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Theresa Hitchens
United Nations Institute for Disarmament Research, Theresa.hitchens@edu.edu

Michael Katz-Hyman
Henry L. Stimson Center, Michael.katz-hyman@edu.edu

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ESTABLISHING SPACE SECURITY: A PRESCRIPTION FOR A RULES-BASED APPROACH

Theresa Hitchens and Michael Katz-Hyman

Theresa Hitchens is the Director of the Center for Defense Information, Washington, D.C.

Michael Katz-Hyman is the Research Associate for the Space Security Project at the Henry L. Stimson Center, Washington, D.C.

The question of what constitutes the proper military uses of space is not just a debate over space weapons and attacks on satellites. It is a debate that sheds light on the fundamental decisions that states and their citizens will have to make over the next century as we both explore and exploit space for its scientific, strategic, and economic value. Furthermore, the context of this debate changes year to year as the physical and political environment of space changes.

Complicating the debate is the fact that while prescriptions for response to the changing space environment differ, the goal for most of those involved is the same: maintaining reliable access and use of space for all peaceful actors – including militaries. Arguments surrounding space weapons or treaties normally do a great disservice to the fact that most of the participants in these debates agree on more things then they perhaps realize.

Before attempting to lay out what we believe to be the most reliable and stable U.S. strategy for reaching this goal, it is important to review some of the basic facts that provide a backdrop to this debate.

The Space Environment

The specter of space warfare currently is not the main threat to global space assets. Today, the main culprit is space itself. Rather than a benign haven, space is a hazardous place fraught with potential dangers to fragile satellites and spacecraft.

Satellites orbiting Earth have to contend with a variety of natural dangers on almost a daily basis. Significant hazards that can disable or damage satellites include solar radiation, geomagnetic storms, and ionization. Satellite operators have to monitor continually the effect of the space environment on the upper reaches of the atmosphere, which can expand and drag down Low-Earth Orbit (LEO) satellites.

Further, as more and more states and commercial users seek to exploit the advantages provided by space systems for both economic gain and military applications; usable near-Earth space is beginning to become crowded. With the increase in the number of states owning and operating satellites from two – the United States and the Soviet Union – during the Cold War to 41 today (a number that is growing),[1] the potential for interference, collisions, tensions, and competition is increasing. There are some 813 known working satellites on orbit, with about a dozen states able to launch their own satellites.[2] The

[1] Union of Concerned Scientists, "Satellite Data Base" Theresa Hitchens, "International Satellite Innovation and Cooperation," presentation to Military Satellites 2006, Washington, D.C., 18 April 2006, CDI Military Satellites 2006.

[2] Ibid.

Space and Defense, Fall 2006, pp. 15-28.
Center for Space and Defense Studies
Department of Political Science, US Air Force Academy

growing population of satellites and satellite operators – including commercial actors not responsible to any one government – could lead to increasing conflict over access to desired orbital slots, radio frequency interference, and liability for malfunctions or collisions that damage other satellites. Already, several states have made decisions about uses of radio frequency spectrum and satellite launches that have resulted in spats with other spacefaring countries – and in some worrying cases, states have questioned the legitimacy of the voluntary International Telecommunications Union (ITU) process for parceling out spectrum usage and orbital slots for communications satellites.[3] Another complicating factor could be the emergence of a true space tourism industry, which would raise new issues for deconflicting launches and tracking space objects.

The proliferation of satellite technology is not only horizontal but also vertical – meaning that the level of technological sophistication among space actors is growing, with more and more states acquiring capabilities such as high-resolution imagery, high-speed, broadband satellite communications and low-cost, highly maneuverable microsatellites.[4] This dual-pronged proliferation of satellite technology has subsequently resulted in more states applying space capabilities to the military sphere, possibly leading to increased suspicion and tension among spacefaring powers. In particular, U.S. defense officials have expressed concern about possible threats to U.S. space systems, as well as the growing need to prevent potential adversaries from deriving military benefit from space systems in times of conflict. In addition, with a number of spacefaring powers now discussing schemes for conducting manned research on the Moon, asteroids or other planets, the potential for disputes about access to planetary resources is again emerging as an issue of discussion and debate among experts.

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But it is widely agreed that the greatest "environmental" threat currently facing space operations is orbital debris. U.S. Air Force Space Command currently tracks over 9,400[5] manmade space objects routinely, and has detected some 4,500 more that cannot yet be positively identified or routinely tracked.[6] The objects that can be tracked reliably by the Space Surveillance Network's 30-odd radars and optical facilities range in size from large satellites down to objects ten centimeters in diameter.[7] Even more threatening is the amount of smaller-sized debris that cannot be seen, or can only be detected momentarily. Nuts, bolts, paint flecks, and frozen droplets of un-burned rocket fuel all whiz around the Earth at speeds approaching seven to eight kilometers per second. At these speeds (and at greater relative speeds), debris impacts have the effect of liquefying metal and causing catastrophic failure of satellites.[8] For example, on 29 March 2006, the Russian Ekspress AM11 communications satellite stopped operating; the cause was determined as a hypervelocity debris

[3]Indonesia, China, the United Kingdom, and Russia are among those countries who have been involved in disputes over orbital slots; for an overview of the ITU process and challenges to the regime see, Theresa Hitchens, *Future Security in Space: Charting a Cooperative Course*, (Washington D.C.: Center for Defense Information, September 2004), pp. 39-50.

