereby the United States is making momentous policy changes while rebuffing international attempts to discuss, let alone negotiate, new rules for space security. More importantly, this strategy overestimates the United States' ability to accomplish its objectives in space without widespread acceptance of equitable rules to protect legitimate space activities.

The disjunction between the George W. Bush administration's strategic principles and preferred rules for space and those of the other space-faring countries has grown so great that the space governance system may collapse unless its core elements are strengthened, updated, and expanded. Modest accords about mutual concerns such as space debris and voluntary rules of the road could be useful at the margins. But these minor steps would not repair the gaping cracks at the center of the space security system unless they are linked to the foundational 1967 Outer Space Treaty (OST) and to serious consideration of questions that the existing legal framework does not adequately address. For example, the OST legitimates the free use of outer space for activities that are "in accordance with international law, including the Charter of the United Nations, in the interests of maintaining international peace and security." But aside from prohibiting weapons of mass destruction in space and military activities on celestial bodies, the Treaty does not delineate between military uses of space that are genuinely peaceful and thus protected, and those that are intolerably threatening. Nor does it tell how to balance the interests of military, commercial, and civilian space users around the world. These questions cannot be answered by reference to an abstract, idealized conception of space as a realm beyond the reach of normal human affairs. Instead, sustainable space security will require more refined rules for military uses of space that reinforce, rather than undermine, an approach to terrestrial security based on reassurance and restraint.

I. Competition and Restraint Shape the Initial Rules for Space

US space security policy evolved as an integral part of the Cold War competition with the Soviet Union. The superpower struggle involved not only a military dimension, where the primary goal was to preserve stable deterrence, but also a political dimension, where the core objective was to create international arrangements that promoted American interests and appealed to the rest of the "free" world. Even in the military dimension, the superpowers soon came to recognize that some rules and restraint would enhance their security. Thus, despite their intense rivalry, space was never an arena for a no-holds-barred clash of brute force against brute force any more than it was a zone of pure peace and harmonious cooperation. Instead, what developed was a patchwork of international agreements, principles, national policies, and informal behavioral rules through which all the states with a stake in space tried to balance their common and conflicting interests.

The Origins of the Space Security Regime

In the early US space program, developing a supportive political and legal foundation for information-gathering satellites was considered more important than beating the Soviets off the launch pad.[2] In the wake of the Korean War, President Eisenhower wanted to cut US defense spending without falling behind the Soviet Union in the arms race. He needed reliable information about military developments behind the Iron Curtain in order to negotiate arms control, to retain defense sufficiency in the absence of agreements, or to destroy Soviet targets if all else failed. Reconnaissance satellites could address these needs, but only if their use was legitimatised. Therefore, the Eisenhower administration not only talked about peaceful uses of space for the benefit of mankind while quietly pursuing military applications, but it also acted in ways that showed concern for both power and legitimacy. For example, it launched its first satellite as a scientific project for the 1958 International Geophysical Year; it selected a civilian launch option over a military program that was ready sooner; and it took great pains to position itself as the champion of openness, international cooperation, and the rule of law in space. Soon after Sputnik was launched, Eisenhower observed that the Russians had "done us a good turn, unintentionally, in establishing the concept of freedom of international space."[3]

The 1967 Outer Space Treaty enshrined the basic principles of free access, non-appropriation, equitable benefits, and peaceful use in the operative articles of the Treaty, not merely in the more aspirational preamble.[4] The United States was most interested in formalizing the principle that outer space, unlike air space, should be free for access and use without the permission of the underlying states. To secure broad agreement on the Treaty, however, the United States had to accept Brazil's proposal to precede the freedom-of-use principle with the commitment that the exploration and use of space shall be for the benefit of all countries, irrespective of their degree of economic or scientific development (Art. I.1). The freedom-of-use principle is strengthened by Article II's prohibition on national appropriation, the formalization of a declaration made by then-Senator Johnson shortly after Sputnik was launched: "We of the United States do not acknowledge that there are landlords of outer space who can presume to bargain with the nations of the Earth on the price of access to this domain."[5] The right to use space is qualified both by Article IX's insistence that one country's use of space should neither interfere with other countries' current space activities nor degrade the space environment for future users, and by Article VII's assignment to launching States of international legal liability for damage done to other States Parties.

The portions of the OST devoted explicitly to military uses of outer space tried to balance the political benefits of peaceful space with complex military considerations. Article IV's prohibition on weapons of mass destruction in space creates a legally binding obligation built upon declaratory statements made in support of the 1963 UN General Assembly Resolution 1884 on "Stationing Weapons of Mass Destruction in Outer Space." It took a series of compromises in the early 1960s to move the superpowers from unproductive posturing over broad, one-sided proposals to a more limited, mutually beneficial cooperation. They had to de-link space from other disarmament issues and agree that even small nuclear weapons were, by definition, weapons of mass destruction (WMD). The United States had to stop reflexively insisting that verification must include inspections, while the Soviets had to stop drawing a distinction between "innocent" satellites and "espionage" and start tacitly legitimating reconnaissance satellites. The United States had to reassure the Soviet Union that it was no longer taking an all-or-nothing approach to space arms control that included a ban on ballistic missiles while the Soviets had to accept, at least temporarily, the US preference for a declaratory agreement over a treaty requiring ratification. Four years later, President Johnson was able to build on this narrow, informal agreement to gain unanimous Senate consent to ratification of a treaty that not only banned WMD in space, but also prohibited States from using the Moon and other celestial bodies for military purposes. The Treaty still said nothing about putting conventional weapons in orbit, sending ballistic missiles with nuclear warheads through space, or deploying most types of anti-satellite weapons. Article III established the general requirement that all space activities shall be conducted in accordance with international law, including the United Nations Charter, thus limiting the legitimate use of force in space to self-defense.

The vague formulation of Article III leaves much leeway for space-based military support operations to enhance deterrence, but it contradicts claims that anything not explicitly prohibited in Article IV is permitted.[6]

Other space-related arms control accords show comparable concern for both the military and the political dimensions of the US Cold War strategy. The formal limits on space-based military activities are narrowly drawn: the 1963 Limited Test Ban Treaty outlawed nuclear tests in space but allowed them underground; the 1972 Anti-Ballistic Missile Treaty prohibited space-based missile defense but permitted limited land-based systems; and various accords banned interference with "national technical means of verification" — a euphemism for photo intelligence satellites and other remote monitoring systems. The superpowers calculated that it was in their security interests to rule out certain forms of military competition in space, and they gained political benefits by showing that they could cooperate enough to limit those aspects of the arms race that the rest of the world found most threatening.

Informal Restraint on Anti-Satellite Weapons

Although anti-satellite weapons (ASAT) were technically feasible and legally permissible during this period, neither superpower made a sustained effort to develop and deploy ASATs or space-based weapons that could hit terrestrial targets. Instead, both appeared to exercise contingent restraint — i.e., to signal that they would keep their own ASAT efforts at a low level as long as the other side did likewise, but that they were prepared to accelerate their nascent ASAT programs if the other side did.[7] The United States began developing nuclear-armed ASATs in the 1950s as a hedge in case the Soviets placed nuclear weapons in orbit, a concern that was diminished by Soviet endorsement of 1963 UNGA resolution. Existing strategic missiles could be used as ASATs, but the electromagnetic pulse from their nuclear warheads would have damaged American satellites as well as Russian ones, making them impractical for most uses.[8] When the Soviets initiated tests of a non-nuclear co-orbital satellite interceptor system in 1968, the United States assessed that this primitive system did not pose an immediate threat and that a competitive response could stimulate the Soviets to develop a more capable system. Therefore, the United States increased passive protection for its satellites and preserved its own rudimentary ASAT system, but actually reduced funding for next-generation ASAT work. The United States interpreted the Soviet decision to stop ASAT testing in 1971 as reciprocal restraint, a view that was reinforced by several minor agreements providing implicit protection for certain satellite activities.[9] It does not appear that the superpowers exchanged views about military space activities writ large, however, neither side proposed including an ASAT ban in the 1972 Anti-Ballistic Missile Treaty.[10]

The US preference for tacit cooperation reflected hard-headed security calculations:

1. Space weapons were technologically challenging, expensive, vulnerable, and offered the United States few, if any clear advantages over land-, sea-, or air-based systems for most military missions.
2. If the United States deployed space weapons, the Soviet Union would follow suit so the advantage for the US would be short lived, whereas if the United States exercised restraint the Soviets would either reciprocate or take an incremental step toward space weapons that the US could quickly counter.
3. The United States was more dependent on satellites for military-support functions than the USSR was, so it had more to lose if attacks on space assets were legitimized.
4. Many benign security-related uses of space, such as arms control verification and early warning, helped to stabilize deterrence, whereas the deployment of offensive space weapons would create destabilizing incentives for pre-emptive attack.

The combination of principles, narrow legal prohibitions, and broader tacit restraint that shaped space security policy from the mid-1950s through the mid-1970s was reasonably stable because it fit well with a bilateral strategic context that emphasized mutual deterrence and limited arms control. The largely informal approach had shortcomings, though. As was true in other areas of détente, Americans sometimes accused the Soviets of breaking unwritten rules of restraint, for example by sharing reconnaissance data with client states, although it is still not clear (a) that the Soviets agreed that such a norm existed; (b) that they actually provided the information; and (c) that the Americans were not engaging in similar behavior from time to time.[11] Misperceptions and false alarms also caused problems. When three American satellites were temporarily blinded in 1975, initial news coverage emphasized the possibility that the Soviets were testing lasers to blind US early-warning satellites. Puzzling features, such as the long duration of one episode, the simultaneous effects on several satellites in different orbits, and the fact that the radiation did not come from the one known Soviet laser test-site, were cited as evidence that the Soviet anti-satellite threat must be very advanced and extensive. With no ASAT treaty, the United States had no consultative and clarification mechanism to invoke, so it took several months for the incidents to be attributed to a fire along the trans-Siberian pipeline. A press statement by then Secretary of Defense Donald Rumsfeld failed to end lingering suspicions.[12]

The inadequacy of the informal approach to ASAT restraint became more obvious when the Soviets resumed testing in early 1976. The tests had little military significance — the Soviet's ASAT system became significantly less reliable after they started using the new guidance system that was the main reason for these tests.[13] Nevertheless, American security experts attributed tremendous political significance to the tests as evidence that the Soviets placed a higher value on incremental improvements to their ASAT system than they did on stable deterrence and détente. The Americans did not give serious consideration to an alternative explanation — that Soviet leaders were feeling increasingly threatened by the growing US advantage in military-support satellites and wanted to signal that reciprocal ASAT restraint could not continue indefinitely without corresponding limits on military satellites.[14]

Space security policy reviews undertaken at the end of the Ford administration and the beginning of the Carter administration led to a two-track political and military strategy: the United States would ramp up research and development of next generation ASAT weapons, preferably to pressure the Soviets to accept legally binding ASAT limits, but also to deter attacks on US satellites and to hold Soviet satellites at risk if arms control failed.[15] This shift to coercive diplomacy reflected growing doubts about the assumptions underlying past attempts to keep space as a sanctuary for military-support satellites. Technological change was blurring the distinction between "benign" and "threatening" uses of space: for example, photoreconnaissance satellites were gaining real-time transmission capabilities and early-warning satellites were becoming precise enough for targeting, not just general observation of troop movements or ballistic missile launches. This blurring exacerbated concerns that the Soviets might exploit American restraint by suddenly deploying an advanced ASAT system or claiming sanctuary for military-support activities that strengthened their hand in regional crises, small-scale conflicts, and possibly even a superpower war. The change in political context and policy beliefs was even more dramatic. Space was no longer assumed to be an arena where the superpowers clearly recognized a shared interest in modest arms control, transparency, and tacit restraint to stabilize mutual deterrence. Instead, space security policy was increasingly shaped by the broader shift to a "countervailing" deterrence strategy that required American superiority in every aspect of the military balance so that the Soviets would not try to offset weakness in one area by moving the competition to another venue where they could compete on more favorable terms.

Carter's two-track ASAT policy helped finesse internal US disagreement about what, if any, mutual restraints on offensive space activities would actually enhance national security. Even with the new tests, the Soviet co-orbital ASAT system used outdated technology and had serious limitations on the timing, frequency, and number of interceptor launches; the speed and reliability of intercept; and the altitude that could be reached. The Defense Department was directed to develop immediately an operational direct-ascent ASAT system that would be "orders of magnitude more advanced." The Miniature Homing Vehicle (MHV) ASAT would ride on a short-range attack missile carried by an F-15 fighter, so it could deploy rapidly from many locations, destroy a target within minutes of launch instead of the several hours needed for a co-orbital interceptor, and attack a large number of Soviet satellites in a short period of time, leading one proponent to claim that it would be capable of "sweeping the skies clean in twenty-four hours." By pressing forward much faster with ASAT technology development than with negotiations, the Americans accelerated the rate of technological change, intensified Soviet concerns about US military space capabilities, and exacerbated domestic disagreements over the possibility that the United States might use its technological prowess to gain perpetual dominance in space.

When ASAT negotiations finally started in mid-1978, the US team had no specific instructions for nearly a year because the President wanted a comprehensive ban on dedicated ASAT weapons but the military preferred a no-use/non-interference agreement linked to broad, informal "rules of the road" analogous to rules for military operations on the high seas. Nearly a year later, the United States finally proposed a short-term no-use/non-interference agreement, possibly coupled with a testing moratorium and a long-term goal of banning all dedicated ASAT weapons. The American proposal placed no constraints on military support satellites. While significant progress was made toward a no-use agreement, the Soviets reserved the right to attack satellites whose "hostile or pernicious acts" threatened their security.[16] The United States postponed the next round of ASAT negotiations that might have finalized this deal in order to concentrate on SALT II ratification, but did not have a parallel delay in the ASAT development track of their strategy. The Soviet invasion of Afghanistan in December 1979, followed by their resumption of ASAT testing in April 1980, ended Carter-era attempts at cooperative ASAT control and left only the competitive pursuit of space weapons.

The Cold War Quest for Space Dominance

An arms race in space seemed inevitable by the mid-1980s because the Reagan administration maintained that the only way to deal with the "Evil Empire" was to develop the capability to fight and win a nuclear war. Military satellites for early warning, communication, targeting, and damage assessment played an integral role in Defense Secretary Weinberger's Strategic Modernization Program. The threat from the Soviet co-orbital ASAT system was deemed to be much greater than it had been a decade earlier, although that technology had not significantly improved. The Defense Department also assessed that the Soviets had a ground-based laser ready for use in an ASAT role, and would be able to deploy a space-based ASAT laser in the early 1990s.[17] The Reagan administration cited the threat posed by Soviet military-support satellites, such as the RORSAT radar ocean reconnaissance system for tracking and targeting US carrier battle groups, as a reason why the United States needed an advanced ASAT capability regardless of Soviet ASAT development or restraint. The military also began to pursue a new type of war-fighting capability — the ability to apply force from space to terrestrial targets. Reagan's March 1983 Strategic Defense Initiative (SDI) speech and US efforts to reinterpret the ABM treaty as inapplicable to "exotic" technologies provided yet another impetus for the United States to intensify work on a wide range of offensive and defensive space weapons and space-based military support systems. Funding for the Department of Defense's space activities, which had remained consistently low from 1959-

1979, more than quadrupled from 1980 to 1988.[18] Unified space commands were established, first within the individual services, and then for the entire military in the form of the US Space Command (SPACECOM). In short, the Reagan administration radically reoriented US space security policy away from all vestiges of cooperative restraint in order to compete with the Soviets in all aspects of military space.

Contrary to expectations, a superpower space race never materialized. The initial constraints on the Reagan administration's program were technological and budgetary: cost projections for the MHV program rose from $500 million to $5.3 billion by 1986 for a system that could only reach 30% of the satellites in the Joint Chiefs of Staff's target list and that could only give high confidence of destroying a fraction of them.[19] Congress began to exert its power of the purse after the administration rebuffed two Soviet suggestions for new space arms control negotiations: a 1981 proposal to prohibit stationing any weapons in space and attacking or interfering with permitted space objects, and a 1983 proposal that would also prohibit testing new ASAT systems and eliminate existing ASAT systems, including the operational Soviet co-orbital interceptor. In response to a Soviet promise not to put ASATs in space if the US pledged reciprocal restraint, the administration rushed to conduct its first in-space test of the MHV system in a way that was clearly done for political rather than technological reasons, Congress blocked funding of ASAT tests against objects in space unless the Soviets did so again.[20] In 1988, the Reagan administration cancelled the MHV program while proclaiming even more boldly than before that the military's basic missions in space went beyond space support and force enhancement to include space control and force application.[21]

Even as superpower relations warmed, the Soviet Union disappeared, and Russia's space-related military programs deteriorated, the George H. W. Bush administration maintained that national security required the near-term deployment of missile defenses and anti-satellite weapons. The programs were refocused, however, on less ambitious goals like protecting against a limited nuclear strike rather than a massive attack. They also favored more attainable kinetic-energy (KE) "hit-to-kill" options over more futuristic technologies. Neither Congressional efforts to permanently ban all ASAT tests nor administration attempts to significantly increase funding for a KE ASAT program succeeded, although Congress did place a one-year ban on testing the ground-based Mid-infrared Advanced Chemical Laser (MIRACL) against objects in space.

By the mid-1990s, the notion of a space war seemed anachronistic to most people. The Clinton administration neither actively promoted major new space arms control initiatives nor paid much attention to the old space warriors in Congress and SPACECOM who thought that the demise of the Soviet Union made US space dominance easier to attain but no less valuable to have.[22] Although space policy innovations promoted commercial development and multilateral civilian programs such as the International Space Station, the competitive military space policy rhetoric inherited from the Reagan and Bush I administrations was not revised to reflect growing international cooperation. Official policy documents still assigned DOD responsibility for thinking about space control and force application, while specifying the importance of treaty compliance and the need to consider diplomatic and legal measures, not just military ones.[23] The administration neither endorsed nor repudiated SPACECOM's long-range planning documents that presented numerous space control and force application options that it wanted to develop in case a policy change made space weapons a high priority again.[24] National policy debates and US-Russian security discussions focused on the pros and cons of missile defense as a response to threats posed by potential proliferators like North Korea, Iraq, and Iran.

The Clinton administration tried to have it both ways on offensive space weapons. It declared that the US had no near-term requirement for ASATs and blocked Congressional efforts to add funding to the FY 1998 Defense Appropriations

Bill for space-based missile defense research (disguised as asteroid defense), a military space plane, and the Army's KE ASAT program that had been terminated in 1993. At the same time, the administration reassured Congress that it was funding other, less provocative anti-satellite technologies and space-based missile defense research. DOD space budgets dropped sharply in the first few years of the Clinton administration, then climbed slowly back to Bush I levels as the Clinton administration tried to show Congressional critics that it was doing enough on missile defense. President Clinton did not take Russian Premier Yeltsin up on his 1997 offer to begin new talks about banning ASAT weapons. He acquiesced to domestic pressure for the first MIRACL test against an object in space, but downplayed the significance of the experiment by characterizing it as an attempt to assess the satellite's vulnerability to inadvertent or deliberate lasing, rather than as a test of the lasers themselves.[25] Meanwhile, the United States' reliance on space-based assets for military support and force enhancement in conventional conflicts continued to increase. Advances in computing capabilities made it possible by the late 1990s to get satellite imagery to tactical users in near-real time, while GPS-guided bombs were used extensively for the first time in Kosovo.

In short, the rules for space security that evolved during the second half of the Twentieth Century were very robust in some regards and very fragile in others. Both the broad principles and the specific prohibitions of the Outer Space Treaty seemed to have nearly universal support. Great efforts were made to justify any military space activity as "peaceful" and few people seriously expected to see military bases established on the Moon or weapons of mass destruction placed in orbit. The Anti-ballistic Missile Treaty survived SDI and all the other challenges of the Cold War years, so it was reasonable to expect continued agreement that missile defense activities in space or elsewhere should not progress to the point where they undermined either side's confidence in its deterrent. Likewise, neither superpower ever actually deployed a weapon in space that could hit targets on earth nor demonstrate more than a rudimentary ASAT capability.

Sometimes restraint reflected a deliberate policy decision, while at other times, it flowed from technical and budgetary limitations. Restraint was strongest when national security strategy emphasized stable mutual deterrence and arms control for reassurance and when technological capabilities and military practices made it easier to draw conceptual distinctions between military-support satellites that stabilized deterrence and offensive space weapons that could undermine it. Technology and policy changes of the late 1970s blurred the line between "benign" and "threatening" military support satellites. US policymakers still acknowledged that increasingly capable military-support satellites could not be protected without cooperative restraint, yet feared that "to the extent that ASAT development is suppressed and the vulnerability of spacecraft masked, the superpowers will be more and more tempted to deploy threatening spacecraft. And…pressures will in turn build to set aside the treaty and deploy ASATs."[26] The Reagan administration tried to escape this dilemma by asserting that competitive ASAT development offered more protection for US satellites than cooperative restraint would, but its plans were blocked, first by technical and budgetary problems, and then by Congressional refusal to fund advanced ASAT work when the purported threat no longer wished to compete. Neither the first Bush administration nor the Clinton administration developed a coherent post-Cold War space security policy to match the principles, legal rules, and informal operating practices with changed circumstances. That was left for the second Bush administration to do.

