THE HENRY L. STIMSON CENTER

PRESERVING FREEDOM OF ACTION IN SPACE: REALIZING THE POTENTIAL AND LIMITS OF U.S. SPACEPOWER

MICHAEL KREPON, THERESA HITCHENS, AND MICHAEL KATZ-HYMAN

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The Henry L. Stimson Center
1111 19th Street, NW
12th Floor
Washington, DC 20036

Telephone: 202-223-5956
Fax: 202-238-9604

www.stimson.org
email: info@stimson.org

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PREFACE

Dear Colleague,

I am pleased to share with you this new report *Preserving Freedom of Action in Space: Realizing the Potential and Limits of U.S. Spacepower*. Michael Krepon, Theresa Hitchens and Michael Katz-Hyman have written a thoughtful and useful exploration of space power - how we need to think about it, and what we need to do to manage and maintain the use of space for its diverse uses in the 21st century world. The authors underscore the shared vulnerability of the world's societies, should conflict in space disable or destroy the satellites that play such a vital role in the global economy and in support of humanitarian operations. They advocate a new code of conduct for space that would provide added assurance of space security to global stakeholders that benefit from the services satellites provide.

This work is the collaboration of the Stimson Center's founding president, Michael Krepon, who currently leads the Center's work on space and various proliferation issues, as well as South Asia, his able Research Associate Michael Katz-Hyman, and Theresa Hitchens, the Director of the Center for Defense Information. We have enjoyed a productive collaboration with Ms. Hitchens and CDI, and are pleased that this creative partnership has generated such a constructive and useful set of ideas about space power. I also want to thank National Defense University Press, which has given us permission to publish this essay in advance of its inclusion in an edited book on spacepower theory.

Sincerely,

Ellen Laipson
President and CEO

PRESERVING FREEDOM OF ACTION IN SPACE:
REALIZING THE POTENTIAL AND LIMITS OF U.S. SPACEPOWER

by
Michael Krepon, Theresa Hitchens, and Michael Katz-Hyman

Our working definition of spacepower is the sum total of capabilities that contribute to a nation's ability to benefit from the use of space. Spacepower, like other types of power, can wax or wane depending on a country's choices and the choices of its potential adversaries. Wise choices can lead to cumulative increases in spacepower, but even wise national choices can be negated, in part, by poor choices by other space-faring nations. For example, significant debris increasing events in space could impair spacepower for all nations.

There is widespread agreement on what most of the key elements of spacepower are, but not all key elements are equal. Key elements would surely include possessing the relevant technology base, physical infrastructure, and workforce necessary to excel in space. Space prowess is also measured by how purposefully and successfully these essential elements are applied to specific missions. Many missions increase the sum total of a nation's capability in space. Uncontroversial metrics would include the utilization of space for the advancement of knowledge and for exploration; the facilitation of commercial transactions, resource planning, and terrestrial economic development; monitoring planetary health; mapping; telecommunications and broadcasting; assisting first responders, search and rescue operations, and disaster relief; and providing early warning of consequential events.

These pursuits are clearly indicative of a nation's space prowess, but space prowess and spacepower have different connotations. Since meaning is partly defined by circumstances, and since circumstances, with respect to the utilization of space, are so favorable for the United States, it is understandable why passionate and articulate American advocates of spacepower often define this term in a muscular way. Many forceful advocates equate spacepower with military missions because U.S. forces are extraordinarily dependent on space assets, because these assets confer significant advantages while saving countless lives on the battlefield, and because the negation of these assets would be so harmful.[1] Another reason why spacepower is widely defined in muscular terms is because commercial, communication, and military uses of space have become less separable.

[1] See, for example, David E. Lupton, *On Space Warfare: A Spacepower Doctrine* (Maxwell AFB, Ala.: Air University Press, June 1998); Colin S. Gray, "The Influence of Spacepower upon History," *Comparative Strategy* 15, no. 4 (October-December 1996): 293-308; Jim Oberg, *Spacepower Theory* (Washington, D.C.: GPO, 1999); and *Air Force Doctrine Document 2-2, Space Operations* (Maxwell AFB, Ala.: Air Force Doctrine Center, November 27, 2001).

While the military uses of space are growing for the United States and other space-faring nations, sweeping analogies between spacepower and terrestrial military power are unwise. In space, power is not accompanied by weapons – at least not yet. And in space, weapon-enabling technologies are widely applicable to nonmilitary pursuits. The "hard" elements of spacepower are increasingly important, and yet are currently confined to gravity-bound battlefields. In contrast, the "soft power" aspects of space prowess are unbounded, with satellites used for direct broadcasting and communication becoming conveyor belts for the projection of national culture and economic transactions. The long history of international cooperative research among civil space agencies reflects another element of soft spacepower. Collaborative missions such as the Apollo-Soyuz mission, the International Space Station, and the Space Shuttle attest to the utility of soft spacepower as a diplomatic instrument. China, an emerging spacepower, is following this well-trodden path, at least in part, by forging space cooperation agreements with nations such as oil-rich Nigeria.

