Chapter 28:

Space Law and the Advancement of Spacepower

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Space law has and should continue to play an essential role in the evolution of spacepower. Testing the principle of "freedom of space" and helping establish the legality of satellite overflight were primary objectives of National Security Council Directive 5520, the first U.S. space policy, approved by President Dwight D. Eisenhower in May 1955;[1] during the 1960s, the superpowers and other emerging spacefaring states negotiated a far-reaching and forward-thinking Outer Space Treaty (OST);[2] and today, a variety of transparency and confidence-building measures (TCBMs) for space are being discussed and debated in a number of fora.[3] Law can be perhaps the single most important means of providing structure and predictability to humanity's interactions with the cosmos. Justice, reason, and law are nowhere more needed than in the boundless, anarchic, and self-help environment of the final frontier. The topics that space law is designed to address, the precedents from which it is drawn, and the pathways ahead that it illuminates will be critical determinants of the future development of spacepower.

Although there is some substance to arguments that the OST only precludes those military activities that were of little interest to the superpowers and does not bring much clarity or direction to many of the most important potential space activities, the treaty nonetheless provides a solid and comprehensive foundation upon which to build additional legal structures needed to advance spacepower. Spacefaring actors can most effectively improve on this foundation through a number of actions including further developing and refining the OST regime, adapting the most useful parts of analogous regimes such as the Law of the Sea and Seabed Authority mechanisms, and rejecting standards that stifle innovation, inadequately address threats to humanity's survival, or do not provide opportunities for rewards commensurate with risks undertaken. In the three sections below, this chapter explores other specific ways improvements in space law may contribute to furthering the quest for sustainable space security, enabling more direct creation of wealth in and from space, and ultimately improving the odds for humanity's survival by helping to protect the Earth and space environments. Without clearer and better developed space law, humanity may squander opportunities and investments, making it more difficult for spacepower to enable these and other critical contributions to our future.

While desires for better refined space law to advance spacepower may be clear, progress toward developing and implementing improvements is not likely to be fast or easy. Terrestrial law evolved fairly steadily and has operated over millennia. Space law, by contrast, is a relatively novel concept that rapidly emerged within a few years of the opening of the space age and thereafter greatly slowed. The objectives of space law must include not just aspirational goals such as structuring competition between humans and

helping define and refine fundamental interactions between humanity and the cosmos but also more mundane issues such as property rights and commercial interests. It is likely there will be growing pressure for space law to provide greater predictability and structure in many areas despite the fact that it can be very difficult to establish foundational legal elements for the cosmic realm such as evidence, causality, attribution, and precedence. Moreover, any movement toward improving space law is likely to be slowed by discouraging attributes associated with spacepower that include very long timelines and prospects for only potential or intangible benefits. These factors can erode acceptance of and support for improving space law at both the personal and political levels, but they also point to the need for an incremental approach and reinforce the long-term value of law in providing stability and predictability.

Other impediments to further developing space law are exacerbated by a lack of acceptance in some quarters that sustained, cooperative efforts are often the best and sometimes the only way in which humanity can address our most pressing survival challenges. Cosmic threats to humanity's survival exist and include the depletion of resources and fouling of our only current habitat, threats in the space environment such as large objects that could strike Earth and cause cataclysmic damage, and the eventual exhaustion and destruction of the Sun. The message is clear: environmental degradation and space phenomena can threaten our existence, but humanity can improve our odds for survival *if* we can cooperate in grasping and exploiting survival opportunities. Law can provide one of the most effective ways to structure and use these opportunities. Sustained dialogue of the type this volume seeks to foster can help raise awareness, generate support for better space law, and ultimately nurture the spacepower needed to improve our odds for survival.

The Quest for Sustainable Security

In examining space law, spacepower, and humanity's quest for sustainable security, it is prudent for spacefaring actors to transcend traditional categories and approaches by considering resources in novel, broad, and multidimensional ways. This chapter attempts to employ the spirit of this unrestrained approach but is not suggesting that everything discussed would necessarily turn out to be useful or implementable in the real world. In addition, it is often not practical or even possible to examine space law developments in discrete ways by delineating between legal, technical, and policy considerations or between terrestrial and space security concerns. Over the long run, however, an expansive approach will undoubtedly reveal and help create the most opportunities to advance space law and spacepower in the most significant and lasting ways. Nonetheless, when beginning the journey, small, incremental steps are the most pragmatic way to develop and implement more effective space law, and the process should first focus on improving and refining the foundation provided by the OST regime.

Most spacefaring actors understand the merits and overall value of the OST regime; they are much more interested in building upon this foundation than in creating a new structure. As the most important first steps toward further developing space law, the international community needs to find better ways to achieve more universal adherence to

the regime's foundational norms and embed all important spacefaring actors more completely within the regime. Beginning work to include major non-state actors in more explicit ways could prove to be a difficult undertaking that would require substantial expansion of the regime and probably should be approached incrementally. Fortunately, the security dimensions of the regime have opened windows of opportunity and important precedents have been set by expanding participation in the United Nations Committee on the Peaceful Uses of Outer Space and the World Radio Conferences of the International Telecommunications Union (ITU) to include nonstate actors as observers or associate members. Some form of two-tiered participation structure within the OST regime might be appropriate for a number of years and it may prove impractical to include nonstate actors in a formal treaty, but steps toward expanded participation should begin now, both to capture the growing spacepower of nonstate actors and to harness their energy in helping achieve more universal adherence to the regime. Perhaps most importantly, these initial steps should help promote a sense of stewardship for space among more actors and increase attention on those parties that fail to join or comply with these norms. Of course, these first steps alone would be insufficient to make large improvements or assure compliance with the regime, yet they might be among the most easily undertaken and significant ways to advance space law in the near term. Other specific areas within the OST regime that should be better developed, perhaps through creation of a standing body with implementation responsibilities, include the article VI obligations for signatories to authorize and exercise continuing supervision over space activities and the article IX responsibilities for signatories to undertake or request appropriate international consultations before proceeding with any activity or experiment that would cause potentially harmful interference.