II. The Current Situation

The strategic context for space security has changed dramatically over the past fifty years. The Cold War ended and the Soviet Union dissolved nearly fifteen years ago, so military and political competition with Moscow no longer drives US space policy. As the United States has surged forward in its military space capabilities, the program that Russia inherited from the Soviet Union has stagnated in some areas and deteriorated in others.[27] Other space powers, most notably Europe, China, Japan, India, and Israel, are developing impressive indigenous space capabilities, so the number of countries that could directly affect each other's space activities is growing even as the technology and spending gap between the United States and all potential space competitors has widened.[28] Since the 1980s, the information revolution and economic globalization have made the commercial space industry an increasingly important player with varying degrees of independence from national governments. By 2003, world satellite industry revenues had reached $91 billion, total consumption of satellite-based telecommunication and sensing services had topped $1 trillion, and an incalculable amount of additional global economic activity relied on satellites for high-speed financial transactions, real-time inventory tracking, and other efficiencies.[29] US military reliance on satellites for communications, precision targeting, navigation, remote sensing, and weather forecasting has also grown dramatically, and the US commercial space industry remains beholden to the military as its most lucrative and reliable customer.[30] While there is some dispute over the magnitude and pace of these changes, the basic trends are clear and the primary disagreements involve their implications for space security.

The Quest for Dominance Resumed

The George W. Bush administration has used growing US reliance on vulnerable commercial and military satellites to justify its quest for an expanded version of Reagan-era military space dominance, sized not in reaction to the probable near-term threat posed by a specific country's space activities, but in response to the US military space community's desire to dominate any conceivable future adversary. The report of a commission chaired by Donald Rumsfeld and released shortly before he became Secretary of Defense portrayed conflict in space as inevitable. To avoid a "Space Pearl Harbor," it warned, the United States must finally "develop the means to deter and defend against hostile acts in and from space."[31] The commission proposed organizational and management changes to speed technology development, to increase resources, and to sustain Presidential leadership. It also recommended an active US effort to reshape the space legal and regulatory environment. The report provided an extremely permissive interpretation of the current rules for space by insisting that "there is no blanket prohibition in international law on placing or using weapons in space, applying force from space to earth or conducting military operations in and through space" without mentioning any of the restrictions and qualifications on the use of force in, from, or through space that do exist. It also warned against "agreements intended for one purpose that, when added to a larger web of treaties or regulations, may have the unintended consequences of restricting future activities in space."[32]

Instead of releasing a new National Space Policy during its first term, the Bush administration reinterpreted the ambiguous Clinton-era document as requiring the development and deployment of space weapons, rather than as it was originally understood — i.e., as instructions to protect US freedom of action in space through deterrence and diplomacy, with more offensive means of space control reserved as a long-term last resort at odds with current policy.[33] Lower-level military planning documents provide more explicit, if less authoritative, depictions of security through perpetual "space dominance." SPACECOM's 1998 *Long Range Plan* defines this as 1) <u>control of space</u> — the ability to ensure uninterrupted US access and freedom of action in space and to deny this to others if required; 2) <u>global engagement</u> — the combination of global surveillance from space, worldwide missile defense, and force application from space; 3) <u>full force integration</u> that uses space-based information and communication systems as a "force multiplier" for terrestrial operations; and 4) <u>global partnerships</u> that leverage civil, commercial, and international space systems to bolster and decrease the costs of military capabilities.[34] In other words, the SPACECOM goal is to be able to see anything in and from space, to attack it quickly if ordered to do so, to defend all US space assets, to control other countries' access to and use of space, and to secure foreign cooperation with these objectives.

Whereas the Clinton administration was unenthusiastic about some aspects of the SPACECOM plan and actively opposed to others, the current Bush administration shows no such reluctance. Instead, it has pressed Congress for major increases in funds for military space activities: total unclassified spending on selected programs related to space weapons nearly tripled from the FY 2002 Defense Appropriations Bill (which still reflected Clinton-era priorities) to the FY 2005 Defense Appropriations Bill, and classified spending on military space activities has probably increased at a similar or greater rate.[35] The Bush administration re-energized, at least temporarily, some old space weapons programs, including the KE ASAT, space-based lasers, the Multiple (formerly Miniature) Kill Vehicle interceptor, and a military space plane. It also initiated a number of new space control and force application programs.[36] The Air Force has begun publicly to document its plans to develop specific types of space weapons, including "hypervelocity rod bundles" (a.k.a. "rods from God") and to describe operational plans for pre-emptive or retaliatory attacks, not only on enemy military satellites, but also against third-party-owned commercial or civilian satellites being used by an adversary.[37]

The Bush administration has radically altered the strategic context from mutual deterrence mixed with reassurance to a much more assertive mix of coercive prevention and asymmetrical deterrence and started to unilaterally rewrite the rules for space security. Three key developments occurred in June 2002. First, President Bush gave a speech outlining a new US national security strategy that included the intention to initiate force, including nuclear weapons if necessary, to prevent so-called "rogue states" from acquiring weapons of mass destruction. The United States has elaborated this doctrinal shift in several more formal documents, coupled it with a major expansion of its arms and acquisition plans, and demonstrated the will to start a preventive war, as occurred in Iraq.[38] The US withdrawal from the ABM Treaty took effect shortly after the President's speech, followed by an intensified effort to develop a wide range of missile defense technologies (most of which would also have offensive capabilities) and to deploy a rudimentary system. The removal of treaty restrictions on missile defenses was accompanied by reductions in the legal constraints on US and Russian offensive nuclear weapons, severely weakening two traditional pillars of the nuclear restraint regime.[39] Then, at the end of June 2002, Secretary Rumsfeld announced that SPACECOM would merge with STRATCOM, making a single command authority responsible both for US strategic nuclear forces and for four "emerging missions" that track neatly with the original SPACECOM vision: "global strike; information operations; missile defense; and command, control, communications, intelligence, surveillance, and reconnaissance (C4ISR).[40] In short, the United States is developing an integrated set of nuclear and precision-guided conventional options for long-range offensive strikes backed by comprehensive missile defense, and space is the glue that holds it together.

President Bush depicted his coercive prevention strategy as a fundamentally new approach to threats posed by "shadowy terrorist networks" and "unbalanced dictators with weapons of mass destruction" that cannot be deterred or contained, so the United States must be "ready to strike at a moment's notice in any dark corner of the world." The United States has made no serious effort to engage other countries in a discussion about how this strategic context affects the rules for space security. Instead, it acts as if it can get rid of inconvenient agreements such as the ABM Treaty, preserve those aspects of the Outer Space Treaty that it still favors, and still find international partners to share costs and provide specific technologies for its space programs. This underestimates how negative the international reaction is likely to be.

Understanding the International Reaction

When countries like Russia and China question the impact of US military space programs on "strategic stability," they are not just thinking about traditional arms control issues like

ASATs and missile defense. They are also concerned that space-based sensing and information management allow the United States to conduct large-scale traditional missions like the 2003 attack on Iraq more efficiently, while precision technology permits extremely intrusive small-scale missions to be performed from far way, with no warning, and perhaps no attribution. At a time without another superpower to balance or deter the United States, they fear that expanded military use of space may reduce US concerns about costs and casualties that have traditionally had a self-deterring effect on the use of force. [41]

The challenge for Russian security planners is to maintain deterrence stability while US capabilities are steadily improving and Russian capabilities are declining both quantitatively and qualitatively. The Bush and Putin administrations speak warmly of their new strategic partnership, yet suspicions linger along with massive nuclear arsenals on continual alert. In February 2004, Russia used its largest war game since the early Reagan years to demonstrate that Russia's deterrent remains strong and that Russia could match the United States in areas such as new nuclear weapons development and war-time satellite launch. Russia claims to have developed a hypersonic missile that could maneuver through a future US anti-missile system and to have tested a modernized version of its nuclear-tipped ABM system around Moscow. Several missile launch failures during the Russian war game, however, were embarrassing reminders that the Russian military has serious reliability problems and it is hard to know whether these modernization efforts are more than public relations exercises.[42] Moreover, pervasive gaps in Russia's early-warning satellite systems prevent Russian military leaders from having confidence that they would know if they were to come under attack at any time from any direction. The more that space-based systems reduce US concerns about the costs of using force, the more likely Russia is to seek asymmetrical, and potentially very destabilizing, ways to shore up its own deterrent.

China has a more immediate problem because it has a much smaller nuclear deterrent and a core security issue — Taiwan — that could cause a near-term conflict with the United States. China has historically been the most restrained of the nuclear powers, with an unwavering "No First Use" policy, an unequivocal pledge not to use nuclear weapons against non-nuclear countries, and a very small arsenal. Since China has only about 20 single-warhead ballistic missiles that could reach the United States, it is concerned about even a rudimentary US missile defense system, especially in the context of the coercive prevention strategy. It is equally concerned by US plans to use space for advanced reconnaissance and precision targeting while controlling other countries' use of space for military purposes. China is clearly considering alternative responses, including expanding its offensive capabilities to overwhelm US defenses and finding asymmetrical ways to "negate" US space assets. But it, like Russia, would prefer to focus on economic development, not military competition with the US.[43]

Chinese representatives to the Conference on Disarmament (CD) have repeatedly declared that US plans for expanded military space activities run "counter to the fundamental principle of peaceful use of outer space" and have speculated that the US goal in outer space is to "defy the obligations of international legal instruments and seek unilateral and absolute military and strategic superiority."[44] Such statements are clear evidence of international opposition to practices that go beyond the kinds of space-based military support activities that have been tolerated to date under the ambiguous language of the OST.[45]

Efforts to de-legitimize certain space activities as inconsistent with the Outer Space Treaty's peaceful-use provisions could be interpreted as a subtle way of suggesting that any legal protection the Treaty currently provides would be jeopardized if the United States continues to expand its military space activities without international agreement on the limits of peaceful use. These observations might be intended to induce caution by reminding a wide range of interest groups, especially the commercial space industry, that their vulnerable assets could be easily disrupted, damaged, or destroyed if the United States refuses to work out more refined international agreement about which military uses of space are peaceful and which are not. The diplomatic statements also establish a record that could be used to legitimate attacks on military-support satellites if any space-faring country ever felt threatened enough to employ a high-leverage asymmetrical response to US military advantages.

Shortly after the demise of the ABM Treaty, China and Russia submitted a working paper outlining the basic elements of a new "Prevention of an Arms Race in Outer Space" (PAROS) agreement. It would complement the Outer Space Treaty by banning weapons in space (in orbit, on celestial bodies, or stationed in space in any other way) and threats or use of force against space objects.[46] This joint document appears designed to maximize international support for PAROS negotiations because it leaves out more controversial features of earlier Chinese proposals, including bans on most, if not all ABM systems and on space-based sensors that operate as part of a weapons system. However, Chinese diplomats still say that issues raised in their earlier PAROS working papers about missile defense, intrusive surveillance, and precision targeting remain part of the official Chinese position and must be addressed at some point.

The United States has rejected PAROS negotiations on the grounds that there is no need for new measures to prevent an arms race in space because there is no arms race in space. This retort had some validity during the Clinton administration, when the United States was canceling or scaling back space weapons research, had explicitly ruled out space-based interceptors for a limited national missile defense, and was willing to join a space security discussion group in the CD in order to get a negotiating mandate for a Fissile Materials Cut-off Treaty (FMCT).[47] Under current circumstances, however, the rejoinder is true only in the narrow sense that there is not, and probably will not be, a Cold

War-style "space arms race," i.e., an action-reaction dynamic between peer competitors. But it ignores the broader problem that other countries feel deeply threatened by US plans for military space dominance in the context of its overall attitude toward security policy and they could react asymmetrically against US space assets if less drastic measures fail to satisfy their concerns. They are not satisfied by US reassurances that its military space activities will be restrained by UN Charter provisions governing the use of force, by military rules of engagement, and by requirements for high-level approval of particularly consequential military space operations — especially because the United States interprets "anticipatory self-defense" much more broadly than most other countries and seems to view space-enabled precision weapons as more "humane" and usable.[48] Calling for PAROS negotiations is a way to start talking about this larger problem by focusing on the part that has the longest history of broad-based international opposition. International support for addressing PAROS is nearly unanimous; recent UN General Assembly resolutions have passed with the approval of about 170 countries and abstentions by only the United States, Israel, and sometimes one or two smaller countries.[49]

The United States deflected responsibility for blocking international discussions of space security for several years because of a procedural deadlock in which China refused to support negotiations on a Fissile Material Cutoff Treaty unless the United States agreed to PAROS negotiations. In August 2003, China made a major concession by accepting a PAROS committee with a discussion mandate rather than a negotiation mandate. The United States responded by deciding to review its FMCT position, which suddenly seemed like less of a priority. In July 2004, the United States announced that it was no longer interested in an FMCT with verification provisions, claiming that verification would be expensive and intrusive without guaranteeing compliance.[50] Since few other FMCT supporters agree that verification must be perfect to be worthwhile, the US shift effectively perpetuates the CD standstill.

In short, US plans for expanded military activities in space, especially when combined with the strategic doctrine of coercive prevention, are perceived internationally as presenting a serious problem, but the United States will not acknowledge any legitimate reason for concern. It has unilaterally withdrawn from the ABM treaty and is refusing to discuss, let alone negotiate, new rules for military space activities in the CD, in the UN Committee on the Peaceful Uses of Space (COPUOS), or in any other multilateral forum.[51] US efforts to unilaterally rewrite the rules for space in support of a national security strategy of coercive prevention could provoke a major international policy confrontation in which the United States would be isolated unless it restores a diplomatic dimension to its space security policy and considers more collaborative steps to protect its own space assets without threatening other countries.

Why the International Reaction Matters

SPACECOM supporters often question why the United States should enter into uncomfortable diplomatic discussions, let alone negotiate any new rules for military space activities, when it has an across-the-board advantage in this arena. The United States has used the muted reaction to the ABM Treaty's demise to claim that even traditional arms control supporters no longer see US space dominance as destabilizing and to question the motives of countries that want the issue on the international agenda. When Bush administration officials dismiss concerns about international reactions to US space policies, they typically either say that foreign countries make defense decisions for domestic or regional reasons without reference to the United States, or they say that US military superiority will be sufficient to dissuade most countries and to deter or defeat anyone foolish enough to challenge the world's sole superpower.

One problem with this response is that US efforts are unlikely to produce such a decisive level of unilateral space dominance that the US would no longer need to worry about asymmetrical attacks. Achieving the SPACECOM vision would be prohibitively expensive; launch costs alone are still $10,000 or more per pound despite decades of effort to reduce them.[52] Air Force Space Command compared its projected resource growth with the estimated cost of acquiring all the capabilities for which is it responsible in the timeframe desired by the warfighter. It concluded that the requirements were "unexecutable" because the cost would be almost double the available resources in the next decade.[53] Key systems are likely to be even more expensive than these estimates, as evidenced by the cost overruns and delays that have already occurred in the development of the Space-based Infrared System, the Future Imaging Architecture, and the Evolved Expendable Launch Vehicle.[54] Moreover, given the difficulties in the commercial space industry and decisions by the two largest US firms — Lockheed Martin and Boeing — to concentrate primarily on government business rather than foreign commercial sales, it is unrealistic to expect private industry to invest its own capital in research and development, or to achieve economies of scale needed to reduce the per-unit cost of satellites and launch services. Finally, with US budget pressures caused by the war in Iraq and increasing concern about projected federal budget deficits, future spending on military space activities is more likely to be scaled back than to be ratcheted farther upward.

Even if the United States were willing and able to spend whatever it takes to achieve space dominance, the laws of physics limit what is realistic to do in space. Several assessments of space weapon proposals have determined that few are worth pursuing due to technical difficulties, high costs, susceptibility to counter-measures, and availability of cheaper, more effective ways to perform the same military mission.[55] One narrow task for which space weapons might seem uniquely qualified in theory would be boost-phase defense against certain types of ICBMs launched from the interior of large countries like China and Russia. Once one examines the practical details, however, the application that purportedly provides one of the strongest cases for space weapons actually illustrates a very different point: United States withdrawal from the ABM treaty removed a legal constraint without altering immutable laws that make offense generally easier and less expensive than defense in space.

A study by the American Physical Society determined that space-based interceptors (SBIs) "would have the same time constraints and engagement uncertainties as terrestrial-based interceptors," and thus their kill vehicles would need as much mass as those for other basing modes. A thousand or more space-based interceptors would be needed for a system with the lowest possible mass and a realistic decision time, which would require a five- to ten-fold increase over current US space-launch rates.[56] Even if the United States decided to pay all the costs associated with building, operating, and launching such a system, it would take a number of years to deploy. If any space-faring country ever decided that this system might actually affect their deterrent, it would be "trivial to destroy the SBIs one by one as the constellation is being built" or to deploy space mines near the space-based interceptors.[57] A space-based missile defense system would be subject to single-point failure because once one or more SBIs had been destroyed, the attacker could launch missiles through the hole in the defense constellation. If the defender tried to protect itself with another SBI, it would create a new or enlarged hole in the system.[58] Some analysts have suggested that preventive attacks against SBIs are unlikely because "existing international law would require the state responsible … to repay the United States the cost of the SBI and its launch."[59] But if the United States continues to repudiate central components of space law and to stretch the definition of "peaceful uses" far beyond its traditional meaning, then it would be unrealistic to expect legal protection.

In short, despite the many changes recommended by the Rumsfeld Commission and the strenuous development efforts being undertaken by SPACECOM proponents, the United States is no more likely to gain decisive space dominance in the coming decades than it was in the past. The gap between US space capabilities and those of other countries is growing, but so is the ability of other countries to use asymmetrical strategies against US space systems if necessary. It appears that all space services can be denied or disrupted at a fraction of the cost and technical expertise required to perform them. The United States risks having the worst of both worlds if it provokes or inspires other countries to develop new military space capabilities that the United States would find threatening and it erodes the legal and diplomatic tools for managing space security without being able to provide reliable military protection for its own satellites, let alone those that the rest of the world uses to operate an increasingly complex world economy and to manage the environmental consequences of globalization.

III. A More Constructive Approach to Space Security

Rather than assuming that conflict in space is inevitable and then taking unilateral actions that turn that dire assumption into a self-fulfilling prophecy, the United States could lead international efforts to update the rules for space so that they fit the changing circumstances of global security. As the dominant power in space and in world politics, the United States could be confident that an expanded and elaborated set of formal and informal rules would reflect its preferences and could be widely accepted as long as the rules also enhanced the security and prosperity of others. Of course, the United States could only return to its traditional position as champion of an approach to space security based on peaceful cooperation, freedom of access, equitable benefits, and transparency if its political leaders accepted something that a majority of the public already knows: competing for national advantage by deploying anti-satellites weapons, space-based missile defense interceptors, and other expanded military uses of space is no more likely to bring lasting security now than during the Cold War.[60] Key trends associated with globalization and the information revolution strengthen, rather than undermine, the logic of restraint that shaped US space security preferences in the 1950s and 1960s. They also pose new challenges that are best addressed through a comprehensive effort to formalize, operationalize, and institutionalize new rules for space within the broader strategic context of global security.

Globalization Strengthens the Logic of Mutual Restraint

For proponents of the SPACECOM vision, technological change and diffusion strengthen the case for space weapons by increasing American dependence on military and commercial satellites and by expanding potential threats to them. Their selective analysis ignores other countervailing effects of technological change and diffusion that strengthen traditional arguments for space weapons restraint:

- Technological advances are also occurring in non-space-based weapons systems, so it remains true that space weapons offer the United States few, if any, advantages for most military missions. For example, a combination of cruise missiles and intercontinental ballistic missiles retrofitted with conventional warheads could provide access, reach, accuracy, and short response time comparable to space-based "global engagement" weapons at a fraction of the cost and no more international opprobrium than should be expected with a "bolt from the blue" space weapons attack. [61]

- Technological diffusion means that if the United States deploys space weapons, a number of other countries have the ability to emulate or offset them, so the advantage to the United States would be short-lived. Now and for the foreseeable future, no country or combination of countries could match the United States in terms of total military space spending or technological sophistication of military space systems. This means that the United States can afford to exercise restraint knowing that other countries have even less incentive or ability to suddenly surge ahead of the US than the Soviets did during the Cold War. If, however, the United States continues to forge ahead toward highly threatening space weapons, plenty of countries have enough knowledge, resources, and capabilities to expand their military space operations in ways that would increase the net uncertainty, expense, and insecurity of US space activities. In a global economy, secrecy and export controls cannot protect the American technological advantage in space; instead, they sabotage the US satellite industry and motivate other countries to develop indigenous capabilities and cooperative arrangements that exclude the United States.[62]

- <u>The United States depends on space more than any other country does, so it has the most to lose if attacks on space assets are legitimized.</u> For much of the Cold War, the United States' highest priority for military space was to legitimate and protect its information-gathering satellites in order to compensate for the secretive nature of the Soviet Union. Today, the United States' military and economic superiority is due in large part to its sophisticated use of space-based information and communication systems, so it should be trying to strengthen legal protections and norms against attacking space assets, not undermining restraints and exaggerating the ease with which a hostile state or terrorist group could cause a "space Pearl Harbor" as a high-leverage asymmetrical attack.