Soft spacepower is nowhere more evident than in the commercial realm, where economic competition is sometimes fierce but multinational cooperation is required. The world relies at present on five major multinational corporations for the provision of global telecommunications. Global and national reliance on space assets have become intertwined not only for communications, but also for banking, disaster monitoring, weather forecasting, positioning, timing and navigation, and myriad other activities central to modern life. Indeed, most satellites are primarily used for commercial and civil uses, although they also can serve military purposes. The use of space for commercial and economic development, as well as for other soft power applications can be jeopardized if the deployment and use of weapons in space occurs. This is because once weapons in space are used, weapon effects may not be controllable, as it is difficult to dictate strategy and tactics in asymmetric warfare. Consequently, weapon effects may not be limited to a small subset of satellites, or satellites of a particular nationality. In this sense, hard and soft spacepower cannot be decoupled. The misapplication of hard spacepower could therefore have indiscriminate effects, particularly if a destructive strike against a satellite results in significant and long-lasting debris.

The misapplication of hard power here on Earth could also adversely affect relations between major powers, friends, and allies. The interconnectedness of hard and soft spacepower means that poor decisions by one space-faring nation are more likely to negatively affect all other space-faring nations, a situation that does not arise in non-nuclear, terrestrial conflict. The length of recovery from poor decisions in space is also far longer than from non-nuclear, terrestrial conflict. For example, when conventional battles take place on the ground, sea and air, debris is a temporary and geographically limited phenomenon. Minefields can be marked or cleared and chemical warfare can be contained or cleaned up – although this may take large amounts of both time and money. Battlefield debris in space, however, can last for decades, centuries, or even millennia, thereby constituting an indiscriminate lethal hazard to space operations. Debris generated in space also tends to spread to other orbits over time, and environmental clean-up technologies in space do not appear promising at present.[2] In gravity-based warfare, the victor's

[2] J.-C. Liou and N.L. Johnson, "Risks in Space from Orbiting Debris," *Science*, Vol 311, January 20, 2006, p.340.

spoils are gained through unhindered access. But unhindered access is likely to be lost in the event that weapons are used in or from space, even for the "victor."

Battlefields in space are therefore fundamentally different from those on land, at sea, or in the air. The potentially disabling problem of space debris is now well recognized even by advocates of hard spacepower. "Hit to kill" kinetic energy anti-satellite weapons (ASATs) that were tested in the 1970s and 1980s have therefore fallen out of favor – at least in the United States, but apparently not in the China, whose January 2007 test was the worst debris generating event in the history of the space age.[3] The earliest ASAT weapons – nuclear warheads atop ballistic missiles – would produce indiscriminate and lethal effects, as the United States learned after conducting a series of atmospheric nuclear tests in 1962. Nonetheless, this method of space warfare could still be employed. Currently, the preferred U.S. methods of using force to maintain "space control" entail nondestructive techniques (although U.S. officials and military leaders have not ruled out destructive methods). But bounding the unintended, negative consequences of warfare in space depends on truly heroic assumptions, beginning with the dictation of rules of warfare against weaker foes. In unfair fights, however, weaker foes typically play by different rules. And if debris-causing space warfare hurts the United States severely, it is reasonable to expect that U.S. fastidiousness in engaging in warfare in space may not be reciprocated – as the Chinese kinetic-kill ASAT test seemed to indicate.

While appreciation of soft spacepower has expanded, arguments over the military uses of space have actually narrowed over time. In an earlier era, there were heated debates over the propriety of using space for monitoring secret military activities. Beginning in the 1970s, "national technical means" used to monitor nuclear forces received formal treaty protection. Subsequent debates focused on the propriety of using space to assist military operations. During the administrations of Presidents Jimmy Carter and Ronald Reagan, Soviet negotiators sought expansive definitions of space weapons (including the Space Shuttle!) to constrain perceived U.S. military advantages in space. These negotiating gambits have long since lost their audience. The use of satellites to assist military operations here on Earth is no longer controversial; instead it has now become the primary (and widely envied) metric of spacepower.

While debates over spacepower and its advancement have become more narrowly drawn, they continue to be quite heated. Current debates focus not on the military uses of space, but on its "weaponization." This dividing line is admittedly not clear cut, and is fuzziest on the issue of jamming, when disruptive energy is applied not against satellites *per se*, but against satellite communication links. Another gray area in the spectrum leading from militarization to weaponization relates to lasing objects in space.

While acknowledging gray areas, and discussing them further below, we submit that they do not absolve or oblige us to obliterate useful distinctions between the militarization and weaponization of space. It is true, for example, that long-range ballistic missiles that carry deadly weapons transit space en route to their targets. But these are ground-based weapons aimed at ground-based targets, rather than being weapons based in space or aimed at space-based targets. Rigorous

[3] Frank Morring Jr., "Worst Ever: Chinese anti-satellite test boosted space-debris population by 10% in an instant," *Aviation Week and Space Technology*, February 12, 2007, p.20.

analysis mandates that we distinguish between transitory phenomena and permanent conditions. Similarly, we can and must be able to differentiate between the uses of lasers for range-finding, space tracking, and communication purposes, and the use of lasers to temporarily disable or destroy satellites. One type of activity provides substantial benefit while the other invites great risk.