[4]Hitchens, "International Satellite Innovation and Cooperation."

[5]NASA, *Orbital Debris Quarterly News*, Sara Portman, ed, Volume 10, Issue 1, January 2006, p. 7. See also U.S. Strategic Command (STRATCOM) Fact Sheet, Space Control:Reentry Assessment and Space Surveillance (last updated March 2004) Offutt Air Force Base, Neb.: U.S. Strategic Command Public Affairs Office.

[6]Author email exchange with a NASA official.

[7]STRATCOM Fact Sheet, "Space Control: Reentry Assessment and Space Surveillance."

[8]For more on laboratory testing of hypervelocity impacts see NASA Orbital Debris Program Office.

impact.[9] Such impacts, particularly in Geosynchronous Orbit (GEO) where the satellite (and most other large communications satellites) was stationed, are rare; National Aeronautics and Space Administration (NASA) computer models predict only about ten catastrophic collisions over the next 200 years.[10] But according to a recent study by NASA debris experts J.C. Liou and Nicholas Johnson, even without any new launches, the debris population will increase in the coming centuries.[11] "In reality the situation will undoubtedly be worse, because spacecraft and their orbital stages will continue to be launched," Johnson said.[12]

The U.S. Air Force understands the danger of debris generation and the unintentional negative consequences that debris can have. Deputy Under Secretary of the Air Force Gary Payton recently spoke out against debris generating anti-satellite weapons, stating, "We'd be fools to actually get into the kinetic energy anti-satellite business. It would be hugely disadvantageous for the U.S. to get into that game."[13] Nonetheless, there remain those in the U.S. national security community promoting the use of debris-creating kinetic energy anti-satellite (ASAT) weapons and space-based kinetic energy interceptors for attacking ballistic missiles, as well as weapons based in space that in and of themselves, by virtue of their on-board fuel and desirability as targets, would present a debris hazard.

[9] *SpaceDaily.com*, "Russian Satellite Failure Caused by Space Garbage," 17 April 2006, accessed from Russian Satellite Failure Caused by Space Garbage.

[10] Mike Toner, "Final Frontier Littered with Junk," *Cox News Service*, 27 February 2006.

[11] J.C. Liou and N.L. Johnson, "Risks in Space From Orbiting Debris," *Science*, Vol. 311, 22 January 2006.

[12] Toner, "Final Frontier Junk."

[13] Jeremy Singer, "USAF Interest in Lasers Triggers Concerns About Anti-Satellite Weapons," *Space News*, 1 May 2006.

The Way Forward

The above facts about the current "state of space" leave U.S. decision makers with a weighty dilemma: how best to guarantee reliable access and use of space for all peaceful actors, including the U.S. military, while at the same time preventing dangerous and destabilizing behaviors in space or conflicts that threaten space assets.

Some believe that the deployment of ASATs and space weapons now, before there is a recognized or developed threat, would serve to dissuade any use of force against potential U.S. targets in space, as well as improve ground-strike capabilities. Others believe that space is an inherent sanctuary and that the proper response is a pre-emptive arms control treaty, barring all weapons, not just weapons of mass destruction,[14] from space. In our view, the best approach to ensuring future security in space can be found somewhere in the middle of this spectrum. Establishing good practices by all actors, based on solid behavioral norms and the rule of law, are at the heart of the approach laid out below.

If space is a sanctuary, this is due to political will as well as technological and economic limitations. During the Cold War, the United States and the Soviet Union – after testing, and in some cases temporarily deploying, space weapons – realized the intricate linkage between space assets and nuclear forces and the inherent dangers of deeming satellites legitimate physical targets. The primary issue was one of stability: with space assets (i.e. spy satellites) serving as key strategic nuclear warning systems, any actions that were perceived by either side to threaten their secure functioning could have dire consequences, including accidental nuclear war.

[14] The Outer Space Treaty of 1967 banned the stationing of weapons of mass destruction in orbit. While there is some debate as to whether the "peaceful purposes" dictum of the OST bans the use of other types of weapons in space, it is generally accepted that stationing or use of conventional weapons in space is not proscribed.

Thus, neither side moved to deploy permanently either anti-satellite weapons or weapons based on orbit. While the Cold War is over, the dynamics of the space-nuclear stability equation have changed little – with the only issue being the emergence of new space and nuclear weapons players who arguably have tense and inherently less stable relations among each other than did the United States and Soviet Union.

In addition, although access to space is growing, it always has been and remains today a very expensive place to operate and satellites are high-cost, high-value assets, meaning that cost considerations are always at the forefront in weighing national security tradeoffs. A risky security environment for satellites would inevitably raise costs for all space actors.