- <u>Even though the line between "benign" military-support satellites and "threatening" military space capabilities is less clear now than it was in the 1950s and 1960s, it is still valuable to differentiate between uses of space that enhance mutual security and those that are destabilizing.</u> In scenarios where adversaries were both armed with anti-satellite weapons, there would be strong incentives to strike first. But space-based weapons can be destabilizing

> even if only one country possesses them. For example, one of the main arguments for space-based weapons is to shorten the response time between target identification and attack. A pre-emptive security strategy that places a premium on speed, however, quickly runs up against the limits of intelligence and human judgment. In Iraq and Afghanistan, the United States launched a number of fast, precise, lethal attacks against purported leadership targets, only to learn later that some attack decisions were spectacularly wrong. The United States pays a high price in lost legitimacy for such mistakes, especially when it goes to war with few allies and little foreign support. The "collateral damage" in these cases was relatively minor compared with the general carnage of war, but a single mistake could cause mass casualties if, for example, a precision attack on a biological weapons storage facility pinpointed the explosion a few meters away from where weapons were actually stored — close enough for the shock wave to rupture the containers and disperse the agents, but not close enough for the heat (and radiation, if nuclear warheads were used) to sterilize the pathogens.[63]

Changes associated with globalization also mean that stable mutual restraint is unlikely to occur through tacit bargaining and informal policy coordination alone. During the Cold War, the United States used a combination of legal obligations and reciprocal restraint to gain political and military benefits from cooperation while keeping certain options open vis-à-vis the Soviet Union and avoiding bruising bureaucratic battles at home. As we have seen, this worked reasonably well when the strategic context seemed to reflect a shared commitment to deterrence and détente, but was highly unstable when the strategic context was oriented more toward war-fighting. Misperceptions and action-reaction cycles drove the superpowers in an increasingly competitive direction even when the US preference was for cooperation because key formal rules were ambiguous and norms were imputed but never directly discussed. Moreover, there was no reliable way to differentiate between dedicated efforts to achieve ASAT capabilities and hedging strategies or bargaining chips, and there were no institutional channels for consultation, clarification, and dispute resolution regarding superpower space security.

The prospects for miscommunication, misperception, and inadvertent conflict are multiplied in a world with many space powers unless the rules for cooperation are more clearly defined, states and non-state actors (e.g. commercial entities that may be only loosely associated with states) provide information to document their compliance with the rules, and international arrangements exist both to assist less developed countries with their compliance obligations and to address concerns about willful non-compliance. Of course, multilateral negotiations can be more challenging than bilateral ones, but skillful, motivated diplomats can take advantage of complexity to forge creative bargains and focus intense pressure on recalcitrant states. It is unrealistic to expect that multinational space cooperation will spontaneously increase and be sustained over time with no formal discussion, let alone negotiation, of new rules and reciprocal obligations to enhance mutual space security. It is equally unrealistic to hope that codes of conduct, rules of the road, parallel unilateral declarations, and other less formal arrangements can provide the same scope and stability of cooperation as full-scale legal agreements, without the corresponding difficulties of negotiation and ratification.[64]

The Inadequacy of Incrementalism

Any consideration of new rules for space security immediately encounters a basic problem: the current leadership of the United States is intensely skeptical about international constraints on US freedom of action, yet it is hard to imagine international initiatives that could significantly strengthen space security despite the opposition of the United States.[65] Some analysts, therefore, try to position themselves as offering a “realistic” middle ground between space warriors and space sanctuary “purists.” They argue that the United States should unilaterally shape how and when space is weaponized by using more passive and defensive measures for satellite protection while neither being the first to deploy dedicated ASATs, space-to-Earth weapons, or space-based missile defense, nor ruling out these options except, perhaps, through carefully tailored constraints such as a ban on missile or ASAT tests that generate debris above 300 miles.[66] Such a treaty would appeal to many, but not all, US military space users who want to minimize the proliferation of debris that could damage their satellites, but it is hard to imagine why countries without the non-destructive anti-satellite capabilities being developed by the United States would accept this as an isolated measure.

Another suggestion is to precede PAROS negotiations by seeking international agreement on verification and transparency measures that would enhance space security "whether or not new treaty prohibitions are implemented." Michael Krepon suggests that "if Russia and China are as concerned about an arms race in space as their public statements suggest, they will accept the application and adaptation of intrusive measures negotiated for other purposes to a space assurance regime" even though this would "require that Moscow accept even more openness regarding military practices established over the past two decades, and that Beijing adopt a sea change in attitude toward transparency."[67] Regardless of whether or not Russia and China are sincerely interested in mutual constraints on space weapons, they are unlikely to accept specific demands for intrusive verification, let alone undertake a "sea change" in attitudes toward transparency, before the United States even agrees to a negotiating mandate for a PAROS committee. It would be most unfortunate if we repeated the Cold War pattern of interpreting the rejection of a "first step measure" that asked the other side to make all the major concessions as evidence that they were more interested in competition than cooperation.

A third incremental strategy is to focus on relatively non-controversial functional areas where everyone's interests could be served by closer cooperation, and to hope that progress in these areas will spill over into cooperation on more difficult problems over time. For example, Theresa Hitchens has proposed concentrating for now on three major baskets of issues: Space Environment (debris, spectrum interference, and crowding of satellites in Geostationary Orbit); Transparency and Confidence Building (e.g. space surveillance and data sharing); and Rules of the Road (new norms for responsible space behavior).[68] Other proposals hoped to build on nascent US-Russian cooperation in programs such as the Joint Data Exchange Center (JDEC).[69] While such proposals could be very useful as part of a general effort to address international concerns about space security in a strategic context of restraint, reassurance, and transparency, they are at odds with the United States' quest for space dominance coupled with a more pre-emptive and coercive national security strategy. In this context, JDEC, the Russian-American Observation Satellite program, and other bilateral space initiatives are essentially dead because the security bureaucracies on both sides are not convinced that cooperation would actually be mutually beneficial, equitable, and enduring. It may be possible to isolate some cooperative space endeavors outside the security realm from this larger context, but then they will be just that — isolated ventures with no broader effect on security relationships.

Elements of a Comprehensive Space Security System

If the quest for unilateral space dominance is likely to lead to an expensive and dangerous policy confrontation while proposals for informal, incremental, or isolated forms of international space cooperation are inadequate to address the core problem, then it seems prudent to start considering the basic elements of a more comprehensive approach to a mutual space security even though the political preconditions are not currently in place. The basic objectives would be to better protect legitimate space activities while providing more reliable reassurances about how those activities will operate and how their benefits will be shared. Achieving lasting security at an acceptable cost does not depend on negotiating a super-treaty that provides formal legal specifications for all space activities. Instead, it involves piecing together a mutually reinforcing set of principles, norms, laws, and informal operating practices that match the strategic circumstances and that are widely perceived as legitimate by all space powers.

Rebuilding the political foundations for a more constructive space policy requires reevaluating the strategic circumstances associated with globalization. Space policy is but one of many security problems that illustrate the fallacies of assuming that the ascendance of the United States as the sole information-age superpower offers perpetual military dominance that can be used to achieve a wide range of American objectives regardless of other countries' interests or concerns. Just as we saw that trends associated with globalization strengthen rather than undermine the logic of mutual restraint in space, the development and diffusion of other technologies that are integral to the global economy and that create new vulnerabilities provide powerful incentives for all countries, regardless of their historical animosities, to engage in forms of security collaboration that would have been unthinkable during the Cold War.[70] A shared interest in preventing global terrorism, particularly acts of mass destruction, is motivating new forms of information sharing and policy coordination not only among the United States and its traditional allies, but also with Russia and other countries that are simultaneously cited as justifications for US military transformation. The United States also needs international support to use its military superiority in ways that are considered legitimate enough to avoid stimulating a counter-reaction. That support will be increasingly difficult to achieve unless other countries get more reliable reassurances that this concentration of power will provide protection for everyone — not just the favored few — and that it will not be used against anyone who displeases the United States but is not considered by the rest of the world to be a threat to international peace and security. It remains to be seen how long it will take for the United States to remember that if it wants more reliable cooperation, it must return to its traditional leadership role in building rules and institutions that shape everyone's behavior for the benefit of all. Even before this general reorientation of US security policy occurs, the dangerous futility of trying to protect US space assets through competitive national programs should be clear enough to create the political conditions for a serious discussion of collaborative steps to enhance space security.

The Outer Space Treaty should remain as the foundational legal document because its fundamental principles — freedom of access, non-appropriation, equitable benefits, transparency, and peaceful use — make even more sense now that numerous countries can affect each other's use of space positively or negatively, deliberately or inadvertently, and when even countries without their own programs see space-based information and communication systems as increasingly important for security and economic growth. It would be counter-productive to try replacing the Outer Space Treaty and the various other international space agreements with a single Comprehensive Space Treaty, or to attempt renegotiating specific provisions of the Outer Space Treaty (which would be extraordinarily difficult and would require re-ratification by all member states). Instead, the focus should be on international discussions leading to agreement on one or more supplemental accords, with the understanding that more effective and equitable rules, higher rates of participation, more widespread compliance, and more vigorous international responses to non-compliance are likely to require formal negotiations, legally binding agreements, and implementing organizations that have both resources and political clout. Since the Conference on Disarmament remains the international community's sole standing body for negotiating multilateral arms control agreements, the United States should cease using procedural maneuvers to preclude even a preliminary discussion about cooperative measures to enhance space security — especially if it wants to continue keeping military matters off the COPUOS agenda.

One new rule that follows logically from the OST principles and that could, with US support, gain widespread assent, would be a categorical prohibition on the destruction of peaceful space assets or direct interference with their legitimate purposes. This would begin with a ban on testing and deployment of weapons based in space or targeted at space assets. It should prohibit further development of space-based anti-missile systems because their very limited defensive benefits are dwarfed by the new level of vulnerability they would create for satellites in geostationary orbit.

Although destructive anti-satellite attacks are more obviously objectionable than reversible ones, legitimating any type of attack on peaceful space assets would undermine rather than reinforce the central norm. If the United States tried to exempt non-lethal anti-satellite weapons while banning destructive ones, it would decrease the probability of international agreement on easier means of attacking satellites, such as nuclear explosions, debris-generating kinetic energy ASATs, and destruction of ground stations, in order to preserve an option that the United States could not exercise without risking major economic disruption, diplomatic outrage, and military consequences when other countries developed and used non-lethal weapons against the United States and its allies.

A wide range of military-support, commercial, and civilian space activities could damage or destroy space assets even if that was not their primary purpose or their intent. It would, therefore, be necessary to devise behavioral rules to facilitate the continued growth of international space operations while minimizing inadvertent problems, unwarranted suspicions, and deliberate misuse. There are numerous proposals to be evaluated here, including measures to prevent orbital overcrowding and debris generation, to increase missile launch transparency, and to avoid maneuvers that might be mistaken as aggressive or used to hide hostile intent until it was too late for defensive maneuvers. The likelihood of agreement on any of these measures would be significantly greater in the context of US support for a space security system based on mutual cooperation and restraint rather than national dominance. The prospects for successful implementation and high levels of confidence in compliance over time would also be vastly improved if the United States returned to its traditional role as champion of transparency in space activities and helped to create a climate in which states could exchange sensitive information about their space programs without fear that it would be misused.

Some analysts have suggested that the latent capability to use a wide range of space technologies as anti-satellite weapons provides a useful hedge against the possibility that another country might take advantage of American restraint. It is debatable whether advertising and planning to use residual capabilities in an ASAT mode represents a prudent insurance policy or a blueprint for instability. Given that such latent capabilities are an endemic feature of the space age whose use could set revolutionary precedents, though, it would be foolish to ignore their implications until a crisis occurs or to delegate the decision to a small group of national security officials who do not represent the range of interests at stake. The challenge is to develop a clear set of behavioral rules about the circumstances in which it would or would not be legitimate to use latent capabilities against space assets which have lost their protected status. Should the basic principle be "no first use" then "anything goes;" some type of just war criteria to be applied by national decision makers; or some international process to authorize interference with or destruction of hostile space assets in the interests of international peace and security?

Any international rules about the destruction of peaceful space assets or direct interference with their legitimate purposes will require greater clarity and more widespread agreement about which military space activities are truly peaceful and what constitutes legitimate use. Article III of the Outer Space Treaty provides a useful starting point, but few countries accept the United States' claim that anticipatory acts of coercive prevention such as the Iraq War are consistent with the definition of self-defense in the UN Charter or international law more generally. If the United States wants to retain international legal protections for its military-support satellites during a conflict, then the US role in that conflict would need to fit under the common definition of self-defense or be explicitly authorized by the UN Security Council.

The more difficult question involves the need for rules about destabilizing military-support activities during peacetime. In the Cold War bilateral context, "destabilizing" activities increased real or perceived incentives for the other side to acquire more arms, to strike first in a crisis, or to launch a preemptive attack to escape from mutual deterrence. Michael Krepon and others have tried to identify dangerous space activities that could destabilize space security, but there should also be an attempt to assess how continual advances in US capabilities to collect and control information from space affect the stability of global security writ large. If the United States continues to pursue increasingly capable reconnaissance systems such as space-based radar, relies more on space for coercive diplomacy short of war, and retains coercive prevention as its national security strategy, other countries may feel intolerably threatened and seek similar or asymmetrical responses unless the United States accepts some limits on its non-weapons uses of military space.

International support for a strengthened set of space security rules will also need more specification about the allocation of benefits from space activities. One pressing question at the moment involves the provision of orbital data necessary for a growing number of countries to operate safely in space. The world has relied almost exclusively on the United States for this data and analytical support, but the Air Force is now restricting some information. This move away from transparency would provide little cover for US satellites that can already be tracked through other means, yet would create problems for other countries and make them less likely to provide space-related data to the United States. Another ongoing initiative involves the global exchange of satellite remote sensing and other earth observation data through the February 2005 agreement to establish a Global Earth

Observation System of Systems (GEOSS). The Bush administration has favored a largely voluntary arrangement to facilitate the exchange of data that states are already collecting, but this minimal form of cooperation could be expanded and institutionalized so that all member states and international organizations could have reliable, low-cost access to satellite sensing information needed for sustainable agriculture, environmental protection, humanitarian relief, and many other activities that contribute to global security.[71] Issues of equity also arise in deliberations over the International Telecommunication Union's allocation of increasingly scarce orbital slots and in concerns about how the deregulation and privatization of telecommunications services will affect access in less lucrative markets.[72] If the technology for space mining and other resource extraction ever becomes practical, then there will need to be equitable rules for managing these activities too.

Reaching domestic and international agreement on rules that balance the various interests at stake in space security will be challenging, and working out the practical details of implementation will be equally demanding. That is all the more reason to start taking these questions seriously now, so that progress toward constructive arrangements for managing space activities has a hope of moving at least as rapidly as space technology develops and spreads around the world.

Notes

[1] This paper was prepared as part of CISSM's Advanced Methods of Cooperative Security Program at the Maryland School of Public Policy with generous support from the John D. and Catherine T. MacArthur Foundation.
[2] Walter A. McDougall, The Heavens and the Earth, 2nd ed. (Baltimore: Johns Hopkins University Press, 1997) pp. 108-134.

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[3] Quoted in John Lewis Gaddis, "Evolution of a Reconnaissance Satellite Regime," in Alexander George, et al. eds., U.S.-Soviet Security Cooperation (New York and Oxford: Oxford University Press, 1988), p. 355.
[4] See Ram Jakhu, "Legal Issues Relating to Global Public Interest in Outer Space," Center for International and Security Studies at Maryland working paper, forthcoming, esp. pp. 6-17.
[5] Treaty on Outer Space, Hearings before the Committee on Foreign Relations, United States Senate, Ninetieth Congress, First Session, March 7, 13, and April 12, 1967, US Government Printing Office, Washington, D.C., pp. 105-6.
[6] See Raymond Garthoff, "Banning the Bomb in Outer Space," International Security 5:3 (Winter 1980/81), pp. 25-40.
[77] See Steven Weber, Cooperation and Discord in U.S.-Soviet Arms Control (Princeton: Princeton University Press, 1991), pp. 204-272.
[8] US and Soviet high altitude nuclear tests before the LTBT generated artificial radiation belts that damaged or destroyed satellites and persisted for an extended period of time, in addition to causing a variety of problems with electronic devices on earth. For example, the 1962 "Starfish Prime" test burned out streetlights in Hawaii, destroyed seven satellites in seven months, and left an artificial radiation belt that lasted until the early 1970s. See Barry D. Watts, The Military Uses of Space: A Diagnostic Assessment (Washington, D.C.: Center for Strategic and Budgetary Analysis, February 2001), p. 19.
[9] The 1971 Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War committed the superpowers to consult immediately in the event of interference with communication or early warning satellites, while the 1971 Hot Line Modernization Agreement specified the use of Soviet Molniya and American Intelsat satellites for crisis communication and committed both sides to ensure their continuous and reliable operation.

[10] Raymond Garthoff views this omission as a serious missed opportunity because the Soviets felt threatened by the existing American ASAT system that was more capable than their own, while the Americans were planning to unilaterally dismantle that system and preferred not to develop a more capable system unless the Soviets did so. In Détente and Confrontation (Washington, D.C.: Brookings, 1985), pp. 189-90.
[11] Weber, Cooperation and Discord, p. 238.
[12] Philip J. Klass, "Anti-satellite Laser Use Suspected," Aviation Week & Space Technology (December 8, 1975), p. 12 and "DOD Continues Satellite Blinding Investigation," Aviation Week & Space Technology (January 5, 1976), p. 18. See also Steven Weber and Sidney Drell, "Attempts to Regulate Military Activities in Space," in Alexander George, et al., eds., U.S.-Soviet Security Cooperation (New York and Oxford: Oxford University Press, 1988), p. 397.
[13] Paul Stares, Space and National Security (Washington, D.C.: The Brookings Institution, 1987), p. 88.
[14] Weber, Cooperation and Discord, p. 263.
[15] Donald Hafner, "Averting a Brobdingnagian Skeet Shoot," International Security 5:3 (Winter 1980/81), pp. 56 and 60.
[16] Quoted in Paul Stares, The Militarization of Space: U.S. Policy, 1945-1984 (Ithaca, NY: Cornell University Press, 1985), pp. 198-9.
[17] Department of Defense, Soviet Military Power 2nd ed. (Washington, D.C.: US Government Printing Office, 1983) pp. 67-8.
[18] See Tamar Mehuron, "2004 Space Almanac," Air Force Magazine (August 2004), p. 32, available at: www.afa.org/magazine/aug2004/0804space_alm.pdf. The constant dollar figures show a jump in DOD space budget from about $3.8 billion in FY1980 to about $18 billion in FY 1988. The 1988 edition of Soviet Military Power (p. 44) assess Soviet spending on military space programs to be about $80 billion over the past decade, but that would be in 1988 dollars and probably not comparable. The comparative space launch charts look dramatic because the gap between Soviet and US

launches increases steadily after the mid-1960s, but it is not a good measure of relative military space capability Because the short lifetimes of many Soviet satellites required frequent replacement launches to retain a capability in being.

[19] John Pike and Eric Stambler, "Anti-Satellite Weapons and Arms Control, in Richard Dean Burns, Encyclopedia of Arms Control, vol. II (New York: Charles Scribner's Sons, 1993), p. 994; Stares, Space and National Security, pp 103 and 108.

[20] In 1983, Congress withheld some funds for ASAT testing until the administration certified that the tests were necessary and that it was negotiating in good faith the Soviet Union. The next year, it made significant cuts in MHV funding. The reciprocal moratorium offer was made by General Secretary Andropov to a group of visiting US Senators on August 19, 1985, the day before the Soviet Union presented their new draft treaty to the UNGA. On August 21, the Administration informed Congress that it would soon conduct its first test of the MHV against an object in space, but technical problems meant that the only way it could conduct the test before the upcoming Geneva Summit was to change the objective from hitting a balloon with special instruments to assess numerous parameters of system function to hitting a defunct US satellite that could show nothing more than whether or not a hit had occurred. See Weber and Drell, "Attempts to Regulate Military Activities in Space," pp. 416-17.

[21] The 1988 National Space Policy was the first to explicitly identify the Department of Defense's four basic missions in space as space support, force enhancement, space control, and force application. See Steven Lambakis, On the Edge of the Earth (Lexington, KY: University Press of Kentucky, 2001), pp. 229-30.

[22] There were attempts to strengthen the Missile Technology Control Regime and to negotiate bilateral early warning and pre-launch notification agreements with Russia but no effort to bring these initiatives into the broader context of CD discussions on PAROS.

[23] The White House, National Science and Technology Council, "Fact Sheet: National Space Policy," (September 19,

1996), p. 5, available at:
http://www.ostp.gov/NSTC/html/fs/fs-5.html.
[24] USSPACECOM, Vision for 2020 (February 1997) and USSPACECOM, Long Range Plan (April 1998) will be discussed in more detail in the next section.
[25] The White House Office of the Press Secretary, "Press Briefing on the Line-Item Veto," (October 14, 1997), available at: http://clinton6.nara.gov/1997/10/1997-10-14.raines-bell-hamre-press-briefing-on-the-line-item-veto.html. DOD News Briefing with Kenneth Bacon (including MIRACL experiment), Thursday October 23, 1997, available at http://www.dod.mil/cgi-bin/dlprint.cgi?http://www.dod.mil/transcripts/1997/t10231997_t1023asd.html. See also Patricia McFate, "Arms Control in Outer Space," in Jeffrey A. Larsen, ed., Arms Control: Cooperative Security in a Changing Environment (Boulder, CO: Lynne Reinner, 2002), p. 296.
[26] Ashton Carter, "Satellites and Anti-Satellites: the Limits of the Possible," International Security 10:4 (Spring 1986), p. 68.
[27] Pavel Podvig, "Russia and Military Uses of Space," Stanford University Center for International Security and Cooperation, available at: http://russianforces.org/podvig/eng/publications/space/20040700aaas.shtml.
[28] Laurence Nardon, "The World's Space Systems," Disarmament Forum 1 (2003), pp. 33-40. These countries and a handful of others can manufacture and launch their own satellites; they and many other countries also have missile with sufficient range to hit satellites in low-earth orbit. For comparison purposes, in 2001, the military and civilian space budget of the United States was approximately $27 billion, while the European budget was $6 billion primarily for commercial applications, the Japanese space budget was $2.5 billion, Russian and Chinese space budgets were around $1 billion, and all others were $500 million or less. The disparity in government spending on space-based military activity is even starker, with the United States spending nearly thirty times the European total. See Xavier Pasco, "Ready for Take-

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off? European Defence and Space Technology," in Carl Bildt, et al., Europe in Space (London: Centre for European Reform, October 2004), p. 19. Available at: http://www.cer.org/uk/pdf/p527_space_pol_eu.pdf.