We further argue that U.S. national security and economic interests are advanced by seeking to clarify this distinction, and by seeking the concurrence and reinforcement of this distinction by other key space-faring nations.

By seeking to distinguish between the militarization and weaponization of space, we argue that analogies between spacepower and other forms of military power have only limited utility. In other realms of military affairs, we measure power by metrics such as the number of weapons available, various characteristics that make such weapons more effective, and their readiness of employment. Accordingly, the distinction between militarization and weaponization is meaningless when we discuss air, ground, and naval forces. In contrast, space power is defined at present without reference to the deployment and use of weapons in space. We argue that the absence of these conditions is favorable to the United States and facilitates the spacepower of all space-faring nations.

While some have compared space to another "global commons," the high seas, we believe this analogy to be deeply flawed. Warships provide back-up for sea-based commerce, but they are essentially instruments of war fighting. Satellites, on the other hand, usually serve multiple purposes in both military and nonmilitary domains. A ship damaged in combat can seek safety and repairs at a friendly port. The debris from combat at sea sinks, and rarely constitutes a lingering hazard. Satellites, unlike warships, are extremely difficult, if not impossible, to defend. If space weapons are deployed and used, no nation can expect there to be safe havens in space. And if the most indiscriminate means of space warfare are employed, debris will become a long-lasting hazard to military and non-military satellite operations.

All countries would be victimized if a new precedent is set and satellites are targeted in warfare. As the preeminent space power, the United States has the most to lose if space were to become a shooting gallery. The best offense can serve as an effective defense in combat at sea, but this nostrum doesn't apply in space, since essential satellites remain extremely vulnerable to rudimentary forms of attack. The introduction of dedicated and deployed weapons in space by one nation would be replicated by others that feel threatened by such actions. The first attack against a satellite in warfare is therefore unlikely to be a stand-alone event, and nations may choose different rules of engagement for space warfare, and different means of attack once this threshold has been crossed.

Our analysis thus leads to the conclusion that the introduction and repeated flight-testing of dedicated space weapons would greatly subtract from U.S. spacepower, placing at greater risk the military, commercial, civil, and life-saving benefits that satellites provide. Instead, we propose a space assurance strategy that seeks to preserve and grow the advantages the United States now enjoys as the preeminent spacepower, while hedging against hostile acts by other space-faring nations.

We argue that realizing the benefits of spacepower requires acknowledgement of four related and unavoidable dilemmas. First, the satellites upon which spacepower rests are extremely vulnerable. To be sure, advanced space-faring nations can take various steps to reduce satellite vulnerability, but the limits of protection will surely pale besides available means of disruption and destruction, especially in low Earth orbit (LEO). Vulnerabilities can be mitigated, but not escaped.

The dilemma of the profound vulnerability of essential satellites has been reinforced by another dilemma of the space age: satellites have been joined at the hip with the nuclear forces of major powers. Nuclear deterrence has long depended on satellites that provide early warning, communication, and targeting information to national command authorities. To mess with the satellites of major powers has meant – and continues to mean – the possible use of nuclear weapons since major powers could view attacks on satellites as precursors to attacks on their nuclear forces. Even nuclear powers that do not rely on satellites for ballistic missile warning still rely on them for communications and targeting. Preemptive attacks on these satellites could be interpreted as a precursor to nuclear strikes.

The third dilemma of spacepower is that space disruption is far more achievable than space control. A strong offense might constitute the best defense on the ground, in the air and at sea, but this principle holds little promise in space since a strong offense in this domain could still be negated by asymmetric means. Space control requires exquisitely correct, timely, and publicly compelling intelligence; the readiness to initiate war and to prevent another nations from shooting back; as well as the ability to dictate the choice of strategy and tactics in space. It takes great hubris to believe that even the world's sole superpower would be able to fulfill the requirements of space control when a one dollar bag of marbles could destroy a one billion dollar satellite, with proper insertion into LEO. The ability of the United States to dictate military strategy and tactics in asymmetric, gravity-bound warfare has proven to be challenging; it is likely to be even more challenging in space, where there is less margin for error.

The fourth, overarching dilemma relating to spacepower therefore rests on the realization that hard military power does not ensure space control, particularly if other nations make unwise choices, and if these choices are then emulated by others. The United States has unparalleled agenda-setting powers, but Washington does not have the power to dictate or control the choices of other nations.

These dilemmas are widely, but not universally, recognized. Together, with the widespread public antipathy to elevating humankind's worst instincts into space, they help explain why the flight-testing and deployment of dedicated space weapons have not become commonplace. These capabilities are certainly not difficult to acquire, as they are decades old. Indeed, tests of dedicated ASAT weapons have periodically occurred, and such systems were deployed for short periods during the Cold War. Surely, if the weaponization of space were inevitable, this would have occurred when the United States and the Soviet Union went to extraordinary lengths to compete in so many other realms. The weaponization of space has not occurred to date and is not inevitable in the future for two compelling reasons: public citizens strongly dislike the idea of weapons in space, and most national leaders have long recognized that this would open a Pandora's Box that would be difficult to control.