One key way the United States could help better define OST implementation obligations and demonstrate leadership in fostering cooperative spacepower would be to share space situational awareness (SSA) data globally in more effective ways through the Commercial and Foreign Entities (CFE) program or some other approach. Congress has extended the CFE Pilot Program through September 2010 and, following the February 2009 collision between the Iridium and Cosmos satellites, there is more worldwide attention focused on space debris and spaceflight safety as well as considerable motivation for the United States to improve the program by providing SSA data to more users in more timely and consistent ways. A most useful specific goal for the CFE program would be development of a U.S. Government–operated data center for ephemeris, propagation data, and premaneuver notifications for all active satellites; consideration should also be given to the utility and modalities of creating or transitioning such a data center to international auspices.[4] Users would voluntarily contribute data to the center, perhaps through a Global Positioning System (GPS) transponder on each satellite, and the data would be constantly updated, freely available, and readily accessible so that it could be used by satellite operators to plan for and avoid conjunctions.[5] Difficult legal, technical, and policy issues that inhibit progress on sharing SSA data include bureaucratic inertia, liability, and proprietary concerns; nonuniform data formatting standards and incompatibility between propagators and other cataloguing tools; and security concerns over exclusion of certain satellites from any public data. Some of these legal concerns could be addressed by working toward better cradle-to-

grave tracking of all catalogued objects to help establish the launching state and liability; using opaque processes to exclude proprietary information from public databases to the maximum extent feasible; and indemnifying program operators, even if they provide faulty data that results in a collision, so long as they operate in good faith, exercise reasonable care, and follow established procedures.

History suggests there is a very important role for militaries both in setting the stage for the emergence of international legal regimes and in enforcing the norms of those regimes once they are in place. Development of any TCBMs for space, such as rules of the road or codes of conduct, should draw closely from the development and operation of such measures in other domains such as sea or air. The international community should consider the most appropriate means of separating military activities from civil and commercial activities in the building of these measures because advocating a single standard for how all space activities ought to be regulated or controlled is inappropriately ambitious and not likely to be helpful. The U.S. Department of Defense requires safe and responsible operations by warships and military aircraft but they are not legally required to follow all the same rules as commercial traffic and sometimes operate within specially protected zones that separate them from other traffic. Full and open dialogue about these ideas and others will help develop space rules that draw from years of experience in operating in these other domains and make the most sense for the unique operational characteristics of space. Other concerns surround the implications of various organizational structures and rules of engagement for potential military operations in space. Should such forces operate under national or only international authority, who should decide when certain activities constitute a threat, and how should such forces be authorized to engage threats, especially if such engagements might create other threats or potentially cause harm to humans or space systems? Clearly, these and a number of other questions are very difficult to address and require careful international vetting well before actual operation of such forces in space. Finally, consider the historic role of the Royal and U.S. Navies in fighting piracy, promoting free trade, and enforcing global norms against slave trading. Should there be analogous roles in space for the U.S. military and other military forces today and in the future? What would be the space component of the Proliferation Security Initiative and how might the United States and others encourage like-minded actors to cooperate on such an initiative? Attempts to create legal regimes or enforcement norms that do not specifically include and build upon military capabilities are likely to be divorced from pragmatic realities and ultimately be frustrating efforts.[6]

Seemingly new U.S. focus and direction on space TCBMs initially was provided by a statement that appeared on the Obama administration White House Web site on January 20, 2009: "Ensure Freedom of Space: The Obama-Biden administration will restore American leadership on space issues, seeking a worldwide ban on weapons that interfere with military and commercial satellites."[7] The language about seeking a worldwide ban on space weapons was similar to position papers issued during the Obama-Biden campaign but much less detailed and nuanced; it drew considerable attention and some criticism.[8] By May 2009, the "Space" part of the Defense Issues section on the White House Web site had been changed to read:

Space: The full spectrum of U.S. military capabilities depends on our space systems. To maintain our technological edge and protect assets in this domain, we will continue to invest in next-generation capabilities such as operationally responsive space and global positioning systems. We will cooperate with our allies and the private sector to identify and protect against intentional and unintentional threats to U.S. and allied space capabilities.