[29] Satellite Industry Organization, "The State of the Satellite Industry Report," June 2, 2004, available at: http://www.sia.org/industry_overview/03industrystates.pdf.

[30] For example, the per-troop use of communications bandwidth was fifty times greater in the 2001-2 military operation in Afghanistan than it was in the Gulf War a decade earlier. See Michael O'Hanlon, Neither Star Wars Nor Sanctuary: Constraining the Military Use of Space (Washington, D.C.: Brookings, 2004), p. 4.

[31] "Report of the Commission to Assess United States National Security Space Management and Organization," Executive Summary, (January 11, 2001), pp. 8-10 (Hereafter cited as Rumsfeld Commission Report). Available at: http://www.defenselink.mil/pubs/spaceintro.pdf.

[32] Rumsfeld Commission Report, pp. 17-18.

[33] Theresa Hitchens, "National Space Policy: Evolution by Stealth?" Arms Control Today 34:9 (November 2004), pp. 19-20. The Air Force Space Command's "Strategic Master Plan FY06 and Beyond," (October 1, 2003) states that the development and deployment of counterspace weapons is already required by US policy, but that approval by the President or Secretary of Defense will be needed before these weapons are used. The document is less forward-leaning on space-based weapons to attack terrestrial targets, saying that the SPACECOM vision calls for them, but that national leadership still must decide whether or not to pursue them (p. 35). Available at http://www.cdi.org/news/space-security/afspc-strategic-master-plan-06-beyond-pdf.

[34] US Space Command, "Long Range Plan Implementing USSPACECOM Vision for 2020," (April 1998), available at: http://www.fas.org/spp/military/docops/usspac/lrp/toc.htm.

[35] Mehuron, "2004 Space Almanac," p. 32

[36] Jeffrey Lewis, "Selected Space Programs in the 2005 Appropriations Process," Prepared for the 9th Annual

ISODARCO Meeting, Nanjing, China (October 2004), at: http://www.cissm.umd.edu/AMCS/publications.htm. See also Jeffrey Lewis, "Lift-off for Space Weapons: Implications of the Department of Defense's 2004 Budget Request for Space Weaponization," CISSM working paper, (July 21, 2003), available at: http://www.cissm.umd.edu/documents/spaceweapons.pdf.

[37] "The U.S. Air Force Transformation Flight Plan, (November 2003) at: http://www.af.mil/library/posture/AF_trans_flight_plan-2003.pdf. US Air Force, "Counterspace Operations," Air Force Doctrine Document 2-2.1 (August 2, 2004), at: http://www.dtic.mil.doctrine/jel/service_pubs/afdd2_2_1.pdf. See also Theresa Hitchens, "USAF Counterspace Operation Doctrine: Questions Answered, Questions Raised," (October 4, 2004). Available at: http://www.cdi.org/friendlyversion/printversion.cfm?documentID=2504.

[38] Remarks by the President at 2002 Graduation Exercise of the United States Military Academy, West Point, New York (June 1, 2002). Available at: http://www.whitehouse.gov/news/releases/2002/06/20020601-3.html; "The National Security Strategy of the United States of America" (September 2002). Available at: http://www.whitehouse.gov/nsc/nss.html; and "National Strategy to Combat Weapons of Mass Destruction" (December 2002). Available at: http://www.whitehouse.gov/news/releases/2002/12/WMDStrategy.pdf.

[39] The withdrawal from the ABM Treaty occurred right after the US and Russia signed the Moscow Treaty, an extremely permissive accord where the sole legal obligation — to reduce down to 1,700-2,200 "operationally deployed strategic warheads" doesn't take effect until the day when the treaty expires at the end of 2012. Russia responded to the US withdrawal from the ABM Treaty by declaring that it would not ratify START II. Thus, START I is the only accord that

currently limits US and Russian strategic offensive or defensive arms, and it is set to expire in 2009.

[40] In the remainder of the paper, despite the merger of SPACECOM into STRATCOM, I will continue to use the label "SPACECOM" to refer to supporters of this vision within STRATCOM and elsewhere in the space security community.

[41] An extended discussion is in John Steinbruner and Nancy Gallagher, "Prospects for Security Transformation," CISSM working paper, (July 2004), at: http://www.cissm.umd.edu/documents/securitytransform.pdf.

[42] Nikolai Sokov, "Military Exercises in Russia: Naval Deterrence Failures Compensated by Strategic Rocket Successes," CNS Research Story, February 24, 2004. Available at: http://www.cns.miis.edu/pubs/week/040224.htm.

[43] Jeffrey Lewis, The Minimum Means of Reprisal, Ph.D. Dissertation, University of Maryland, 2004, available at: https://drum.umd.edu/dspace/retrieve/2077/umi-umd-1886.pdf.

[44] For examples, see the statement by Ambassador Li Changhe at the March 12, 1998 CD Plenary Meeting at www.nti.org/db/china/engdocs/lich0398.htm; Fu Zhigang, "A Chinese View of Star Wars," The Spokesman No. 72 (no date, circa 2000), pp. 17-18; and the statement by Ambassador Hu Xiadodi, at the June 7, 2001 CD Plenary Meeting at: http://un.fmprc.gov.cn/eng/12869.html.

[45] Air Force lawyers maintain that "various unopposed military uses of space may as a practical matter enlarge the unofficial definition of 'peaceful purposes' to the point that specific arms control agreements may be the only effective limitation on development and deployment of various weapons in space." This claim that the continuous escalation in the use of space for military purposes by the US is going uncontested, and therefore is permissible under the Outer Space Treaty, reflects the controversial premise that anything not explicitly prohibited by a treaty is permitted, ignores extensive diplomatic opposition to expanded US military space activities, and assumes that a formal protest under OST

Article IX or some forceful reaction would be the only types of international opposition that matter. See Elizabeth Waldrop, "Weaponization of Outer Space: U.S. National Policy," High Frontier (Winter 2005), pp. 36-37

[46] "Possible Elements of a Future International Legal Agreement on the Prevention of the Deployment of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects," CD/1679 (June 23, 2002). Available at: http://ods-dds-ny.un.org/doc/UNDOC/GEN/G02/624/84/PDF/G0262484.pdf?OpenElement.

[47] "Statement by Ambassador Robert T. Grey, Jr., "United States Representative to the Conference on Disarmament," Washington File (September 14, 2000). Available at: http:usinfo.org/usia/usinfo.state.gov/topical/pol/arms/stories/00091501.htm.

[48] For arguments that the United States may be legally or morally bound to use space assets to meet the Law of Armed Conflict's criteria of necessity, distinction, proportionality, humanity, and chivalry, see Waldrop, op cit., pp. 40-41. A more general argument about the morality of many military space activities is Col. John Hyten and Dr. Robert Ury, "Moral and Ethical Decisions Regarding Space Warfare," Air & Space Power Journal (Summer, 2004), at: http://www.airpower.maxwell.af.mil/airchronicles/apj/apj04/summer04/hyten.html.

[49] In 2004, the annual U.N. General Assembly resolution urging steps to consolidate and reinforce the legal regime for outer space, including the establishment of an ad hoc Committee on PAROS in the CD, was supported by 167 countries, with no opposition, and abstentions only by the United States, Israel.

[50] Dafna Linzer, "U.S. Shifts Stance on Nuclear Treaty," Washington Post (July 31, 2004), p. A1.

[51] Many members would like COPUOS to adopt the weaponization of space as an agenda item. After COPUOS held a policy conference on military uses of space in the early Reagan years, however, there has been an unwritten

agreement, largely at the insistence of the United States, that COPUOS will no longer discuss military matters.

[52] See Futron, "Space Transportation Costs: Trends in Price per Pound to Orbit," (September 6, 2002), at: Http://www.futron.com/pdf/futronlaunchcostwp.pdf.

[53] Air Force Space Command, "Strategic Master Plan FY06 and Beyond," (October 1, 2003), p. 13.

[54] Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, "Report of the Defense Science Board/Air Force Scientific Advisory Board Joint Task Force on Acquisition of National Security Space Programs," (May 2003) at: http://www.fas.org/spp/military/dsb.pdf.

[55] Bruce M. DeBlois, Richard L. Garwin, et al., "Space Weapons: Crossing the U.S. Rubicon," International Security 29:2 (Fall 2004), pp. 50-84; Bob Preston, et al., Space Weapons, Earth Wars (Santa Monica, CA: RAND, 2002), and David Wright, Laura Grego, and Lisbeth Gronlund, The Implications of Physics for Space Security, Occasional Paper of the Committee on International Security Studies, American Academy of Arts and Sciences, forthcoming.

[56] "Report of the American Physical Society Study Group on Boost-Phase Intercept Systems for National Missile Defense: Scientific and Technical Issues," (July 2003), p. xxix at: http://www.aps.org/public_affairs/popa/reports/nmd03.cfm

[57] DeBlois, Garwin, et al., op cit, pp. 82-3.

[58] The same problem also means that the United States could not use space-based weapons to deny other countries access to space; at most, it could marginally increase the costs of access and generate tremendous hostility in the process. See Wright, Grego, and Gronlund, The Implications of Physics for Space Security.

[59] DeBlois, Garwin, et al., p. 83.

[60] The American public shares the Bush administration's concerns about proliferation, but strongly favors multilateral cooperation over unilateral military action for addressing security problems. When presented with arguments for and against negotiating a ban on space weapons, 65% of respondents favored a new PAROS accord and only 35%

opposed it. Only 21% of respondents wanted the United States to "build a missile defense system right away, while 68% wanted to do "more research until such a system is proven to be effective" and 8% thought that the United States "should not build a missile defense at all." See Steven Kull, "Americans on WMD Proliferation," (a CISSM/PIPA/Knowledge Networks Poll) April 15, 2004, available at: http://www.pipa.org/OnlineReports/WMD/WMDreport_04_15_04.pdf.

[61] Garwin, DeBlois, et al., pp. 67-77.

[62] James A. Lewis, Executive Director, Preserving America's Strength in Satellite Technology: A Report of the CSIS Satellite Commission (Washington, D.C.: Center for Strategic and International Studies, April 2002).

[63] Robert W. Nelson, "Nuclear Bunker Busters, Mini-Nukes, and the U.S. Nuclear Stockpile," Physics Today (November 2003), available at: www.physicstoday.org/vol-56/iss-11/p32.html.

[64] Terms like "codes of conduct" and "rules of the road" can refer to everything from weak coordinating mechanisms that apply only during peacetime to elaborate proposals modeled on arms control treaties that would be no easier to negotiate or to secure Congressional support for implementation just by virtue of being called something other than a treaty. From an international law standpoint, any agreement that was meant to be legally binding has the same legal status regardless of whether or not it is called a treaty. In terms of the US domestic approval process, the more significant an agreement is, the stronger the reasons are for following the treaty approval process (two-thirds Senate support for ratification) rather than using the Congressional executive agreement process (majority approval by both houses of Congress) or trying to claim that no legislative approval is needed. Either house of Congress can withhold funding or use other legislative strategies to block implementation if they do not like the substance of the accord or the process by which the Executive Branch minimized the need for Congressional approval.

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[65] Some analysts have proposed using an "Ottawa Process," — i.e., working out an agreement among like-minded states to build pressure on other states for constructive negotiation and cooperation. While this strategy had some benefits in the landmines case, the Bush administration is much less susceptible to international pressure than the Clinton administration was and few space security challenges do not involve the United States in some capacity. See Rebecca Johnson, "Multilateral Approaches to Preventing the Weaponisation of Space," Disarmament Diplomacy 56 (April 2001), available at: http://www.acronym.org.uk/dd/dd56/56rej.htm.
[66] O'Hanlon, Neither Star Wars Nor Sanctuary, esp. pp. 138-9.
[67] Michael Krepon with Christopher Clary, Space Assurance or Space Domination (Washington, D.C.: The Henry L. Stimson Center, 2002), pp. 108, 110, and 114.
[68] Theresa Hitchens, Future Security in Space (Washington, D.C.: Center for Defense Information, September 2004).
[69] John Steinbruner, "The Significance of Joint Missile Surveillance," Occasional Paper of the Committee on International Security Studies, American Academy of Arts and Sciences, (July 2001), available at: http://www.cissm.umd.edu/documents/jointmissile.pdf.
[70] For a more general analysis of the changing circumstances of global security, see John Steinbruner and Nancy Gallagher, "Constructive Transformation: An Alternative Vision of Global Security," Dædelus 133:3 (Summer 2004), pp. 83-103.
[71] Joanne Irene Gabrynowicz, "Global Remote Sensing: Issues and Opportunities," CISSM working paper, forthcoming.
[72] Ram Jakhu, "Safeguarding the Concept of Public Service and the Global Public Interest in Telecommunications," Singapore Journal of International and Comparative Law 5:1 (2001), pp. 71 et seq.

Enhancing Space Security in the Post Cold War Era: What Contribution from Europe?

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A recent article published in a newly created review about the future of European defense and security stressed the particular capability of Europe to deal with serious security situations that classical military forces traditionally have difficulties dealing with. The American author from the National Defense University explained that "recently, US policy makers have begun to reach out to our European allies, capitalize on their expertise, and promote their increased participation in post-combat situations."[1] Underscoring, in this case, a five-nation European decision to create a future European Gendarmerie Force, he went on to argue that the Europeans have "extensive experience … in the calculated application of force against non-combatants in post-conflicts situations, … while using excessive force has catastrophic consequences," finally pointing at the "potentially vital European security contribution in crisis hotspots."[2] If one considers the current situation in the security discussions for space, much of this difference of perspective and the possible objective of an improved mutual understanding is likely to frame future international debates. Given the difficult dialogue between the United States and its major strategic partners, namely Russia and more recently China, Europe may be in a position to bring new insights into the debate.

Differences of Perspectives in The Military Uses Of Space

The future of space will be largely determined by the nature and level of military effort that will be attached to it. The United States, as the dominant space power, will have a key role in this determination. History teaches us that the United

States has always relied a lot on space for its own security and that this has led it to be the leader in military space applications.

The Particular Standpoint of the United States

Basically organized during the Cold War nuclear era for enhancing the strategic postures of the superpowers, military space systems have evolved after the Cold War to be used more practically as "force multipliers" in most recent conflicts.

For the first time, space has appeared as a means of increasing the efficiency and effectiveness of military operations. Information coming from space allows commanders in distant headquarters to locate, in real time, the location of their forces and those of their opponents, and to guide weapons precisely to their targets. In the United States, space technologies have been reorganized to augment the "strategic control" military doctrine based on aerial dominance and to help keep the number of casualties on the ground to a minimum.

But what can be called the post-Cold War era of the military uses of space, even if still underway, appears likely to be followed soon by a third era that will make space even more central in US defense and security policy. Considering the ever changing security environment, with enlarged security requirements ranging from classical military needs to counterterrorism and homeland defense types of missions, space assets are likely to gain more flexibility as well as more adaptability, making them more and more central in the security posture of the United States. Responding effectively to these new security challenges will require complete and "intelligent" information technologies (i.e. many types of sensors and data processing). Moreover, the importance of continuous information flows will become more significant either in coalition-led wars, when partners have to share data coming from their own systems, or for security-oriented missions dealing with instant and concealed threats. This global trend requires more and more complex systems of systems, based on higher and higher data-rate transmission capabilities, as well as networked space assets and information processing facilities and equipment.

Whatever the technology-intensive solutions that will be pursued, there is no doubt that this new set of military and security technologies, based on the simultaneous use of satellites, computers, and telecommunications systems, is both far-reaching and innovative. Whether this incorporation of advanced communications and information technologies produces a "revolution in military affairs" can be debated, but its technological advantage is unquestionably changing American military forces. These innovations have begun to affect how the US has organized and trained for warfare, and even how it thinks about it – and the pace of change is accelerating. From being a "force multiplier," space has become a "strategic enabler," meaning that the use of space is now largely considered in the United States as being one of the cornerstones of its comparative strategic edge in the world. This basic evolution was recognized in 1999 when the second Defense Space Policy directive in US military history mentioned space as being a "national vital interest" for the United States. This directive, published in 1999[3] under the Clinton presidency, has paved the way for the US space military thinking that is supported by the current administration. At least, no one should be surprised then that these efforts include both an increased reliance on space assets to fight wars on the ground, as well as new projects to protect these assets from attacks in orbit, leading to possible weapons deployed in space. This only shows how a particular history of mixing policy and technology can lead to what already appears as one of the most contentious international issue for the years to come, the "weaponization of space."

Different Countries, Different Perspectives

To say the least, what is stemming from a very nationalistic and somewhat idiosyncratic security and military standpoint in the United States is not likely to be considered a universal starting point to discuss the security issues in space.

It must first be noted that the US level of reliance on space for its defense and security interests remains unique in the world. As already recalled, this reality is related to the particular history of the political and military position of the United States; it also reflects the need to capitalize on an already developed powerful industrial base and know-how that has helped America reinforce its international status as a political and economic superpower. Possible "peer strategic competitors" such as Russia or China have either lost a large part of their ability to compete in these high-technology fields or have just begun their entry in the "race." Moreover, other military doctrines or different political objectives may not consider space as such a central issue even if it is widely accepted that satellites will have an increasing role in global security.

This is particularly true for Europe. The European space strategy must be seen as an indicator for the larger political construction process that is constrained by a number of collective rules. For years already, it has been recognized that only a collective regional effort would enable Europe to reinforce its presence in space that was mainly symbolized by the creation in 1975 of the European Space Agency (ESA). Built for dealing with scientific and civilian space applications only, ESA was never intended to provide the foundation for a future large-scale European military space effort. For years, it has been very clear that any attempt to build a genuine European military space policy would then have to be supported by a full scale European Security and Defense Policy (ESDP) that would reflect a unanimous consent on the political and military future of Europe among its Member States. Due to enduring national foreign and military policy differences, this has never happened. And it is fair to say that, given enduring national differences in policies and budgets, this perspective is not likely to change significantly.

Still, this does not mean that Europe has not attempted to address larger common security issues. As a matter of fact, inter-governmental discussions, even though held under strict limitations since the 1990s, have lead to some limited agreements on security and defense between the Member States. European governments have agreed to develop their own collective armed forces, so as to meet their NATO and European Union (EU) commitments. At the Helsinki summit in 1999 the EU agreed to work on the creation of a common European Security and Defense Policy (ESDP). The point of the ESDP is to allow the EU to carry out small-scale "crisis management" operations when NATO is not involved. The EU has therefore committed itself to a “headline goal” of creating a so-called “European Rapid Reaction Force” of 60,000 troops, plus supporting naval, aerial, and civilian capabilities. This force has recently been declared operational even if major capability issues remain to be solved.[4] The EU wants to be able to tackle the so-called “Petersberg tasks” (humanitarian relief, rescue missions, peacekeeping and peace-making) without having to rely on the United States for transport aircraft, intelligence gathering, command and control, and other capabilities. At the same summit, EU Member States have decided to develop collective capability goals, particularly in the fields of command and control, intelligence, and strategic transport. In particular, European governments recognize that they will have to adapt their intelligence and information resources to cope with more volatile situations – possibly even those involving the use of weapons of mass destruction. Space-based technology is now widely perceived as a necessary building block of a European autonomous intelligence system directed toward more elusive enemies such as international terrorist networks.

This evolution shows how much Europe is progressively finding its own *aggiornamento* for building its own defense and security identity, with a clear emphasis on the latter. It is noticeable that the two European space “flagship” programs, namely Galileo for navigation and localization applications and services and the Global Monitoring for Environment and Security program (GMES), are deliberately dealing with the security issues rather than with strictly defense issues, and remain for this reason managed at the European level by civilian authorities. If some military space capabilities have been developed in response to nationally strategic motivations (information autonomy especially) by some of the EU Member States, it is now admitted that the ESDP will have to capitalize on these efforts without implying any active European military space policy *per se,* since such a policy would lack national legitimacy and support. After all, European Member States themselves have never developed extensive military space means apart from the ones that were politically significant. This is why, for example, France has developed *Helios* (military Earth observation), *Syracuse* (military telecommunications by satellite), and will develop *Spirale* (initial space capabilities for early warning). All these systems reflect the perceived necessity felt by some Member States, notably France, to have at their disposal the necessary means for relative autonomy in security decision-making. By contrast, it is fair to say that Europe is not in the position to strategically rely on space assets and design a purely military space policy to tackle the new defense challenges that are implied. In brief, Europe cannot – and will not want to – make the strategic choice that has been made in the United States on the same issues.

Based on this general strategy, military space investments in Europe, even for France, are likely to remain driven by their political and budgetary significance rather than supported by any collective strategic-level decision to increase the reliance on space for military purposes. Two formerly parallel evolutions are thus converging.

First, it is recognized by Member States that more investments should be devoted to space programs, as it is perceived that the strategic context has changed and that it is necessary to improve a number of strategic functions such as threat evaluation. This is the meaning of some national experimental programs such as *Essaim* (electronic intelligence) or *Spirale*, mentioned above. It is also understood that space programs developed for strategic purposes must be usable at the operational or tactical level if possible, without reaching the level of investment in "Network Centric Warfare"-like capabilities envisioned in the United States.

Second, it is now recognized that Europe should invest more in space for its security and that both the preferred – because it is the most accessible – and the obligatory – by construction – way forward will be to consider security as a more general concept that will be much more broadly construed than having only a military dimension.