The fact of the matter is that space as it relates to national security cannot be treated the same as the Navy treats the sea or the Air Force treats the sky. It is physically different, and the concepts of dominance and superiority have fundamentally different meanings and connotations in space. The laws of physics and the globalization of space access dictate that no one nation, one person or one entity can "own" space; and, more importantly, means that the actions of any one actor in space cannot fail to have direct repercussions upon the space-based assets of others. The physical and cost environments of space described above alter the threat perceptions of states and create a large gap between policy, capability, and political will. By this, we mean that policies that call for space weapons cannot, by themselves, remove the technological roadblocks to develop those weapons, nor can they necessarily create the political and diplomatic impetus to actually pay for or use them. Even if such weapons are technically, economically and politically feasible, the use of anti-satellite or space-based weapons are likely to cause more harm than good to the future access to and use of space across the board, especially if the weapon is debris-generating or if it can easily be countered with a low-cost debris-generating weapon.

Debris-generating weapons, in particular, present a lose-lose situation, as Payton outlined above. Further, there is a danger that the advent within the U.S. military of dedicated ASAT weapons using temporary and reversible means, while directly avoiding the debris problems of kinetic or high-powered directed energy weapons and certainly preferable to such destructive weapons, could lead other states to choose less advanced, cheaper means to counter U.S. technological superiority. Much as we see in Iraq with relatively low-cost improvised explosive device (IEDs), the rules of warfare will be hard to dictate in space, as they are on the ground.

space cannot be treated the same way the Navy treats the sea or the Air Force treats the sky

Moreover, because space is a global commons and most satellites are used for civil or commercial activities, warfare in space would be certain to debilitate its use for near- and mid-term economic and scientific development. The rise of tensions and the threat of warfare would undercut future cooperation on space exploration, and thus hamper long-term scientific development that would benefit future generations.

For all of these reasons, we hold that a space war fighting strategy based on dedicated ASATs and space-based weapons would undercut, rather than enhance, U.S. national security and global security in space. Present U.S. policy and strategy should instead be focused on establishing good practices and the rule of law in space in order to foster a stable basis for interaction among space actors.

Unfortunately, as fears about the security of space assets grow, several states – led by the United States but also including China, India, and Israel

– are debating the need to both protect their space assets and prepare for space war by building capabilities to disrupt or destroy the space assets of potential enemies. This insecurity is in itself dangerous because it threatens to lead to a vicious circle whereby one nation reacts to "defend" against a perceived threat, leading a second nation to feel threatened by the first's defensive actions and take its own "defensive" actions that further escalate the tensions – or even create tensions that were not present in the first place.

At the same time, we cannot ignore that U.S. space assets – including its important military assets – are vulnerable, and may be subject to future threats. This is a serious issue and one that requires a coherent effort to address. A strategy to protect global space access and keep space free from warfare does not, and should not, require the United States to accept victimization and be left defenseless. There are common sense steps that leadership in the United States can take to ensure the safety and security of its space assets. Furthermore, there are steps that the United States can take in concert with its political and economic partners to increase all states confidence in secure and peaceful access to space.

debris as small as one centimeter in diameter can cause catastrophic damage to a satellite

Improve Space Surveillance and Tracking

One of the immediate, and most important, ways that space security can be improved would be through an improved, better-structured system for space surveillance and tracking. "Seeing" what is going on in space is critical for detecting and monitoring space debris, as well as for following satellites and spacecraft in order to predict and avoid potential collisions. It is also important for diagnosing satellite failures, and for detecting and monitoring potential deliberate threats against space assets. Effective space surveillance would also be the underpinning for the development of an international space traffic management regime (discussed below). Finally, space surveillance and tracking provides an essential element in any effort to build confidence and dampen threat perceptions by increasing transparency among actors.

Unfortunately, surveillance and tracking capabilities currently are not sufficient. There are technical limitations that require concerted efforts to overcome. Finding and reliably tracking space objects, especially debris, remains a major challenge, requiring a network of radar and optical sensors and complex computer modeling capabilities to project orbital trajectories. Neither of the world's two major space surveillance networks, the U.S. Space Surveillance Network (SSN) and the Russian Space Surveillance System (SSS) can reliably track debris smaller than ten centimeters in diameter (the size of a baseball) in LEO, even though debris as small as one centimeter in diameter can cause catastrophic damage to a satellite. Further, neither system can reliably detect or track objects smaller than about one meter in diameter in the critical GEO where most of the world's communications satellites are stationed. Neither the SSN nor the SSS is able to track space objects in real time, as this would require much larger numbers of sensors. Finally, as an artifact of the Cold War, neither the U.S. nor Russian network provides good coverage of near-Earth space in the Southern Hemisphere since each network was optimized to focus on the other side's space systems.[15]

Process issues for sharing space launch and space surveillance data also are becoming a question as more space actors emerge. Only the United States routinely shares space surveillance data with other space actors, and that process has become more complicated due to increased concern in the United States about the security of

[15] Hitchens, "Future Security in Space," p. 31.

its own space assets. While the international space industry has informal protocols for communications about the launch, subsequent whereabouts and health of commercial satellites, there is not a routine, codified process for data and information sharing in existence. Current international instruments for registering satellite launch and radio frequency/orbital slot allocations – maintained by the United Nations (UN) and the International Telecommunications Union (ITU) respectively – are poorly complied with and inadequate.