Much has changed since the end of the Cold War, but the fundamental dilemmas of space control, including the linkage of satellites to nuclear deterrence among major powers, have not changed. The increased post-Cold War U.S. dependence on satellites makes the introduction of dedicated space weapons even more hazardous for national and economic security. Advocates of muscular space control must therefore take refuge in the fallacy of the last move, since war-fighting plans in space make sense only in the absence of return fire. Offensive counter-force operations in space do not come to grips with the dilemmas of spacepower, since proposed remedies are far more likely to accentuate, rather than reduce, satellite vulnerability.

This analysis leads inexorably to a deeply unsatisfactory and yet inescapable conclusion: Realizing the enormous benefits of space prowess and spacepower depends on recognizing the limits of power. The United States now enjoys unparalleled benefits from the use of space to advance national and economic security. These benefits would be placed at risk if essential zones in space become unusable as a result of warfare. Spacepower and space assurance depend therefore on the preservation and growth of U.S. capabilities in space. Paradoxically, the preservation and growth of U.S. spacepower will be undercut by the use of force in space.

Because the use of weapons in or from space can lead to the loss or impairment of satellites of all major space powers, and since all major space powers depend on satellites for military and economic security, it is possible to craft a regime based on self-interest to avoid turning space into a shooting gallery. This outcome is far more difficult to achieve if major space powers engage in the flight-testing and deployment of dedicated ASAT weapons or space-to-Earth weapons. We therefore argue that it would be most unwise for the United States, as the spacepower with the most to lose from the impairment of its satellites, to initiate these steps. Similar restraint, however, needs to be exercised by other major space-faring nations, some of which may feel threatened by the preservation and growth of U.S. spacepower, or may believe that it is necessary to hold U.S. space assets at risk. The United States is therefore obliged to clarify to others the risks of initiating actions harmful to U.S. satellites, without prompting other space-faring nations to take the very steps we seek to avoid. Consequently, a preservation and growth strategy for U.S. spacepower also requires a hedging strategy because, even if the United States makes prudent decisions in space, others may still make foolish choices.

HEDGING

The exercise of restraint from using weapons in space is not easy for the world's most powerful nation or for other nations fearing catastrophic losses that they believe might be averted by disabling U.S. satellites. We must therefore consider the possibility that, even if U.S. leaders act wisely, other leaders in weaker nations may make costly, poor decisions. How, then, might U.S. spacepower influence the decisions of other nations to leave vulnerable satellites alone?

We maintain that a prudent space posture would clarify America's ability to respond purposefully if another nation interferes with, disables, disrupts, or destroys U.S. satellites, without being the first to take the very actions that we wish others to refrain from taking. Thus, our proposed hedging strategy would not include the flight-testing and deployment of dedicated ASAT or on-orbit weapons because such steps would surely be emulated by others, and would increase risks to vital U.S. space assets. Whatever preparations the United States takes to hedge against attacks on U.S. satellites must be calibrated to maximize freedom of action and access in space. Hedging moves that create an environment where the flight-testing and deployment of space weapons would be a common occurrence would thus be contrary to U.S. military and economic security.

Responsible hedges by the United States include increased situational awareness, redundancy, and cost-effective hardening of satellites and their links. The strongest hedge the United States possesses is its superior conventional military capabilities, including long-range strike and special operations capabilities. Since an attack on a satellite can be considered as an act of war, the United States could respond to such an attack by targeting the ground links and launch facilities of the offending nation or the nation that harbors a group carrying out such hostile acts. Far more punishing responses might be applicable. A hedging strategy is also likely to include ground-based research and development into space weapon technologies, activities that are underway in major space-faring nations.

The demonstration of dual-use or multi-use space technologies that could be adapted, if needed, to respond to provocative acts would constitute another element of a responsible hedging strategy. Such technologies could include on-orbit rendezvous, repair and refueling technologies and other proximity operations. These activities are also essential for expanded scientific and commercial use of space, and would be key enabling technologies for long-duration missions such as the return to the Moon and the exploration of Mars.

A prudent hedging strategy would also align U.S. military doctrine and declaratory policy with America's national security and economic interest in preventing weapons in space and ASAT tests. In the context of a proactive Air Force counter-space operations doctrine and official disdain for negotiations that might constrain U.S. military options in space, the hedging strategy we advocate might be perceived as preliminary steps toward actions we would oppose. Wise hedging strategies would therefore also be accompanied by constructive diplomatic initiatives.

The flight-testing of multi-purpose technologies, the possession of dominant power projection capabilities, and the growing residual U.S. military capabilities to engage in space warfare should provide a sufficient deterrent posture against a "space Pearl Harbor."[4] These capabilities would also clarify that the United States possesses the means to compete effectively in a competition that other major space powers claim not to want, as well as to react in a prompt and punishing way against hostile acts against U.S. space assets.

If all responsible space-faring nations adhere to a "no first ASAT" test regime, and an adversary still carries out a "space Pearl Harbor" by using military capabilities designed for other purposes,

[4] U.S. Department of Defense, "Report of the Commission to Assess United States National Security Space Management and Organization" (Washington, DC: Dept. of Defense, 2001), p.8.

the United States has the means to respond in kind. U.S. latent or residual space warfare capabilities exceed those of other space-faring nations, and are growing with the advent of ballistic missile defenses. We maintain that the existence of such capabilities constitutes another element of a hedging strategy, while providing further support for our contention that dedicated ASAT tests and deployments are both unwise and unnecessary.