A Possible European Approach to "Space Security"

Such a balanced view is inevitably leading Europe to give increasing attention to space security as a whole. Technically, even if the levels of dependence, as well as the doctrines for the military uses of space, are different on both sides of the Atlantic, it is clear that protecting its investments in space is a legitimate issue for Europe. An increasing number of actors, both governmental and private, will interact in space, bringing about a parallel increase of "space traffic."[5] This will create a new space landscape with new opportunities, but also with new security challenges. As demonstrated by the rising interest in selected applications such as earth observation satellites or by the sometimes worrying efforts worldwide to become equipped with dual space and missile launch technologies, an increasing number of emerging countries will have their own space capabilities in years or decades from now. In parallel, enduring trends towards the privatization of the space actors, as demonstrated by the telecommunication domain as well as in the field of space imagery, may also constitute an important factor of change for an activity that was reserved for governmental users only a few years ago. Last but not least, the development of new space technologies, applications, or services will contribute to complicating the regulation of the space activity as a whole and will intrinsically pose new security challenges for any space faring country, and beyond for any developed or emerging country. For the first time, space is in the process of becoming an issue that will concern the whole international community and will not be restricted to bi- or multi-lateral regulations, as has been the case since the beginning. These new factors will inevitably create new security issues with impacts that will be very different according to the respective national situations.

Addressing these future challenges may well fit the European security model that is progressively shaping up. Most of the issues evoked above cannot be treated through a military approach only and would benefit from a clearly articulated security-oriented international policy. Europe's experience in shaping a collective security policy could then both prove well adapted and useful for the international community. Indeed, while the multilateral strategic debate on future weaponization of space remains locked at the Disarmament Conference, a new approach for improving space security may be required that would first deal with shorter term security challenges on a global basis. Putting space activities in a new collective security perspective seems to be required before making any national decisions for military programs that would only partially address those challenges.

Such a collective effort will require a delicate balance of incentives and regulations that will have to satisfy both national and collective security interests. An ultimate goal could be a commonly accepted principle that would make space activities more transparent, decreasing the chance of illicit, aggressive, or misunderstood behaviors, and consequently decreasing the need for heavily militarized national defenses of space assets.

Install Confidence Building Measures as a Major Milestone

Any realistic international regulation will have to reflect a collective understanding on the extent of its perimeter and on its nature. A number of recent publications[6] have pleaded in favor of the establishment of "codes of conduct" or new "rules of the road," with sometimes the ultimate goal of a new treaty that would update the 1967 Outer Space Treaty and would impose more explicit constraints like a total prohibition of arms deployment in space or guarantees of non-interference with commercial and civilian satellites. A number of these analysts are asking for better regulation of behaviors in space in the many domains that constitute the day-to-day space life, namely the debris mitigation along with the satellite registration procedures, frequency spectrum management, as well as the launch domain or on-orbit operations management.

Each of those domains deserves a great deal of attention on the part of the current space faring nations, first of all to regulate their own activities in space. Also, possible evolution in space activity worldwide naturally leads to invitations to new space nations to comply with some kind of collective rules in these areas. Already, convincing efforts have been undertaken for a number of years in some of these domains. To cite a few, debris mitigation or frequency spectrum sharing have been ruled by common procedures, either organized on an interagency basis[7] or by an *ad hoc* international organization.[8] It remains true that either a number of these advances have been made inside a rather limited club of countries that will be enlarged in the future, or that the present rules remain the subject of constant criticism on the part of nations that may still feel treated as secondary players.

To be realistic, the sensitivity of the technical aspects surrounding these issues makes any attempt to modernize international space life very difficult. Debris mitigation techniques are now largely used in all the modern launchers to prevent accidental explosions in orbit, which have been one of the major sources of debris to date. These techniques, often complicated, have been, and continue to be, the subject of technical discussions between the major space agencies. How about enlarging these discussions, and more than that, how about sharing these technologies with countries that are eager to proceed with their own space launches but that may also have worrisome on-going ballistic missiles programs? At least, such situations may multiply and become the subject of difficult trade-offs or negotiations. Improving collective security in space can bump into national security concerns, either because of the necessary sharing of sensitive technologies or because of the unwillingness of some to give up some technical, industrial, or military advantage that their space technologies are thought to provide.

Whatever their merits, the many proposals for creating new regulations in space will collide with national policies that will tend to see the negative aspects of such constraining regulations. These proposals will certainly not be easily adopted. Any proposal to mandate new rules for space security will have to rely on larger efforts to create a more favorable political environment in the first place. A constant difficulty will reside in the necessity to find a non-legally binding procedure with sufficient political backing so as to define some kind of an international regime such as those already existing for other strategic issues.[9] Increasing space transparency in a credible manner without challenging national security issues, while giving enough incentives to newcomers for getting them engaged in such a process, is the most striking difficulty for any future space security architecture and for space diplomacy today.

A first objective then should be to intensify talks about the global space security issues and increase a mutual awareness and understanding of the issues on a voluntary basis. For such a security architecture to become reality, it must also appear clearly to any player that international cooperation on new "rules of the game," engaging newcomers to comply to more transparent behaviors, may well contribute more to international security in space than any dedicated space weapons applications. Only step-by-step international agreements can create the awareness for each space faring nation that militarily realistic collective security and confidence-building measures will make more contributions to national military and defense interests than national military policies only. Increasing transparency in space on a voluntary basis would have as a first goal to take care of any uncontrolled developments (in the launchers domain, for example), that may be deemed “civilian,” but that may in effect increase the insecurity in space, either voluntarily or involuntarily. Then, non-binding mechanisms should be found so that discussions between states can engage on a sufficiently forceful basis. The final goal should be that a collectively regulated worldwide space activity would first make it impossible for any country announcing peaceful space development to engage in military developments in a covert manner. While such a collective action would not prohibit any military space deployment, one can hope that it could ultimately help create a new space environment that would result in such military developments being perceived as being less useful and less legitimate. As it has been the case for each of the domains concerned by such non-binding arrangements, this kind of collective security strategy would of course require each player to sincerely play the “rules of the game,” implying then to balance the national interest of each party with the security interests of the international community.

If one looks at the sense of what has been done in Europe for some fifty years now, such collective “virtuous circles” have sometimes become reality. After all, it was the main goal of European construction to stop the fiercest war history of the twentieth century and prepare a new era in which former enemies would have the common goal to maintain the peace for the following 100 years and beyond. Working in the same direction on the international space scene would make sense for Europe. Because it is not involved in the current discussions about the weaponization of space, and because it is by design able to think through the new security challenges on a more global and collective basis, Europe may then be well-placed to help decrease the coming tensions in space.

<u>Collective "Space Surveillance" as a Possible First Concrete Step in Europe for Increasing "Space Transparency"</u>

A number of candidate confidence-building measures can be considered for improving international cooperation in space, based on the European Model of "win-win" security situations. Among these, "space surveillance" is seen today in Europe as a necessary domain of investment. Some programs exist already that could be the foundation of future European development in this domain. First, it is now largely recognized that space surveillance is a *sine-qua-non* activity for engaging seriously in any space security discussion, as well as for Europe's assuming fully its status as a space power. For years already, a few European states have developed a limited amount of systems for space surveillance that could quickly allow ESA to emerge as a regional leader by federating these existing capabilities. But also, in a domain of constant worry for the space nations, and at a time when any misinterpretation may well lead to escalating "space war"-like situations, any contribution to the knowledge of the space environment and debris would appear as a positive confidence-building measure. In this respect, it is noticeable that Europe has recently stepped up its efforts on the subject, initially through mainly national and military-driven programs that are progressively envisioned as forming a possible European-wide system for the surveillance of space debris and the space environment.

From National Programs

If ESA has acted as a catalyst and aggregator of national capabilities, the nations involved in ESA's projects have had to realize that the benefits of such projects had to be shared for the common good. The current European security space systems are coming from very different origins. The case of France is particularly interesting as it is and will be one of the main contributors to such a pan-European system. It is now at the forefront of this collective effort. The radar capability that was developed nationally had to do with its nuclear deterrence force, one of France's most protected and classified capabilities. Today, the defense-oriented bi-static radar GRAVES[10] and the ballistic missile test *armor* radar on the tracking ship Monge, respectively managed by the National Aeronautics Studies and Research Office (ONERA) and the defense procurement agency, Délégation Générale à l'Armement (DGA), are considered as spearheading the future European surveillance system. Such equipment is already operated along with other European capabilities such as the German radar FGAN-TIRA, belonging to the Research Establishment for Applied Science, or the British Chibolton radar, owned by the Rutherford Appleton Laboratory. Some complementary optical capabilities can also been derived from national efforts.[11] While still limited in size and performance, these capabilities have allowed ESA to become an active player in the field of space surveillance. It has made possible an important collaboration with the United States, with the constant feeling on the part of European nations that ESA, as a European institution, was gradually assuming a legitimate role in a field that was dealing with the security of space and of the European nations involved in space activity.

Toward a European Development

This European context also explains why GRAVES has just been modernized in 2005, while a new project for a European Space Surveillance System has been presented in a recent conference held in Darmstadt. Based on a study in 2002 commissioned by ESA about a "European Space Surveillance System," this project has based its analysis on past national experiences. Two technical projects could soon be on the European table, one dealing with the surveillance of low Earth orbit and the other devoted to the surveillance of satellites and debris in geostationary orbit.[12] One interesting issue is the possibility of creating and maintaining a catalogue that would help relate any debris to its origin, for example to an explosion of an orbital object that could then be identified. In this field, some efforts are also being made for developing relevant software that would be able to make the best of the improved European system.

Monitoring and cataloguing capabilities clearly fit the European "security policy" concept. Such a cooperative system would prove the interest for a distributed system between the European countries, while putting the European institutions in a position to give a concrete example of new security concepts to the benefit of their Member States. More than that, building a surveillance system that would be operational at the regional scale would also contribute to making Europe a potentially important contributor to a worldwide system with a particular interest in complementing the US surveillance system. No doubt that this capability will be considered a primer for European cooperative undertakings. Technically, the new European cataloguing capabilities could clearly improve any GEO cataloguing strategy that requires recurrent and updated observations to secure correct orbital data, better identify uncatalogued objects, and task observations for catalogue maintenance and maneuver identification.[13] In brief, cooperative space surveillance is a good candidate for increasing the security in space by allowing improved data collection, which in turn can provide better space management capabilities, or even better security assessments.

Given these future capabilities, possibly used as a complement to the US space surveillance network, such a European system would not only help predict the course of space debris, but it would also answer the increasing need to enhance the control of the satellite population, which may already, or soon will, pose a number of difficulties due to weak or unobserved registration procedures. Again, highly contentious situations could develop in future years as an increase in the number of space objects and actors may be expected. Not only better registration procedures will be needed, but better surveillance tools will have to be put in place to ensure these rules are enforced in a more demanding manner for better transparency and collective security. Technical developments in the field of space surveillance in Europe may then be regarded as exemplifying a collective political solution for helping the international community deal with these issues.

One Step Beyond: Addressing the Issue of "Space Security" in a Comprehensive Manner

Thus, a first relatively quick effort for a relatively modest amount of money could be initiated to set up a European space surveillance system that would improve collective management of the space environment and promote "space transparency" as a confidence-building measure. Such a strategy would already help decrease the risks, intended or non-intended, of conflicting or ambiguous situations that could increase tensions in space. Besides this contribution to a global surveillance network, such a development in Europe appears as a natural move that corresponds to its gradual investment in space with strategic programs, such as Galileo and GMES, that will also have to operate with the assurance of their continuous security, defining then a typical "win-win" situation.

Still, in this case, like in others, two main types of difficulties subsist when it comes to defining the conditions for global cooperation. First, such a "transparency" strategy will have to deal with national security interests that may seem contradictory to its initial purposes. For the sake of this cooperation, discussions should be between the European space faring nations to guarantee that their national security interests will not be endangered by such cooperative endeavors. At least initial discussions in this field will have the merit to reinitiate the debate on space security without addressing the most contentious issues, while it may help each nation to reassert its position in the global framework of space security and hopefully help override current diplomatic obstacles. Second, and this may prove to be far more difficult, a huge task will consist of engaging emerging space countries to observe and comply to this new "transparency" context, with the goal to guarantee any of those countries an equitable access and use of space, hopefully in a more open manner, preventing thus the proliferation of insecure or non-peaceful practices and activities.

In the case of launching debris mitigation, it will be necessary to engage countries that will pursue autonomous launching efforts to comply with collective security rules by granting them access to launch-related debris mitigation techniques. If debris mitigation good practices have already been successfully applied as a collective behavior between the main spacefaring countries, newcomers may judge more demanding policies in this respect as too intrusive and judge them as interference with their own right of access to space. Still, given the short- to mid-term evolution expected from an increased use of space by new countries, the international community will have to find ways to develop attractive policies and set up cooperative technical tools to verify and control their application. Current perspectives toward an increased "weaponization" of space seem to constitute one of the only paths pursued for ensuring a more efficient "space security." This must change. For sure, such programs will never help initiate the necessary collective strategy to decrease the chances for illicit, irresponsible, or dangerous behavior. Only such a collective strategy based on mutual trust and reinforced by an operational collective surveillance system, can lead to shared "principles of conduct." Convincing ourselves today that the space environment must be rapidly the object of most special care, given its fragility and its particularities, would be a first step towards safer international space activities.

Notes

[1] David Armitage, "The European Gendarmerie Forces: An American Perspective," Eurofuture (Summer, 2005), pp.63-65
[2] Ibid
[3] Defense Space Policy Directive, # 3100.10, July 9, 1999.
[4] These capability issues are dealt with at the EU level in the framework of ECAP panels process (for European Capability

Action Plan). In a complementary manner, new "Battle Groups" have also been created following a 2004 Franco-British initiative that aimed at setting up national or multinational quick response forces to deal with sudden crisis situations.

[5] See for example S. Collard-Wexler, J. Cowan-Sharp, S. Estabrooks, T. Graham, W. Marshall, Space Security Index 2004, available at http://www.Space Security.org, p.43-46. See also Corinne Contant, Petr Lala, Kai-Uwe Schrogl, IAA Study on Space Traffic Management, IAC-04-IAA.5.12.4.01, as a precursor presentation to the recently completed path-breaking International Academy of Astronautics study on "space traffic management."

[6] Notably Michael Krepon and Michael Heller, "A Model Code of Conduct for the Prevention of Incidents and Dangerous Military Practices in Outer Space," Henry L. Stimson Centre, (also published as an article in Disarmament Diplomacy, N°77, June 2004, available at http://www.acronym.org.uk/dd/dd77/77mkmh.htm) or Richard Garwin, Kurt Gottfried, and Len Meeker, "A Draft Treaty Limiting Anti-Satellite Weapons," already proposed in 1983 and republished by the Union of Concerned Scientists. See also Theresa Hitchens, Future Security in Space, Charting a Cooperative Course, (Washington, D.C. : Centre for Disarmament Information, September 2004).

[7] Such as the interagency debris committee (IADC) created in 1993 under the auspices of the United Nations and which gathers the major space agencies to develop and implement common regulations allowing a diminution of the debris produced during the launch and orbital operations.

[8] Such is the role of the International Telecommunication Union (ITU), which registers and administrates the national requests for frequencies and orbital slots.

[9] For example, on the model of the Missile Technology Control Regime (MTCR) with the goal to curb ballistic missile proliferation.

[10] Grand Réseau Adapté à la Veille Spatiale

[11] See Heinz Klinkrad, "Monitoring Efforts – Efforts Made By the European Countries," ESA/ESOC, presentation made during the 10th International colloquium on aerospace security held in Toulouse, November 27-28, 2002 (hosted by the French National Air and Space Academy). From the same colloquium material, see also Richard Crowther / Qinetiq, "The Current Situation Regarding Space Debris and Future Problems." and Thierry Michal / ONERA, "Les perspectives d'avenir pour les équipements-sols" for a discussion about GRAVES functioning and perspectives.
[12] This study, led by the French ONERA also gathered expertise from Germany and from the United Kingdom, was presented in a 2005 technical paper. A first system envisioned for 2010 with some upgrade made in 2015 would reach 1700 km range and bring some 98% LEO coverage while the GEO strategy, based on the use of three sites distributed globally, would offer a 95% GEO coverage at the 2015 horizon. T. Donath, *et al*, "Proposal for a European Space Surveillance System," presented in ESTEC, 2005
[13] Ibid, p.4.

Space Superiority

Robert Dickman

The United States national security space community was reorganized in 2002. In practice, most of that reorganization was within the military side of the military-intelligence partnership that is called National Security Space.

Because of the challenges the United States Air Force has faced in several of its major acquisition programs, much of the attention and most of the public discussion has focused there. However, the Air Force has also made excellent progress in thinking through its policies and strategies with respect to space.

At the top level, the Air Force's expectations for space power and air power are pretty well aligned. First, the Air Force supports those who are engaged in active national security efforts. While these *may* be policy makers, in this context they are primarily those involved in what is traditionally called Force Enhancement within the space community. They collect and pass information: missile warning; weather; the broad spectrum of intelligence, surveillance, and reconnaissance; position, navigation, and timing; and the whole variety of communications, from highly mobile voice through wideband to highly protected systems.

As important as this has been in the past, in the era of net-centric warfare these are absolutely critical capabilities. If we fail to ensure the right information gets to the right person, not only will we have failed the customer, people in harm's way will die.

To be sure, this responsibility does not rest solely with space. In the communications dimension, space's strength really is best seen in what is called the last tactical mile – closing the link to the combatant where the big fiber network is available, and where line of sight is not suitable; that is, in most of the places where we and our partners will fight.

In the area of sensing, the synergy with other systems is even more obvious and essential. We are trying to achieve what we call persistent surveillance: the ability to know something of intelligence value about everything, everywhere, all the time, and a lot about something when it is required. Space-based radar is a good example.

The value of the space-based component in the fight is the ability to look deep into denied areas and to continue to look around the globe even if our primary interests are localized. However, where a space-based radar is *less* effective is trying to provide continuous, detailed coverage over a local area. That is where an aircraft such as Joint Stars today, or future platforms with improved radar, excel. The challenge, then, is to integrate all the capabilities in a manner that is seamless to the user. This sounds very much like net-centric warfare.

A second area of importance to space power is one also shared by our counterparts whose expertise is in the air, sea, or land. Space capabilities are essential to net-centric warfare. One of the challenges with net-centric warfare is that to work it depends on leading edge technologies in sensors, communications, and information handling. And while our technological superiority in weapons platforms can be challenged by very few, and even there only in narrow areas, the technology of the net is far more ubiquitous. In some senses, those in the space business are more vulnerable to asymmetric threats than their colleagues in other military domains.

Having great strength in the area, and we do have significant advantages with our space systems over any likely adversary, is not a guarantee of protection. But being vulnerable to an asymmetric threat is not unique to space. At the start of the two great wars of the twentieth century, Britain had considerable advantage on the seas. In fact, Winston Churchill may have coined the term “Sea Superiority” during his 1940 speech that is better remembered for his discussion of the air battle over Britain. Despite the enormous advantage Britain, and later the alliance, had at sea, the submarine had an impact all out of proportion to its purely military strength.

As we have been thinking through our space policies and strategies, this Naval construct has proved useful – although not the full story. The United States Air Force uses the term “Space Superiority” in the same way it talks about “Air Superiority” and very much the same way Britain used the term “Command of the Sea” for countless decades.

We have no intent to be the only ship on the ocean. We welcome robust, global space capabilities and underlying space industrial base.

We have no intent to deny legitimate free passage. Since the launch of Sputnik the right of free passage in orbit has been recognized by every nation around the world.

We do intend to defend ourselves in space should it be necessary, just as His Majesty’s fleets defended themselves and British interests so effectively on the high seas.

The United States government would regard willful interference or attacks on US space systems as hostile acts, and reserves the right to defend itself in a manner of its own choosing.

Similarly, while we have no intent to interfere with free passage of non-belligerents, the United States has every intent of denying the hostile use of space capabilities against us. Whether those capabilities are owned by the enemy, allied with the enemy, or fly a neutral flag but are knowingly providing aid to the enemy, they are legitimate targets – on land, on the sea, in the air, and in space.

For practical reasons, our approach to space superiority emphasizes:

- Understanding the space environment;
- Protecting our own capabilities;
- And using reversible means whenever practicable to deny capability that supports an adversary.

The Air Force recently fielded a Counter-Communications System – a fancy name for a jammer. Interfering with or otherwise exploiting enemy command control communications is as old as warfare – whether capturing couriers, cutting telegraph lines, using ULTRA to read encrypted Enigma traffic, or jamming radio signals.

To those who would suggest that because a radio signal is relayed through a satellite it should somehow be immune from electronic warfare, this author can only say: think about what you are saying.

To say that because a communications station operates through a satellite rather than by line of sight, microwave, or fiber, it should be off-limits from physical attack, this author can only say: think about what you are saying.

To say that because the radio repeater is a satellite rather than a truck carrying a mobile communications system, the port of embarkation or the means of transportation should not be attacked to deny the capability being delivered, this author can only say: think about what you are saying.

And while physically destroying a satellite is technically much harder than attacking the link or ground segment and is likely to generate debris and could have other ramifications that we would prefer not to deal with, that possibility during some future conflict cannot be dismissed on either legal or philosophical grounds. It may be that we will try to preclude a hostile use of space by diplomatic or other non-lethal means, but rest assured that if such measures fail, we reserve the right under international law to damage or destroy such a capability in self-defense.

We are not alone in our thinking about protecting and denying space capabilities. It is useful to remember that the only physical anti-satellite system (ASAT) maintained for operational use in the history of the space age – at least as far as we know – was the co-orbital ASAT in the inventory of the Soviet Union.

It was tested in space some twenty times, and it was a major consideration to those in the space defense business at the time. American satellites posed a threat to the Soviets, and they intended to deny our capability if necessary in wartime. We knew that, they knew that, and we both accepted that space would not be a sanctuary in the unlikely event of conflict. It was in their doctrine then, and it is in our doctrine now.