Ongoing space policy reviews including a congressionally directed Space Posture Review and Presidential Study Directives on National Space Policy are likely to encourage policies that are more supportive of pursuing TCBMs as well as greater reliance on commercial and international partners.[9] Consideration is also being given to the best ways to reconcile any new approaches with the 2006 U.S. National Space Policy language about opposing "development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space" while encouraging "international cooperation with foreign nations and/ or consortia on space activities that are of mutual benefit."[10] Spacepower actors can expect to continue making progress in developing effective, sustainable, and cooperative approaches to space security by building on the ongoing thoughtful dialogue between all major space actors in several venues that emphasizes a number of mainly incremental, pragmatic, technical, and bottom-up steps. Prime examples of this approach include the February 2008 adoption by the United Nations General Assembly of the Inter-Agency Debris Coordination Committee (IADC) voluntary guidelines for mitigating space debris and the December 2008 release from the Council of the European Union of a draft Code of Conduct for outer space activities.[11]

Beyond the OST, efforts to craft comprehensive, formal, top-down space arms control or regulation continue to face the same significant problems that have overwhelmed attempts to develop such mechanisms in the past. The most serious of these problems include disagreements over the proper forum, scope, and object for negotiations; basic definitional issues about what is a "space weapon" and how they might be categorized as offensive or defensive and stabilizing or destabilizing; and daunting concerns about whether adequate monitoring and verification mechanisms can be found for any comprehensive and formalized TCBMs. These problems relate to a number of thorny specific issues such as whether the negotiations should be primarily among only major spacefaring actors or more multilateral, what satellites and other terrestrial systems should be covered, and whether the object should be control of space weapons or TCBMs for space; the types of TCBMs that might be most useful (for example, rules of the road or keep-out zones) and how these approaches might be reconciled with the existing space law regime; and verification problems such as how to address the latent or residual antisatellite (ASAT) capabilities possessed by many dual-use and military systems or how to deal with the significant military potential of even a small number of covert ASAT systems.

New space system technologies, continuing growth of the commercial space sector, and new verification and monitoring methods interact with these existing problems in complex ways. Some of the changes would seem to favor TCBMs, such as better radars and optical systems for improved SSA, attribution, and verification capabilities;

technologies for better space system diagnostics; and the stabilizing potential of redundant and distributed space architectures that create many nodes by employing larger numbers of smaller and less expensive satellites. Many other trends, however, would seem to make space arms control and regulation even more difficult. For example, micro- or nanosatellites might be used as virtually undetectable active ASATs or passive space mines; proliferation of space technology has radically increased the number of significant space actors to include a number of nonstate actors that have developed or are developing sophisticated dual-use technologies such as autonomous rendezvous and docking capabilities; satellite communications technology can easily be used to jam rather than communicate; and growth in the commercial space sector raises issues such as how quasi-military systems could be protected or negated and the unclear security implications of global markets for dual-use space capabilities and products.

There is disagreement about the relative utility of top-down versus bottom-up approaches to developing space TCBMs and formal arms control but, following creation of the OST regime, the United States and many other major spacefaring actors have tended to favor bottom-up approaches, a point strongly emphasized by U.S. Ambassador Donald Mahley in February 2008: "Since the 1970s, five consecutive U.S. administrations have concluded it is impossible to achieve an effectively verifiable and militarily meaningful space arms control agreement."[12] Yet this assessment may be somewhat myopic since strategists need to consider not only the well-known difficulties with top-down approaches but also the potential opportunity costs of inaction and to recognize when they may need to trade some loss of sovereignty and flexibility for stability and restraints on others. Since the United States has not tested a kinetic energy ASAT since September 1985 and has no program to develop such capabilities, would it have been better to foreclose this option in order to purse a global ban on testing kinetic energy ASATs, and would such an effort have produced a restraining effect on Chinese development and testing of ASAT capabilities? This may have been a lost opportunity to pursue legal approaches but is a complex, multidimensional, and interdependent issue shaped by a variety of other factors such as inabilities to distinguish between ballistic missile defense and ASAT technologies, reluctance to limit technical options after the end of the Cold War, emergence of new and less easily deterred threats, and the demise of the Anti-Ballistic Missile Treaty.

Moreover, the Chinese, in particular, apparently disagree with pursuing only bottom-up approaches and, in ways that seem both shrewd and hypocritical, are currently developing significant counterspace capabilities while simultaneously advancing various top-down proposals in support of prevention of an arms race in outer space initiatives and moving ahead with the joint Chinese-Russian draft treaty on Prevention of Placement of Weapons in Outer Space (PPWT) introduced at the Conference on Disarmament in February 2008. If the Chinese are attempting to pursue a two-track approach to space arms control, they need to present that argument to the international community much more explicitly. The current draft PPWT goes to considerable lengths in attempting to define space, space objects, weapons in space, placement in space, and the use or threat of force, but there are still very considerable definitional issues with respect to how specific capabilities would be classified. An even more significant problem relates to all the terrestrial capabilities

that are able to eliminate, damage, or disrupt the normal function of objects in outer space, such as the Chinese direct ascent ASAT. One must question the utility of a proposed agreement that does not address the significant security implications of current space system support for network enabled terrestrial warfare, does not deal with dual-use space capabilities, seems to be focused on a class of weapons that does not exist or at least is not deployed in space, is silent about all the terrestrial capabilities that are able to produce weapons effects in space, and would not even ban development and testing of space weapons, only their use.[13] Given these weaknesses in the PPWT, it seems plausible that it is designed as much to continue political pressure on the United States and derail U.S. missile defense efforts as it is to promote sustainable space security.