Further, the fact that the U.S. Air Force's SSN has a de facto monopoly on surveillance and tracking data unfortunately is perceived by a number of space actors outside the United States as a potential problem. There are emerging fears, including among U.S. allies and friends, that a U.S. decision to refuse to provide data could impinge on other state's ability to access space; or that data provided by the U.S. may not be reliable, as was the case with U.S. intelligence provided to the international community in the run up to the American invasion of Iraq. While we are not making a value judgment on the validity of such fears, the fact that such perceptions exist is, in and of itself, a worrisome development with regard to the growing level of tension among space actors.

Thus, as critical first steps towards both protecting U.S. space assets and for ensuring future access to space for all, the United States should take a leadership role in addressing space surveillance needs. This should include technical research and development to improve the capabilities of the SSN, particularly with regard to detecting and tracking smaller sized space debris and gaining more clarity about the environment in GEO. Fortunately, the U.S. Air Force has made space surveillance – and what the service dubs "space situational awareness," a term that includes satellite monitoring and diagnostics – a high priority. For example, the service is working to improve its network of ground-based telescopes to enhance images digitally and make it easier to combine the images obtained with other sources to create more detailed pictures.[16] Unfortunately, several other key programs are in trouble. The Space Based Space Surveillance (SBSS) system – expected to comprise four or five satellites carrying optical sensors for tracking objects in LEO and designed to augment the ground-based network which cannot see through cloud cover – is behind schedule and the single space surveillance satellite it is supposed to replace is likely to reach the end of its life before the first satellite of the new system can be launched.[17] Another satellite effort, called the Orbital Deep Space Imager and designed to detect and track objects in GEO, was canceled by the Air Force in early 2006.[18] The Air Force should redouble efforts – and the Congress should support those efforts – to speed SBSS and retarget funding to the Orbital Deep Space Imager as soon as possible, among other efforts to robustly fund required updates to the SSN.

With regard to data sharing, the U.S. Department of Defense (DOD) should move more rapidly to set clear processes and guidelines for its new Space-Track program for disseminating orbital data to other states, commercial users and researchers. Interim guidelines have been put forward, but it remains unclear how the system may work in future. In addition, DOD should reverse its policies aimed at applying restrictions on how approved users publish and redistribute the data and analyses based on the data. Currently, researchers must have written permission from the Office of the Secretary of Defense to pass on or publish data gathered through Space-Track, including basic data such as the number of debris in the current SSN catalog. The basic orbital elements of any space object –

[16] John A. Tirpak, "Securing the Space Arena," *Air Force Magazine Online*, Vol. 87, No. 7, July 2004.

[17] Jeremy Singer, "Air Force Plans SBSS Studies," *Space News*, 27 February 2006.

[18] Ibid.

that in the past were published by NASA free to anyone who wanted to view them – are of next to no use to those who might wish to target satellites; further a determined attacker could find ways to do so without access to that data.[19]

U.S. government and DOD officials should also be encouraging other states to build capacity, particularly in the area of sensors and collision avoidance models. Although there is naturally some concern on the part of the intelligence and military space community about improved capabilities on the part of non-U.S. actors leading to potential threats to U.S. satellites, there also could be some value to additional, complementary space surveillance assets. For one thing, non-U.S. data could be used to verify findings by the SSN – something that in a crisis situation could be very helpful politically. Several European countries currently operate radar and telescope facilities that are used, on an occasional basis, to detect and track debris. Indeed, the European Union and the European Space Agency are contemplating a program to link current European assets into a unified network that could function independently of the U.S. SSN. The United States should work with its European allies to encourage such a program, but at the same time urge the Europeans to craft a network that would fill current gaps in the SSN and that would function at least partially in tandem with it. This would require that the U.S. space surveillance community move away from its cultural proclivity toward excess secrecy; and that the Europeans suppress any knee-jerk anti-American reaction to the idea of complementarities. But there is no reason that space surveillance data provided by overlapping, but separate networks, could not be produced in a fashion that would protect necessary secrecy regarding national capabilities but at the same time allow wide sharing of basic, critical data.[20]

the United States should resurrect its moribund process for pre-launch and post-launch notification

Finally, the U.S. government should work with the commercial satellite industry – and the international community – to establish clear processes for industry-to-industry communications, and to build and support a more robust system for registering satellite operations data. For example, immediate efforts should be undertaken to improve (and improve compliance with) the UN Satellite Registry, including requiring registrants to report when an object has moved from its initial insertion orbit, becomes dysfunctional or its orbit begins to decay. In addition, the United States should resurrect, on a multinational basis starting with those states capable of space launch, its moribund bilateral effort with Russia to develop a process for pre-launch and post-launch notification. The U.S.-Russia agreements were primarily aimed at providing transparency about ballistic missile launch, but were quite detailed and the data exchange proposed would be inherently applicable to space launch and the prevention of interference or collision.[21]

[19] Theresa Hitchens "Safeguarding Space: Building Cooperative Norms to Dampen Negative Trends," *Disarmament Diplomacy*, No. 81, Winter 2005, p. 59.

[20] Theresa Hitchens, "The Next Galileo Flap? EU Space Surveillance Move Provides Opportunities, Challenges, for U.S.," *Space News*, 16 May 2005.