Fortunately, deterrence on a much larger scale succeeded throughout the Cold War and the threshold of physical attack in space was not crossed. However, the next time a satellite system is jammed on either the uplink or the downlink will not be the first. For us to believe otherwise, or to believe that threats will forever be limited to jamming, is naïve, and such thinking endangers our partners and us.

Hopefully this has been helpful in putting the Air Force's view of space superiority in a proper context – analogous to Air Superiority and Sea Superiority.

Now the discussion will return to that first space task – providing space support to our warfighters. Despite wishing to say that the future is all rosy – it is not. True cooperation is going to take hard work and substantial give-and-take on both sides.

The principal reason, easy to understand but hard to resolve, is that we are transforming our military into a net-centric force far more quickly than many in the United States may have expected, and possibly faster than our partners will be able to react.

Here is a straightforward space example. We have entered the design phase for our Transformational Satellite (TSAT) program. TSAT is one element of a bigger Transformational Communications Architecture that includes UHF, SHF, Ka and EHF satellite communications, the GIG Bandwidth Expansion, Joint Tactical Radios, and a whole lot more.

The underlying assumption, or "goal," is that every "thing" will have an Internet Protocol, or IP, address, and will be connected to every other "thing" such that all they need to do to communicate is use the right IP addresses. The "things" may be soldiers, vehicles, aircraft, sensors, commanders, supply systems – anything.

No more point-to-point circuits. No more separate radios or satellite terminals for each network, or even for each frequency. GPS imbedded so everyone is on the same physical grid and time base. Information posted as it is collected, available to everyone to use as they need – horizontally integrated, in our vocabulary.

We are not going to achieve this objective this year, or next – although we will be demonstrating some of it with combat forces in the field. We will be there sooner rather than later because we have a Secretary of Defense that has made transformation a very high priority. That means programs and dollars are pushed toward that goal.

The reason it will be hard to cooperate fully on Force Enhancement from space will be the different rates of change on our systems and those that belong to either other nationals or NATO. For example, we have excellent agreements with the United Kingdom, the Netherlands, and Canada on our Advanced EHF Satellite Communication system (AHEF SATCOM). When we entered those agreements we all expected AEHF to be the basis for protected communications for at least the next generation of satellites. Now we expect to curtail that procurement at three or four satellites and transition as soon as we can to TSAT. It is not that we do not like AEHF – it will provide unprecedented capabilities. It is that AEHF will not meet the needs of the net-centric, IP-based, highly mobile transformed fighting force in the air, on land, or at sea.

We have got to be interoperable with our partners. We are committed to interoperability with NATO. It is likely that any system we field will be backwards compatible – but that is not how we intend to fight. In this global war on terrorism, we intend to fight with the best capabilities we can field. So, we have work to do to make greater cooperation possible.

Operation Iraqi Freedom brought home this changing nature of communications in another pretty remarkable way. In the mid-1990s this author was involved in developing a Military Satellite Communications Architecture. We projected enormous growth in requirements, and proposed systems intended to meet them.

We have an organization within our requirements process called the Joint Requirements Oversight Council (JROC) – made up of the Vice Chairman of our Joint Chiefs of Staff and the Vice Chiefs of our four Services. They can be thought of as the number two uniformed leaders in the joint community and the four services. Generally, what they say goes.

The JROC members looked at our architecture, asked us to re-examine our requirements growth, and asked if there was firm data to back it up. This author acknowledged there was not, but that history had shown we always underestimated. The five senior people talked a little, asked a few more questions, talked a little more, and then rejected our proposal.

In truth, we had got it wrong, but we had *under*estimated, not overestimated. If we had done everything we advocated, we would still be very short of communications capability, and would have committed to programs that would not have met the need. So the JROC got the right answer – although perhaps for the wrong reasons.

During the peak of combat operations in Iraq, close to 80 percent of the satellite data used by the coalition, measured in bits, was carried on commercial systems. It is not that we prefer commercial communications – it has its place and will always be in the architecture. But in wartime we would rather use our dedicated and protected military systems. The truth is, we had no choice. We had bits of information to move, and no more satellites to carry them. It was a good market for the commercial providers.

Like any dual-use application, this cuts both ways. The challenge is that relying on commercial solutions exposes both us as a customer and the private ventures that sell to us to a wide array of threats – including deliberate interference. We must address these threats together.

The question of electronic warfare during conflict was also at the heart of the Galileo/GPS discussions that extended over such a long time and were largely concluded with the June 2004 US-EU agreement in Ireland. We believed that neither the Galileo signals nor any of our own GPS signals should overlay the GPS military signals, or M-code, that we will start deploying next year.

The reason is straightforward: M-code is intended to be used by our forces and our partners in conflict, even in a situation where we would deny all other space-based navigation signals, from GPS or elsewhere, within a local area. It is a key part of our precision strike architecture. If M-code and any other signal occupy the same frequency band, and we need to deny that other signal, it makes that reversible electronic denial, mentioned earlier as our goal, much more difficult.

To be clear, our negotiations over the past year or so had absolutely nothing to do with whether or not we thought Galileo should be fielded. That is Europe's business, not that of the United States.

Our agreement to move to a common open signal between Galileo and GPS in our next generation system acknowledges our understanding of the inherent value of 50 or 60 satellites providing the civil capability rather than just 24 GPS satellites. The negotiations were about a militarily significant issue – we intend for those 24 plus GPS satellites to continue to contribute to our asymmetric advantage as they did so well during Operation Enduring Freedom and then Iraqi Freedom.

Hopefully this excursion into the areas of space policies and strategies helps to develop an appreciation of the hard work ahead of us. If we are to maintain strong partnerships around the globe, we need to develop clear processes for addressing security-related concerns, and also provide room for each party to ask and answer the quintessential question: is it in our best interests? It is disingenuous to ask another country to act contrary to its best interests. But where our interests align, we can and will reap the most benefits.

It is interesting that when talking with colleagues from overseas, they often remark that it is very hard to predict what Americans will do. This author does not think it is hard at all – in fact, Winston Churchill might have had it about right when he said, "The Americans will always do the right thing...after they've exhausted all the alternatives."

The European Security Strategy released last year noted, "The transatlantic relationship is irreplaceable. Acting together, the European Union and the United States can be a formidable force for good in the world." We are in this global war on terrorism together. When we are done, we will find ourselves in a better, more secure world.

Space Security: A Non-US Point of View

Bertrand de Montluc*

Space as a Dimension: A Medium in and of Itself

During the Cold War, space was a transit place for ballistic missiles, a targeting tool, and a multi-purpose technical resource for surveillance, thereby providing National Technical Means for the monitoring of treaty compliance, observation of infrastructures and forces, and early warning.

At the end of the twentieth century, space had also become an operational asset acting as a force-multiplier.

In 2005, space has become a force-enabler, a resource not simply for augmenting certain available options for action, but also allowing those options to function more effectively when networked. In that sense, space must be understood as a dimension, a medium to be exploited and mastered.

Different Players' Perceptions of This Change

In the concert of nations, and even world powers, this new conception of space is only now beginning to be perceived. In the United States it was taken seriously much earlier, as illustrated in a policy statement published by the Pentagon in July 1999, "Space is a medium like the land, sea and air.… It is a strategic enabler.… Space forces are integral to the deterrent posture of the US armed forces."[1] In 1997, the United States Space Command published a document entitled

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* This paper represents only the individual views of the author, and not necessarily those of the French government or any other organization.

"Vision for 2020." Nearer the present day, and even more explicitly, is the document published in September 2004, "Air Force Doctrine – Counterspace Operations."[2] Together, these documents demonstrate an ongoing revolution being led by the United States military with determination and impressive resources, while also calling on substantial civilian capabilities. It is readily understood that the United States needs to protect this system and make it secure as a whole.

In other countries, and notably in Europe, the perception of space as a medium, the awareness of the fact that satellites provide value-added for defense and security, has come about differently and more gradually, in a context of more significant public investment in the civilian than in the military sphere, with a broader approach to security than that based on specific defense capabilities, and in many cases using tools that are more technological than operational in nature.

However, the situation in Europe is continuing to change, and reflection is under way in a number of European Union (EU) Member States on the need to develop their defense capabilities, move toward a "Network Warfare" logic, and develop a more global and encompassing approach to security. France, especially, has pursued these goals. At another level, the European Union, fifty years after the failure of an integrated European defense capability, is undertaking the construction of a European Security and Defense Policy (ESDP), filling in the gaps in its capacity, and promoting industrial research and technology development in security. Several recent documents illustrate this: the report of the space assets group in the context of the European Capability Action Plans (ECAP) capacity review, examination of the value-added of space systems for security by the Space and Security Expert Group (SPASEC) on behalf of the European Commission, and the European Council-endorsed document "The Space Dimension of ESDP."[3]

Thus in Europe space is beginning to be understood as a dimension and a medium in which it is important to deploy assets as much for economic reasons,[4] as for defense and security. Making these assets safe and secure is also recognized as important. Today one gets the impression that despite major differences in approach and rates of investment on either side of the Atlantic, the goal of preventing a situation in which space would become a non-secure, uncontrolled medium, could perhaps be shared if common benefits can be found and if it is possible to agree at the outset on a concrete view of the basic situation prevailing on the "space highways."

On April 18, 2005, Javier Solana, EU High Representative for Common Foreign and Security Policy, addressing *Institut d'Etudes Politiques* students in Paris, wondered aloud, "What can we do separately to cope with international crime and ecological disasters? … Surely it is obvious that together we have more weight." Likewise, in the context of "space security," is it not to our mutual benefit to have a space environment that is better known and more secure? This is not simply a typically European rhetorical question, but a proposal for an empirical, utilitarian approach, because the fact is that issues related to space security are going to arise in concrete terms.

<u>Issues of Safety and Security</u>

It is a fact that more intensive exploitation of space as a medium may raise issues of safety and security. There may, indeed be reasons to believe that space could, perhaps by 2020, become a less secure medium. A number of factors, identified by analyses completed in the United States, and more recently in Europe through a number of European policy documents previously referenced, lead to that conclusion.

- The exploitation of space is expanding and it is no longer reserved for scientists and technological demonstrators. Applications are diversifying, and certain important players are from the private sector.

- State actors are increasingly numerous. According to the 2003 Euroconsult directory, there are "30 emerging space programs across the world," and in a few years over a dozen nations will have earth observation programs of varying degrees of sophistication.
- The space environment features at least three major factors: 1) increasing numbers of civilian launch vehicles; 2) increasing numbers of operational satellites produced for telecommunications and meteorological and terrestrial observation applications; 3) the expanding role of the space segment in responding to the goals and issues associated with mastery of information and the provision of assistance to security forces.

All these various reasons argue in favor of raising the issue of security in space in a more concrete and less theoretical, doctrinal, legal or ideological manner.

The Need for New Analysis

If we assume that the risks of various types and in various degrees are growing, if only as a long-term trend, it would be relevant to conduct an analysis free of any dogmatism. It is true that this issue is made more complex by a number of hangovers from past analyses. The debate is often conducted from a legal point of view, concentrating exclusively on the issue of the "weaponization of space." For years this discussion has been purely semantic and centered on the militarization/weaponization dialectic. There is a great deal of literature on the topic.

Summarizing, we can say that the military use of space (its militarization) comprises the whole range of space assets that enable the armed forces to augment their military effectiveness. Such use of space is traditionally described as passive, non-destructive, and peaceful, and therefore compatible with the Outer Space Treaty of 1967. The expression "weaponization of space" is used to define the process leading to the operational deployment of weapons in space, of assets capable of being used aggressively against the military satellites of other powers. The treaties in force offer no clear guidelines for these issues. In the case of a country such as France, three principles guide thought on this: 1) freedom of access to space for all for peaceful purposes; 2) the preservation of the security and integrity of satellites in orbit; and 3) due consideration for the legitimate defense interests of States.[5]

It seems that the issue of weaponization is one specific aspect, aimed at lethal responses to illegal actions prejudicial to vital interests, of a broader and more immediate subject: how to make space more secure. It is this question that the author proposes to address.

How can we reduce the probability of irresponsible actions in a medium such as space as it is used currently? This is a question that has arisen historically for other environments, such as the sea, air, and polar regions, for example, and the answers have varied. To examine the issue and identify ways forward that meet the needs of the collective interest, there must be thorough knowledge of the environment being discussed and cooperative work to keep space under surveillance.

Making Space Safer (or At Least Less Insecure) for the Global Community

To make space safer for the global community, we might think in terms of a code of good conduct or a "highway code" in order to approve terms on which access to and life in space are permitted, improve the management of space traffic, and make adaptive adjustments to orbital techniques. We must also protect the ground segments associated with the space segments, a priority issue in the current climate of terrorist threats.

What the remainder of this paper will address are two issues particularly relevant to knowledge of the space environment:

space surveillance and space debris mitigation. The remarks that follow – albeit highly provisional and informal – come from the standpoint of an experienced policy analyst.

Space Surveillance

Over the time span that seems to be the most relevant – the next twenty years or so – the importance of space will progress substantially, and it will become the host medium for a diverse range of technological systems in an expanding number of operational spheres.

In such a context, the surveillance of space will have just as much of its purpose in advance warning of objects in orbit that might enter into accidental collision with satellites when they are launched or once they are in orbit, as in detecting possible threats that might strike them. Surveillance might, in fact, become a precondition of our capability to access space on acceptable security and safety terms and to conduct operational activities there, activities on which players in both the economic and security spheres depend.

In this sense, it is necessary to understand that the ultimate purpose of space surveillance is fundamentally dual. By contributing to the detection and characterization of possible anomalies affecting satellites, this discipline could become a helpful tool for stabilizing the space environment and facilitating space situational awareness, which is an essential prerequisite for any reflection upon the concepts of space control and space denial.

Requirements and Needs in this Area

The February 2005 report of the Panel of Experts on Space and Security previously referenced had several useful observations related to space surveillance:

- Space surveillance systems must provide information concerning: main characteristics of satellites (in particular orbit parameters, activity status); main characteristics of potentially threatening debris (in particular trajectory data, physical parameters); pertinent information related to space weather and near earth objects.

- Possibly using links with other sources of information, the systems should provide products and services: up-to-date space situation including information needed to perform anomaly assessment (i.e. trajectory prediction for atmospheric re-entering debris or spacecraft); alert cues in order to avoid collisions or deterioration due to potentially destructive space medium parameters; dossiers including imagery of in-orbit satellites.
- For Europe's sake the services provided would be: acquire a sufficient knowledge of the medium in space in order to safeguard the functional capabilities of any European satellite assets; monitor European satellites in order to detect any damaging risk due to collision with debris; observe and possibly forecast space weather in order to protect assets; verify the application of international treaties in outer space; participate in the evaluation of the technology of countries and organizations.

There are other relevant documents on these topics with their origin in France. For example, there is a classified report on the prospects for military space policy in France and Europe, coordinated by a former French ambassador to the United States.[6] And the Aeronautics and Astronautics Association of France (AAAF) report, "Space for Defense, a European Vision" (April 2005), includes a chapter entitled, "The Vulnerability of Space Systems: The Need for Minimum Guarantees."[7]

A European View on this Issue

From the SPASEC group's report:

> While Europe is able to detect and catalogue some space debris using facilities implemented by some Member States, most of the data are still provided for free by the United States of America. This situation could change in the near future, and the data already provided are not exhaustive or not made available at the needed time. The lack of a European Space Surveillance Capability is identified as a serious capability gap that must be one of the priorities for the future European Space Program.

The development in Europe of a system capable of covering all orbits would be difficult from a technical standpoint, involving global coverage by a network of optical and radar observation assets. Along the same lines as the capability developed by the North American Aerospace Defense Command (NORAD), it would be necessary to monitor, detect, and identify nearly 10,000 objects orbiting at altitudes ranging from a few hundred to over 36,000 kilometers. Such capacity could certainly not be established other than gradually and in partnership among European countries.

France, the United Kingdom, and Germany have begun to put in place means for ground-based surveillance, and the mutually complementary nature of these seems to be established. A project for the networking and development of embryonic capabilities would make it possible to meet the need to validate information provided by allied, and possibly also Russian, sources.

Beyond this, establishing a general code of good conduct, or of international minimum guarantees, could be based on a stepping-up of the surveillance of space shared internationally in the clearly defined mutual interest. This does, however, assume acceptance of limited distribution of information as to the existence and character of each nation's satellites. As the AAAF report, "Space for Defense" states, "The subject remains highly sensitive, and one must proceed in the mutual interest of space nations, which implies evaluating the type of interoperability desirable for these systems as well as the necessary ensuing legal arrangements."

The promotion of this tool would be fully meaningful if the other nations with concerns for space security were participants in it. If Europe were to succeed gradually, using existing bricks, to build preliminary ground-based assets developed in certain European countries and by the European Space Agency (ESA), in equipping itself with a European mini-NORAD "European space surveillance network" of dual character, managed by civilians if necessary, but made properly secure, why not imagine that Europe could organize in relation to the main source of data, the United States, a minimum of compatibility, interfacing and networking of data useable in a context of interoperability? This is may be a pipe dream, but would it not be truly a "Win-Win" situation?

The Space Debris Issue

Space situational awareness can help define and foresee accidents, or abnormal, anomalous, or prejudicial behavior in connection with civilian, commercial, and defense space assets. It can also provide advance protection from objects in orbit that may collide with satellites when these are launched or when they are functioning in orbit. In this sense, the ultimate purpose of surveillance is dual in nature.

The monitoring of debris has been a subject of serious concern since the 1990s, and consideration of it has progressed on the basis of a pragmatic approach adopted through technical and expert work on the issue. The Inter-Agency Space Debris Coordination Committee (IADC) began to draw up guidelines in 1994.

It is necessary to be aware of the fact that most of the man-made objects orbiting in space are not active: only six per cent of space objects are operational satellites! This means that space debris is in the majority and such debris is traveling in a medium shared with inhabited and non-inhabited objects carrying out vital tasks related to communications, radionavigation, earth, atmosphere and climate observation, surveillance, and security. This represents a diversified range of issues for the public and private space communities due to the possibility of accidental collision and corruption of communications links and observation data.

This statement of fact would appear to lead to the conclusion that the benefit would be minimal if only one or two space powers were to introduce preventive and precautionary measures. If space is to be made safer and is to be protected in a manner to ensure that all can make use of its unique characteristics, we need to think in terms of a concerted and even cooperative effort between space nations for the benefit of users. Such effort would not have as its goal the creation of legislation just for the fun of it, but ensuring that space as a medium remains a place for fair and safe economic competition and that the regions most valuable in technical or economic terms will be viable for future generations.

The IADC enables the exchange of information, facilitates cooperation, and makes possible precise assessment of the progress made in consideration and awareness of this area. The International Academy of Astronautics (IAA) submitted a position paper on orbital debris in 2001 and will complete a final report in 2005 which will propose "debris mitigation strategies, technical solutions, guidelines to avoid debris, prevent effects of explosion, protect some highly sensitive regions in LEO and GEO orbits."[8]

Essentially, the status of these much-heralded guidelines does not appear to go any further than a code of conduct. Further effort could be made to promote "worldwide awareness" and exchanges at the international level of technical experience. These exchanges, which could include the results of research conducted under the heading of space debris surveillance by official agencies in charge of security, defense, and aerospace research, as well as by agencies such as the French national space agency CNES, the French National Aerospace Research Organization (ONERA), and the European Space Agency, which have begun to invest effort in these issues, would gain from being networked.

Conclusion

What then might be the objectives, problems, and actions in making space secure. Our objectives are not revolutionary. They would involve tentatively stepping up discussions on space security issues with a view to promoting the idea that the best interests of every state would be best served by a common approach in this area, rather than following a set of compartmentalized national policies. Concerted action, and even analysis of options for sharing capabilities, could offer advantages under a win-win logic: the accumulation of greater quantities of data, achievement of a degree of interoperability, and holding back sterile and costly competition. Surely a contribution to US capacity through a degree of sharing of the task of keeping space under surveillance would help make space more secure globally for the partners involved. Would this not be a reasonable goal? Would it not then be possible to reconsider the issue of the "weaponization of space" from a different angle, on the basis of generally agreed concrete analysis?

At the same time, we must not blind ourselves to the difficulties. Progress in this field requires the following:

- Communication on sensitive technical issues;
- A willingness to disclose technical data in the industrial context;
- A mechanism for organization and implementation; and
- Greater trust between the major spacefaring nations and with the emerging economies.

But that should not stop us from continuing to seek innovative ways forward to guarantee a stabilization of the space environment, protective of the security and safety interests of the various parties involved, and promoting the development of space activities.

Notes

[1] U.S. Department of Defense, "Department of Defense Space Policy," (July 9, 1999)
[2] United States Space Command, Vision for 2020, (February 1997); and Air Force Doctrine Document 2_2_1, Counterspace Operations, (August 2004)
[3] The report of the Space Assets Group of the European Capability Action Plan is not publicly available. But see European Commission, Report of the Panel of Experts on Space and Security, (February 2005), and Assembly of the Western European Union, "The Space Dimension of the ESDP," Document A/1881, (November 30, 2004). This latter document contained recommendations that were endorsed by the European Council
[4] European Commission, White Paper Space: A new European frontier for an expanding Union - An action plan for implementing the European Space policy, (November 2003), stresses the economic payoffs to Europe from enhanced space activities.
[5] Statement of French representative, May 27, 2004 at the informal plenary discussion of PAROS (Preventing an Arms Race in Outer Space) at the Conference on Disarmament
[6] This individual is Francois Bujon de L'Estang, who headed a group chartered by the French Defense Minister during 2004. The group's report has not been made public.
[7] Association Aeronautique & Astronautique de France and Academie Nationale de l'Air & de l'Espace, "Space for Defence: A European Vision," (April 2005)
[8] The study will be published on the IAA web site, http://www.iaanet.org, when it is formally released, probably in early 2006.