Since Sino-American relations in general and space relations in particular are likely to play a dominant role in shaping the quest for space-power and sustainable security during this century, other proposed Sino-American cooperative space ventures or TCBMs are worthy of further consideration, including inviting a taikonaut to fly on one of the remaining space shuttle missions and making specific, repeated, and public invitations for the Chinese to join the International Space Station program and other major cooperative international space efforts. The United States and China could also work toward developing nonoffensive defenses of the type advocated by Philip Baines.[14] Kevin Pollpeter explains how China and the United States could cooperate in promoting the safety of human spaceflight and "coordinate space science missions to derive scientific benefits and to share costs. Coordinating space science missions with separately developed, but complementary space assets, removes the chance of sensitive technology transfer and allows the two countries to combine their resources to achieve the same effects as jointly developed missions."[15] Michael Pillsbury outlined six other areas where U.S. experts could profitably exchange views with Chinese specialists in a dialogue about space weapons issues: "reducing Chinese misperceptions of U.S. Space Policy, increasing Chinese transparency on space weapons, probing Chinese interest in verifiable agreements, multilateral versus bilateral approaches, economic consequences of use of space weapons, and reconsideration of U.S. high-tech exports to China."[16] Finally, Bruce MacDonald's report for the Council on Foreign Relations, "China, Space Weapons, and U.S. Security," offers a number of noteworthy additional specific recommendations for both the United States and China. For the United States, MacDonald recommends assessing the impact of different U.S. and Chinese offensive space postures and policies through intensified analysis and "crisis games" in addition to wargames; evaluating the desirability of a "no first use" pledge for offensive counterspace weapons that have irreversible effects; pursuing selected offensive capabilities meeting important criteria—including effectiveness, reversible effects, and survivability—in a deterrence context to be able to negate adversary space capabilities on a temporary and reversible basis; refraining from further direct ascent ASAT tests and demonstrations as long as China does, unless there is a substantial risk to human health and safety from uncontrolled space object reentry; and entering negotiations on a kinetic energy ASAT testing ban. MacDonald's recommendations for China include providing more transparency into its military space programs; refraining from further direct ascent ASAT tests as long as the United States does; establishing a senior national security coordinating body, equivalent to a Chinese National Security Council; strengthening its leadership's foreign policy

understanding by increasing the international affairs training of senior officer candidates and establishing an international security affairs office within the People's Liberation Army; providing a clear and credible policy and doctrinal context for its 2007 ASAT test and counterspace programs more generally, and addressing foreign concerns over China's ASAT test; and offering to engage in dialogue with the United States on mutual space concerns and become actively involved in discussions on establishing international space codes of conduct and confidence-building measures.[17]

Harvesting Energy and Creating Wealth in and from Space

Spacefaring actors should again consider revising and further developing the OST regime as a key first step when seeking better ways to harvest energy and create wealth in and from space. Expanding participation in the OST as recommended above would also be helpful, but other steps such as reducing liability concerns and clarifying legal issues with respect to harvesting energy and generating wealth are likely to be more effective in furthering commercial development of space. Of course, as with security, a range of objectives and values are in tension and require considerable effort to change or keep properly balanced. The OST has been extremely successful thus far with respect to its primary objective of precluding replication of the colonial exploitation that plagued much of Earth's history. The international community should now consider whether the dangers posed by potential cosmic land grabs continue to warrant OST interpretations that may be stifling development of spacepower, and, if these values are found to have become imbalanced, how impediments might best be reduced. Spacefaring actors should again use an expansive approach to consider how perceived OST restrictions and the commercial space sector have evolved and might be further advanced in a variety of ways including reinterpreting the OST regime itself, becoming more intentional about developing spacepower, creating space-based solar power capabilities, and improving export controls.

While the OST has thus far been unambiguous and successful in foreclosing sovereignty claims and the ills of colonization, it has been less clear and effective with respect to de facto property rights and other liability and commercialization issues. OST language, negotiating history, and subsequent practice do not preclude some level of commercial activity in space and on celestial bodies, but various articles of the OST support different interpretations about the potential scope of and limitations on this activity. The treaty most clearly allows those commercial activities that would be performed to support exploration or scientific efforts. It is far more problematic with respect to commercial space activity that would result in private gain or not somehow equitably distribute gains among all states. Even if it were found that commercial activities would not "appropriate" space resources, however that might be defined, it would be difficult to reconcile such activity with the spirit of the OST regime, especially since the regime provides no guidance on how private or unequal gains might be distributed. In addition to clarifying potential property rights and wealth distribution mechanisms, consideration should be given to reevaluating liability standards. The OST and 1972 Liability Convention establish two distinct liability structures: launching states are absolutely liable to pay compensation for any damages caused by space objects on Earth or to aircraft in flight

but are only liable for damages caused in space by space objects if found to be negligent. A challenge for the international community is how best to evolve the existing space law regime based on either absolute liability or fault/negligence, depending upon the location of the incident, into a structure that might provide enough clarity to help establish liability for damages in space and perhaps provide better incentives for commercial development.[18]

Additional interpretation issues stem from the fact that OST is embedded within a larger body of international law and that broad regime is evolving, sometimes in ambiguous and contradictory ways. Elements within this large regime are of unclear and unequal weight: the Moon Agreement with its Common Heritage of Mankind (CHM) approach to communal property rights and equally shared rewards undoubtedly has some effect in advancing the CHM principle in both formal and customary international law. At the level of formal international law, however, the Moon Treaty falls well short of the OST due to its lack of parties, especially among major spacefaring states, particularly in contrast to the OST, a treaty that has been ratified by some 94 states and in force for over 40 years.