[21] For more information regarding the June 2000 U.S.-Russian Joint Data Exchange Center and the subsequent December 2000 U.S.-Russian Pre- and Post-Launch Notification Agreement, see: Lt. Col. Peter L. Hays, USAF, United States Military Space: Into the Twenty-First Century, INSS Occasional Paper 42, USAF Academy, Colo.: Institute for National Security Studies, September 2002, p. 96,; and U.S. Department of State Fact Sheet, "Memorandum of Understanding on Notification of Missile Launches," 16 December 2000.

Redundancy and Protection

Multiple reports have pointed to the vulnerabilities that stem from the United States' increased dependency on space assets for military operations, homeland security, and economic prosperity. These include the 2001 "Report of the Commission to Assess United States National Security Space Management and Organization," chaired by Donald Rumsfeld prior to his appointment as U.S. defense secretary, and known as the Space Commission Report. The report famously warned of the potential of a "Pearl Harbor" in space, and stated: "[The] present extent of U.S. dependence on space, the rapid pace at which this dependence is increasing and the vulnerabilities it creates all demand that U.S. national security space interests be recognized as a top national security priority."[22] It is true that U.S. satellite systems have both inherent, and unfortunately sometimes engineered, vulnerabilities – both with regard to the basic space environment and to potential deliberate attacks. The prescription for resolving this situation is the development and implementation of a coherent strategy for both protection of space systems – including their terrestrial nodes – as well as for providing redundant capabilities both in space and terrestrially.

On this front, there already has been slow progress. In recent years, DOD officials have been particularly worried about the vulnerabilities of commercial satellites, given that the military is heavily reliant on commercial providers for its own communications needs – especially in wartime, when some 65-80 percent of military communications is carried over commercial bandwidth.[23] A February 2004 report by a special Satellite Task Force of the President's National Security Telecommunications Advisory Committee (NSTAC) highlighted commercial satellite vulnerabilities, including the lack of encrypted uplinks and downlinks.[24] DOD subsequently launched a sustained effort to work with the CEOs of major commercial providers to come up with criteria and commercial best practices to address security concerns and establish reporting processes for problems.[25] This effort should continue to receive priority U.S. government attention, and be expanded to include working with U.S. allies and friends. Not only are many commercial satellite providers multinational companies, but also allied satellite capabilities are crucial to joint operations in times of crisis and war. In addition, in Europe there is an increasing awareness of the importance of satellite services to security and to European militaries – an awareness that should help provide a foundation for any U.S.-led efforts to build processes that would underpin mutual security interests.

The use of redundant systems and subsystems, terrestrial back-up links, unmanned aerial vehicles (UAV), high altitude airships, and on-orbit spares can help to alleviate single point failures and also provide needed emergency assets. Again, the U.S. Air Force in particular has recognized the potential value of non-space systems for providing space-like capabilities and is actively pursuing UAVs and high-altitude solutions.[26] Initiatives such as the Operationally Responsive Space (ORS) program,[27] designed to

[22]Report to Assess United States National Security Space Management and Organization, 11 January 2001, (hereafter, Space Commission Report), p. ix.

[23]Richard H. Buenneke, "Commercial Satellite Communications: Supporting Defense Transformation."
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[24]The President's National Security Telecommunications Advisory Committee, Satellite Task Force Report, Fact Sheet, February 2004; author conversations with several government and industry officials involved.

[25]Buenneke, p. 9

[26]Jeffrey Lewis, "It's a Bird, It's a Plance, It's a....Stratelite?" *Defensetech.org*, 18 December 2004; "Lockheed Wins $149.2M Contract for High Altitude Airship (updated)," *Defense Industry Daily*, 16 January 2006,.

[27]For an overview of the concept of ORS and some of the difficulties that planners and engineers are encountering

ensure rapid access to space and reconstitution of lost satellites, and the advent of microsatellites that can be networked to provide the same functionality as one large satellite, also could be used to help to alleviate these failure points – as well as provide a revolutionary improvement in satellite costs and capabilities. However, it should be stated that both ORS systems and microsatellites could also be weaponized, and the perception that such technologies are being developed for offensive or destructive purposes must be balanced by responsible rules for their use (see below). That said, more priority – and funding – should be placed on finding ways to prevent satellite capabilities from becoming single point failures for the U.S. military and national security community.

both Operationally Responsive Space systems and microsatellites could be weaponized

Civilian Cooperation

Many of the tensions during the Cold War were dampened to some degree by civilian space cooperation between the Soviet Union and the United States. The transparency gained by both sides and the subtle shifting in perceptions that came in the wake of Apollo-Soyuz also cannot be discounted. But joint missions such as Apollo-Soyuz provided not just the political appearance of cooperation; they also laid the groundwork for substantive Russian-U.S. cooperation in space today. Without cooperation during the Cold War, and smart engagement with Moscow immediately after the fall of the Soviet Union, the United States would most likely lack access to the International Space Station in light of the current state of the Space Shuttle fleet.

Today, while there is no "cold warrior" competitor to the United States, civilian cooperation with states such has China would give each nation an opportunity to gauge each other's plans in space. Many in the U.S. government understand the benefits of cooperation, including from a strategic and intelligence context. Recent discussions of cooperation with China on space endeavors, including the visit to China by NASA administrator Michael Griffin, are positive steps in building economic and strategic confidence between the two states at a time when the two militaries seem to be on a collision course with regard to space.