A SPACE PRESERVATION AND GROWTH STRATEGY

A successful hedging strategy preserves and grows U.S. spacepower. In contrast, the flight testing and deployment of dedicated ASAT and on-orbit weapons increases the likelihood that U.S. space assets would not be available or would be gravely impaired when needed. Space control operations that foster the preservation and growth of U.S. spacepower are to be welcomed; space control operations that would have the net effect of placing U.S. satellites at greater risk are to be avoided.

The U.S. Air Force's doctrine on space control operations, *Counterspace Operations*, requires the identification of adversary space assets and space-related capabilities on Earth. Identified targets include on-orbit satellites (including third-party assets), communication links, launch facilities, ground stations, and Command, Control, Computer, Communication, Intelligence, Surveillance, and Reconnaissance (C4ISR) resources.[5] Many of these satellites or space-related assets can be targeted using multi-purpose conventional capabilities. For example, launch facilities and ground stations can be targeted by ground forces, warships, and air power. Communication links can be jammed using proven systems, and elements of C4ISR can be neutralized using cyber attacks. Many space powers possess these capabilities to varying degrees, which may help explain why dedicated systems to attack satellites have rarely been flight tested or deployed.

The vulnerability of terrestrial space assets can be mitigated in a number of different ways. Equipment can be hidden, hardened or operated stealthily. Depending on the order of battle and opposing military capabilities, some assets could be protected by overwhelming force, and assets lost in battle can sometimes be replaced in quantity. These considerations are quite different in space, where force replacement is usually problematic and protection measures operate, at best, on the margins of economic and technical possibility.

Major space powers should be adept at locating satellites in Earth orbit. Maneuvering in space, unlike terrestrial warfare, is usually very limited. While satellites can be placed in orbits that pass over regions with limited space surveillance capabilities, the nature of orbital mechanics dictates that, at some point, satellites will be visible to ground observers.[6] Fuel is a more precious commodity in space due to its weight and very limited prospects for refueling. Maneuvering for most spacecraft is limited to normal station-keeping operations. Moreover, satellites, unlike tanks, cannot be suitably armored for combat. They can be hardened to withstand some types of electromagnetic interference and small impacts, but it is not feasible to shield against an impact

[5] *Counterspace Operations*, Air Force Doctrine Document 2.2-1, August 2, 2004, pp. 32-33.
[6] Even classified satellites, for which no orbital data is publicly available, have been tracked by amateur ground observers using nothing more then a camera and a stopwatch. See, for example, the *Visual Satellite Observer's Home Page* website at <http://www.satobs.org/>.

from even a marble-sized debris hit, much less an intentional physical attack. Spacecraft shielding increases launch weight and costs approximately $10,000 per pound.[7]

Operating satellites in formations for defensive purposes is quite different from operating aircraft carrier battle groups. Valuable warships can survive direct hits of various kinds, and the debris from losses at sea sinks to the bottom of the ocean. In contrast, the debris from satellite warfare could impair an entire formation in space, placing at risk the orbit of the high value satellite meant to be protected. Arming satellites with defensive weapons is not a satisfactory solution for many reasons. Unlike warships or tanks that can maneuver and fire many weapons, satellites have little carrying capacity beyond that required to perform their missions. The fundamentals of space warfare described above – including the difficulties in dictating tactics and the choice of weapons, as well as the consequences of space debris – appear immutable. The marginal cost of attack will always be less than the marginal cost of defense, since attacking does not necessarily require technological sophistication and since limited attacks can be decisive.

If satellites cannot be effectively defended by space weapons, the protection of essential but vulnerable satellites rests largely on deterrence. When offense is too lethal to use because its net effect would be to harm vital national assets and interests, the default option for freedom of action in space is to accept mutual vulnerability. Nuclear deterrence had many detractors during the Cold War, even though it helped prevent nuclear exchanges between ideological, well-armed foes. The more power a nation possesses, the harder it is to accept vulnerability. But the benefits of hard and soft spacepower inescapably depend on satellites that are far easier to attack than to defend.

Asymmetric capabilities and vulnerabilities in space do not negate the precepts of deterrence or the essence of mutual vulnerability. During the Cold War, for example, Beijing faced not one, but two hostile superpowers, and yet chose to maintain nuclear forces that were significantly inferior to those of the United States and the Soviet Union. Presumably, China's leadership concluded that relatively few mushroom clouds were needed to clarify superpower vulnerability.