Most fundamentally, however, the current lack of clarity within space law about property rights and commercial interests is the result of both space law and space technology being underdeveloped and immature. Of course, there is also a "chicken-and-egg" factor at work since actors are discouraged from undertaking the test cases needed to develop and mature the regime because of the immaturity of the regime and their unwillingness to develop and employ improved technologies and processes as guinea pigs in whatever legal processes would be used to resolve property rights and reward structures. The most effective way to move past this significant hurdle would be to create more clear mechanisms for establishing property rights and processes by which all actors, especially commercial actors, could receive rewards commensurate with the risks they undertake. In addition, any comprehensive reevaluation of space property rights and liability concerns should also consider how these factors are addressed in analogous regimes such as the Seabed Authority in the Law of the Sea Treaty. Unfortunately, however, there are also several problems with attempting to draw from these precedents. First, several of the analogous regimes like the Law of the Sea build from CMH premises in several ways and it is not clear this approach is entirely applicable or helpful when attempting to sort through how the OST should apply to issues like property rights and reward structures. Second, while these analogous regimes are undoubtedly better developed than the OST and have a significant potential role in providing precedents, today they are still somewhat underdeveloped and immature with respect to their application in difficult areas such as property rights and reward structures, again limiting the current utility of attempting to draw from these precedents.

Provisions of the OST regime are probably the most important factors in shaping commercial space activity, but they are clearly not the only noteworthy legal and policy factors at work influencing developments within this sector. Legacy legal and policy structures developed during the Cold War were probably adequate for the amount of commercial space activity during that period, but it is far from clear they will be

sufficient to address the significant and sustained increase in such activity since that time. In the 1960s, the United States was the first to begin developing space services such as communications, remote sensing, and launch capabilities but did so within the government sector. This approach began to change in the 1980s, first with the November 1984 Presidential Determination to allow some commercial communication services to compete with Intelsat and continuing with subsequent policies designed to foster development of a commercial space sector. By the late 1990s, commercial space activity worldwide had outpaced government activity, and although government space investments remain very important, they are likely to become increasingly overshadowed by commercial activity. It would be helpful if governments, and the U.S. Government in particular, could more explicitly develop and consistently implement legal structures and long-term policies that would better define and delineate between those space activities that ought to be pursued by the private and public sectors as well as more intentionally and consistently develop the desired degree of international cooperation in pursuing these objectives.

Other clear commercial and economic distinctions with the Cold War era have even more significant implications for the future of space-power: whereas the Soviet Union was only a military superpower, China is a major U.S. trading partner and an economic superpower that recently passed Germany to became the world's third largest economy, is poised to pass Japan soon, and is on a path to become larger than the U.S. economy, perhaps within only about 10 years. Because of its economic muscle, China can afford to devote commensurately more resources to its military capabilities and will play a more significant role in structuring the global economic system. For example, China holds an estimated $1.4 trillion in foreign assets (mainly U.S. treasury notes), an amount that gives it great leverage in the structure of the system.[19]

The United States and other major spacefaring actors lack, but undoubtedly need, much more open and comprehensive visions for how to develop spacepower. This study is one attempt to foster more dialogue about these issues, but the process should continue, become more intentional and formalized, and be supported by an enduring organizational structure that includes the most important stakeholders in the future of spacepower. Legal structures should be a foundational part of creating and implementing the vision to develop spacepower, but a broader approach should be:

> focused on opening space as a medium for the full spectrum of human activity and commercial enterprise, and those actions which government can take to promote and enable it, through surveys, infrastructure development, pre-competitive technology, and encouraging incentive structures (prizes, anchor-customer contracts, and property/exclusivity rights), regulatory regimes (port authorities, spacecraft licensing, public-private partnerships) and supporting services (open interface standards, RDT&E [research, development, test, and evaluation] facilities, rescue, etc.).[20]

In addition, consideration should be given to using other innovative mechanisms and nontraditional routes to space development, including a much wider range of Federal Government organizations and the growing number of state spaceport authorities and other organizations developing needed infrastructure. Finally, the United States should make comprehensive and careful exploration of the potential of space-based solar power its leading pathfinder in creating a vision for developing spacepower. Working toward harvesting this unlimited power source in economically viable ways will require development of appropriate supporting legal structures, particularly with respect to indemnification and potential public-private partnerships.

Global licensing and export controls for space technology have often been developed and implemented in inconsistent and counterproductive ways. It is understandable that many states view space technology as a key strategic resource and are very concerned about developing, protecting, and preventing the proliferation of this technology, but the international community, and the United States in particular, needs to find better legal mechanisms to balance and advance objectives in this area. Many current problems with U.S. export controls began after Hughes and Loral worked with insurance companies to analyze Chinese launch failures in January 1995 and February 1996. A congressional review completed in 1998 (Cox Report) determined these analyses violated the International Traffic in Arms Regulations (ITAR) by communicating technical information to the Chinese. The 1999 National Defense Authorization Act transferred export controls for all satellites and related items from the Commerce Department to the Munitions List administered by the State Department.[21] The stringent Munitions List controls contributed to a severe downturn in U.S. satellite exports.[22] To avoid these restrictions, foreign satellite manufacturers, beginning in 2002 with Alcatel Space (now Thales) and followed by European Aeronautic Defense and Space, Surrey Satellite Company, and others replaced all U.S.-built components on their satellites to make them "ITAR-free."[23]