China as a Military Space Competitor

James A. Lewis

Public recognition of China's long-standing and ambitious space program increased dramatically with the orbit of a taikonaut around the earth. The orbital mission was an assertive step into what many have lately seen as an American province. China's motives for going into orbit are similar to those that drove Russia and the US to undertake manned missions – to gain national prestige and to signal wealth, commitment, and technological prowess.

Manned space flight is primarily a political act. While China gains real political benefit from orbiting a human, the military benefits are small. China is already among the leading space powers and is developing a full range of space capabilities. Its manned program is one of these capabilities and in some ways is the least interesting militarily. This paper puts Chinese military space efforts in perspective and considers how the US might respond.

Manned platforms have little military utility. When Russia and the US began manned space exploration, some thought that human space flight might provide military benefit and that a capsule and its pilots could act as an extension of air operations. This proved to be an illusion. The ability to put humans in space shows a level of technical proficiency, but a manned program provides only indirect benefits to national security. These benefits result from applying the abilities and the confidence that manned space flight brings to unmanned programs with greater military utility. In fact, by taking resources away from space programs with greater military utility, the manned space effort may slow China's progress in military space activities.

Since the 1970s, China's leaders have seen space programs as a tool to speed technological modernization and recognition of China as a great power. China's long-standing national space program is relatively advanced. It includes an indigenously developed family of liquid-fueled space launch vehicles that are competitive with western launchers, a large space research effort, and an extensive satellite industry. This satellite industry lags behind those of the US and Europe, but joint ventures with foreign firms over the last decade have helped China improve its satellite manufacturing capabilities. China has made space remote sensing a priority and has developed its own communications and navigational satellites. The range of Chinese space-related activities indicates a commitment to self-sufficiency and, perhaps, a desire to play a leading role in space.

China has also identified space activities as an area where it could erode the US military advantage. Beginning with the 1991 Gulf War and again in the recent conflicts in Kosovo, Afghanistan, and Iraq, the Chinese learned that space power is essential for effective military action. China's leaders undoubtedly wish to no longer depend on CNN to learn when US carrier battle groups are approaching Taiwan. Given US reliance on space assets, the Chinese believe that space may be an area where the US may be vulnerable. Public accounts of China's military planning indicate that it does not wish to leave the US unchallenged in the use of space in the event of a conflict.

However, the Chinese are not mirror-image competitors for the US. This could change as China's GDP increases and if relations between the two countries grow worse. But for now, China seems to want to avoid what some perceive as the Soviet error of spending themselves into bankruptcy in an arms race with the US. Reacting to a vigorous discussion in Chinese military journals, many analysts assert that what the Chinese seek, while upgrading their military capabilities, is asymmetric advantage and to find areas where the US and its style of warfare is more vulnerable to attack, an approach sometimes captured with a phrase used in writings from

China's People's Liberation Army (PLA): "overcoming the superior with the inferior."

If China's goal is asymmetric advantage, some military space activities are more valuable for achieving this than others. Although China is exceptionally secretive about many aspects of its space programs (and this in itself helps generate suspicion), and although it frequently blurs the line between civil and military space activities, enough information about its programs has been made public to allow us to begin to assess the implications for US military operations and national security. An initial conclusion from this information is that China does not concentrate its space efforts on the programs that could provide asymmetric advantage, and it is not a competitor in military space.

A review of what China builds and launches suggests that China's military space efforts are often more a demonstration of technological prowess and sophistication across a broad range of space activities, rather than an effort to build an operational military space capability. China has not assembled nor does it maintain the full range of capabilities in space needed for intelligence and military benefit. In some cases, China appears to build a satellite in order to show what it can do rather than to meet an operational need. A desire to demonstrate self-reliance (an important factor of Chinese policy in many areas beyond space) often seems to drive military space activities.[1]

For example, China and the European Union recently agreed that China would be one of the participants in the Galileo navigational satellite program. (Several other countries, including Canada and Israel, are also participants.) While technology transfer from Europe to China and input from China into Galileo's design and operation will be limited, cooperation will allow China to develop a more sophisticated understanding of navigational satellites. Press reports note that China has expressed interest in Galileo's "Public Regulated Service," which is intended for use by security services.[2] Galileo is another example of how China has used foreign partnerships to speed its indigenous space effort, not through the theft of technology, but by participating in and learning from the experience of other programs. But with access to Galileo, in addition to the access to Glonass and GPS signals, why China should build and launch three Beidou navigation satellites? Three satellites are not enough for effective military use, and the funds spent on Beidou could probably have been better spent on other types of satellites that could provide asymmetric advantage.

Opaqueness on the part of the Chinese complicates analysis, but we can make some observations about Chinese military space activities based on observable and quantifiable data. It is next to impossible to hide many space activities, since launches and satellites are easily observed. This launch and satellite data provides the best insights into China's military space efforts and suggests that they are not concentrating on asymmetric advantage and instead are exploring the range of military space capabilities, albeit on a much lesser scale than the US and at a much slower pace.

China has programs for communications, reconnaissance, navigation, anti-satellite (ASAT), and electronic intelligence (ELINT) collection.[3] If we take the most inclusive estimate for the classification of Chinese government satellites and assume that most have some military function, the distribution of launches does not differ greatly (except in ballistic missile early warning) from that found in the US or in Soviet military programs.

Satellites Launched by Type (in percent)

	Com	**Nav**	**Image**	**SigInt**	**EWarn**	**Other**	**Weather**
US	17%	12%	41%	7%	7%	11%	6%
Russia	17%	12%	42%	11%	5%	9%	6%
China	23%	7%	44%	9%	0%	5%	12%

If the goal is to gain asymmetric advantage, China should invest primarily in those systems that pose a greater risk to the US or offer greater potential for asymmetric advantage. These include satellite reconnaissance, signals intelligence (SIGINT), ASAT, and microsatellites. Satellite navigation and communications increase the capabilities of Chinese forces; satellite reconnaissance and anti-satellite programs degrade the capabilities of US forces. China over-invests in navigation and communications satellites. These programs pose less of a challenge to the US and will create less of an advantage for Chinese forces than satellite reconnaissance and anti-satellite capabilities.

The major and crucial difference, however, is the on-orbit presence. China does not have a continuous military space presence equal even to what the Soviet or the US was able to muster in the 1970s. In the last decade, the number of Chinese launches has totaled only about twelve percent of US launches. In any given period, the Chinese operate no more than six to ten satellites with most being communications rather than sensor platforms. The operational life of Chinese satellites, which press reports state is considerably shorter than those of comparable US satellites, also reduce China's on-orbit military presence. While China's announced goal is to create a multi-satellite system for continuous operations, they have not committed the resources to achieve this.

Military Launches Per Year[4]

	1993	94	95	96	97	98	99	2000	01	02	TOT
US	12	11	9	11	9	5	7	11	7	1	83
Russia	26	26	15	8	10	9	6	7	9	7	123
China*	1	2	2	3	6	6	4	5	1	4	34

*All non-commercial Chinese launches

Reconnaissance Satellites

A brief review of Chinese space programs reinforces a sense of unevenness in China's approach to military operations in space. Satellite reconnaissance is a clear example of this unevenness. For space programs with military applications, China has made the most progress in developing satellite reconnaissance capabilities, but these capabilities are still insufficient to provide military advantage.

Remote sensing technologies are a crucial element for building information superiority, and the Chinese military has identified them as a vital area for building its space capabilities.[5] China has built and flown numerous remote sensing and reconnaissance satellites, albeit on a sporadic and experimental basis. The first models were primitive, having poor image resolution (resolution refers to the level of detail in the imagery collected by the satellite) and relying on film recovery to provide data. Over time, Chinese remote sensing efforts have become more sophisticated and the Chinese space remote sensing program is marked by a continuous degree of incremental improvement.

Building an effective satellite reconnaissance program has several phases. The first phase is the acquisition of the necessary technologies, their integration into functional satellites, and undertaking a successful reconnaissance operation. The second phase is to orbit a network of satellites, both reconnaissance and data relay, build ground stations and analytical centers to acquire and use the satellite imagery in a timely fashion, and make satellite reconnaissance a routine activity. For military purposes, this must be accompanied by the creation of the capability to build remote sensing satellites and keep them continually in orbit to provide timely coverage.

Chinese reconnaissance satellites in the 1970s and 1980s (the FSW series) lagged far behind their US and Soviet counterparts. The FY-1 series were an improvement, but still closer in capability to Landsat than to an intelligence satellite. The 1990s China-Brazil Earth Resources Satellite (CBERS) program still did not provide high-resolution imagery, but its multi-sensor payload and digital transmission capabilities showed considerable sophistication.[6] Recent remote sensing satellites, such as the ZY-2 (launched in 2000), use data links to relay electro-optical imagery back to earth by radio signal rather than film drop, providing a greater reconnaissance capability. The HY-1, launched in 2002, was designed for maritime surveillance and will carry improved optical sensors that may approach the capabilities of early 1990s western commercial sensors.

The third phase is the integration of satellite imagery with other kinds of intelligence and into military planning, first at the strategic level (which the US and Soviet Union did in the 1960s), and then increasingly into tactical operations (initially as the provision of target packages to support individual air missions, later in the provision of near real-time data to commanders). This phase is, in some ways, more difficult as it requires re-conceptualization of strategy and tactics. An educated guess would put the Chinese somewhere early in phase two and movingly ahead at a stately, if respectable, pace, if the reports of PLA plans to have a constellation of four radar and four optical reconnaissance satellites in place by 2010 are accurate.[7]

China's primary weakness in building reconnaissance satellites is in sensors. Developing sensors capable of providing high-resolution imagery from space is a task that at one time only the US and the Soviets had mastered. One of the changes in the last decade is that high quality space sensors are increasingly available from a range of other nations and on a commercial basis. China has sought to buy remote sensing technology from US, European, Russian, and perhaps Israeli sources. Efforts by China for the covert or illegal acquisition of space sensor technology is more likely to be an espionage concern, rather than the space launch technology that preoccupied the US Congress in the late 1990s.

High resolution is important for intelligence analysis – many details of weapons systems cannot usually be determined from one-meter imagery – but it is less important for reconnaissance purposes. One-meter imagery is sufficient to identify ships, aircraft, and armored vehicles. Twenty meters would provide a limited capability to identify naval vessels. The type of sensor used to collect the imagery is another factor for assessing the value of this imagery for military and intelligence purposes. Multispectral satellites, which can use infrared radiation for imaging, are more useful and provide more information, but (at least for commercially available systems) do not have as good a resolution as visible light imagery. A decision to pursue a high-resolution radar imagery satellite would provide the capability to see through clouds and unmask decoys.

China has been working on an indigenous synthetic aperture radar satellite for at least a decade. A few recent reports suggest that the China's remote sensing program may have taken a great leap forward through the acquisition of advanced radar sensors with one-meter resolution from a Russian source (other reports put it at twenty meters).[8] If this is true, it would go far to solve the lack of advanced sensors that hampers the Chinese reconnaissance satellite program. Radar can see through clouds or rain and is particularly useful for maritime monitoring. This maritime mission is likely to be of high interest to the Chinese military, given the importance of Taiwan and the limits of their "blue water" naval capability. Both the Russians and the Canadians developed radar satellites in order to monitor naval activity. China has some experience in the use of satellite data for ocean surveillance, as it has had access to Canadian RADARSAT data for several years and has operated a satellite maritime surveillance center for more than a decade.

Data relay satellites are essential for military space architecture. China has developed data relay satellites – special satellites that support reconnaissance by receiving signals from a reconnaissance satellite when it is out of range of a ground station, say over the eastern United States, and then relaying the signals back to China. Some sources say China plans to orbit two geo-stationary data relay satellites to support its other space sensor and military communications programs. These satellites reportedly form part of a larger command, control, and intelligence effort being undertaken by the PLA.

What China has done on the ground is as important for satellite reconnaissance – and as limiting – as what it has done in space. Satellite reconnaissance depends on more than the possession of satellites. Countries seeking to use satellites for military purposes often overlook this terrestrial and expensive element of space power. Effective use of satellite services requires the development of a support infrastructure of analysts and operators and the integration of satellite data and services into military plans and operation.

China has several decades of experience with remote sensing programs, and its access to data from foreign satellites could help develop the analytical capabilities needed for an effective military satellite reconnaissance system. Access to satellite data from foreign civil remote sensing satellites is important for understanding the pace at which China could develop its military capabilities. China has ground stations that receive data from France's SPOT, the European Union's ERS, the US LANDSAT, Japan's JERS, and the Canadian RADARSAT. Access to data from these satellites provides China with practical experience in analyzing and using satellite remote sensing data from optical, multispectral, and radar sensors (on Chinese and foreign spacecraft).[9]

China has established five national-level centers for the analysis of space imagery, the most prominent being the China National Remote Sensing Center, which coordinates both civil and military satellite remote sensing efforts, and the Institute of Remote Sensing Applications.[10] China has been quick to recognize the usefulness of Geographic Information Systems (GIS).[11] The PLA General Staff Headquarters' Third Department, usually seen as primarily focused on SIGINT, reportedly also plays a role in analyzing satellite intelligence.[12]

Integration of imagery and other intelligence from space-based assets is a complex task. It requires a more flexible command structure and a greater emphasis on communications and the use of information at all levels of command. China lags behind in this area, where progress depends less on space programs and more on modernization of the PLA. China also lacks battlefield experience with tasking and integrating space data into military operations. Exercises can only go so far in remedying this. These problems can be overcome only through experience, suggesting that there will be a lag of some duration between China's acquisition of reconnaissance satellites and a functional military capability. In watching China's satellite reconnaissance program, we need to look not only for improvements in hardware and coverage, but for the changes in PLA organization and tactics that will indicate when space activities are becoming an integral part of China's military operations.

The Russians have used radar satellites for ocean reconnaissance since the 1960s. These maritime reconnaissance radar satellites provided data for long-range anti-ship missiles aimed at US task forces, an option that would be attractive to the Chinese military. However, radar satellites are only one part of an effective space maritime reconnaissance architecture. To be fully effective, they must be complemented by space-based SIGINT collection. In this regard, China's military space program does not seem to have put a high emphasis on SIGINT.

Signals Intelligence

SIGINT encompasses the interception of electromagnetic radiation to obtain two different forms of intelligence: communications intelligence (COMINT) and electronic intelligence (ELINT).[13] ELINT is an essential companion to imagery for reconnaissance, especially strategic and naval reconnaissance. China has a ground-based SIGINT network that has been described as "the most extensive signals intelligence capabilities of all the countries in Asia."[14] This capability is based on ground stations, ships, and mobile platforms. China has acquired modern aircraft platforms, not satellites, to carry out its SIGINT missions. China also monitors international communications satellites from facilities in China.[15] The program is managed by the Third Department of the General Staff Headquarters, which is responsible for monitoring foreign and internal military communications and producing finished intelligence.

China's efforts at SIGINT and ELINT in space, however, have been sporadic. China had an experimental satellite ELINT program in the 1970s started at the behest of senior Chinese political leadership, but allowed the program to drop after a few years.[16] The Shi Jian (SJ) "Scientific Experiment" satellites have characteristics of SIGINT satellites.[17] The first SJ launch in 1979 failed. A second launch in 1981 succeeded, but was followed by a long hiatus, with the next SJ not being launched until 1994.[18]

China also launched two DQ-1 satellites in 1990 that, although they were identified as being for atmospheric research, had many of the characteristics of ELINT satellites. Based on publications by Chinese scientists in technical journals, some observers believe that China has resurrected space ELINT research at several Chinese institutes with connections to the military. ELINT packages could piggyback onto other satellite payloads, or they could be deployed independently.

The absence of dedicated ELINT satellites (and the resultant dependence on ground and aerial platforms) may be indicative of a territorial scope to China's ambitions. Alternatively, it could indicate a high degree of success in China's ability to covertly deploy SIGINT payloads. The clandestine nature of such programs and the paucity of public information make it hard to assess the degree of progress, but at least in one area, the program seems to be demonstrably deficient.

The Russian ELINT Ocean Reconnaissance Satellite (EORSAT) system provides direct tactical support to Russian air and naval forces by transmitting almost real-time targeting data. This targeting data can be sent directly to specially equipped ships (the Chinese do not appear to have such ships) or to ground stations for relaying to attacking naval forces. EORSAT, which used a constellation of satellites to provide coverage and, when ships were detected, to deliver data on multiple targets rapidly to weapons systems, was an essential part of Soviet planning to attack the US Navy.

China's lack of a space ELINT capability is puzzling and suggestive given its purchase of long-range anti-ship missiles from Russia. The ability of these missiles to use satellite data, both ELINT and radar, to target ships is an essential component of their long-range capability. In particular, the SS-N-26 long range anti-ship missile is made by the same Russian entity that is allegedly supplying China with space radar sensors, NPO Mashinostroyenia. NPO Mashinostroyenia has a long history of developing advanced anti-ship cruise missiles and has considerable experience in using radar satellite data with the targeting of Western naval forces.[19] If China does not invest in space surveillance, the effect is to limit the effectiveness of their new purchases. Despite upgrades to their naval forces and weaponry, the Chinese do not seem to be in any rush to deploy supporting ELINT satellites. This may be only a temporary delay; it could reflect either satisfaction with current levels of collection or a conscious decision not to expend resources on ELINT, or it might be a failure to fully understand the interconnection between space assets and terrestrial force. The best way for foreign analysts to determine if China has increased its SIGINT capabilities in a naval context would be to look for new kinds of antennae on Chinese naval vessels or new kinds of data relays coordinated with missile-firing exercises.

In the absence of dedicated SIGINT platforms, some observers in Congress and elsewhere suggested that China sought to acquire advanced western communications satellites for use as collection platforms. They argued that the APMT communications satellite, which used a large, sensitive antenna to provide telecommunications services in the Ku-band and had a design similar to US signals intelligence satellites, could be used by China for intelligence collection. However, the only signals APMT could collect were mobile telephone signals from subscribers to APMT's mobile telephones. It could not listen to other signals, and since the Chinese had no opportunity to replace APMT's telecommunications components with equipment more useful for espionage, APMT would only have collected Chinese mobile phone calls that the PRC could intercept at much lower cost on the ground in China.

While US fears over APMT were completely exaggerated, the continued Chinese preference for terrestrial rather than spaced-based interception is suggestive and may indicate a strategic outlook that is inward-focused and regional. Moving to a more aggressive space-based program would be a good indicator of a change in intentions.

Microsatellites

China's slow pace in developing robust space-based imagery and SIGINT capabilities that parallel those developed by the US does not foreclose the possibility of asymmetric advantage. China could attempt to use microsatellites to provide itself with electronic intelligence or other capabilities in space. In the past, microsatellites would have not been the ideal platform for the full range of tasks involved in electronic intelligence collection or other military space activities. Successfully using microsatellites as a replacement for larger military platforms still requires a high degree of technological sophistication.

However, the continuing trend to reduce the size and weight of space-qualified components without sacrificing performance continues to reduce this disadvantage. It may also be possible to use constellations of microsatellites to mimic the collection performance of a single, large platform. The ability to launch multiple satellites at the same time, which China first performed in 1981, could make the use of such constellations easier. The US has reportedly used clusters of relatively small satellites to perform maritime ELINT missions, and other reports suggest that the US will use clusters of small satellites in future imagery architectures. A decision by China to push satellite ELINT based on microsatellites might provide a fast and inexpensive way to add this capability.

In 1998, Tsinghua University formed a cooperative research program with a company formed by the University of Surrey, a leading microsatellites research facility. The cooperative effort led to the successful launch by China of a microsatellite in May 2000. Surrey built a microsatellite named Tsinghua-1 under a “Know-How Transfer and Training” agreement. Tsinghua-1 was a demonstrator for an eventual constellation of five Chinese microsatellites that would provide global, high-resolution imagery. Tsinghua-1 was also planned to carry out communications research in Low Earth Orbit. In part as a result of the cooperative program, Tsinghua can now build its own microsatellites.

In April 2004, China launched a payload of two indigenously developed small satellites with potential military capabilities. The first was a 452-pound microsatellite, “Experiment Satellite I” and a 55-pound nanosatellite, "Nanosatellite I.” Experiment Satellite I transmits remote sensing data for mapping. Nanosatellite I was designed to perform unidentified technology experiments.[20]

Microsatellites could offer a range of military capabilities. Besides anti-satellite operations, small cheap satellites could provide a surge capability for crises.[21] As sensors continue to become smaller and cheaper, microsatellites could be launched and deployed in swarms to provide in-depth, redundant coverage of a particular area. Using a number of micro-reconnaissance satellites in the right constellation could, for example, cover large portions of the Pacific Ocean and ease the burden of maritime surveillance.[22] Microsatellites could also provide on-demand enhancement of communications capabilities, or they could be used to jam the target satellite’s reception of commands from the ground.

Microsatellites may also be attractive from an investment and budget perspective. The return on investment for a military space program is greatest in its initial phase. Adding a military space element provides an immediate improvement for intelligence and planning. A military force that goes from having no satellite reconnaissance or ELINT capability to having some capability gains a tremendous advantage. Going from a 1990 to a 2000 collection capability does not provide the same increase in advantage. After this initial large pay-off, further investments and technical refinements provide declining returns.

