THE SPACE SECURITY INDEX: CHANGING TRENDS IN SPACE SECURITY AND THE OUTER SPACE TREATY

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The Outer Space Treaty and space security

The 1967 Outer Space Treaty (OST) provides the basic legal framework for the governance of outer space. Drafted at a time when military competition threatened the preservation of outer space for peaceful purposes, it is commonly described as a "non-armament" treaty. That term is inaccurate for two reasons. First, the OST does not ban all weapons in outer space, just weapons of mass destruction. Second, the scope of the OST is more comprehensive; besides weapons, it addresses the broader *security* of outer space.

The Space Security Index (SSI) was one of the first research and policy tools to use and promote the term "space security". Based on the principles enshrined in the OST, which recognizes "the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes" and the belief that "the exploration and use of outer space should be carried on for the benefit of all peoples", the SSI defines space security as the secure and sustainable access to and use of outer space, and freedom from space-based threats. This concept is increasingly used by the space community, including a wide array of civil, military and commercial actors, because it creates a framework in which competing interests in outer space can be brought together.

Consequently, the SSI reflects a shift in how the goals of the OST are conceptualized, away from a narrow focus on weapons to a broader concern for the security of outer space as an environment that is accessible to all states for peaceful purposes. The SSI is more than a concept, though; it is also a process that convenes researchers and internationally respected space experts to develop an annual, comprehensive assessment of the status of space security according to eight indicators.[2] This process tracks the impact of the use of outer space, the regulation of those activities and the

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overall impact over time on the security of outer space as an environment. The SSI provides both a concept and a method for the space community to reflect on how the broad goals set out in the OST are being achieved.

Changing trends in space security

The annual assessment contained in the SSI captures changing trends in space security. An analysis of these changing trends indicates that the goals of the OST have become more important at the same time that the secure and sustainable access to, and use of, space and freedom from space-based threats are increasingly threatened. The duty to preserve outer space for peaceful use by all has become more important as access and use have grown. Each year, at least one state accesses outer space for the first time. Today, 47 states own satellites, compared to only seven in 1967. This growth in space access is also qualitative. While outer space continues to be heavily used for national security purposes, particularly by Russia and the United States, more countries are investing in space capabilities for an increasing number of reasons, including economic and social development. The Indian Space Research Organization has developed a number of communications satellites that provide tele-education and tele-health applications, as well as remote-sensing satellites that enhance agriculture, land, and water resource management, and monitor disasters. Other states, including Algeria, Egypt, Nigeria and South Africa, are also building satellites to support national development efforts. Around the world, Earth observation satellites are used for such essential services as monitoring natural resources, disasters and climate change, as well as assisting with search and rescue. In 2006, the Cospas–Sarsat International Satellite System for Search and Rescue Satellites, which operates with the cooperation of 39 countries, assisted in the rescue of 1,666 people.

Likewise, the commercial space industry is making outer space significant to the daily lives of people around the world through the dramatic growth of satellite services such as telecommunications, direct broadcasting, Earth imaging and global positioning. These services have jumped to 60% of satellite industry revenues, up from 45% just five years ago. The industry itself is also growing—in 2005, commercial satellite industry revenues were estimated at US$ 88.8 billion. Outer space has become a way of life in the twenty-first century.

However, the growth of space actors and stakeholders, of space use and dependence, and the rapid technological advancements that have given rise to this growth are paradoxical. On the one hand, they indicate the success of efforts to maintain outer space as a secure and accessible environment. On the other hand, they bring with them new challenges that have yet to be addressed in the international governance framework for outer space, making it a more precarious operating environment. It has become more difficult to achieve the goals of the OST.

Five shifting or emerging trends demonstrate this challenge and indicate a need to revisit the international policy framework for outer space: 1) the growing threat of space debris; 2) strategic rivalry in civil space projects; 3) emerging regional tensions in military space applications; 4) long-term, strategic military–commercial partnerships; and 5) a weakening distinction between the technology and the concepts of space protection and space negation.