There are two key reasons why the United States should move away from the priorities in its current space export control regime. First, an overly broad approach that tries to guard too many things dilutes monitoring resources and actually results in less protection for "crown jewels" than does a focused approach, and second, a more open approach is more likely to foster innovation, spur development of sectors of comparative advantage, and improve efficiency and overall economic growth. Congress and the Obama administration should make it a priority to reevaluate current U.S. export controls and adjust laws and policies accordingly. Excellent starting points are the recently released recommendations for rebalancing overall U.S. export control priorities in the congressionally mandated National Academies of Science study.[24] In addition, the United States should implement key recommendations from the Center for Strategic and International Studies study on the space industrial base such as removing from the Munitions List commercial communications satellite systems, dedicated subsystems, and components specifically designed for commercial use.[25]

Environmental Sustainability and Survival

Work toward developing space law to advance spacepower and improve environmental sustainability and humanity's odds for survival faces a number of daunting challenges, including a high "giggle factor," long timelines that can be beyond our political and personal awareness, and potential returns that are uncertain and intangible. While difficult, work in this area is absolutely critical since it may hold the key to humanity's survival, and it must be pursued with all the resources, consistency, and seriousness it deserves. The quest to improve space law to support environmental and survival objectives should focus on three areas: space debris, environmental monitoring, and planetary defense.

Human space activity produces many orbital objects; when these objects no longer serve a useful function, they are classified as space debris. Over time, human activity has generated an increasing amount of debris; the number of catalogued debris objects has gone from about 8,000 to over 18,000 during the past 20 years.[26] The most serious cause of debris is deliberate hypervelocity impacts between large objects at high orbital altitudes such as the Chinese direct ascent kinetic energy ASAT weapon test of January 2007, which now accounts for more than 25 percent of all catalogued objects in low Earth orbit (LEO).[27] If current trends continue, there is growing risk that space, and LEO in particular, will become increasingly unusable. Fortunately, there is also growing awareness and earnestness across the international community in addressing this threat. Overall goals for spacefaring actors with respect to space debris include minimizing its creation while mitigating and remediating its effects—space law can play an important role in all these areas. Key approaches to minimizing creation of debris are commercial best practices and evolving regimes such as the IADC voluntary guidelines adopted by the United Nations General Assembly in February 2008. Spacefaring actors also need to consider mechanisms to transition these voluntary guidelines into more binding standards and ways to impose specific costs such as sanctions or fines on actors that negligently or deliberately create long-lived debris. Fines could be applied toward efforts to further develop and educate spacefaring actors about the debris mitigation regime as well as to create and implement remediation techniques. An additional potential source of funding for mitigation and remediation would be establishing auctions for the radio frequency spectrum controlled by the ITU that would be analogous to the spectrum auctions conducted at the national level by organizations like the Federal Communications Commission. Finally, it must be emphasized that techniques for remediating debris using lasers or other methods are likely to have significant potential as ASAT weapons, and careful international consideration should be given to how and by whom such systems are operated.

Space provides a unique location to monitor and potentially remediate Earth's climate. It is the only location from which simultaneous in situ observations of Earth's climate activity can be conducted, and such observations are essential to developing a long-term understanding of potential changes in our biosphere. Because so much is riding on our understanding of the global climate and our potential responses to perceived changes, it is particularly important to apply apolitical standards in getting the science right and controlling for known space effects such as solar cycles when making these observations. If fears about global warming are correct and the global community wishes to take active

measures to remediate these effects, space also provides a unique location to operate remediation options such as orbital solar shades.

It is also imperative that the United States and all spacefaring actors think more creatively about using spacepower to transcend traditional and emerging threats to our survival. Parts of space law can help to illuminate paths toward and develop incentives for creating a better future. Space, perhaps more than any other medium, is inherently linked to humanity's future and survival. We need to link these ideas and better articulate ways spacepower can light a path toward genuinely cooperative approaches for protecting the Earth and space environments from cataclysmic events such as large objects that may collide with Earth or gamma ray bursts that may have the potential to render huge swaths of space uninhabitable. Better knowledge about known threats such as near Earth objects (NEOs) is being acquired but more urgency is needed. All predicted near approaches and possible NEO impacts such as that of the asteroid Apophis, predicted for April 13, 2029, ought to be seen as opportunities since they provide critical real-world tests for our ability to be proactive in developing effective precision tracking and NEO mitigation capabilities. In the near term, it is most important for national and international organizations to be specifically charged with and resourced to develop better understanding of NEO threats and mitigation techniques that can be effectively applied against likely impacts. Ultimately, however, we cannot know of or effectively plan for all potential threats to Earth but should pursue a multidimensional approach to develop capabilities to improve our odds for survival and one day perhaps become a multiplanetary species.

There will be inevitable missteps, setbacks, and unintended consequences as we refine space law to improve our quest for sustainable space security, generate wealth in and from space, and protect the Earth and space environments. The inexorable laws of physics and of human interaction indicate that we will create the best opportunities for success in improving space law by beginning long-term, patient work now rather than crash programs later. This patient approach will allow the best prospects for space law to provide a solid foundation for the peaceful advancement of spacepower.