We argue, by analogy, that asymmetries related to dependence on space and capabilities in space do not alter the fundamentals of vulnerability and deterrence. The country with the most to lose from attacks on satellites, the United States, also has the most capabilities to respond with lethal force, which would be more indiscriminate because of the impairment or loss of its satellites. We have argued elsewhere that space warfare and its effects are unlikely to be country-specific. Because space warfare is inherently more indiscriminate than terrestrial warfare, and because all space-faring nations are increasingly dependent on space assets for national and economic security, all major powers face the same fundamental dilemma that satellites are both essential and extraordinarily vulnerable, and that the use of weapons in space is likely to have unintended, negative consequences. Those who argue that it is possible to carry out a "discriminating" attack against satellites that does not harm human beings and that serves national purposes must believe in the fallacy of the last move. Mechanical objects may be the initial victims of space warfare,

[7] Futron Corporation, "Space Transportation Costs: Trends in Price Per Pound to Orbit 1990-2000," <http://www.futron.com/pdf/resource_center/white_papers/FutronLaunchCostWP.pdf>.

but satellites are very unlikely to be the only victims of space warfare, since they are directly linked to soldiers, noncombatants, and nuclear weapons.

Nuclear deterrence was based on the repeated testing of nuclear weapons and their means of delivery, as well as on the deployment of many dedicated weapon systems in a high state of launch readiness. If we were to adopt such practices for dedicated ASAT or space-to-Earth weapons, satellite security would be greatly diminished, and relations among major powers would deteriorate along with international space cooperation. At best, a very uneasy standoff in space could result from the flight testing and deployment of dedicated ASAT weapons. For all practical purposes, however, this uneasy standoff already exists because of the residual military capabilities major space powers have to disrupt or destroy satellites. Since these capabilities are well understood, they do not need to be demonstrated by new testing, the net effect of which would be more worrisome than reassuring.

Mutual assured destruction in space is therefore far easier to maintain than nuclear deterrence during the Cold War, because mutual vulnerability from the use of weapons in or from space does not require demonstrations of the weapons in question. And unlike nuclear deterrence, which had the practical effect of limiting freedom of action, acceptance of mutual vulnerability in space would maximize freedom of action and access. Despite these significant differences, there are two principle connecting threads between the acceptance of mutual vulnerability between major nuclear powers and major space powers. First, attacks on satellites in crises between major powers risks the use of nuclear weapons. And second, existential vulnerability to nuclear and satellite attacks is not soluble by military means.

CODE OF CONDUCT

We view a Code of Conduct for Responsible Space-Faring Nations as a necessary complement to a hedging strategy, and as an essential element of a space posture that provides for the preservation and growth of U.S. space capabilities. We argue that a code of conduct makes sense for several reasons. With the increased utilization and importance of space for national and economic security, there is increased need for space operators and space-faring nations to act responsibly. While some rules and treaty obligations exist, there are many gaps in coverage, including how best to avoid collisions and interference, appropriate uses of lasers, and notifications related to potentially dangerous maneuvers. Because the increased utilization of space for security and economic purposes could lead to friction and diminished space assurance, it serves the interests of all responsible space-faring nations to establish rules of the road to help prevent misunderstandings and grievances.

Another reason for pursuing rules of the road is that interactive hedging strategies could generate unwanted actions in space by nations concerned about the import of technology demonstrations and flight tests. We have therefore argued that hedging strategies need to be accompanied by diplomatic initiatives to set norms that increase the safety and security of satellites vital to U.S. national and economic security. A code of conduct would serve these purposes.

No codes of conduct or rules of the road are self-enforcing. Despite traffic laws, some drivers still speed. But having rules of the road reduces the incidence of misbehavior, and facilitates actions against reckless drivers. We acknowledge that there are no traffic courts for misbehavior in space, but we nonetheless argue that having agreed rules of the road in this domain will also reduce the incidence of misbehavior, while facilitating the isolation of the miscreant as well as necessary remedies.

Traditional arms control was devised to prevent arms racing between the superpowers. With the demise of the Soviet Union, concerns over arms racing have been replaced by concerns over proliferation and nuclear terrorism. Cooperative threat reduction initiatives have been designed to deal with contemporary threats. These arrangements have taken myriad forms, including rules of the road to prevent proliferation. Since the flight testing, deployment and use of weapons in space would increase security concerns, and since security concerns are drivers for proliferation, agreed rules of the road for space could supplement other codes of conduct that seek to prevent proliferation.

Codes of conduct supplement, but are different from, traditional arms control remedies. Skeptics of new arms control treaties to prevent space weapons argue that it would be very difficult to arrive at an agreed definition of space weapons, and that even if this were possible, it would be very hard to monitor compliance with treaty obligations. A code of conduct would focus on responsible and irresponsible activities in space which, in turn, would obviate the need for an agreed definition of space weapons. For example, a code of conduct might seek to prohibit the deliberate creation of persistent space debris. Behavior, not an agreed definition of space weapons, is of primary importance. Moreover, the deliberate creation of persistent space debris is very hard to hide and can be monitored by existing technical means.