A more dangerous space environment

Travelling at speeds of 7.5km/s, space debris poses a serious danger to the sustainability of outer space activities. In the early 1990s the annual rate of space debris production began to decline significantly, due in part to international awareness and mitigation efforts. Yet, in the first six weeks of 2007, the population of large space debris (>10cm) increased by over 20% due to the Chinese anti-satellite (ASAT) test on 11 January 2007 and the explosion of a Russian Proton rocket body on 19 February 2007. By April 2007, 1,497 large pieces of debris from the Chinese ASAT test had been catalogued by the US Space Surveillance Network (SSN)[3] and over 1,000 additional large pieces were created by the Russian rocket explosion.[4] These are two of the worst man-made space-debris-creating events on record.[5]

The severity of these events reinforces what is becoming a long-term trend: the annual rate of space debris production has been steadily rising since 2004. In 2006, 517 new pieces of large space debris, caused by a combination of space launches, satellite fragmentation and debris collision, were catalogued by the SSN. This is twice the average annual amount of debris produced during the Cold War. Moreover, a recent study by the US National Aeronautics and Space Administration (NASA) reveals that the rate of space debris creation will begin to increase rapidly in the next 50 years due to natural processes in the space environment that cause existing debris to collide and multiply. Although the Scientific and Technical Sub-Committee of the UN Committee for the Peaceful Uses of Outer Space (COPUOS) adopted landmark debris mitigation guidelines on 21 February 2007, the creation of space debris will outpace mitigation efforts and protective space surveillance capabilities in the future. More debris makes it more dangerous to operate in the space environment; too much debris could make certain orbits unusable in the future.

Strategic competition in civil space programmes

Trends are also changing in the nature of civil space programmes as more states seek to gain the benefits of outer space. Civil space activities are an arena that fosters great international cooperation and scientific advancement. In recent years, however, several civil space programmes have experienced changing funding and policy priorities that indicate growing strategic competition. In particular, there has been a shift back to the large-scale projects that dominated the Cold War, with a particular emphasis on human space flight and lunar exploration. In 2005 China became the third country to launch a human into outer space, and India has since announced plans for a human spaceflight programme. Moreover, in 2006 a succession of policy announcements signalled a new space race to the Moon. China, India, Japan, Russia, the United States and the European Space Agency have announced plans for lunar exploration and, in the cases of China and the United States, the building of lunar bases. These declarations indicate that the Moon is once again becoming a source of rivalry. Such rivalry can bring tremendous technological breakthroughs, but the military tensions that drove the past space race, or that might drive the emerging one, cannot be ignored. Although the OST precludes the application of national sovereignty to celestial bodies or the establishment of military bases on the Moon, access to such key resources provides clear strategic advantages in outer space.

While international cooperation remains a hallmark of civil space programmes and facilitates the proliferation of technical capabilities for states to access outer space, it is coloured by geostrategic competition, particularly among major space powers. Cooperation and competition in civil space programmes largely follow patterns of terrestrial endeavours. The United States is seeking to relax trade restrictions on sensitive space technologies for India, while China is working with key allies such as Pakistan, Nigeria and Venezuela. It is possible that, as in the past, competition in outer space will exacerbate political and military tensions on Earth.

Regional tensions driving the use of space for terrestrial military operations

Outer space has become a way of war as much as it has become a way of life. During the Cold War, the military rivalry between the Soviet Union and the United States, which threatened the security of outer space, provided much of the motivation behind the OST. Today it is possible to see similar tensions between China and the United States, although their capabilities in outer space differ greatly. However, the present differs from the past in that military uses of outer space are no longer restricted to the superpowers. More and more, regional rivalries are being expressed with dedicated military or dual-use space systems. In Asia, Taiwan is suspected of providing its military with images of China from its Formosa II research satellite. In the wake of recent missile launches by North Korea, Japan, which already has four remote-sensing satellites for national security reconnaissance purposes, is considering legislation to permit direct military use of satellites, which would allow it to develop higher-grade military capabilities. Pakistan aims to develop remote-sensing capabilities to support its military, and India is moving forward with plans for a unified military space command. Similar expressions of regional tensions are becoming evident in the Middle East. While Iran's space programme is still meagre, it is significant that its first and only satellite is designed for remote sensing and officials claim that it is capable of spying on Israel, despite its limited resolution. Israel in turn has several state-owned remote-sensing satellites and its air force has recently been given authority over all national security space activities.

In practice, international law has long accepted these military uses of outer space as peaceful, and they do not in themselves challenge space security. Yet, to the extent that they are driven by military tensions on Earth and that outer space is viewed as an extension of the battlefield, there is the risk that actors will target military space assets. Moreover, if capabilities in outer space are not evenly developed then targeting these space assets might become a strategy of asymmetric threat response or deterrence. China's ASAT test on 11 January 2007 could be seen from this perspective. China is by no means the only state to have ASAT capabilities. The Soviet Union and the United States tested kinetic hit-to-kill ASAT systems during the Cold War and the United States has an ongoing kinetic-energy interceptor programme. With the spread of missile technologies, more states, including Iran, North Korea and Pakistan, are developing prerequisite ASAT capabilities to launch a payload into space. In addition, most states have the ability to employ basic electronic jamming or low-power laser dazzling against unhardened satellite sensors. With the growth of regional military tensions between space-capable states, there is a greater potential for these capabilities to be used, threatening the free and unhindered access to and use of space.