Notes

1. The best and most comprehensive analysis of the complex maneuvering by the superpowers at the opening of the space age remains Walter A. McDougall's Pulitzer Prize–winning . . . *the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985). National Security Council Directive 5520 is reprinted in John M. Logsdon, ed. *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program*, vol. I, *Organizing for Exploration* (Washington, DC: NASA History Office, 1995), 308–313. McDougall in *Heavens and Earth* and R. Cargill Hall's introductory essay, "Origins of U.S. Space Policy: Eisenhower, Open Skies, and Freedom of Space," in *Exploring the Unknown* masterfully develop the context and purposes of the directive. Hall uses the term *stalking horse* to describe the purpose of the IGY satellite in relation to the WS–117L (America's first reconnaissance satellite program). *Peaceful purposes* for space activity are often referenced and cited but never authoritatively defined.

2. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (General Assembly resolution 2222 [XXI], annex), adopted December 19, 1966, opened for signature January 27, 1967, and entered into force October 10, 1967.
3. The term *transparency* apparently connotes espionage when translated into Chinese and since the Chinese are a key party that spacefaring actors wish to engage, consideration should be given to finding an alternative term, perhaps *clarity of intensions*.
4. For an outstanding and detailed analysis of the benefits and challenges associated with creation of an international data center, see Lee-Volker Cox, "Avoiding Collisions in Space: Is It Time for an International Space Integration Center?" research paper, U.S. Army War College, March 30, 2007, available at <www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA469676&Location=U2&doc=GetTRDoc.pdf>.
5. Space situational awareness (SSA) issues are framed by specialized concepts and jargon. *Conjunctions* are close approaches, or potential collisions, between objects in orbit. *Propagators* are complex modeling tools used to predict the future location of orbital objects. Satellite operators currently use a number of different propagators and have different standards for evaluating and potentially maneuvering away from conjunctions. Maneuvering requires fuel and shortens the operational life of satellites. Orbital paths are described by a set of variables known as ephemeris data; two-line element sets are the most commonly used ephemeris data. Much of this data is contained in the form of a satellite catalog. The United States maintains a public catalog at <www.space-track. org>. Other entities maintain their own catalogs. Orbital paths constantly are perturbed by a number a factors including Earth's inconsistent gravity gradient, solar activity, and the gravitational pull of other orbital objects. Perturbations cause propagation of orbital paths to become increasingly inaccurate over time; beyond approximately 4 days into the future, predictions about the location of orbital objects can be significantly inaccurate. For more about SSA concepts, see Brian Weeden, "The Numbers Game," *The Space Review*, July 13, 2009, available at <www.thespacereview.com/article/1417/1>. For discussion about ways to share SSA data and other space security ideas fostered by meetings between the Department of Defense Executive Agent for Space and the Chief Executive Officers of commercial satellite operators, see David McGlade, "Commentary: Preserving the Orbital Environment," *Space News*, February 19, 2007, 27.
6. On the role of militaries in enforcing legal norms and analogies between the law of the sea and space law, see R. Joseph DeSutter, "Space Control, Diplomacy, and Strategic Integration," *Space and Defense* 1, no. 1 (Fall 2006), 29–51.
7. The statement appeared on the Defense Agenda section of the White House Web site, available at <www.whitehouse.gov>.
8. See in particular, the *Space News* editorial for February 2, 2009, "Banning Space Weapons— and Reality."
9. Section 913 of the Fiscal Year 2009 National Defense Authorization Act (P.L. 110–417) directs the Secretary of Defense and Director of National Intelligence to submit a Space Posture Review to Congress by December 1, 2009. In addition, the Obama administration has ongoing Presidential Study Directives that are examining the need for changes to current National Space Policy; see Amy Klamper, "White House Orders Sweeping U.S. Space Policy Review," *Space News*, July 15, 2009.
10. The unclassified version of current National Space Policy was posted on the Office of Science and Technology Policy Web site on October 14, 2006.
11. United Nations General Assembly Resolution 62/217, "International Cooperation in the Peaceful Uses of Outer Space," February 1, 2008, and Council of the European Union, "Council Conclusions and Draft Code of Conduct for Outer Space Activity," December 3, 2008.
12. Ambassador Donald A. Mahley, remarks at the State of Space Security Workshop, Space Policy Institute, George Washington University, Washington, DC, February 1, 2008.
13. Fact sheet, "Preventing the Placement of Weapons in Outer Space: A Backgrounder on the Draft Treaty by Russia and China," ReachingCriticalWill.org, available at <www.reachingcriticalwill. org/legal/paros/wgroup/PAROS-PPWT-factsheet.pdf>. For an outstanding analysis of trigger events for space weaponization and why space-basing is not necessarily the most important consideration, see Barry D. Watts, *The Military Use of Space: A Diagnostic Assessment*

(Washington, DC: Center for Strategic and Budgetary Assessments, February 2001), 97–106. Watts argues: There are at least two paths by which orbital space might become a battleground for human conflict. One consists of dramatic, hard-to-miss trigger events such as the use of nuclear weapons to attack orbital assets. The other class involves more gradual changes such as a series of small, seemingly innocuous steps over a period of years that would, only in hindsight, be recognized as having crossed the boundary from force enhancement to force application. For reasons stemming from the railroad analogy . . . the slippery slope of halting, incremental steps toward force application may be the most likely path of the two. Watts discusses high-altitude nuclear detonations, failure of nuclear deterrence, and threats to use nuclear ballistic missiles during a crisis as the most likely of the dramatic trigger events.