However, there are still major barriers to international cooperation – not only with China – that one day may lead to conflict. Current export regulations, such as the International Traffic in Arms Regulation (ITAR), while designed to ensure that select technologies do not reach the hands of those wishing to attack U.S. targets, also has the unintended consequence of limiting the amount of beneficial cooperation that can occur between states in the space arena. ITAR not only restricts cooperation between the United States and China, but between the United States and its allies as well as U.S. companies and any foreign entity. These export restrictions do not just limit the amount of business that can be done between states; they have also been identified as contributing causes to the failure of missions. For example, following the recent failed NASA DART (Demonstration of Autonomous Rendezvous Technology) mission designed to test automatic maneuvering in space, the mishap investigation board pointed to ITAR regulations that created "perceived restrictions" in what NASA engineers could discuss with the foreign designers of a main component that was found to be a root cause of the malfunction.[28]

International cooperation between non-U.S. companies is still proceeding but at a glacial pace. The United States would be wise to re-evaluate if

see Jeremy Singer, "Responsive Space," *Air Force Magazine*, Vol. 89, No. 3, March 2006,.

[28] NASA, "Overview of the DART Mishap Investigation Results," 15 May 2006, The full report itself was not released due to ITAR concerns.

ITAR regulations governing space activities, particularly commercial and civil activities, are still in the best interest of U.S. companies and international security, especially if those regulations prevent cooperation that can lead to valuable confidence building measures. The measures in train to find ways to cooperate with China, while protecting genuine national security concerns, also must be continued, prioritized, and supported by Congress and across the U.S. space community.

Code of Conduct

The 2001 Space Commission Report also contained an important, but oft-overlooked recommendation:

> The U.S. will require…engaging U.S. allies and friends, and the international community, in a sustained effort to fashion appropriate "rules of the road" for space.[29]

Rules of the road, or codes of conduct, are not new to the military sphere. They are tried and tested ways to shape behaviors and avoid dangerous misunderstandings and conflicts. Perhaps the most successful and famous set of rules of the road is the 1972 Incidents at Sea Agreement (IncSea), signed between U.S. Secretary of the Navy John Warner and his Soviet counterpart. Thirty other navies signed subsequent agreements.[30] Today, the administration of President George W. Bush and the U.S. Armed Forces champion a number of executive-level codes of conduct designed to fight proliferation of dangerous materials necessary for the construction of weapons of mass destruction (e.g. – the Proliferation Security Initiative and the International Atomic Energy Agency Code of Conduct on the Safety and Security of Radioactive Sources).

A code of conduct for space would not have to be negotiated in a multinational forum like a treaty, nor would it need to be subject to ratification in the U.S. Senate. A sustained effort on the part of the United States would only require finding another state, or states, willing to agree upon appropriate rules. It could even be argued that if the United States unilaterally declared that it would follow certain rules in space, other states would join, based on U.S. space leadership. However, due to the current political context, an international effort, even if limited to a select number of countries, would be preferable to a unilateral declaration.

Key elements of a code of conduct for responsible spacefaring states would include debris mitigation, traffic management, and the preannouncement of dangerous maneuvers such as close passes or docking.

Debris Mitigation

The United States has been a leader in the arena of space debris mitigation, fully supporting and promoting international efforts to develop a voluntary set of guidelines for space operators. In 2002, the Inter-Agency Space Debris Coordinating Committee (IADC), comprising the space agencies of China, France, Germany, India, Italy, Japan, Russia, Ukraine, the United Kingdom and the United States, plus the European Space Agency (ESA), issued a set of technical guidelines for debris mitigation. Those proposed guidelines were submitted to the UN Committee on the Peaceful Uses of Outer Space (COPUOS) for consideration by member states. After several years of political jockeying, a less technically specific version of the IADC guidelines were crafted by a working group in June 2005 and accepted by COPUOS's Scientific and Technical Subcommittee at the organization's March 2006 meeting.[31] The voluntary guidelines,

[29] Space Commission Report, p. 18.
[30] Michael Krepon, "Ground Rules for Space," *Bulletin of the Atomic Scientists*, May/June 2005, p. 68.
[31] United Nations Press Release, "Outer Space Scientific and Technical Committee Concludes 43rd Session in Vienna," UNIS/OS/329, March 8, 2006; author

which include a provision pledging signatories to avoid the intentional destruction of space objects that would create long-lived debris,[32] are now being reviewed by individual national governments and are expected to be finally approved in 2007.[33] Not only should the United States accept these guidelines, but it should also continue to push for more progress in the international arena. One effort that the United States could lead would be military-to-military discussions among spacefaring states aimed at pledging to uphold strictly the mitigation guidelines including during weapons tests. In addition, the United States should work with other spacefaring states to establish, based on the voluntary guidelines, legal structures that could reinforce compliance with best debris practices at the international level – so as to create a level playing field for industry and at the same time avoid backsliding, particularly by those states seeking entry to the international market by offering cheap launch and satellite services to the detriment of voluntary rules which are perceived to increase near-term costs. For example, a working group at COPUOS's legal subcommittee should be stood up to explore how the Liability Convention could be used, or amended, to enforce strictures against debris creation. In the meantime, debris mitigation guidelines would be easily absorbed into a space code of conduct.