Long-term military–commercial partnerships

The way in which outer space is used for military purposes is shifting to the private sector. Militaries are relying more and more on commercial capacity to supplement their capabilities, particularly to meet communications and imaging needs. The US Department of Defense (DoD) estimates that over 80% of the satellite bandwidth needs for Operation Iraqi Freedom is provided through commercial services. In 2006, the DoD also spent US$ 70 million to procure commercial high-resolution satellite imaging. However, increasingly militaries are developing long-term, strategic partnerships with the private sector in space activities. The DoD is revamping its procurement processes to provide continuing, stable, commercial wideband services. Direct partnerships include the Paradigm Secure Communications' SkyNet 5 military communications satellites (United Kingdom); ImageSat International's Eros B optical remote-sensing satellite (Israel); and MacDonald Dettwiler and Associates' Radarsat radar-imaging satellites (Canada). In each of these cases, the country indicated is the prime recipient of the service, but excess capacity can be sold to other states. This relationship is akin to that with private military contractors.

The long-term implications of this trend are not yet clear, but are potentially worrisome when combined with the growing extension of the battlefield into outer space. Commercial assets risk becoming military targets, and if they serve more than one client, third parties may also be negatively affected. As the line between military and commercial actors in outer space continues to blur, the possible consequences must be considered before there are any "casualties".

The growing challenge of space-based dual-use technologies

It is becoming more difficult to guard against casualties in outer space. All space technology is dual-use; however, the capabilities of dual-use space-based technologies are increasing and can be used directly for a range of space system protection and negation purposes. On the one hand, newer, more adaptable technologies such as small satellites are facilitating more active space system defences. Small satellites can provide key protection capabilities such as on-orbit servicing, greater manoeuvrability in space, in-orbit space surveillance, faster hardware replacement in the event of satellite failure, and clusters of defensive satellite configurations. On the other hand, the same benefits of size and manoeuvrability can also support more active negation activities. Small satellites are easy to hide and difficult to detect. They can be discreetly released into orbit, approach other satellites and cause physical harm.

Projects that are developing close-proximity, rendezvous, and space-based surveillance capabilities for protection purposes include the joint German–Russian–Canadian on-orbit servicing programme Technology Satellite for Demonstration and Verification of Space Systems (TECSAS), the ConeXpress Orbital Life Extension Vehicle (CS-OLEV) being developed by Orbital Recovery and the European Space Agency (ESA), the Orbital Express mission jointly managed by the US Defense Advanced Research Projects Agency (DARPA) and NASA, and the US Air Force's Autonomous Nanosatellite Guardian for Evaluating Local Space (ANGELS). There is no evidence to suggest that these programmes are being developed for space systems negation purposes. Nonetheless, the destructive potential of manoeuvrable small satellite technology were demonstrated when NASA's Demonstration of Autonomous Rendezvous Technologies (DART) spacecraft unexpectedly collided with the target satellite during its 15 April 2005 mission. Dedicated military programmes that are developing similar advanced dual-use technologies include the US Air Force's Experimental Satellite System-11 (XSS-11) and the Microsatellite Demonstration Science and Technology Experiment Program (MiDSTEP) sponsored by DARPA, the US Air Force and the US Navy. These programmes are developing space-based technologies that could support a variety of protection and negation activities. Like the technology behind them, the line between protection and negation activities in outer space is ambiguous; the difference between protection and negation is increasingly not clear, and not shared.

The ambiguity of more active space-based protection and negation technology and activities is a challenge for space security. The difficulty in distinguishing between protection and negation capabilities and intent reduces transparency, can fuel negation/protection spirals and cause fear and mistrust that can trigger confrontation in outer space or pre-emptive responses. However, regulation of new technologies is both impractical and undesirable because such advancements cut across all space applications. This is an area where technology has outpaced diplomacy.

International policy gap

The changing trends in space security are outgrowing the existing international governance framework for outer space. It is no longer accurate to claim that there is progressive development of international space law. Two key developments in international law and policy illustrate what is not taking place. First, the Conference on Disarmament (CD) has been stalled on a programme of work since 1998, preventing formal discussion and negotiation of an agreement to prevent an arms race in space. Second, efforts to extend the mandate of COPUOS to include issues related to the militarization of space have also been waylaid. Diplomacy is failing to keep pace with innovations in who uses outer space, how it is used and for what purposes.