14. Philip J. Baines, "The Prospects for 'Non-Offensive' Defenses in Space," in *New Challenges in Missile Proliferation, Missile Defense, and Space Security*, ed. James Clay Moltz (Monterey: Center for Nonproliferation Studies Occasional Paper no. 12, Monterey Institute of International Studies, July 2003), 31–48.
15. Kevin Pollpeter, *Building for the Future: China's Progress in Space Technology during the 10th 5-year Plan and the U.S. Response* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2008), 48–50.
16. Michael P. Pillsbury, "An Assessment of China's Anti-Satellite and Space Warfare Programs, Policies, and Doctrines," report prepared for the U.S.-China Economic and Security Review Commission, January 19, 2007, 48.
17. Bruce W. MacDonald, *China, Space Weapons, and U.S. Security* (New York: Council on Foreign Relations, September 2008), 34–38.
18. Although article VII of the Outer Space Treaty discusses liability, that article was further implemented in the Convention on International Liability for Damage Caused by Space Objects, commonly referred to as the Liability Convention. Under the Liability Convention, article II, a launching state is absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth or to aircraft in flight. However, under articles III and IV, in the event of damage being caused other than on the surface of the Earth by a space object, the launching state is liable only if the damage is due to its fault or the fault of persons for whom it is responsible (that is, commercial companies) under a negligence standard. Convention on International Liability for Damage Caused by Space Objects (resolution 2777 [XXVI] annex), adopted November 29, 1971, opened for signature March 29, 1972, and entered into force September 1, 1972.
19. James Fallows, "The $1.4 Trillion Question," *The Atlantic* (January–February 2008).
20. Peter Garretson, "Elements of a 21st-century Space Policy," *The Space Review*, August 3, 2009, available at <www.thespacereview.com/article/1433/1>.
21. The January 1995 failure was a Long March 2E rocket carrying Hughes-built Apstar 2 spacecraft, and the February 1996 failure was a Long March 3B rocket carrying Space Systems/Loral-built Intelsat 708 spacecraft. Representative Christopher Cox (R–CA) led a 6-month long House Select Committee investigation that produced the "U.S. National Security and Military/Commercial Concerns with the People's Republic of China" report released on May 25, 1999 (available at <www.house.gov/coxreport>). In January 2002, Loral agreed to pay the U.S. Government $20 million to settle the charges of the illegal technology transfer and in March 2003, Boeing agreed to pay $32 million for the role of Hughes (which Boeing acquired in 2000). Requirements for transferring controls back to the State Department are in Sections 1513 and 1516 of the Fiscal Year 1999 National Defense Authorization Act. Related items are defined as "satellite fuel, ground support equipment, test equipment, payload adapter or interface hardware, replacement parts, and non-embedded solid propellant orbit transfer engines."
22. Satellite builders claim that their exports dropped 59 percent in 2000 and that since March 1999 their share of the global market declined sharply (from 75 percent to 45 percent). Evelyn Iritani and Peter Pae, "U.S. Satellite Industry Reeling Under New Export Controls," *The Los Angeles Times*, December 11, 2000, 1. According to *Space News,* 2000 marked the first time that U.S. firms were awarded fewer contracts for geostationary communications satellites than their European competitors (the Europeans were ahead 15 to 13). Peter B. de Selding and Sam Silverstein, "Europe Bests U.S. in Satellite Contracts in 2000," *Space News*, January 15, 2001, 1, 20.

23. Peter B. de Selding, "European Satellite Component Maker Says it is Dropping U.S. Components Because of ITAR," *Space News Business Report*, June 13, 2005; and Douglas Barrie and Michael A. Taverna, "Specious Relationship," *Aviation Week & Space Technology*, July 17, 2006, 93–96.
24. National Research Council, *Beyond "Fortress America:" National Security Controls on Science and Technology in a Globalized World* (Washington, DC: National Academies Press, 2009). With the new administration and Congress as well as former Congresswoman Ellen Tauscher confirmed in the key position of Under Secretary of State for Arms Control and International Security, conditions for changing the space export control law are the most favorable they have been for the last decade.
25. *Briefing of the Working Group on the Health of the U.S. Space Industrial Base and the Impact of Export Controls* (Washington: Center for Strategic and International Studies, February 2008).
26. Comprehensive and current information about orbital debris is provided by NASA and the European Space Agency at <www.orbitaldebris.jsc.nasa.gov> and <www.esa.int/esaMI/Space_Debris/ index.html>.
27. "Fengyun 1–C Debris: Two Years Later," *Orbital Debris Quarterly News* 13, no. 1 (January 2009), 2. As a result of the January 11, 2007, Chinese ASAT test, the U.S. Space Surveillance Network has catalogued 2,378 pieces of debris with diameters greater than 5 centimeters, is tracking 400 additional debris objects that are not yet catalogued, and estimates the test created more that 150,000 pieces of debris larger than 1 square centimeter. Unfortunately, less than 2 percent of this debris has reentered the atmosphere so far and it is estimated that many pieces will remain in orbit for decades and some for more than a century. By contrast, destruction of the inoperative USA–193 satellite on February 21, 2008, occurred at a much lower altitude and did not produce long-lived debris; the last piece of catalogued debris from this intercept reentered on October 9, 2008. On the engagement of USA–193 see, in particular, James Oberg, "OPERATION BURNT FROST: Five Myths about the Satellite Smashup," NBC News Analysis, February 27, 2008, and James E. Oberg, "Down in Flames: Media 'Space Experts' Flub the Shoot-Down Story," *The New Atlantis*, no. 24 (Spring 2009), 120–129.