The United States has championed codes of conduct governing militaries operating in close proximity at sea (Incidents at Sea Agreement, 1972), in the air and on the ground (The Dangerous Military Practices Agreement, 1989). More recently, the United States has championed codes of conduct to reduce proliferation threats, including The Hague Code of Conduct (2002) and the Proliferation Security Initiative (2003). The 2001 Space Commission Report chaired by Donald Rumsfeld also endorsed rules of the road for space.[8]

Codes of conduct typically take the form of executive agreements in the United States. They can begin as bilateral compacts and grow into significant multilateral agreements that codify expected behavior and clarify unacceptable behavior. Codes of conduct are either an alternative to, or a way station toward more formal treaty-based constraints that often take extended effort.[9]

Some rules of the road, formal agreements, and elements of a code of conduct already exist for space. The foundation document that defines the responsibilities of space-faring nations is the

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[8] U.S. Department of Defense, "Report of the Commission to Assess United States National Security Space Management and Organization" (Washington, DC: Dept. of Defense, 2001), p.18.
[9] For more information regarding space code of conduct approaches, see: Michael Krepon and Christopher Clary, *Space Assurance or Space Dominance: The Case Against Weaponizing Space*, (Washington, D.C.: The Henry L. Stimson Center, 2003), and Theresa Hitchens, *Future Security in Space: Charting a Cooperative Course*, (Washington, D.C.: Center for Defense Information, September 2004).

Outer Space Treaty (1967). Other key international agreements and institutions include the Liability Convention and the International Telecommunications Union (ITU).

There is growing sentiment among space operators to develop and implement several key elements of a code of conduct, including the need for improved data-sharing on space situational awareness; debris mitigation measures; and improved space traffic management to avoid unintentional interference or collisions in increasingly crowded orbits. A more comprehensive code of conduct might include elements such as notification and consultation measures; provisions for special caution areas; constraints against the harmful use of lasers; and measures that increase the safety of, and reduce the likelihood of, damaging actions against satellites, such as the deliberate creation of persistent space debris. Key elements of a code of conduct are useful individually, but they are even more useful when drawn together as a coherent regime.

Situational Awareness

Space situational awareness (SSA) – the ability to monitor and understand the constantly changing environment in space – is one of the most important factors in ensuring the safety and security of all operational satellites and spacecraft. SSA provides individual actors with the ability to monitor the health of their own assets, as well as an awareness of the actions of others in space. Transparency measures can be particularly helpful in providing early warning of troubling developments and in dampening threat perceptions. One measure of U.S. spacepower and space prowess is America's unparalleled space situational awareness capabilities. Thus, the United States is in a position to become a leader in building space transparency, which is the foundation stone of norm setting and rules of the road in space.

Traffic Management

The International Academy of Astronautics (IAA) "Cosmic Study on Space Traffic Management" defines space traffic management as follows:

> Space traffic management means the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and return from outer space to Earth free from physical or radio-frequency interference.[10]

We also endorse intermediate steps toward this outcome, and advocate empowering or creating an industry advisory group that could recommend actions and participate in the work of international bodies.

Notification and Consultations

The development of more formal processes for notification of satellite maneuvers is critical for ensuring space situational awareness; without such notification, satellite tracking and collision avoidance become much more difficult. Pre-launch notification could assist space surveillance as well as traffic management. A model for pre-launch notification might be the June 2000 U.S.-

[10] Corrine Contant-Jorgenson, Petr Lála and Kai-Uwe Schrogl, eds., "Cosmic Study on Space Traffic Management," (Paris, France: International Academy of Astronautics, 2006), p. 10, <http://iaaweb.org/iaa/Studies/spacetraffic.pdf>.

Russian Joint Data Exchange Center[11] and the August 2000 U.S.-Russian Pre- and Post-Launch Notification Agreement.[12] Elements from these agreements – as well as other ideas for data provision – might be studied by COPUOS's Scientific and Technical Subcommittee, and translated into recommendations for either a voluntary regime or a possible multilateral accord.

Special Caution Areas

The IAA Cosmic Study mentions two different approaches to what the Dangerous Military Practices Agreement has termed "special caution areas." In space, special caution areas might consist of provisions for safe distances or zones around satellites or more general "zoning" rules that restrict certain activities in certain orbital planes. Further in-depth study of the technical requirements and legal considerations surrounding the establishment of special caution areas is required before judgments can be made on the practicality and utility of such approaches—work that IAA or other organizations could easily pursue.

Debris Mitigation

The deliberate generation of persistent space debris constitutes a hazard to space operations. Debris mitigation is therefore the most pressing problem related to space traffic management. It is also the code of conduct element that has been furthest developed. The Inter-Agency Space Debris Coordination Committee comprised of the space agencies of the world's major space powers has developed a number of debris mitigation guidelines. Several nations have incorporated the agreed measures into their national laws and regulatory systems and others are moving to do so. The United States is a leader in codifying strong debris mitigation guidelines. Thus, the United States is well placed to use this element of its soft spacepower to set strong international norms and work toward legally-binding, formal international accords.

No Harmful Use of Lasers

There are at least two precedents for restricting the use of lasers during peacetime: the Dangerous Military Activities Agreement and the Incidents at Sea Agreement, also known as the "IncSea" accord.[13] The multiple applications of lasers highlights the utility of establishing rules of the road that distinguish between acceptable uses – such as range-finding, communication, and information gathering – and uses that could be considered acts of war, such as dazzling, blinding, and damaging satellites. Norms regarding laser power/configuration for tracking purposes might be discussed to reduce the likelihood of damage to satellites and to reduce miscalculation. We endorse the convening of a panel of technical specialists to discuss this – perhaps under the auspices of the IAA. COPUOS might also usefully propose procedures for dealing with laser incidents.