In a shift of strategy, however, the international community is beginning to respond to growing governance challenges in outer space by adopting more flexible and less formal approaches to space security. Recent proposals tabled at the CD have sought to broaden the space security debate from a narrow focus on weapons to include issues such as transparency- and confidence-building measures. States are also expressing more support for a code of conduct for space or voluntary "rules of the road" for space operations. Initial progress in this new approach is evident with the adoption of the voluntary guidelines on space debris mitigation at COPUOS, which will be referred to the UN General Assembly in the fall of 2007. There is potential for COPUOS to apply this same technical approach to space traffic management. The ability of this approach to maintain the security of outer space will depend on its capacity to address some of the more controversial issues challenging space security, particularly those related to military and national security uses of space; this may be a function of political will rather than process.

Moving forward on space security

Outer space now effects almost every person around the globe in ways that were hardly imaginable 50 years ago. The duty to preserve outer space as a global commons for the benefit of all peoples has become more vital at the same time that the task of safeguarding the security of outer space has become more challenging. Moreover, some of the most pressing security issues are not being addressed in traditional forums. Additional steps must be taken to ensure that the security of outer space is sustained.

The role of the SSI is to provide a tool to inform policy. The analysis of changing trends in space security captured by the SSI indicates critical issues that must be addressed by the international community in order to protect the security of outer space. The specific process of the SSI, however, also sheds light on how these issues are best addressed. First, any efforts to preserve and enhance space security must include the relevant actors and stakeholders—governments, militaries, scientists, industry, consumers and civil society. Second, these efforts must not be too narrow—arms control issues cannot ignore concerns for space debris, peaceful exploration, commercial access, and so forth. Third, these efforts must prioritize the security of outer space as an environment, which means the safe and sustainable access to and use of outer space, and freedom from space-based threats. This means taking issues and actors out of discrete contexts such as national security, scientific and technology advancement, revenue, convenience, and so forth, and examining them in the broader context of space security.

Above all, this process must begin with the OST. A famous adage states that "the more things change, the more they stay the same" and this is no less true in outer space. Many of the challenges to space security captured by the SSI are reminiscent of an earlier age in outer space, when it was threatened by competing interests. It is in this context that the OST was negotiated, to maintain security and stability in space. The OST is a guide, however, and not a panacea. The methods used to achieve the goals that it sets out must change to keep pace with the growing number of actors, stakeholders, uses, technologies and concepts that shape the security of outer space.

Notes

1 This article is based on a longer study of space security entitled "Space Security 2007", which will be published in June 2007. The

full report will be available at <www.spacesecurity.org/SSI2007.pdf>. The 2006 report is currently available on the website. The members of the Spacecurity.org research consortium include the Secure World Foundation, the Cypress Fund for Peace and Security, the Institute of Air and Space Law at McGill University, Project Ploughshares, the Simons Centre for Disarmament and Non-Proliferation Research at the University of British Columbia, and the Space Generation Foundation, in cooperation with the International Security Research and Outreach Programme of Foreign Affairs and International Trade Canada and supported by the Ford Foundation.

2 The eight indicators in the Space Security Index are 1) the space environment; 2) space laws, policies, and doctrines; 3) civil space programmes and global utilities; 4) commercial space; 5) space support for terrestrial military operations; 6) space systems protection; 7) space systems negation; and 8) space-based strike weapons.

3 "Chinese ASAT test," *CelesTrack*, 23 July 2007, <www.celestrak.com/events/asat.asp>.

4 Kelly Young, "Rocket explosion creates dangerous space junk", *NewScientist.com*, 22 February 2007, <http://space.newscientist.com/article/dn11239-rocket-explosion-creates-dangerous-space-junk.html>.

5 The last US kinetic ASAT test in 1985 would have created roughly the same amount of debris as the Chinese test, given that both were aimed at weather satellites of approximately the same size (much of the debris from the 1985 test could not be tracked at the time given the limited resolution of the SSN). However, the US test in 1985 took place at an altitude of approximately 550km, thus most of the debris returned to the atmosphere in a relatively short period of time. The high altitude of the Chinese test, combined with the large amount of debris produced however, contribute to the severity of the event. See David Wright in this volume. The Russian rocket explosion created as much if not more debris than the Chinese ASAT test (the final number of catalogued objects from the two tests is not complete at the time of writing). The explosion took place in an elliptical orbit with an altitude range of 500–15,000km, so much of the debris is likely to remain in orbit for a long time.