Traffic Management

Space traffic management is also an arena where there is slow progress toward creating rules-based processes that could help avoid interference, collision, and conflict in space. Since 2001, U.S. and international industry and scientific organizations have been examining the issues involved with coordinating space launch and on-orbit operations – many of which overlap with the discussions regarding debris mitigation. One of the first major reports on the subject was issued in 2001, following a series of workshops held by the American Institute of Aeronautics and Astronautics, called "Addressing the Challenges of the New Millennium." That report highlighted the fact that current international laws and regulatory structures fall short in providing "clear legal guidance," and that there exist no rules that "prohibit new satellites being launched into orbits that could later threaten existing satellites" or rules regarding maneuvering of spacecraft.[34]

the United States could lead military-to-military discussions to uphold strict debris mitigation during weapons tests

The most recent, and comprehensive, report was issued by the International Academy of Astronautics in September 2005. The "IAA Cosmic Study[35] on Space Traffic Management" lays out the many space traffic challenges, overviews the current legal and regulatory framework, and puts forward a framework of required elements for addressing space traffic in the launch phase, the on-orbit operations phase, and the re-entry phase for debris.[36] Some major elements of the IAA framework include clarifying liability for damages in outer space, the

conversations, 30 March 2006, with a government official who attended the meeting.

[32]Committee on the Peaceful Uses of Outer Space, "Intercessional Meeting of the Working Group on Space Debris of the Scientific and Technical Subcommittee: Progress Report of the Chairman of the Working Group on the Results of the Intercessional Meeting," A/AC.105/2005/CRP.18, 16 June 2005.

[33]Author conversations with a government official who attended the meetings, 30 March 2006.

[34]American Institute of Aeronautics and Astronautics, "International Space Cooperation: Addressing Challenges of the New Millennium," 6th International Space Cooperation Workshop Report," International Activities Committee, March 2001, p. 9.

[35]The term "cosmic" study means that the report has been approved by the IAA Board at its highest level.

[36]Kai-Uwe Schrogl and Petr Lala, coordinators, " IAA Cosmic Study Space Traffic Management," International Academy of Astronautics, 18 September 2005, Executive Summary, pp. 1-11.

establishment of "right of way rules" for objects on orbit, establishing prioritization rights for maneuvering, notification pre-launch, upon maneuvering and when de-orbiting (as noted above) and a number of debris mitigation mechanisms mentioned previously in this article.[37] The study concludes that by 2020 "an inter-governmental agreement could be drafted, building on but not replacing the principles incorporated in the existing space treaties. . . . This international inter-governmental agreement would comprise a legal text, which cannot be changed easily, and technical annexes, which can be adapted more easily, (modeled on the texts of the ITU….)"[38]

The United States could, and should – as it has done in the debris mitigation issue – take a leadership role in building off the IAA work toward a coherent legal framework governing space traffic management. This would benefit the U.S. commercial satellite industry by establishing a level playing field for space operations and would benefit U.S. civil and military space programs by establishing a process for avoiding conflicts and improving transparency regarding other space actors. A key priority for ensuring space security in the future will be just that: establishing norms of behavior and rules of law that can govern the activities of space actors in peacetime, including conflict resolution mechanisms, sanctions, and appropriate military responses for those who would seek to threaten the safety of other space actors.

Dangerous Maneuvers

The IAA report also recommends a concept called "zoning" and in tandem the importance to notify other satellite operators of planned maneuvers. Zoning would be the space based analog of a common naval and ground-based military interaction, namely "special caution areas." For example, the 1989 Prevention of Dangerous Military Activities Agreement between the United States and the Soviet Union calls on land forces to initiate and remain in constant contact if they are within predefined areas. While zoning in space would have to have a different physical implementation than special caution areas on the ground, the concept would increase security by reducing tensions and perceived threats. Essential to a monitored and verifiable zoning implementation would be improved space surveillance capabilities (as described in the previous sections).

As confirmed by DART, even planned civilian maneuvers in space can result in collisions. It is therefore important that responsible spacefaring states agree to pre-notify each other before any dangerous maneuvers – such maneuvers would have to be defined by the states agreeing to the rule, but may include docking, repair, or close proximity autonomous operations.

Codes of conduct exist for almost every sphere of military operations and international cooperation – except space. Space also deserves such rules of the road. While no rule can prevent bad actors from breaking them, an agreed upon code of conduct will encourage good behavior, increase confidence in international relations, reduce tensions, and provide the legal and international support required to identify and respond to rule breakers.

Responsible Hedging

It is also in the best interest of the United States to maintain responsible hedges against an actor who would choose to break the code of conduct or shatter the long-standing informal space weapons moratorium. These hedges would serve as both a deterrent and retaliatory function, allowing the United States to quickly respond to unwise actions of a state or a non-state actor.

[37]Ibid.
[38]Ibid., p. 10.