This pattern of a large initial payoff followed by declining marginal returns would make microsatellites attractive, as they lower the initial cost of entry into space. Small, cheap satellites could provide China with an easier path to attaining some space capabilities and provide the potential for asymmetric warfare in space. The cost advantage of microsatellites could, if properly handled, allow China to compete at some levels with the larger and more expensive US systems without having to match the US dollar for dollar.[23] Test deployments by China of microsatellite systems for military communications, reconnaissance, or SIGINT would indicate a decision to seriously pursue this approach to space power.

Anti-Satellite Capabilities

Public reports also suggest that microsatellites may play an important role in asymmetric anti-satellite efforts. China's close study of US military tactics in the 1990 Persian Gulf War and the conflicts that followed showed the PLA how the US military was increasingly integrating space assets into its planning and operations. While effectively conceding that its conventional ground, air, and naval forces do not yet challenge the US military, China has looked for vulnerabilities where US military effectiveness could be degraded. Attacking space assets is one such area and the Chinese have pursued research into anti-satellite capabilities.

Anti-satellite programs entail ground-based high-energy weapons, ground or air launched interceptor missiles, or "hunter-killer" satellites that destroy their target through either explosion or ballistic impact. China has pursued all three types of anti-satellite efforts since the 1980s, and has claimed that it can use ground-based lasers to damage sensors on reconnaissance satellites. The US Department of Defense estimates say that China could develop a ground launched "direct ascent" ASAT system within two to three years. Advanced space-based weapons (i.e. laser-carrying satellites) are not currently a part of China's anti-satellite efforts. The most immediate threat comes from attack satellites. China appears to be developing two kinds of attack satellites: conventional hunter-killer satellites and microsatellites.[24]

Some unofficial Chinese sources claim that China has developed parasite satellites for anti-satellite purposes. These are small satellites that are carried into orbit by a mother satellite. The mother satellite closes with the target and releases the parasite, which, using radar or perhaps heat-seeking sensors, then attaches itself to the target where it then could detonate or wait passively for a later command from the ground. If this sort of program is feasible (and the final stage of getting the parasite close enough, given fuel constraints and the need to avoid any damage or disruption to the host to avoid attracting attention, might be difficult), it could allow a quick strike at the beginning of any conflict to simultaneously disable many space assets.

China has also reportedly worked on the larger and more traditional co-orbital hunter-killer satellites. These are large satellites that are put in the same orbital track as the target and maneuvered from the ground to close with the target. At close range, some ASATs carry on-board sensors that would guide the satellite to within range. The hunter-killer would then launch either kinetic or explosive projectiles or explode itself. China's initial efforts in this area appear to reflect early work done by the Soviets.

China has a long-standing capacity to track objects in space.

It is based on a number of ground stations (including two located outside of China) and four satellite tracking ships. The ability to track object in space is critical for space operations. China would need this capability in order to carry out manned missions, as well as for orbiting satellites. However, it is also critical for anti-satellite operations, whether ground-based or for in-orbit attacks. Locating US satellites is a necessary precursor to the successful conduct of anti-satellite operations. This combination of tracking capability and a range of experimental anti-satellite programs suggest that anti-satellite efforts could be the greater source of risk for the US. This concern needs to be tempered by the lack of actual ASAT tests by the Chinese. An operational ASAT program would test its weapons (as the US and the Soviets did in the past) against space targets. Although there have been terrestrial tests ground of lasers that may have been for anti-satellite purposes,[25] the Chinese have not conducted tests against targets in space.

Paper Dragon or Fledging Competitor?

Secrecy and dissimulation complicates analysis of China's space efforts,[26] and many questions remain about China's military space capabilities. China is actively pursing military, civil, and commercial activities in space. China has built and launched a broad range of military satellites (albeit with varying degrees of sophistication and performance), and its space reconnaissance and ASAT programs could pose a challenge for the US. Despite this, China's military presence in space is sporadic. It does not have a coherent military space architecture. If an effective military space program entails continuous coverage by intelligence collection satellites and a network of communications satellites, China has not made the effort. This absence in space is not the result of a lack of technological capability, but reflects a national decision about how to spend resources for space.

China's space budget was a secret until 1994, and it is still not made public in any detailed fashion. Estimates place it variously between \$1 billion and \$3 billion per year, for both military and civil space programs.[27] Given the complexity of China's government accounting process and its legacy of a command economy, where not all costs are reflected in a program budget, this is likely an underestimate.[28] Even if the budget were two or three times as large as the public figures, it would still be small for the tasks China has set for itself.[29] China has publicly said that its space program will select a limited number of projects that are of "vital significance" to the nation and concentrate its resources on them.[30] However, at first glance China's space effort would appear to be spread too thin to be optimally effective.

Possible rationales for Chinese military space programs fall into three categories: "catch-up," "leap-frog," or "conspicuous consumption." The first involves China trying to bring its space forces up to par with US capabilities. Leap-frog scenarios have China taking advantage of new technologies and an information-oriented approach to warfare to surpass US capabilities in unexpected ways.[31] This approach would mean that military space architecture for China could look very different from that used by the US. A "conspicuous consumption" rationale would involve activities in space done primarily to affirm or enhance China's prestige and influence rather than build a continuous operational presence. While there are elements of all three in China's military space efforts, judging from expenditures and payloads, "leap-frog" and "conspicuous consumption" seem to predominate.

A clearer understanding of Chinese intentions for military space activities needs to examine whether an asymmetric approach is a short-term placeholder while the long-term plan is for China to match the US militarily in space, or whether some programs are only to showcase technological prowess by a space program given broad discretion by China's political leaders. Uncertainty about the scope of military space activities provides benefits to China in that it complicates US planning, but it is not a substitute for military capabilities. China's military space effort now appears fragmented, defensive, and regional rather than offensive and global (albeit with the potential for change).

Since we are unlikely to see greater openness by China in the near term, a series of externally verifiable indicators can be monitored to reduce uncertainly about China's military space efforts. These include increases in the pace of launches, development of better launch on demand capabilities, expanded testing of microsatellites to provide a "breakout capability," ASAT testing, and the appearance of new equipment or new exercises that reflect the integration of space assets into military planning and operations. Changes in the organization of space activities, such as the creation of an organizational entity dedicated solely to military activities or the creation of a civil space agency, would also signal a change in emphasis.

For now, while uncertainty about Chinese intentions in space remains, the US may want to consider how to respond to the potential for challenges from remote sensing or anti-satellite efforts. In each case, deployment is partial and sporadic, but there is enough uncertainty about intentions and rates of progress to raise concerns for US forces and operations.

Implications for the US

The major implication of these Chinese programs and the manned space flight program is that the US can no longer regard military space as an "American lake." For a brief period following the collapse of the Soviet Union, the US was unchallenged in space. This is no longer the case and it is likely that a few nations, including China, are looking at how to use space to erode the overwhelming US military advantage. While China is not a peer or near-peer in space, it is exploring options that will, without mirroring the US, eventually provide it with new military capabilities.

The task for the US is to find means to counter the efforts to gain asymmetric advantage. For Chinese military space programs, and particularly for the reconnaissance and ASAT programs, which offer the greatest payoff to China, the US needs to consider a number of steps. Military planning and operations will need to increase the emphasis on deception. Stealth programs or stealth considerations may need to be extended to include very large platforms that were not previously considered. ELINT and jamming efforts need to take into account the increasing potential of Chinese space sensors. This effort should not be limited to the development of new technologies to deceive Chinese space sensors or make US assets stealthier, but to also change how US forces operate.

Looking for ships or groups of ships on the open sea is a difficult task. Large areas must be surveilled on a regular basis, and coverage must be arranged so that the time between overflights is less than the speed of the ships to move out of range. Monitoring a particular area of ocean is easier. China has sought to extend its surveillance capabilities, which have been limited to date by the need to use either ground or aerial platforms, and will probably use any new space-based assets to watch the sea areas around Taiwan. US naval forces could still retain an element of surprise the further away they are from the Island. This may require positioning ships further out and launching aircraft at a greater range, which will increase aerial refueling requirements and complicate aircraft recovery. Stealth is not an option for aircraft carriers, so the US may also have to rely more on the use of submarine forces. Spoofing capabilities for ships or for battle groups may also be necessary. This could be the use of false radar signals to confuse satellite sensors and to degrade data (a spoof transmission might persuade a satellite that a carrier was several miles from its actual position, for example).

The United States may also have to pay greater attention to deception and decoys in its military activities. The Soviets described this support function as "maskirovka," the use of cover, concealment, camouflage, and deception to defeat reconnaissance. The intent was to preserve surprise and increase survivability. While the US has made considerable strides for some platforms in the use of stealth technologies to defeat radar, maskirovka has otherwise been a tertiary consideration for the military. This may need to be reconsidered as Chinese space reconnaissance capabilities mature. We can no longer assume strategic surprise for our operations.

The US will also need to consider if there is sufficient redundancy for its space assets and how to ensure a surge capability. This involves not only stockpiling of space assets (an expensive proposition), but also ensuring that launch on demand capabilities can meet surge requirements. In part, the US may want to consider moving from a reliance on only a few big, expensive platforms to developing small, cheap (i.e. microsatellite) platforms for reconnaissance, communications, and ELINT in a crisis. While the large, expensive, and capable platforms are more than adequate in peacetime, if they are damaged or disabled in a crisis the US may want to have replacements ready. Swarms of small satellites are harder to target and eliminate. The US expertise in sensors (both reconnaissance and ELINT) would give it an advantage over China in a microsatellite competition.

Redundancy can also be provided by the use of commercial services for imagery and communications. The US has already made considerable strides in this regard. Redundancy obtained through the use of commercial services also provides diplomatic advantages, but foreign service providers may be reluctant to accept US contracts if they believe this will lead to the destruction of their satellites. The US may need to consider programs that would reduce risk for commercial providers (i.e. insurance or some other form of compensation).

There are a number of measures that the US can take in response to a Chinese ASAT capability. It is possible to harden future generations of satellites (although this imposes a weight penalty) and to make them stealthier – harder to detect and target. However, these steps do little for the very large number of existing satellites already in orbit. The US could also upgrade (or restore) its surge capabilities to deploy replacement reconnaissance and communications satellites in the event of a conflict, or look for other methods to build in redundancy and complicate the Chinese task. China would be put in an awkward position, for example, if the US contracted with European satellite service providers. This would put a potential attacker in the position of either not disrupting some US military space activities or broadening the conflict by attacking third party satellites.

Some of the techniques that the US may want to adopt in light of these Chinese ASAT programs include the use of stealth technology to reduce the radar signature, the use of decoys, or the use of constellations of smaller satellites (rather than a single, large craft) to make targeting more difficult and to increase redundancy. "Hiding" an intelligence satellite by orbiting it simultaneously with a more benign spacecraft could also complicate targeting.[32] The US, if it has not already done so, may want to expand its terrestrial surveillance of key US military satellites in order to detect efforts to shadow them or attach parasites.

At first glance, it might also seem worthwhile for the US to pursue negotiations with China to limit and control ASAT capabilities on both sides, as was done with the Soviets. In asking for negotiations, the US may find itself at a disadvantage. Since the gain to China from ASAT capabilities is much greater than the gain to the US of disabling Chinese satellites, China may be unwilling to make many concessions. However, the Chinese have a greater interest in limiting the US ability to deploy space based weapons. A negotiation would likely involve a trade where China agreed to end its ASAT activities in exchange for a US commitment not to weaponize space.

This means that a US decision to initiate negotiations on ASAT weapons would require weighing whether the potential benefits of space weaponization outweigh the benefits of an agreement to secure space assets. The cost of negotiations could also be increased by China's negotiating style and expertise. China lacks a long experience of strategic arms control negotiations and their implementation and verification.

In the past, it has often preferred to engage in multilateral fora (such as the UN General Assembly or the equally unwieldy Conference on Disarmament) rather than on a bilateral basis. This provides China both greater negotiating leverage and a "fuzzier" outcome for security-related issues, but does not suggest any great seriousness of purpose.[33]

Negotiations could too easily formalize China as a potential opponent along the lines of the Soviets. In light of Chinese ground-based and space-based ASAT efforts, US needs might be best served in the near term, not by negotiation, but by ensuring that hardening, redundancy, and surge capabilities are integral elements of its space planning. Trying to force China into the mold of a mirror-image competitor probably hampers US analytical efforts. If China is pursuing not duplication but asymmetric benefit, a program that looks very different from the US may be adequate and may pose unexpected threats. A mirror-image model could distort our understanding of Chinese programs.

In addition to these measures, the US can counter Chinese military efforts in space by continuing to pursue information superiority in its own military planning and acquisitions. The improvements in response time, targeting, and the incorporation of intelligence and information into tactical planning and operations that information superiority and aerospace assets can provide will increase the advantages the US has over other military forces. Continued progress in building a cohesive architecture that combines space, aerospace, and ground assets to expand information superiority will reduce the effect of Chinese efforts in space to degrade US military effectiveness.

Finally, the US may want to consider whether and how to cooperate in civil and commercial space efforts with China. The secrecy that surrounds many Chinese space activities and the blurring of civil and military space programs mean that one of the problems for US policy is that it is difficult to distinguish between areas where cooperation poses little risk and offers benefits to the US and areas where cooperation should be avoided. However, the US and the Soviets were able to cooperate in space (until the invasion of Afghanistan) at a low level of visibility despite a much more confrontational relationship. Cooperation was driven in large measure by political considerations.[34] For China, the US would need to weigh the benefits of encouraging an emphasis on civil space activities and the potentially greater insight into China's space programs and capabilities, against the possibility of inadvertent technology transfer. Overall, however, cooperation in civil space, by reducing uncertainty about China's space programs, would be beneficial.

This latter concern may be overstated, given the progress we have seen to date in China's space efforts. The US should reconsider its restrictions on satellite technology transfer. The extent and progress of Chinese military programs, which were the target of these restrictions, suggest that US policy has been ineffective. The restrictions applied primarily to commercial communications satellites and their launch, and had little effect on military programs, where the technology is largely unrelated to communications satellites. In only a few areas, such as advanced space sensors, does it make sense to continue tight restrictions on satellite technology transfer from the US? To the extent that the restrictions damage US firms (and there is evidence that suggests that they have driven many subcontractors out of the space business) and make it more difficult for US research centers to cooperate with European or Japanese space programs, they actually do more harm to the US than to China. The goal should be to accelerate innovation in the US rather than continue efforts to slow innovation in China.

Notes

[1] See the section on " Science, Technology, and Industry for National Defense" in "White Paper: China's National Defense

in 2000" published by the Information Office of the State Council, Beijing, (October 16, 2000)

[2] BBC, "China Joins EU Satellite Network," available at http://news.bbc.co.uk/2/hi/business/3121682.stm; European Commission, Directorate General for Energy and Transportation, "Galileo: European Satellite Navigation System: Public Regulated Services," available at http://europa.eu.int/comm/dgs/energy_transport/galileo/programme/service_prs_en.htm.

[3] The Chinese reported in their 2000 Space White Paper that "remote-sensing and telecommunications satellites account for about 71% of the total number of satellites developed and launched by China." The figures used in the chart show these categories accounting for 79%.

[4] We used data from four sources (NASA, FAA, the Teal Group and the Air Force Association's Space Almanac to estimate the number of military launches. None of these sources agreed completely with each other. We used the most the FAA numbers, which assign the smallest number of military launches to the US. Other sources, which posit an even higher number of US military launches, reinforce the argument that China is not making a comparable effort in space.

[5] MG Wang Pufeng, "The Challenge of Information Warfare," in China Military Science, (Spring 1995)

[6] China provides 70% of CBERS funding, launch vehicles, and components such as the imaging cameras. China and Brazil plan to build additional satellites with 5-meter resolution instead of the 20-meter resolution for current CBERS. UN Office for Outer Space Affairs, "Highlights in Space Technology and Applications for 2000," available at http://www.oosa.unvienna.org/isis/highlights2000/sect8a.html; Ministry of Science and Technology (Brazil), "China-Brazil Earth Resources Satellite – A Chinese Brazilian Tribute to Our Earths Natural Resources," (October 7, 2002), available at http://www.dgi.inpe.br/html/eng/cbers.htm.

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[7] This would seem to be modeled, of course, on the US reconnaissance satellite constellation, which reportedly has 4 imaging and 2 radar satellites.
[8] Richard Fisher, "Report on the Zhuhai Airshow, November 3-8, 2002" Center for Security Policy, available at http://www.centerforsecuritypolicy.org/index.jsp?section=static&page=zhuhai2002
[9] See, for example, "China Remote Sensing Satellite Ground Station," Chinese Academy of Sciences, available at http://www.rsgs.ac.cn/english.htm; For an early account, see Wang Xinmin, "China Remote Sensing satellite ground station and its research and development," Proceedings, Asian Conference on Remote Sensing 1990, available at http://www.gisdevelopment.net/aars/acrs/1990/H1/dip003.shtml
[10] The Chinese government lists the National Remote- Sensing Center, National Satellite Meteorology Center, China Resources Satellite Application Center, Satellite Oceanic Application Center and China Remote-Sensing Satellite Ground Station, as well as satellite remote-sensing application institutes under related ministries of the State Council, some provinces and municipalities and the Chinese Academy of Sciences.
[11] "China Accelerates Government GIS Project," People's Daily, (May 11, 2000), available at http://english.peopledaily.com.cn/200005/11/eng20000511_40555.html
[12] A.V. Lele, "China as a Space Power," Strategic Analysis, (April 2002)
[13] The US did not officially acknowledge a space-based Sigint capability until 1995. China does not seem to have a MASINT (Measurement and Signatures Intelligence) program, despite the increased attention this "INT" is receiving in the US. See http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB23/14-01.htm
[14] Desmond Ball
[15] http://www.fas.org/irp/world/china/pla/dept_3.htm

[16] Federation of American Scientists, "The experimental ELINT satellites of the late 1970s were discontinued for unknown reasons." http://www.fas.org/spp/guide/china/military/sigint/geo-sigint.htm.
[17] David J. Thompson and William R. Morris, "China in Space: Civilian and Military Developments," Maxwell Paper No. 24, (Air War College, August 2001)
[18] "The SJ Series Scientific Experiment Satellite," China Defense Today, (December 8, 2002), available at http://www.sinodefence.com/space/spacecraft/sj.asp.
[19] http://www.fas.org/spp/guide/russia/military/sigint/ref66
[20] "China Launches two new Satellites," Xinhua News Agency, (April 19, 2004), available at http://news.xinhuanet.com/english/2004-04/19/content_1426357.htm
[21] A surge capability would also require improvement in China's ability to launch on demand. Chinese sources claim they have reduced the time for launch preparations from 90 to 20 or 30 days, according to Zhang Qingwei, President of China Aerospace Science and Technology Corp. "Record number of satellites to lift off," China Daily, (November 14, 2003), available at http://www1.chinadaily.com.cn/en/doc/2003-11/14/content_281739.htm.
[22] For a discussion of the use of clusters of microsatellites, see A. Wicks, A. Da Silva-Curiel, J. Ward, M. Foquet, "Advancing Small Satellite Earth Observation: Operational Spacecraft, Planned Missions and future Concepts," 14th Annual AIAA/USU Conference on Small Satellites, (2000), available at http://www.sdl.usu.edu/conferences/smallsat/proceedings/14/tsi/i-8.pdf
[23] Phillip Saunders, Jing-dong Yuan, Stephanie Lieggi, and Angela Deters, "China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons," Monterrey Institute of International Studies Center for Nonproliferation Studies,

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(July 2002), available at
http://cns.miis.edu/pubs/week/020722.htm

[24] US Department of Defense, "Annual Report on the Military Power of the People's Republic of China," (July 2003), page 36

[25] http://www.worldnetdaily.com/news/article.asp?ARTICLE_ID=18150

[26] For example, in May 2002, the head of China's lunar exploration program told the BBC that China would not be launching a manned mission to the Moon in the foreseeable future. Ouyang Ziyuan, chief scientist of China's Moon exploration program repudiated reports in the Chinese media that Beijing would put a man on the Moon by 2010 and establish a lunar soon thereafter. "We will explore the Moon certainly," he said, "but with unmanned spacecraft." More recently, Chinese defense officials confirmed that China indeed has plans to land on the moon by 2010 and establish a lunar outpost. BBC, "China denies manned Moon mission plans," May 21, 2003, available at http://news.bbc.co.uk/2/hi/science/nature/2000506.stm; BBC, "China Details Space Plans," October 6, 2003, available at http://news.bbc.co.uk/1/hi/world/asia-pacific/3166832.stm

[27] Joseph Kahn, "China's New Great Leap: Into Space," New York Times, (March 15, 2003).

[28] A good recent discussion of the issues in estimating Chinese military expenditures can be found in Richard A. Bitzinger, "Analyzing Chinese Military Expenditures," in Stephen J. Flanagan and Michael E. Marti, The Peoples Liberation Army and China in Transitions, (National Defense University, 2003).

[29] Charges that China's small space budget buys more than it would in the US are true, but need to be put in perspective. The best estimates of a differential between US and Chinese space activity, although dated, is in work done by USTR in preparation for trade agreements with China on commercial space launches found that Western launches might cost perhaps three times more than launches by China. Making a

heroic assumption, this suggests at most the Chinese spend the equivalent of $5 billion for all space activities.

[30] Space White Paper

[31] See Mark A. Stokes, "China's Strategic Modernization: Implications for the United States," (Strategic Studies Institute, Army War College, September 1999) for a discussion.

[32] Walter Pincus, "Smaller Spy Satellites May Give US Stealth Capability Over Trouble Spots," Washington Post, (February 1, 1998). p.A9

[33] State Council of the Peoples Republic of China, "White Paper on China's Space Activities," section on "Prevention of an Arms Race in Outer Space"

[34] Leonard David, "Space Cooperation: The China Factor," Space.com, (January 5, 2003), available at http://www.space.com/news/china_space_020313.html