[11] See Lt. Col. Peter L. Hays, USAF, "United States Military Space Into the Twenty-First Century," INSS Occasional Paper 42, Institute for National Security Studies, U.S. Air Force Academy, Colo., September 2002, pp. 115-116.
[12] U.S. Department of State Fact Sheet, "Memorandum of Understanding on Notification of Missile Launches," Dec. 16, 2000, <http://www.state.gov/t/ac/trt/4954.htm>; Philipp C. Bleek, "U.S., Russia Sign Missile- and Space-Launch Notification Deal," *Arms Control Today*, January/February 2001, <http://www.armscontrol.org/act/2001_01_02/usruslaunch.asp>; Hays, p. 116.
[13] The PDMA prohibits uses of lasers that might harm personnel or equipment: text of the agreement can be found in *International Legal Materials* 28, no. 2 (1989), pp. 877-895; The IncSea accord prohibits the illumination of the bridges of the other parties' ships: "Agreement Between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on the Prevention of Incidents on and over the High Seas," U.S. State Department web site: <http://dosfan.lib.uic.edu/acda/treaties/sea1.htm>.

Increasing Satellite Safety and Reducing the Likelihood of Satellite Damage

A national space strategy designed to preserve and grow U.S. capabilities in space would benefit from steps to increase satellite safety and reduce the potential damage to satellites upon which that strategy rests. This would, of course, include technical protection measures. However, it would also entail proactive measures to prevent weapons-related creation of space debris. As advocates of U.S. spacepower, we therefore believe it would be wise to set rules of the road against the testing of ASATs or other weapons based in space that would create debris by applying energy against targets. To be sure, the 2007 Chinese ASAT test would violate such a rule. The use of weapons that produce indiscriminate and long-lasting damage in ground combat has justifiably earned widespread opprobrium. The use of certain weapons in space could be doubly injurious, since they could produce indiscriminate and long-lasting damage in orbit which, in turn, could prompt similar damage on Earth.

CONCLUSION

We have argued that spacepower rests on a broad foundation, building upward to the orbital dance of satellites. We further argue that spacepower is inextricably linked to, but different from, other forms of military power. The fundamental paradox of spacepower is that satellite effectiveness and vulnerability are inseparable, which makes hard power projection in and from space an extraordinarily risky undertaking. The preservation and growth of U.S. spacepower therefore requires the protection of satellites – vital assets that can readily be lost and quite difficult to replace in combat – by other means. We propose to address this dilemma through a variety of initiatives, including a hedging strategy and diplomatic initiatives centered on a Code of Conduct for Responsible Space-Faring Nations.

About the Authors

Michael Krepon is the co-founder of the Henry L. Stimson Center, where he served as President and CEO from 1989-2000. Mr. Krepon previously served under President Jimmy Carter at the U.S. Arms Control and Disarmament Agency. He also worked for four years on Capitol Hill, handling armed services and defense appropriations matters. Immediately prior to co-founding the Stimson Center, Mr. Krepon was a Senior Associate at the Carnegie Endowment for International Peace.

Mr. Krepon is the author of *Cooperative Threat Reduction, Missile Defense, and the Nuclear Future* (Palgrave Macmillan, 2003) and *Space Assurance or Space Dominance, The Case Against Weaponizing Space* (The Henry L. Stimson Center, 2003). He is the contributing editor of *Nuclear Risk Reduction in South Asia* (Palgrave Macmillan, 2004), and *Escalation Control and the Nuclear Option in South Asia* (The Henry L. Stimson Center, 2004). Mr. Krepon is the author or co-editor of seven other books, including *Commercial Observation Satellites and International Security* (Palgrave Macmillan, 1990) and *Open Skies, Arms Control, and Cooperative Security* (St. Martin’s Press, 1992.)

Theresa Hitchens is the Director of the Center for Defense Information. Previously she was the Editor of *Defense News* from 1998 to 2000, and has had a long career in journalism, with a focus on military, defense industry and NATO affairs. Her time at *Defense News* included five years as the newspaper’s first Brussels bureau chief, from 1989 to 1993. From 1983 to 1988, she worked at Inside Washington Publishers on the group’s environmental and defense-related newsletters, covering issues from nuclear waste to electronic warfare to military space.

She has had a long interest in security policy and politics, having served internships with Sen. John Glenn, D-Ohio, and with the NATO Parliamentary Assembly in Brussels. Most recently, she was director of research at the British American Security Information Council, a think tank based in Washington and London.

Besides her duties as CDI director, Hitchens leads CDI’s Space Security Project. The author of “Future Security In Space: Charting a Cooperative Course,” she also continues to write on space and nuclear arms control issues for a number of outside publications. She serves on the editorial board of *The Bulletin of the Atomic Scientists*, and is a member of Women in International Security and the International Institute for Strategic Studies.

Michael Katz-Hyman served as Research Associate on the Space Security and South Asia Projects from 2004 through 2007. He holds a BS in Physics with a Minor in Technology and Policy from Carnegie Mellon University.