The United States already has overwhelming conventional capability that can serve as a hedge against states. Since attacks on satellites can be viewed as attacks on a state itself, under principles of self-defense, the United States would theoretically have the right to attack terrestrial targets of any nation or actor responsible. This can readily be achieved with the current arsenal of strike weapons. In addition, if the leadership in the United States decided that it must respond "in kind" to an attack on its satellites, and that such action outweighs the consequences of using such a weapon, it could adapt a number of current elements of its arsenal for the mission – including missile defense interceptors, maneuverable microsatellites, and, in particular, jamming equipment that interferes with a satellite's uplinks and/or downlinks. The latter option is one that is perhaps most useful in the real world, given the dual-use, multinational nature of the satellite population, because it would allow reinstatement of the satellite's functions once hostilities were over.

The last element of a hedging strategy is responsible research and development of space negation capabilities, which stops short of testing and deployment. Unlike the Cold War when testing of nuclear weapons was required to demonstrate deterrence, the fact that satellites can be targeted and destroy is indisputable. While testing may increase confidence in a certain weapon system, this is outweighed by the negative political and perhaps debris-generating consequences of such tests, thereby reducing confidence in the availability and reliability of U.S. satellites themselves – and the weapon systems which they support. Research on basic technologies (many of which have dual-use potentialities in any case) makes sense; taking weapons out of the lab and testing them does not.

Some would argue that a President needs as many options available as possible during a crisis situation, and therefore the United States must test and deploy space weapons now to be available when needed. However, the usefulness of ASATs and space-based weapons in a crisis situation is unclear at best; taking out a satellite would certainly not ratchet down tensions, and in fact could lead to immediate retaliation on U.S. space assets. U.S. security is best served by an international security environment that is free of space weapons, so it makes little sense for the United States to be the first to undermine the current status quo. Further, it is a fact of life, and a fact of international security, that sometimes refusing to close one's options results in less, not more, stability in relations with others. A hedging strategy is prudent only as long as it is constructed so as to avoid prompting others to fear that it is a cover for a clandestine, more aggressive strategy.

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Exploration Rules

The Vision for Space Exploration outlined by President Bush in 2004 calls for a large expansion in human exploratory missions. It also seeks international cooperation and commercial partnerships to help reach this goal. In parallel to the planned technological research and development that must be undertaken to realize this vision and efforts to seek partnerships to make it a reality, it would also be wise to begin discussions on what rules and codes should govern such exploration in future. Such confidence-building measures would not only be needed to guarantee that states, individuals, and the private sector have the correct distribution of rights, responsibilities, and opportunities in space but that any increased exploration and scientific and commercial exploitation does not open new avenues of conflict. Discussions about other modes of confidence building regarding exploration would be perfectly legitimate for the United States to press with other states seeking partnership roles in NASA's program.

Negotiate a Weapons Ban

Once the above steps are undertaken, and to some extent completed, states could then come together and negotiate banning the deployment of some or all ASATs and space weapons. This would not be the goal of the above steps, but instead, such a treaty-based arms ban would complement and re-enforce already agreed upon rules and practices – such as the moratorium on testing and deployment and the linking of debris to the Liability Convention. Further, such negotiations could happen on a step-by-step basis. For example, since space debris is a clear and present danger to all space actors, it seems obvious that it would be in everyone's self interest to craft a treaty designed to prevent the testing, deployment, and use of debris-creating weaponry. Such an agreement could also provide a basis for any further discussions about arms control in space. Important, and not to be dismissed, issues that would require serious and difficult negotiations include the feasibility of a sweeping ban on conventional space weapons and the verification of compliance. It should also be noted that states will only sign treaties if it is in their best interest and if doing so will result in a net security gain. It is to be hoped that an increase in shared exploration, monitoring, perceived mutual interests, and security and stability in space will lead states to the conclusion that breaking the space weapons taboo would be a step backward. Thus, our approach to the issue of weapons bans is to see that possibility only as a follow-on to establishing the necessary foundation of peaceful norms, behaviors and practices, rather than a first step toward achieving space security.

America's Leadership Role

This article sets out elements of a possible framework for ensuring long-term security in space in a manner that would support and even improve U.S. national security and global space security. The central core of our concept is the belief that it is critical to protect reliable access to and use of space for commercial, civil, and military actors around the world, and make way for new actors as well, so that humankind can continue to benefit from the life-saving services provided and the knowledge gained by space assets. This framework relies on the establishment of norms of behavior, best practices, and rules of law. It is arguably the case that the technology revolution of the past two decades as applied to the use of space has outstripped the normative and legal instruments set up primarily during the 1960s. Space is too important to allow a kind of Wild West situation to evolve (or perhaps devolve) among space actors. Unfortunately, the present rhetoric in the United States that emphasizes a strategy of space dominance and control – and ultimately war fighting "in, from, and through space" – is fueling tensions rather than dampening them. We believe that the United States instead should be a leader, as it traditionally has been here on Earth, in developing and applying behavioral norms and the rule of law in space. And the time for embracing such a leadership role is now, before the negative trends toward competition and conflict in space accelerate and the situation becomes much more complicated and difficult to address. It is our hope that a broadening and deepening of the current debate about space weaponization among policy makers, military leaders, lawmakers, and the public will establish a better understanding of the requirements for space security, and the criticality of ensuring a stable and peaceful space environment for all actors. No one can own space, and neither can any one be safe in space without ensuring the safety of all.